Power and Ownership Structures among German Companies*
A Network Analysis of Financial Linkages

Jochen Moebert and Patrick Tydecks

February 8, 2007

Abstract

The literature on ownership structures made continual use of notions such as cross-holdings and pyramids which are closely related to the vastly increasing network literature. We propose to transfer successfully applied network methods to the corporate control and corporate governance branch as well. For instance, in this paper we use the MAN-classification scheme, centrality concepts, and network graphs to investigate a unique data set containing 2784 companies of the ownership structure in Germany in 2006. Furthermore, the power or centrality of companies is explained by various company variables.

JEL Classification: G32, L14
Keywords: network, ownership structure, corporate control, power, financial linkages

Contact details of the author:
Darmstadt University of Technology, Institute of Economics, Applied Economic Research and Microeconometrics, Marktplatz 15, Residenzschloss, D-64283 Darmstadt, Germany, *moebert@vwl.tu-darmstadt.de (Jochen Moebert)* *patrick.tydecks@gmail.com (Patrick Tydecks)*

*We are grateful to our supervisor Horst Entorf. We are also grateful to Ulrich Müller, Christoph Wachtel, and Thorsten Jacoby of Hoppenstedt who provide the data base. Igor Goncharev from the 'Monopolkommission' explained us the way indirect relationships are calculated in the 'Hauptgutachten' published in biennial updates. We gratefully acknowledge the assistance of Philip Savage for the rectification of our first version. Jochen Möbert extends his thanks to Martin Hellwig, Christian Laux, and Holger Müller who introduced him into this topic during a seminar.

1 Introduction

Germany's corporate control system has at least three dimensions, i.e., the supervisory board, voting control at general assemblies (cf. Becht and Boehmer (2003)), and ownership stakes.[1] All three are closely related, but due to several specialities in German corporate law the impact of each dimension on the power of a company can be different. Due to ownership structures and these specialities cash flows and voting power are separated in many cases (cf. Bebchuk et al. (2000), Becht and Mayer (2001), among others). In this work we focus on the financial interlocking of German companies. It is widely known that many German firms are owned by large shareholders. Block ownership can have both beneficial and detrimental consequences.[2] Large shareholders might contribute to the success of firms but they can also misuse their power in takeover proposals. A blockholder of both the absorbing company and the acquiring company profits if a firm is sold below its value whereas minority shareholders of the acquired company are exploited. Such blockholder strategies which expropriate minority shareholders are often described by the term 'tunneling' in the corporate governance literature (cf. Bertrand et al. (2002)). Meoli et al. (2006) elaborate the Telecom Italia case where minority shareholders are expropriated by specific network and dual-class structures and Atanasov (2005) documents the malpractice of tunneling during the mass privatization in Bulgaria. Attig et al. (2003) compile a data set on Canadian stock corporations and find evidence for the misuse of power ultimate owners of pyramids holds. They argue that ultimate owners maximize profits at the expense of minority shareholders and companies which have a high distance to the ultimate owners. There is also some evidence that tunneling effects played a role during the financial downturn in the Asian crisis (cf. Johnson et al. (2000), Lemmon and Lins (2003)).[3] However, Franks and Mayer (2001) analysed tunneling effects among German companies in 1990 and found little evidence that tunneling was an important issue.

The goal of this article is not the explanation of a certain feature such as the impact of a blockholder on corporate performance or on the voting power of minority shareholders.[4] Instead, we propose to go one step back, exploit the large data sources available to get a micro-picture of a large part of the German corporate landscape which then provides the basis for thorough investigations in the future. To put into practice such a micro-macro perspective a network approach is a rational choice. This methodology offers both a local micro-perspective since each

[1] Cf. also Goergen et al. (2004) who provide a review of German corporate governance system.

[2] Agency costs might harm whereas increased monitoring efforts can create efficiency, evidence for the latter argument evidence is found by Yafeh and Yosha (2003), Gorton and Schmid (2000) and mixed results are found by Del Guercio and Hawkins (1999)).

[3] Edwards and Weichenrieder (2004) provides us with an econometric method to distinguish detrimental and beneficial effects of large shareholders.

[4] Cf. Gugler (2001) for a cross-country comparison of corporate governance regimes and economic performance.

company and its shareholders can be analysed alone as well as a bird's-eye macro-view due to the interconnectedness of all firms. Furthermore and particularly, the interaction between the micro and macro level can be investigated. Network science offers a variety of ideal tools for the development of real micro-based macroeconomics. The network perspective was implicitly already postulated in the literature on corporate control. La Porta et al. (1999) argued "For most countries, this [network perspective[5]] is the only way to understand the relationship between ownership and control"[6] (cf. also Faccio and Lang (2002), Chapelle and Szafarz (2005), among others). Hence, we analyse a large network data set and thereby extend the literature on company networks. Our aim is the identification of the most powerful companies. We measure the power of companies by centrality concepts. For decades these statistics have been successfully applied in the social network literature. Therefore, our work is based on the company network literature and the vast corporate governance literature. We take into account both fields of research and expect efficiency gains in the case of a merger. Hopefully, an innovative research perspective offering new insights will arise.

Due to its particularities, the German case is intensively debated in the corporate governance literature. However, as for other countries many statements are based on a small data base which concentrates especially on large companies such as listed stock corporations or the largest one hundred companies.[7] The German ownership structure called 'Deutschland AG' was so isolated relative to Anglo-Saxon markets and interwoven that corporate control was implicitly exerted by the national companies themselves. Hence, legitimate ownership rights were disregarded and corporate control from outsiders, such as international shareholders as well as other stakeholders, was limited. This corporate network restrained non-national firms from gaining a foothold in the German company system and specific ownership structures among major companies hindered hostile takeovers.

In recent years, it has been much discussed that the corporate ownership structure is subject to change in Germany. Due to the globalization and tax abatements on capital gains realized by sale, many blockholders diversified their investment portfolio by adding international companies and cutting down national holdings. In particular, bank and insurance companies have changed their investment portfolios. Therefore, long-term relationships which often existed for decades, especially between banks and industrial companies, were broken.[8] These often mentioned

[5] Authors' note.

[6] "Our principal contribution is to find wherever possible the identities of the ultimate owners of capital and of voting rights in firms, so when shares in a firm are owned by another company, we examine the ownership of that company, and so on. For most countries, this is the only way to understand the relationship between ownership and control. These data enable us to address, in a comparative perspective, four broad questions... ." La Porta et al. (1999), p. 472.

[7] For instance, the equity stakes of the largest one hundred companies are investigated in biennial reports of the German Monopolkommission. Publications of Höpner and Krempel (2004) are often based on this data set.

[8] For simplicity, all non-financial companies are called industrial companies.

breakups of bank-industry links being formed during the period of industrialisation (cf. Franks et al. (2005) and Fohlin (2005) who provide us with insights into the historical development of financial linkages in Germany), are the origin of statements such as "Is Deutschland AG kaputt?"[9] This mere detection of an important difference in the network structure is interesting in itself. However, some breakups among large national firms might be replaced by linkages to international connections. Becht and Röell (1999) have documented that companies of many countries in continental Europe have large voting blocks. Possibly, the dissolution among national firms is replaced by new financial linkages among European corporations.[10]

Before we start our network analysis, we will review important contributions to the company network literature in Section Two. Thereafter in Section Three we describe our network data set. In Section Four the most central corporations are identified by the application of standard network concepts. Furthermore, in a subsection to Section Four firm characteristics are used to explain the centrality vector in an econometric model. Hence, we can identify the industries and the firm characteristics which are related to a high or low centrality. We conclude our analysis in Section Five. For many readers the Appendix might also be of interest. Many blockholder structures of large German companies are shown there.

2 Company Network Literature

The network literature about the 'Deutschland AG' and financial interlocking of firms is neither very detailed nor exhaustive. However, there are some important contributions which are first steps towards a deeper understandings of corporate ownership structures. These articles mainly written by social scientists are briefly reviewed here. To zero in on important contributions we review papers focused on the Germany company network. Moreover, we casually include contributions concerned with firm networks from other countries or with interlocking directorates in Germany.[11]

[9] The Economist, Dec 5th 2002, print edition.

[10] Besides a higher degree of internationalisation, concentration within an industry might also be an alternative explanation for the dissolution process among large companies. Brisk competition might force cooperation among firms. Hence, links are broken across an industry whereas the interlocking within main markets of companies is intensified. Allen and Phillips (2000) found a positive impact on operating performance in research intensive industries if blockholdings are combined with product market relationship between purchasing and target firm. Also Fee et al. (2006) investigates the impact of financial linkages among trading partners. They find that equity stakes between customers and suppliers increase the time span of trade relationships. Given these findings, it will be interesting to investigate whether the ownership structure is intensive within industries. However, the answers to these questions are left to future research.

[11] An overview of large company networks in six different countries is given in Windolf (2002).

The second largest network study with respect to size was performed by Kogut and Walker (2001), who used data of the Frankfurter Allgemeine Zeitung GmbH.[12] They investigated how the German ownership network influence merger and acquisition activities from 1993 to 1997. Their firm sample incorporates the largest five hundred non-financial companies, the 25 largest banks, and the 25 largest insurers in 1993. After the selection of this sample the 684 owners of these 550 firms were ascertained. Finally, a binary network of zeros and ones among companies was arranged. The ones represent all direct links if the equity stake of a shareholder was above 5 percent. Hence, this network formation process ignores all blockholders below 5 percent and equally weighted all stakes above 5 percent. They therefore ignore a large part of small shareholders as shown in the next section, where our network data set is analysed. The M&A data base includes 101 acquisitions which take place among the 550 companies from 1994 to 1997. By means of simulation the authors showed that randomly rewiring company holdings affect the German corporate system only slightly.[13] If, for instance, one hundred links are rewired then the average path length only dropped about 20% and the cluster coefficients about 30%. These findings are in line with small world networks and indicate the intrinsic stability of the corporation network. Furthermore, it is argued that mergers and acquisitions maintained the structure of the German company network since very central companies seem to be more active in acquiring firms than the average company in the sample. Therefore, the dissolution of the 'Deutschland AG' is not enforceable within a short timeframe.

In an early study, Pappi et al. (1987) analyse the financial interlocking as well as interlocking directorates of the largest 325 German companies in 1976. The 205 industrial companies were chosen due to the highest turnover level of all companies in 1976. The largest banks are identified by their balance sheet total and the largest insurers were chosen due to a ranking of earned premiums. Each company unit is sectioned into one of ten blocks which are defined by means of a cluster analysis. Thereafter, relationships among the blocks are investigated by analysing personal and financial linkages. Their analysis underpins the power of large German banks in former decades.

Höpner and Krempel (2004) visualized the German company network for 1996 and 2000. The data base includes the one hundred largest companies and is provided by the German Monopolies Commission[14] which publishes an official report about the competitive position of German corporations every second year. Inspection by eye reveals that the network density shrinks because several links were severed between financial and industrial companies. In addition, links between financial companies are diluted. These observations contrast with the stability

[12]The editor of one of Germany's large business newspapers 'Frankfurter Allgemeine Zeitung'.

[13]The rewiring procedure picks company u that severs an existing link to company v and forms a new one to company w (see Watts and Strogatz (1999) for details).

[14]The German name is 'Monopolkommission'.

argument of Kogut and Walker (2001). We conjecture that this contradiction is resolved through the smaller data set used by Höpner and Krempel (2004).

Heinze (2004) investigated the change of interlocking directorates instead of the financial interlocking of the 'Deutschland AG' from 1989 to 2001. He described the different control structures by means of descriptive network statistics and also concentrated on large German companies. Furthermore, he asserts that both the financial network and the personal network of executive and supervisory board members are tightly knit and both networks co-evolved historically. In the twelve year span, many links in the network structure were diluted. But many local network structures such as cliques and core-periphery structures were unaffected. Furthermore, the financial companies are still the most central players. We are not convinced that financial and personal networks co-evolve similarly. Of course, shareholders can affect board elections. However, German laws establish special rules affecting board composition which dilute the power of shareholders. From a theoretical point of view, both types of links can be seen as substitutes of a common goal national companies share. While globalization and German tax policy boost incentives to abolish equity stakes, members of executive and control boards might be willing to strengthen the 'Deutschland AG' by maintaining or intensifying personal relationships.

Recently, the focus among network researchers turned to the analysis of the historical evolvement of company networks. For instance, Windolf (2005) compares the development of U.S. and German firms between 1896 and 1938. His research suggests that the difference between both countries found today is caused by different developments in the 20th century. Whereas the financial interlocking is quite similar, the interlocking among members of the supervisory board was much more concentrated in Germany than in the U.S. Similarly, Schnyder et al. (2006) study the company network of the largest Swiss companies form 1910 to 2000 and distinguish a development period until 1937, a stability period until 1980, and, finally, a period of decline until 2000.

3 Our Data Base

The data collection process started on 20th May 2006 and was completed by 20th June 2006. This process can be separated into four steps. First, we picked all German companies having a turnover of at least one billion euro. This sample includes only single company units but no parent companies which are just holdings or have a turnover below one billion euro. This

core sample contains 597 industrial companies.[15] Second, we gathered all direct and indirect ownership relationships among this core sample. Due to definitional issues, the revenues of financial companies are not termed turnover. The turnover criterion was also chosen by Pappi et al. (1987), however, for the financial companies we adopted, due to better data availability, a different approach from these authors. The third step was the identification of all direct and indirect parent companies of the first chosen sample of 597 units. These direct and indirect links can be conveniently depicted in Network Figures as shown in the Appendix. Also, Kogut and Walker (2001) used such network data but took into account only direct and indirect links of distance two, where the term 'distance' in network terminology is defined as the number of links between two companies. Our data base omits indirect links up to distance seven and offers therefore a much deeper view than earlier work on Germany's corporate structure. This third step extended the total sample to 2784 companies which also contained all major German financial companies. Fourth and finally, all shareholder relationships among all firms were compiled. Our network data set is very different from previous work on company structures performed by economists where the focus is mostly on the position of a single company. For instance, La Porta et al. (1999) provide us with a description of the ownership structure of Allianz and DaimlerChrysler.[16] This micro-perspective instead of a network view makes the application of network tools unappealing or even impossible. An update of the DaimlerChrysler network is shown in Network Figure 10.

The close relationship among Allianz, Dresdner Bank, and Münchner Rück is the classical paradigm of interwoven German companies (cf. La Porta et al. (1999)). In a certain manner, the financial linkages among these three corporations enabled them to bypass German stock corporation law[17] and, therewith, hostile takeovers and more importantly corporate control of outsiders were virtually impossible even if those firms and executives performed poorly. Still today, Allianz and Münchner Rück are important blockholder of each other. The Allianz holds 9.4% of the Münchner Rück whereas the Münchner Rück holds 4.9% of all Allianz shares. Otherwise the Allianz corporation has a dispersed ownership structure. Therefore, the Allianz network consists only of two nodes and two arcs representing the Allianz-Münchener Rück cross-holding. Due to its simplicity the Allianz network is omitted in the company Network Figures shown in the Appendix (However, the ego-centered company networks of Aldi, AMB Generali, AXA, BMW, Commerzbank, Daimler, Ergo concern, Metro, Deutsche Post, Deutsche Telekom, and Volkswagen are depicted in Network Figure 5 to 15 in the Appendix.).

[15] Financial companies are not part of this core sample since by definition financial companies have no balance sheet item called turnover.

[16] Throughout the paper we use reasonable abbreviations for company names. In particular, legal forms of companies are never mentioned in the text. The legends of network figures shown in the Appendix contain full company names. For instance, BMW is called 'Bayerische Motoren Werke AG' in Network Figure 8.

[17] A member of the control board in corporation A cannot be member of the executive board of corporation B if an executive member of corporation B is a member of the control board of corporation A, §100(2)Nr.3 AktG (Prohibition of cross interlocks).

Table 1: Country Ranking

Country	%-share	Country	%-share	Country	%-share
Germany	70.47	Cayman Islands	0.32	Bahrain	0.04
US	4.71	Norway	0.32	Cyprus	0.04
United Kingdom	3.23	Bermuda	0.25	Czech Republic	0.04
Italy	3.20	Canada	0.18	Ireland	0.04
France	3.09	UA Emirates	0.14	Iran	0.04
The Netherlands	2.91	Russia	0.14	Libya	0.04
Japan	2.73	Denmark	0.11	Monaco	0.04
Swiss	1.98	South Africa	0.11	Mexico	0.04
Luxembourg	1.36	Finland	0.07	Portugal	0.04
Austria	1.19	Hong Kong	0.07	T&C Islands	0.04
Belgium	0.93	Kuwait	0.07	Virgin Islands	0.04
Sweden	0.93	Korea	0.04		
Spain	0.54	Saudi Arabia	0.04	Total	100.0
Australia	0.40	Netherlands Antilles	0.04		

Data Source: Hoppenstedt Konzernstrukturen (KSD). The total number of companies is 2784. UAE abbreviates United Arab Emirates. Official country name of Ireland is 'The Republic of Ireland', and T&C Islands full name is 'Turks and Caicos Islands'.

The final data set contains industrial and financial companies, state enterprises, partnerships, and individuals. Our data set also offers an international perspective on the German company network since not only national firms but also foreign firms are taken into account. The number of foreign firms amounts to 824 or 29.53% of the sample size. The number of companies of each country relative to the total number of companies in the network is reported in Table 1. Apparently, large economies such as US, UK, Japan, etc. make up the largest number of foreign firms related to the German company network. Interestingly, firms based in tax havens such as Cayman Islands and Bermuda have a similar large number of relationships than companies located in Spain and Canada.

Another important firm characteristic is the legal form of companies. Legal forms of different countries are not completely comparable. However, the different types of companies were allocated to different groups in keeping with Table 10, as shown in the Appendix. Given this assignment, most companies in our sample are limited companies as documented in Table 2. Expectedly, a large share of private and public limited companies is found. A high number of individuals and state enterprises is also included into the German company network. This finding is often exposed as one major difference in the shareholder structure of Anglo-Saxon and German companies as well as other companies located in continental Europe. According

Table 2: Legal Forms of Companies in our Sample

Legal Form	Group	Legal Form in Germany	#Obs	%-share
Private Limited Company	Ltd.-Group	GmbH	1023	36.75
Public Limited Company	Inc.-Group	AG	690	24.78
Partnership	Partner-Group	KG/OHG	303	10.88
Others	Other-Group		69	2.48
Foundations		Stiftung	35	1.26
Cooperatives		e.G.	26	0.93
Civil Law Association		GbR	4	0.14
Association		e.V.	4	0.14
Private Individuals			368	13.22
State Enterprises			102	3.66
Missing Observations			229	8.23
Sum			2784	100.00

Data Source: Hoppenstedt (KSD) - data bank access is provided via www.konzernstrukturen.de. Abbreviations are listed in Table 2. #Obs signify the number of observations.

to Burkart et al. (2003), the large number of family-owned German corporations is caused by weak minority shareholder protection which is often attributed to the poor German corporate governance system. Even after recent changes no stronger market-oriented governance system is assumed (cf. Terberger (2003), Goergen (2004), among others). Hence, the importance of family blockholders will continue to be a feature in the future. The number of individuals in our network may underrate their power since individuals and families are often ultimate owners of firms. Faccio and Lang (2002) find that Western European firms are either family controlled or have dispersed ownership structures. Their comparison of ultimate owners across countries unveils the exceptional position of family firms in Germany. For instance, for publicly traded firms the ultimate owner is a family in about two-thirds of cases and about nine out of ten unlisted German firms are family-owned.

For generations shareholders of large German corporations have been well-known families. For instance, the Quandt family holds a large share in BMW and the Piëch family and Porsche family are still among the large blockholders of VW (compare Network Figures 8 and 15). The figures show that these families are not only represented by one company protecting rights of a whole family but that there are quite complex holding structures in which several individuals of each family are involved. Interestingly, individuals are sometimes only indirect blockholders of the automobile corporations since limited companies typically in complete individual ownership

lie in between. For instance, Johanna Quandt is the sole owner of Johanna Quandt GmbH & Co. KG which holds 14.21% of all BMW shares. Often the impact of family ownership on firm performance and corporate control is debated. On the one hand family ownership might facilitate a thorough development of a company, on the other hand block ownership might hinder effective corporate control. Recently, Villalonga and Amit (2006) analysed the impact of family ownership on firm performance and found mixed results for US firms. Ehrhardt et al. (2004) as well as Maury (2005) report a positive relationship between operating performance and family-ownership.

State enterprises are also involved in many German companies. Again, Network Figure 15 of VW exemplarily shows a state-firm relationship. The Hannoversche Beteiligungs mbH is a large shareholder of Volkswagen and is owned by the Bundesland Niedersachsen[18]. Similarly, the German state is still engaged in the DAX companies Deutsche Post and Deutsche Telekom imaged in Network Figures 13 and 14. The vast majority of 'state enterprises' are owned by medium-sized and large cities which are often connected to public utility companies as well as local saving banks.[19] Interestingly, in their cross-country comparison La Porta et al. (1999) and La Porta et al. (2002) argue that both a relatively high number of family-owned firms and a large influence of government entities indicate insufficient shareholder rights. For Germany, the low degree of shareholder protection relative to Anglo-Saxon countries is often reported and details about German corporate law - briefly discussed in the following paragraph - point out this fact.

Descriptive Network Statistics

Network consists of vertices and arcs between the vertices. In a company network the vertices are the companies themselves and arcs represent the ownership structures among these companies, where the arrows point from the companies to their shareholders. In total, our company network exhibits 3711 arcs and consists of 192 components, where companies of two different network components are neither directly nor indirectly connected.[20] Weights are attached to each arc to capture the different shares being held and the power exerted by owners. However, for the sake of clarity links in network figures shown in the Appendix are categorized into three classes. The first class summarizes small equity stakes below 10%, the second class contains equity stakes lying in the right open interval from 10% to 50%, and the third class contains equity stakes at or above 50%. In the network figures the three classes have different line widths. For instance, in

[18] Niedersachsen is one out of 16 German states.

[19] Also, the German banking industry has specific regulations. Almost all cities and communities are owners of small saving banks - called Sparkassen - which all together are larger with respect to standard bank characteristics than most listed German competitors.

[20] In fact, the 192 components are weak components which take into account all companies being connected to each other independent of the direction of the arrows (strong components distinguish the direction of the arrows). See de Nooy et al. (2005) for details.

Network Figure 15 an arc with a weight of 15.46 goes from Volkswagen to the Porsche corporation which indicates that Porsche holds 15.46% of all Volkswagen shares.[21]

The mode weight in the complete network shown in Network Figure 1 is 100% whereas the mean value is 45.5% and the median is 27.7%. The mode weight is observed in about one third of all links. Obviously, holdings often completely own their subsidiaries. Means and Medians of previous studies are both about 50% - an overview of several other Germany-related studies is documented in Becht and Boehmer (2003) as well as Goergen et al. (2004). Differences between previous studies and our median can be attributed to our larger data base, to different sample periods, or both. Other often observable link weights are equity holdings of about 10%, 20%, 50%, 75%, and about only a few percent as illustrated in Figure 1(a) and (b). Regarding block ownership, our findings are in accordance with previous studies, e.g., La Porta et al. (1998), who found strong concentrations in ownership structure in nearly all countries. Concentrated ownership structure is also induced by Gemany's Companies Act[22]. Germans stock corporation law gives (minority) shareholders specific rights.

For instance, individual discharges of each member of the supervisory board - instead of contemporaneous discharge of all members - is enforceable by shareholders holding 10% of the voting equity (§120(1) AktG - see also §137 AktG). Similarly, an investor requires at least 20% of the voting equity (§122 AktG) to enforce extraordinary general meetings. At least 50% of all votes are necessary to enforce decisions at general assemblies (§153 AktG). Also, the appointment of auditors scrutinising the formation process, the increase of capital, or capital reduction (§142 AktG) as well as raising a claim against board members or directors (§147 AktG) explicitly requires an ordinary majority. A qualified interest enables shareholders to amend corporate statues (§ 179 AktG) and to increase in registered capital (§182 AktG). Hence, it is obvious that chosen blockholder stakes are not randomly assigned between firms but are chosen to foster or block specific rules.

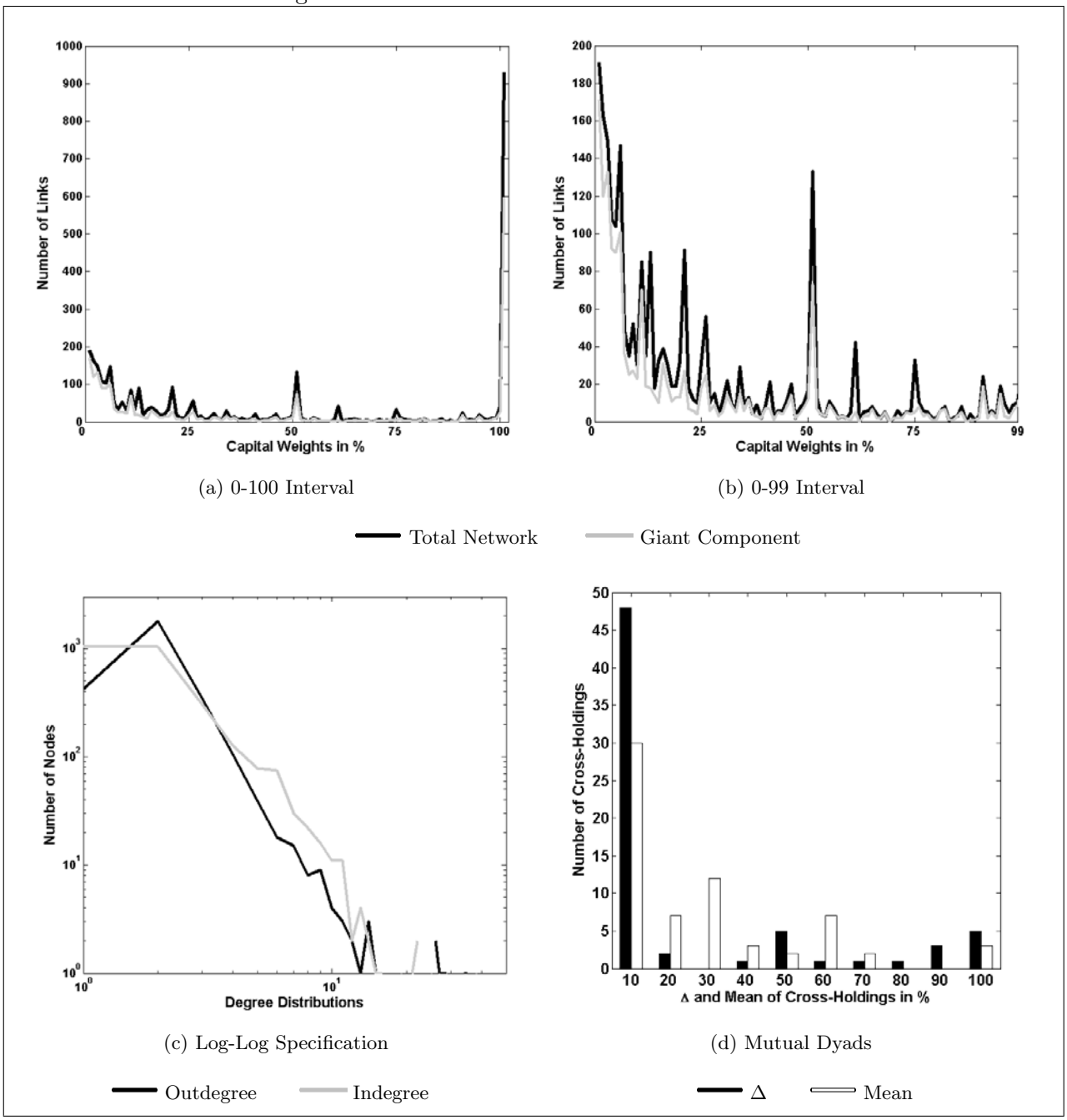
Figure 1(c) shows the distribution of incoming arcs (indegree) and the distribution of outgoing arcs (outdegree) of all companies in our network. Both functions are quite similar. The linearity in the log-log diagram indicates that there are a few central companies with many links and many firms who just have a small number of equity stakes.[23] Subfigure 1(d) shows the

[21] In all Network Figures links are classified into three groups where thicker lines stand for higher equity stakes among the firms. The thinnest lines represent equity stakes up to 10%, medium lines represent stakes from 10% up to 50%, and the thickest lines represent equity stakes from 50% to 100%.

[22] The German company act is called Aktiengesetz and is commonly abbreviated by AktG.

[23] Mathematically, the linearity is reproducible by power law or lognormal distributions. Barabási and Albert (1999) show that many network data sets exhibit power laws. For a general discussion of the characteristics of these distributions and how human behaviour can produce such distributions read Mitzenmacher (2003).

Figure 1: Characteristics of Arcs and Nodes



(a) 0-100 Interval

(b) 0-99 Interval

(c) Log-Log Specification

(d) Mutual Dyads

Data Source: Hoppenstedt KSD. Figure (a) is the distribution of link weights in the $[0, 100]$ interval and Figure (b) the corresponding $[0, 99]$ interval. Figure (c) shows the indegree and outdegree distribution of nodes. Figure (d) reports the difference of capital weights (ΔCapital Weights) for all mutual links. Each value at the abscissa is the upper threshold of a 10%-interval. For example, there are 48 links for which $W_{AB} - W_{BA} < 10\%$ where 10% is the upper threshold of the $[0, 10)$ interval and W_{AB} is the weight from vertex A to vertex B. Personally liable partners are excluded in Figure (d).

mean and the difference Δ of 66 cross-holdings in the total network.[24] Mean and difference are always calculated for each cross-holding. One cross-holding between Allianz and Münchner Rück was mentioned above and another exists between 'Kölnische Verwaltungs-Aktiengesellschaft für Versicherungswerte' and the AXA concern as shown in Network Figure 7. Most cross-holdings such as the Allianz-Münchner Rück link have capital weights below 10% in both directions, therefore, both the difference and the mean of cross-holdings are small. The second cross-holding in Network Figure 7 has values of 25.631% and 23.02%. Hence, the mean is in the 20% interval whereas the difference lies in the 10% interval in Figure 1(d).

MAN-analysis

One powerful mean to analyse networks is the triad MAN-classification scheme proposed by Holland and Leinhardt (1970). This descriptive statistic is a simple count mechanism which picks all possible combinations of triads[25] among all nodes - in our case there are $\binom{2784}{3} = 3,592,429,984$ triads. After each combination the existing links among the nodes are observed. There are sixteen possible combinations depicted in Figure 3 in the Appendix representing the MAN-classification scheme. M represents the number of mutual dyads, A asymmetric dyads, and N null dyads in a triad. In addition, for some triads a letter is added to indicate the direction of the arrows in a triad where D abbreviates down, U up, T transitive, and C cycle.

The MAN-classification scheme measures micro network formations and, contemporaneously, provides access to a macro perspective. All 16 possible triad formations observed in the company network are summarized in Table 3. For instance, 003 triads - the triads which contains three null dyads, i.e., no links at all - are found much more often than expected, whereas 012 triads are less often observed than expected. Thereby, the term 'expected' refers to a random network where each link has the same probability to be present. Table 8 shows the probabilities to observe certain triad formations in a random network. Our results indicate that the network formation process underlies a non-random process. In total, 003 triads and 012 triads are less often observed than expected. This indicates that certain network formations - those where more than one arc is involved - are likely to emerge. One such triad involving more than one arc contains mutual links, i.e., cross-holdings. The MAN-classification scheme reports a very high relative number of 102 triads as indicated by the ratio of observed to expected triads (O/E ratio in Table 3). Hence, we can conclude that firms have a high incentive for cross-holdings. This micro network structure is often seen as a classical form of ownership concentration. The reciprocal relationship can hinder the exercise of corporate control if the reciprocal voting power is large enough and managers are reluctant to explicitly control each other. Given the relative high number of mutual links it is also not surprising that we observe more 201, 120D, 120U, and

[24] Cross-holdings are defined as direct cross-holdings whereas Köke (1999) uses a broader definition which also takes into account circles of large distances.

[25] In network terminology, triads are networks among three nodes and dyads are networks among two nodes.

120C triads than expected. However, the absolute number of these triads is fairly low such that these formations are of minor importance.

Other often debated shareholder structures are pyramids, also called trees and forests.[26] Due to the low absolute number of cross-holdings and due to many asymmetric dyads, tree structures should be likely to emerge. La Porta et al. (1999) as well as Faccio and Lang (2002) report the tree structures as a prevalent company structure in many developed countries. To compare the relevance of tree structures found in previous results with our data set, we can rely on the 021D and 021U triads. They represent small local trees probably embedded in large forests and also hint at the degree of centrality among nodes. The number of 021D and 021U triads is large in absolute as well as relative terms. Both triad types are observed more often than expected.[27] Hence, our statistics confirm well-known results but condenses company information in simple macro measures. Given the high number of 021D and 021U triads and the overall impression of the total German company network indicates that forests are an important structure in our data base. The emergence of these forests is often interpreted as evidence for the balance of power in company networks. Correspondingly, corporate control is exercised in the opposite direction of the arcs. Firms and subsidiaries are (partly) controlled by parent companies or other shareholders whereas the arrows tend to the controlling unit. Such forests are well documented by La Porta et al. (1999) and enhance the control of many companies by an ultimate owner. The pyramids enable the ultimate owner to control companies he is indirectly connected to even if he is only a minority shareholder. For instance, in Network Figure 8 the shareholders of BMW are shown. Via the Dresdner Bank Allianz Corporation has direct as well as indirect influence at BMW's general assembly. This line of argument may explain why large equity stakes of 60% and 75% are less often observed in the giant component (compare Figure 1d) than in the total network. Possibly, corporate control via forests is easier to exert in a larger network component than in smaller ones. Hence, shareholdings and forests may be substitutes.

Additional ownership structures mentioned by Windolf and Beyer (1996) are circles and (nearly) complete cliques. Also, Kogut and Walker (2001) argued that the German corporate network consists of closely knit clusters and brokers filling structural holes between these clusters. As described above, the brokers might be ultimate owners or other central companies which hold pivotal positions in the pyramids. However, the evidence for the existence of circles such as 030C triads is weak. Although the O/E-ratio of 030C triads is large, the number of observed triads is low. In contrast, there is a large number of 021C triads, which confirms that circles are often found in triad formations. Yet, the expected number of 021C triads in a random network is even larger, such that the existence of circles in triads can be interpreted as a statistical

[26] In the corporate governance literature these structures are called pyramids, whereas the graph theoretical notion is tree or forest. Hence, we also use to the last notions. Cf. Godsil and Royle (2001).

[27] An overall test of independence has a χ^2-value of 6 10^8 and, accordingly, clearly refutes the notion that the network is formed by accident.

artefact. Similarly, 210 and 300 triads representing clusters and (nearly) complete cliques are infrequently observed. Hence, it is reasonable to conclude that the impact of circles, cliques, and clusters on the overall structure is moderate and at least for our data set it seems implausible to call circles or cliques a basic ownership structure. In contrast, network patterns discussed in mainstream economics journals focusing on trees and cross-holdings are prevalent.

Sub-Networks

Until now, we have concentrated on information regarding the full company network. The data description is completed by turning to the analysis of subnetworks which only take into account capital linkages and related firms above certain weight thresholds. Table 4 summarizes different network measures for the full network and sub-networks. Each of the three sub-networks is reduced to links with weights above 24%, 49%, or 74%. In all sub-networks the disproportionate number of 021U triads emerge again, whereas the 021D triads are less frequently observed than in a random network having the same number of vertices and arcs. This findings also suggest that the balance of power is funnelled[28] into a small number of companies which are the nodes pointed to by the arrows in the 021U triads. These companies might be the brokers mentioned in Kogut and Walker (2001) or the apex of the pyramids mentioned in La Porta et al. (2002), Claessens (2000), Attig et al. (2003), among others, which are able to coordinate different developments in their subsidiaries and, hence, occupy a strategic position which allows control of local parts of the network. Again, in all four networks 021C triads are less often observed than expected. This underpins the fact that circles are formed incidentally and cannot be seen as a power enhancing mean.

Another important feature can be read off Table 4. The number of components increases when financial linkages below the three thresholds 24%, 49%, and 74% are ignored. The number of large components above fifty nodes decreases continuously, whereas the number of components having more than five or twenty nodes first increases if we take no account of financial links below 24% but then also declines if further thresholds are considered. The giant component in the total network contains 1626 nodes and 2271 arcs. The distribution of capital weights in the giant component is similar to the distribution in the total network. Except as already mentioned, blockholdings of about 60% and 75% are found relatively seldom in the giant component, whereas in the other components these values are relatively often observed. Unsurprisingly, the giant component is quickly decomposed into smaller pieces if low weighted links are disregarded.

The giant components of all sub-networks are shown in Network Figures 2 to 4. The giant component of the sub-network containing only equity stakes above 24% consists almost

[28]This notion is introduced into the network literature by Newman (2001). It implies that all geodesic paths from one vertex to all others in a network component typically go through a very small number of adjacent vertices.

Table 3: Observed and Expected Number of Isomorphic Triads

MAN-Type	Observed	Expected	O/E ratio
003	3,582,363,243	3,582,129,437.72	1.0000653
012	9,821,853	10,288,226.42	0.95
102	227,396	2,462.40	92.35
021D	6,307	2,462.40	2.56
021U	5,872	2,462.40	2.38
021C	4,179	4,924.80	0.85
030T	473	2.36	200.42
111U	385	2.36	163.14
111D	157	2.36	66.53
201	75	0.00	dbz
030C	12	0.79	15.19
120D	11	0.00	dbz
120U	9	0.00	dbz
120C	8	0.00	dbz
210	4	0.00	dbz
300	0	0.00	dbz
Sum	3,592,429,984	3,592,429,984	

Data Source: Hoppenstedt KSD. MAN-Types are defined by Holland and Leinhardt (1970). M counts the mutual dyads, A the asymmetric dyads, and N the null dyads in a triad. In addition, D down, U up, T transitive, and C cycle indicate the direction of links in asymmetric dyads. Confer also Figure 3 and Table 6. The 'O/E ratio' is the ratio of observed number of triad types in our data set relative to the expected number of triad types in a random network model. dbz abbreviates 'division by zero'.

completely of energy companies such as E.ON, RAG, Vattenfall[29], and others. Additionally, many public utilities are part of this sub-network. The giant component of the second sub-network containing only equity stakes above 49% is mainly a Siemens-Bosch network - one of Germany's large technology companies - and the giant component of the 74% sub-network is an Aldi network where the Siepmann Stiftung is the center of a star. Network Figure 5 shows the complete Aldi network in which other foundations, personal liable partners, etc. are also included.

[29]Vattenfall is a Swedish company.

Table 4: Importance of Capital Weights for Company Sub-Networks

Threshold	0%	24%	49%	74%
Companies	2784	2061	1867	1585
Arcs	3711	1771	1445	1152
021D-Triads	6307^{+}	223^{-}	43^{-}	1^{-}
021U-Triads	5872^{+}	2207^{+}	1898^{+}	1009^{+}
021C-Triads	4179^{-}	1054^{-}	696^{-}	493^{-}
Components	192	373	433	437
Component(Companies>5)	66	107	97	83
Component(Companies>20)	8	20	10	3
Component(Companies>50)	3	2	0	0
Companies in Giant Component	1626	117	40	28
Arcs in Giant Component	2271	122	40	27

Data Source: Hoppenstedt KSD. The full network has a threshold of 0%. A sub-network includes all links with weights above the threshold level. 021D-triads counts the number of triads with zero mutual, two asymmetric, one null dyad, and D indicates that both arrows point to one link, i.e., there is one shareholder with two different equity stakes (U=up, C=cycle). $^{+}(^{-})$ indicates whether the observed number of triads is above (below) the expected number of triads. Component(Companies>K) counts the number of network components containing more than K companies, where the number of network components is the number of totally disconnected network parts.

4 Important Companies

4.1 Central Nodes in the Global Network

Here we continue the explorative analysis of the previous Section. However, instead of investigating general network characteristics we try to identify pivotal corporations. The relevance of companies is measured by standard network measures. In Table 5 possibly important nodes are ranked by the indegree as well as indegree closeness centrality of nodes. The indegree statistic measures only the number of links to a company, i.e. counts the number of equity stakes a company has in other companies. The indegeree closeness centrality CC_i[30]of company i is defined as

$$CC_i = \frac{|NC_i|}{|AC|} \frac{|NC_i|}{\sum_{j \in NC_i} d(i,j)} \tag{1}$$

where NC_i is the set of companies which are part of the network component i belongs to, AC is the set of all companies, the bars indicate cardinality of a set, i.e. $|AC| = 2784$ for our data set, and $d(i,j)$ is the distance, i.e. the length of the shortest path, between two companies i and j in the same network component.[31] Companies which are closely connected to others can impact upon these companies since we take into account indegrees only. In contrast, a company which has no other equity stakes has an indegree closeness centrality of zero. Hence, it is reasonable to assume that companies with a larger CC_i are more powerful than companies having a smaller centrality.[32] The closeness centrality is readily calculated and can therefore enhance the literature on company concentration (cf. Claessens et al. (2000), Faccio and Lang (2002), Attig and Gadhoum (2003), Chapelle and Szafarz (2005), among others).[33]

Given the results below, we can give a tentative appraisal of which companies or entities are the most powerful ones in the German company network. As in previous studies, many insurance companies are among the most central companies. In particular, corporations such as Allianz, Münchner Rück, and Ergo as well as many subsidiaries of these companies are found. For instance, Allianz Subalpina[34] is a 98.003% subsidiary of RAS Riunione Adriatica

[30]Notice, that this formula deviates from the standard closeness centrality since our network consists of several components. The standard centrality definition is extended by the the first fraction which controls for the number of nodes in each network component.

[31]See Koschützki et al. (2005) for definitions and more advanced centrality statistics.

[32]The article by Freeman (1979) is a standard reference, although he was not the first to propose centrality concepts. Compare, for instance, Beauchamp (1965) and Sabidussi (1966).

[33]Interestingly, without mentioning the term 'network', Chapelle and Szafarz (2005) use network techniques by applying matrix algebra to calculate ultimate owners. Note that, mathematically the notions 'network' and 'matrix' are synonyms.

[34]This company holds rank 24 in the indegree closeness centrality column. The registered name is 'Allianz Subalpina Società di assicurazioni e riassicurazioni', based in Turin.

di Sicurtà S.p.A. which is a 76.34% subsidiary of the Allianz concern. Similarly, D.A.S., Hamburg-Mannheimer SV, and Victoria Versicherung are all part of the Ergo concern. For details, see the Ergo network imaged in Network Figure 11. Other frequently found industries are banks, energy suppliers, wholesale and retail firms.

Among the banks there are large German banks but there are also many foreign competitors from Italy such as UniCredito, the parent company of the Bayerische Hypo- und Vereinsbank, and Mediobanca. Details about the investment bank Mediobanca, its ownership structure, its power in Italia, and its recent role in the hostile take over of Telecom Italia is provided by Kruse (2005) and Meoli et al. (2006). Japanese banks such as Japan Trustee Services Bank, The Mitsubishi Trust & Banking Corporation, and Sumitomo Mitsui Banking Corporation can also be found. Japanese banks tend to cluster in local company networks called keiretsus (cf. Lincoln et al. (1996) and Lincoln and Gerlach (2004)).[35] They exhibit a high number of linkages among firms and are among the top-ranked companies regarding the number of indegrees. However, Japanese banks are not among the companies with a top-thirty indegree closeness centrality. In contrast, Italian banks and insurance companies are also ranked among the companies showing a high closeness centrality. Hence, Italians financial companies might be more influential in affecting the German economy than companies from other countries.

The national energy market is dominated by E.ON, EnBW, RWE, and Vattenfall[36]. All local-operating German energy companies have to use the power grid of these four companies covering the whole German state. Each of the four big energy players covers a certain geographical area and much smaller competitors operating on a local basis have to use the power grid of one of these companies. Therefore, the big four energy companies are at least within their industry relatively powerful and all four of these large corporations are listed in Table 5. Parts of their ownership structure is shown in Network Figure 2 which stresses the strong interconnectedness among many energy companies as well as their close relationships to public utilities and cities.

Among the corporations with most indegrees are the corporations named Billen and Fenten. These companies are part of Aldi Nord and Aldi Süd which are one of Germany's and Europe's largest retailers. The beautiful Network Figure 5 for Aldi is an isolated network component in the total network. Additional information about the Aldi network can also be found in Network Figure 4, i.e., the giant component of the total network where links below 74% are eliminated. The owners of both companies are the brothers Karl and Theo Albrecht and are the richest

[35] Miyajima and Kuroki (2005) show that Japanese firms can be separated into two groups after the banking crisis in the nineties. The less efficient companies are still strongly connected with banks, whereas the more prosperous corporations exhibit a higher tendency to break these links.

[36] Vattenfall is a Swedish company.

Germans[37]. Accordingly, the entity 'Familie Albrecht' is also related to this company network. In addition, the foundations Markus Stiftung, Lukas Stiftung, Carolus-Stiftung, Siepmann Stiftung, and Jakobus-Stiftung are also part of the Aldi network.

Finally, the French state - Republik Frankreich - is one of the entities exhibiting a high closeness centrality. It is well known that the French state is a large blockholder in large French companies. However, we were quite surprised to learn that this entity is found to play a central role in the German company network, too. Among the direct links, only a 50% holding of the 'Stiftung Centre Culturel Franco-Allemand de Karlsruhe' and a 49.02% holding of the 'Internationale Mosel' are reported. Both participations are rather unimportant for the overall network. Industrial relations between German and French companies are probably essential since the French state directly impinges on France Télécom, Gaz de France, and Renault. Furthermore and even more importantly, there are several indirect relations to financial corporations. The French state holds a 77.69% stake at GAN, and this company is a shareholder of the Italian Mediobanca, which is also among the most central banks. Mediobanca has, as shown in Network Figure 9, a strategic cross-holding with the Commerzbank and, as shown in Network Figure 6, is also an indirect shareholder of the AMB Generali Holding via Assicurazioni Genarali. Finally, there is a seven-distance relationship with the AXA Konzern which contributes to the high centrality the French state exhibits in the German company network. The following seven-distance path is imaged in Network Figure 7.

> AXA Konzern AG ⟶ AXA S.A. ⟶ Les Ateliers de Construction du Nord de la France S.A. ⟶ Eurazeo SA ⟶ Crédit Agricole S.A. ⟶ Assurances Générales de France S.A. ⟶ C.D.C. Cásse des Dépôts et Consignations ⟶ Republik Frankreich

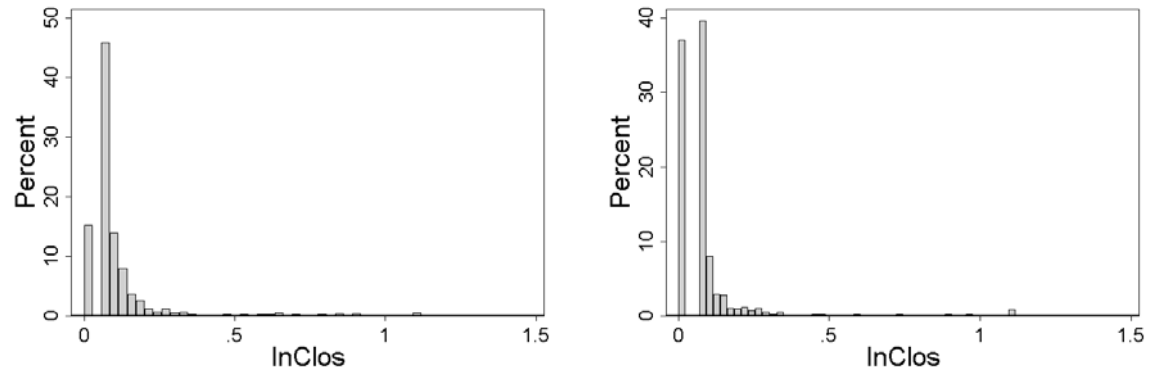
[37]Their wealth is estimated at approx. 18.5 and 15.5 billion USD. See Forbes Special Report 'The World's Billionaires' 03.10.2005.

Table 5: Most Central Companies and Entities

Rank	Company/Entity	#Indegree	Company/Entity	10^{-2} Indegree Closeness
1	Familie Albrecht	46	Allianz AG	3.28
2	Markus Stiftung	34	Münchener Rück AG	3.11
3	Lukas Stiftung	33	Familie Albrecht	1.66
4	Carolus-Stiftung	28	Republik Frankreich	1.62
5	Siepmann Stiftung	27	UniCredito Italiano SpA	1.44
6	Billen GmbH	26	Fondazione Cassa di Risparmio di Torino	1.35
7	Fenten GmbH	25	AVIVA Plc	1.35
8	Assicurazioni Generali SpA	25	Fondazione Cassa di Risparmio Verona[1)]	1.30
9	Allianz AG	20	Markus Stiftung	1.26
10	Coca-Cola Erfrischungsgetränke AG	18	Barclays PLC	1.24
11	E.ON Energie AG	14	The Capital Group Companies Inc.	1.23
12	AXA SA	13	Capital Research & Management[2)]	1.23
13	Nippon Life Insurance Ltd	13	Lukas Stiftung	1.22
14	Münchener Rück AG	13	Assicurazioni Generali SpA	1.21
15	Siemens AG	12	Ergo Versicherungsgruppe AG	1.16
16	EnBW Energie Baden-Württemberg AG	11	RAS Riunione Adriatica di Sicurtà SpA	1.14
17	Japan Trustee Services Bank Ltd	11	Mediobanca Banca dCF SpA[3)]	1.11
18	Ergo Versicherungsgruppe AG	10	Victoria Versicherung AG	1.11
19	The Mitsubishi Trust & Banking[4)]	10	Hamburg-Mannheimer SV AG	1.11
20	Sumitomo Mitsui Banking Corporation	10	Fondazione Cassamarca[5)]	1.11
21	Fidelity Management & Research[6)]	9	RB Vita SpA	1.11
22	Dai-Ichi Kangyo Bank Ltd[7)]	9	Europäische Reiseversicherung AG	1.11
23	UniCredito Italiano SpA	9	Carimonte Holding SpA	1.11
24	Thüga AG	9	Allianz Subalpina[8)]	1.11
25	RWE AG	8	D.A.S. AG[9)]	1.11
26	Mediobanca Banca dCF SpA[3)]	8	Fidelity Investments Ltd	1.10
27	Jakobus-Stiftung	8	Legal & General Group PLC	1.10
28	Adolf Merckle	8	D.A.S. AG[10)]	1.10
29	Vattenfall Europe AG	8	KarstadtQuelle Lebensversicherung AG	1.10
30	ThyssenKrupp AG	8	DKV Deutsche Krankenversicherung AG	1.10

Own Source: Full company names are provided to simplify identification of companies. #Indegree signifies the number of indegrees. $1) - 10)$ full names are provided in Table 9 in the Appendix. Note 9) and 10) have identical abbreviations but different full names. Further abbreviation: SV=Sachversicherung (property insurance). Translations: Lebensversicherung=life insurance, Krankenversicherung=health insurance, Reiseversicherung=travel insurance, Familie=family, Stiftung=foundation, Europäische=European, Republik Frankreich=France. The international company name of Münchner Rück is Munich Re Group.

Figure 2: Distribution of Indegree Closeness Centrality



(a) Full Sample (b) Reduced Sample

Own Source. InClos is the variable name of indegree closeness centrality. The abscissa is restricted to values below 1.5. As shown in Table 5, there are only two centrality values above this threshold. All indegree closeness centrality statistics are multiplied by 10^{-2}.

4.2 Analysing the Centrality Concept

In this subsection we identify several factors which are related to the centrality of all firms.[38] The relationship of the left-hand-side variable InClos, measuring the indegree closeness centrality of firms and covariates, is based on two samples. The first sample includes variables which are observed for all companies, i.e., 2784 observations are available. The second sample - also called reduced sample here - has a larger number of covariates but reduces the non-missing observations to 987. Figure 2 shows the distribution of InClos for both samples.

Hypotheses

Table 6 describes 24 right-hand side variables included in the estimation below. The Sign-column shows expected signs for each explanatory variable. For NET_MoG we expect a positive sign since nodes of larger network components typically exhibit higher indegree closeness centrality.

[38] Heinze (2004) applied the same methodology we adopted here to explain the centrality of interlocking directorates. However, we have some doubt about the validity of this method. The independence assumption prerequisite for the application of standard econometric methods is violated in the case of network data (see Gill and Swartz (2004)). Fortunately, if our doubts are unfounded, then results are viable and if our doubts are justified, then many results published in well-known journals may be error-prone since to the best of our knowledge the interdependencies among companies are always ignored. The issue of interdependence among observations is especially important since most studies focus on large companies which are often closely related in one form or another form.

In contrast, we expect a negative sign for firms having a turnover above 1 billion euro. These companies are often only operational entities controlled by holdings and other shareholders who are not involved in management decisions but have a great impact on firm strategies. We also expect that large firms are more central than smaller ones. Hence, positive signs are allocated to LF_Inc, List, and ACC_Tot. We assume that all other legal forms have a negative impact upon the indegree closeness centrality since they indicate smaller firms, personally liable partners, or states entities. We also include a legal form indicator variable for missing observations to check whether important information may be contained there.

The results of Table 5 suggests positive coefficients for French, Italian, and Japanese companies. Companies from the United Kingdom and the United States outnumber all other countries, but only little evidence for a high centrality of UK or US firms is found. Therefore, negative signs are assumed. Also, the German country variable COU_Ger is likely to be negative because the distribution of the centrality measure in Figure 2 implies that most firms are unimportant for the whole network, whereas only a few are powerful. Since most vertices are German companies, a negative sign for COU_Ger is expectable.

Banks and insurance companies were found to be central corporations in Germany (cf. Höpner and Krempel (2004)). The public utility companies described above might also be powerful. Hence, positive signs are expected for the first three industries mentioned in Table 6. Other industries may be less involved in the corporate company network. In contrast to these industries, negative signs for the manufacturing industry and trade industry are in accordance with our expectations. We also assume a positive sign for the regressor variable Multi since firms offering various products may have stronger incentives to be interwoven with many other companies. Finally, higher profits as well as strong equity positions measured by ACC_Pro and ACC_Equ should both positively affect the probability of acquiring other firms or expand a business and are likely to increase the centrality of a company.[39]

Econometric Models

In Table 7 results of the ordinary least squares regression are reported where we regress the indegree closeness centrality upon firm characteristics (see Table 6 for variable names). Table 7 contains two Sub-Tables 7A and Sub-Table 7B. The first table reports coefficients and p-values of full-sample regressions, i.e., only firm characteristics being observed for all 2784 companies in the network are included. Equation 2 shows the estimation of column OLS_{A1}.

$$InClos = \beta_0 + \beta_1 NET + \beta_2 LF + \beta_3 IND + \beta_4 COU + \beta_5 Multi + \beta_6 List + u \tag{2}$$

where variable names in capitals indicate vectors (containing all variables of each variable group) and u is the error term. Sub-Table 7B contains also coefficients of accounting variables ACC

[39]Notice, for all variable groups the reference group always contains all other companies.

Table 6: Covariates available for the Explanation of Indegree Closeness Centrality

Category (abbr.)	Variable	Description	Sign
Network	NET_MoG	Indicates firms being a member of the giant component	+
(NET)	NET_597	Indicates firms having a turnover above 1 bill. Euro	–
Legal Form	LF_Inc	Indicates incorporated companies	+
(LF)	LF_Ltd	Indicates limited companies	–
	LF_Par	Indicates partnerships	–
	LF_PP	Indicates personally liable partners	–
	LF_Sta	Indicates state enterprises/state entities	–
	LF_Mis	Indicator variables for missing observations	+–
Industry	IND_Ins	Indicates insurance companies	+
(IND)	IND_Ban	Indicates banks	+
	IND_Uti	Indicates public utility companies	+
	IND_Man	Indicates manufacturing companies	–
	IND_Tra	Indicates wholesale and retail companies	+–
Country	COU_Ger	Indicates German firms or entities	–
(COU)	COU_Fra	Indicates French firms or entities	+
	COU_Ita	Indicates Italian firms or entities	+
	COU_Jap	Indicates Japanese firms or entities	+
	COU_UK	Indicates British firms or entities	–
	COU_USA	Indicates U.S. firms or entities	–
Conglomerate	Multi	Indicates firms being active in a main industry and at least five sub-industries	+
Listed	List	Indicates firms having positive market capitalization	+
Accounting	ACC_Tot	Balance sheet total	+
(ACC)	ACC_Pro	Annual net profit	+
	ACC_Equ	Equity Capital	+

Own Source: All variables of the first six categories (from the Network-category up to the Listed-category) are indicator variables and are observed for the whole sample - 2784 companies. The variables of the Accounting category is observed for 987 companies.

being observed for only 987 German companies. Hence, the estimation results shown in column OLS_{B1} are based on Equation 2 where the country vector COU is excluded but equity capital, balance sheet total, and annual net profit are inserted. Using the full variable set in columns $OLS_{\cdot 1}$ – the dot in the subscript here is used to indicate that the statement holds for both the full sample and the reduced sample – is appropriate due to the low degree of multicollinearity being found among indicator variables. In contrast, the correlations among accounting variables themselves are large enough to affect estimation results, as shown below.[40]

In the second column of each Sub-Table we report the results of a stepwise regression which repeatedly decrements all insignificant variables until 5%-significant variables having coefficients above 0.05 in absolute value are left over. One disadvantage of our approach is that the indicator variables only measure average effects for each group. Hence, the centrality difference between banks and insurers in France is the same as between banks and insurers in Italy. Furthermore, the distribution of centrality shown in Figure 2 indicates a nonlinear relationship similar to a hyperbola. Therefore, we can assume that indegree closeness centrality increases more sharply if an already fairly central company adds a power-enhancing characteristic than if a peripheral company adds the same characteristic. A simple solution to take into account this form of nonlinearity is a semi-log specification in a linear model. However, this specification is not applicable due to company centralities of zero. Instead, nonlinear least squares is applied to Equation 3 and Equation 4.

$$\begin{aligned} InClos &= \exp(\beta_0 + \beta_1 NET\_597 + \beta_2 IND\_Ins + \beta_3 IND\_Ban + \\ &\quad \beta_4 COU\_Fra + \beta_5 COU\_Ita + \beta_6 COU\_Jap) + \epsilon_A \end{aligned} \tag{3}$$

$$\begin{aligned} InClos &= \exp(\beta_0 + \beta_1 NET\_597 + \beta_2 LF\_Inc + \beta_3 LF\_Ltd + \\ &\quad \beta_4 LF\_oth + \beta_5 IND\_Ins + \beta_6 ACC\_Tot + \beta_7 ACC\_Tot^2) + \epsilon_B \end{aligned} \tag{4}$$

where all variables are scalars, $exp(.)$ indicates the exponential function, and ϵ_A and ϵ_B are error terms. Regression results of Equation 3 are given in column NLS_A whereas column NLS_B reports results of Equation 4. In each estimation only significant variables which are left over in the linear stepwise regression are used as regressors in the nonlinear estimation.

Regression Results

The ordinary least squares regressions in columns $OLS_{\cdot 1}$ and $OLS_{\cdot 2}$ are discussed first. For each of the indicator variable groups the reference group are the other companies. The network variables are statistically and economically significant and have the expected signs. Firms which are a member of the giant component have a higher centrality, whereas industrial enterprises

[40] The correlations mentioned are ρ(ACC_Tot,ACC_Pro)=0.386, ρ(ACC_Tot,ACC_Equ)=0.411, ρ(ACC_Equ,ACC_Pro)=0.767.

having large turnovers above one billion euro tend to have smaller centrality measures than average firms. Four out of five legal form variables confirm our expectations. Contrary to expectations, LF_Inc has a negative sign. In regression A, the coefficient is statistically insignificant whereas it is highly significant in the reduced-sample regression. This slight difference might be caused by correlation between List and LF_Inc of 0.388 in regression A and 0.517 in regression B. This line of argument is also underpinned by the observation that List is an important variable in the full-sample regression A and not included in B. In regression B no coefficient is available for LF_PP since accounting information excludes private individuals. The variable LF_Mis indicates the missing observations. In regression A no important influence is measured whereas in B the coefficients are statistically significant. However, in the first regression 131 observations are labelled as a missing variable, whereas only five are left in the reduced sample.

Among the coefficients of industry variables the largest values are observed for insurance companies. This confirms our results from the previous Sub-Section where these companies are among the most central companies. At first sight, the results for banks are mixed. In the full-sample regression significant positive coefficients are found, however, no higher centrality can be reported in the reduced-sample regression. This is substantiated by the fact that banks have higher equity positions than non-banks. Excluding the variable ACC_Equ and inserting the bank indicator variable results in a 5%-significant coefficient of 0.102.[41] Therefore, we confirm the result of Pappi et al. (1987) and Höpner and Krempel (2004), i.e. that banks are still among the most powerful German companies. Expectations are also confirmed with respect to other industry variables. However, only IND_Man is significant at the 5% level in column OLS_{B1}. All other coefficients have the assumed sign but are insignificant.

Similarly, the signs and sizes of country variable coefficients in the full-sample regression correspond to expectations for France, Italy, and Japan. The strongest impact is found for Italy. The coefficient for the United States is negative, as assumed, but insignificant. For the United Kingdom and Germany results are not in accordance with expectations. In fact, for Germany the coefficient is also significant but the overall impact on closeness centrality is relatively small. After correcting for multicollinearity, among the three accounting information equity capital seems most relevant (compare regressions OLS_{B1} and OLS_{B2}). Larger companies exhibit higher centrality measures. Consequently, a concave relationship is calculated since the marginal effect decreases with the size of ACC_Equ. Given the high equity positions of banks, it is natural to check the importance of ACC_Equ for non-banks. Excluding banks from our reduced sample leaves 943 observations. Again, results for ACC_Equ and ACC_Equ^2, as well as for all other variables, are verified.[42] Finally, we found a positive and significant relationship for the variables

[41] The corresponding p-value is 0.018.

[42] The new coefficients and p-values are .0256218 (0.004) and -.0003575 (0.019).

Multi and List. But a strong influence can only be measured for List, whereas Multi is dropped in the stepwise regressions $OLS_{\cdot 2}$. Hence, not only large but also listed companies are more central.

The coefficients of nonlinear least squares estimation strengthen the results of the OLS regression. All results with respect to sign and magnitude are confirmed. To compare the magnitudes of characteristics on centrality the coefficients must be plugged into Equation 3 and Equation 4. Then the fitted centrality for Italian banks is $\exp(-2.093 + 0.399 + 1.319) = 0.687$, whereas the centrality based on coefficients in OLS_{A2} is 0.606. French insurance companies using the results reported in column NLS_{A} is $\exp(-2.093 + 0.842 + 0.547) = 0.495$, which is close to closeness centrality based on coefficients in OLS_{A2} is 0.506.[43] Hence, our results seem quite robust to different specifications.

[43]The last value rests upon the following equation 0.114+0.248+0.144=0.506.

Table 7: (Non-)Linear Least Squares Estimation

Table 7 contains several regression results. In each estimation the dependent Variable is InClos, the indegree closeness centrality. The Table is split into two Sub-Tables 7A and 7B. The regression results shown in the first Sub-Table are based on the full sample, whereas the regression results in the second Sub-Table is based only on 987 observations. However, the reduced sample includes also accounting information of German companies. The first two columns of each Sub-Table are estimated by ordinary least squares, whereas the last column reports results of nonlinear least squares estimation.

Sub-Table 7A

	Full Sample		
Variable	OLS_{A1}	OLS_{A2}	NLS_{A}
Network Variables			
NET_MoG	0.043**		
	(0.000)		
NET_597	-0.100**	-0.084**	-1.120**
	(0.000)	(0.000)	(0.000)
Legal Form Variables			
LF_Inc	-0.046		
	(0.127)		
LF_Ltd	-0.076**		
	(0.009)		
LF_Par	-0.068*		
	(0.021)		
LF_PP	-0.078**		
	(0.009)		
LF_Sta	-0.061^{+}		
	(0.068)		
LF_Mis	-0.006		
	(0.871)		
Industry Variables			
IND_Ins	0.229**	0.248**	0.842**
	(0.000)	(0.000)	(0.000)
IND_Ban	0.054*	0.066**	0.399**
	(0.029)	(0.007)	(0.000)
IND_Uti	0.007		
	(0.524)		

Sub-Table 7B

	Reduced Sample		
Variable	OLS_{B1}	OLS_{B2}	NLS_{B}
Network Variables			
NET_MoG	-0.001		
	(0.916)		
NET_597	-0.070**	-0.081**	-0.835**
	(0.000)	(0.000)	(0.000)
Legal Form Variables			
LF_Inc	-0.080**	-0.061*	-0.719**
	(0.005)	(0.027)	(0.003)
LF_Ltd	-0.065*	-0.071**	-0.863**
	(0.010)	(0.005)	(0.000)
LF_Par	-0.065*	-0.074**	-0.870**
	(0.010)	(0.003)	(0.002)
LF_PP			
LF_Sta	-0.134**	-0.103*	-1.564**
	(0.009)	(0.021)	(0.000)
LF_Mis	-0.089	-0.143*	-2.164*
	(0.137)	(0.024)	(0.035)
Industry Variables			
IND_Ins	0.620**	0.613**	1.893**
	(0.000)	(0.000)	(0.000)
IND_Ban	0.004		
	(0.876)		
IND_Uti	0.021		
	(0.114)		

Sub-Table 7A continued

IND_Man	-0.005		
	(0.526)		
IND_Tra	0.005		
	(0.599)		
Country Variables			
COU_Ger	0.029**		
	(0.005)		
COU_Fra	0.134**	0.144**	0.547**
	(0.000)	(0.000)	(0.000)
COU_Ita	0.417**	0.426**	1.319**
	(0.000)	(0.000)	(0.000)
COU_Jap	0.096**	0.096**	0.433**
	(0.000)	(0.000)	(0.000)
COU_UK	0.044		
	(0.111)		
COU_USA	-0.019		
	(0.279)		
Other Variables			
Multi	0.051^{+}		
	(0.081)		
List	0.048^{+}	0.069**	0.443**
	(0.050)	(0.005)	(0.000)
Constant	0.134**	0.114**	-2.093**
	(0.000)	(0.000)	(0.000)
R^2	0.279	0.257	$0.466^{1)}$
#Obs	2784	2784	2784

Sub-Table 7B continued

IND_Man	-0.022*		
	(0.042)		
IND_Tra	0.003		
	(0.778)		
Accounting Variables			
ACC_Equ	0.030*	0.028**	0.208**
	(0.027)	(0.000)	(0.000)
ACC_Equ^2	0.000*	0.000**	-0.005**
	(0.046)	(0.002)	(0.000)
ACC_Tot	0.001^{+}		
	(0.053)		
ACC_Tot^2	0.000^{+}		
	(0.085)		
ACC_Pro	-0.114		
	(0.210)		
ACC_Pro^2	0.014		
	(0.224)		
Other Variables			
Multi	0.041*		
	(0.042)		
List	0.068^{+}		
	(0.053)		
Constant	0.150**	0.161**	-1.750**
	(0.000)	(0.000)	(0.000)
R^2	0.440	0.406	$0.689^{1)}$
#Obs	987	987	987

Data Source: Hoppenstedt KSD and Hoppenstedt Annual Data Information (www.bilanzen.de). p-values in parenthesis. 1%, 5%, 10% significance levels are labelled by **, *, $^{+}$. All except the accounting variables ACC_Pro, ACC_Tot, and ACC_Equ are indicator variables. The reference group for each variable group are the other variables. The coefficient of ACC_Equ^2 is -.0004953 in column OLS_{B1}, -.0004082 in column OLS_{B2}, and -.005028 in NLS_{B}. $^{1)}$ R^2 is not the standard goodness-of-fit since the nonlinear least squares regression contains no intercept.

5 Conclusion

Until now, researchers investigating ownership structures have been content with analysing small local company settings. The notion of patterns called pyramids or cross-holdings can be found over and over again in the existing literature. However, they represent nothing else than local network formations and are, of course, embedded in larger network structures. We believe that future analyses of ownership structures will be enhanced by network tools. For instance, network statistics might offer new variables such as centrality measures, distance to ultimate owners, etc. These variables might lead to new insights on the impact of ownership structures on firm performance. In particular, the continuation of company network analysis is attractive for researchers given the lack of data in the past and the huge data availability today and in coming years. Detailed data sets make it possible for researchers as well as consultants to perform much more detailed firm policies and, hence, take into account the firm-specific environment and dependence structures of companies. Following the adoption of the network methods, the German as well as the global corporate control system can be analysed in greater detail. Hence, we also believe that future researchers of company networks reviewing today's state of research will conclude that the literature was still in its infancy, since even in this article only large companies and their shareholders are taken into account.

We show that the global description of company networks is possible by analysing ownership structures among German companies in 2006. The financial linkages of a huge unique data set containing 2784 single companies were constructed and described. Several statistics - standard in the social network literature - were applied to discover general features of the company network. From our point of view, one major highlight is the MAN-classification scheme, offering a micro-macro perspective which simplifies both specific firm analysis as well as country-specific or global analyses of ownership structures. After the description of certain structural properties a centrality measure, the indegree closeness centrality, was calculated for all vertices. Finally, the explanation of the centrality vector was performed by applying standard econometric techniques.

Our primary results show that most central German companies are still banks and insurance companies. Given the results of Agarwal and Elston (2001) as well as Dittmann et al. (2005) that bank-controlled firms have not been able to outperform in the past our results might be interpreted as an undesirable network characteristic. Another interesting result is the high degree of internationalisation detected in the company network. Today, large German firms are multinational corporations themselves or are often strongly connected to other non-German multinationals. It is reasonable to assume that this fact is a major difference to earlier networks. We found that the UK and US firms in the German company network outnumber firms of other nations, although most Anglo-Saxon firms are less central than firms from other nations.

In particular, Italian corporations, but also French and Japanese companies, occupy central positions in the German corporate system. The results of the MAN-classification scheme (cf. Figure 3) indicate that especially cross-holdings and pyramids are the most common triad formations in the German company network. Other formations such as circles, which are found relatively often in absolute terms, are formed incidentally and are less often observed than in a random network. The importance of pyramids is also underpinned by the observation that in the giant network component which contains 1626 vertices the number of financial linkages with weights of about 60% and 75% is small, whereas in the total network there are many more such capital weights.

Finally, we turn our attention to the methodology applied and add a remark regarding the applied methodology. The start of the network literature is often traced back to Moreno (1934) - incidentally, at the same time Berle and Means (1932) initiated the discussion on separation of ownership and control. Hence, today after seven decades of research, there are much more elaborated network concepts than the ones applied. However, we deliberately stick to well-known but also well-established network statistics due to their simplicity. The use of more modern network techniques can be applied in future research. For instance, network researchers are on the verge of understanding network regression methods applicable to highly interdependent data (for an introduction to these new developments cf. Snijders (2005)). This research may open up new possibilities in social network analysis and, hopefully, will also contribute to the company network literature.

References

Agarwal, R. and J. A. Elston (2001), Bank-Firm Relationships, Financing, and Firm Performance in Germany, Economic Letters, 72, 225-232.

Allen, J. W. and G. M. Phillips (2000), Corporate Equity Ownership, Strategic Alliances, and Product Market Relationships, Journal of Finance, 55, 6, 2791-2815.

Attig, N, K. Fischer, and Y. Gadhoum (2003), On the Determinants of Pyramidal Ownership: Evidence on Dilution of Minority Interests, Working Paper.

Barabási, A.-L. and R. Albert (1999), Emergence of Scaling in Random Networks, Science, 286, 509-512.

Beauchamp, M. A. (1965), An improved index of centrality, Behavioral Science, 10, 161-163.

Bebchuk, L. A., R. Kraakman, and G. Triantis (2000), Stock Pyramids, Cross-Ownership and Dual Class Equity: The Mechanisms and Agency Costs of Separating Control From Cash-Flow Rights, Concentrated Corporate Ownership, R. Morck, ed. 445-460.

Becht, M., E. Boehmer (2003), Voting control in German corporations, International Review of Law and Economics, 23, 1-29.

Becht, M., A. Röell (1999), Blockholdings in Europe: An international comparison, European Economic Review, 43, 1049-1056.

Berle, A., G. Means (1932), The Modern Corporation and Private Property, New York, Macmillan.

Bertrand, M., P. Mehta, S. Mullainathan (2002), Ferreting out Tunneling: An Application to Indian Business Groups, Quarterly Journal of Economics, 117, 1, 121-148.

Chapelle, A., A. Szafarz (2005), Controlling firms through the majority voting rule, Physica A, 355, 509-529.

Claessens, S., S. Djankov, and L. Lang (2000), The Separation of Ownership and Control in East Asian Corporations, Journal of Financial Economics, 52, 81-112.

de Nooy, W., A. Mrvar, and V. Batagelj (2005), Exploratory Social Network Analysis with Pajek, CUP.

Del Guercio, D. and J. Hawkins (1999), The motivation and impact of pension fund activism, Journal of Financial Economics 52, 3, 293-340.

Dittmann, I., E. Maug, and C. Schneider (2005), Bankers and the Performance of German Firms, Working Paper, University of Mannheim.

Edwards, J. S. S. and A. J. Weichenrieder (2004), Ownership Concentration and Share Valuation, German Economic Review, 5, 2, 143.

Fee, C. E., C. J. Hadlock, and T. Shawn (2006), Corporate Equity Ownership and the Governance of Product Market Relationships, Journal of Finance, 61 3, 1217-1251.

Fohlin, C. (2005), The History of Corporate Ownership and Control in Germany, in The History of Corporate Governance Around the World: Family Business Groups to Professional Managers, ed. by R. K. Morck, forthcoming. Unviersity of Chicago Press, Chicago, IL.

Franks, J. R. and C. Mayer (2001), "Ownership and Control of German Corporations", Review of Financial Studies, 14, 4, 943-977.

Franks, J. R., C. Mayer and H. F. Wagner (2005), The Origins of the German Corporation - Finance, Ownership and Control, ECGI - Finance Working Paper No. 110/2005.

Freeman, L.C. (1979), Centrality in affiliation networks, Social Networks, 19, 2, 157-191.

Gill, P. S. and T. B. Swartz (2004), Bayesian analysis of directed graphs with applications to social networks, Applied Statistics, 53, 2, 249-260.

Goergen, M. M.C. Manjon, and L. Renneboog (2004), Recent Developments in German Corporate Governance, ecgi, Finance Working Paper No. 41.

Godsil, C. and G. Royle (2001), Algebraic Graph Theory, Graduate Texts in Mathematics, Springer Verlag.

Gorton, G. and F. A. Schmid (2000), Universal banking and the performance of German firms, Journal of Financial Economics, 58, 29-80.

Gugler, K. (2001), Corporate Governance and Economic Performance, (ed.), Oxford University Press.

Heinze, T. (2004), Dynamics in the German System of Corporate Governance? Empirical Findings regarding Interlocking Directorates, Economy & Society 33(2), 218-238

Holland, P. W. and S. Leinhardt (1970), A method for detecting structure sociometric data, American Journal of Sociology, 76, 492-513.

Höpner, M. and L. Krempel (2004), The Politics of the German Company Network, Competition and Change 8(4), 339-356.

Johnson, S., R. La Porta, F. Lopez-de-Silanes, A. Shleifer (2000), Tunneling, American Economic Review, 90, 22-27.

Kogut, B. and G. Walker (2001), The Small World of Germany and the Durability of National Networks, American Sociological Review 66(3), 317-335.

Köke, F. J. (1999), New evidence on ownership structures in Germany, ZEW Working Paper No. 99-60, Mannheim.

Koschützki, D. K. A. Lehmann, L. Peeters, S. Richter, D. Tenfelde-Podehl and O. Zlotowski (2005), Centrality Indices, 16-61, in Network Analysis, Eds. Ulrik Brandes and Thomas Erlebach, Lecture Notes in Computer Science, Springer.

Kruse, T. A. (2005), Ownership, Control and Shareholder Value in Italy: Olivetti's Hostile Takeover of Telecom Italia, Finance Working Paper, 83, University of Arkansas.

La Porta, R., F. Lopes-de-Silanes, A. Shleifer and R. W. Vishny (1998), Law and finance, Journal

of Political Economy, 106, 1113-1155.

La Porta, R., F. Lopes-de-Silanes, and A. Shleifer (1999), Corporate Ownership Around the World, Journal of Finance, 54, 2, 471-517.

La Porta, R., F. Lopes-de-Silanes, A. Shleifer and R. W. Vishny (2002), Investor Protection and Corporate Valuation, Journal of Finance, 57, 3, 1147-1170.

Lemmon, M. L., K. V. Lins (2003), Ownership Structure, Corporate Governance, and Firm Value: Evidence from East Asian Financial Crisis, Journal of Finance, 58, 4, 1145-1168.

La Porta, R., F. Lopes-de-Silanes, A. Shleifer and R. W. Vishny (2002), Investor Protection and Corporate Valuation, Journal of Finance, 57, 3, 1147-1170.

Lincoln, J. R., M. Gerlach, and C. Ahmadjian (1996), Keiretsu networks and corporate performance in Japan, American Sociological Review, 61, 67-88.

Lincoln, J. R. and M. Gerlach (2004), Japan's Network Economy: Structure, Persistence, and Change, New York: Cambridge University Press, 2004.

Maury, B. (2005), Family ownership and firm performance: Empirical evidence from Western European corporations, Journal of Corporate Finance, 12, 321-341.

Meoli, M., S. Paleari, G. Urga (2006), When controlling shareholders "live like kings". The case of Telecom Italia., Working Paper.

Mitzenmacher, M. (2003), A Brief History of Generative Models for Power Law and Lognormal Distributions, Internet Mathematics, 1, 2, 226-251.

Miyajima, H. and F. Kuroki (2005), The Unwinding of Cross-Shareholding in Japan: Causes, Effects, and Implications, RIETI Discussion Paper Series 05-E-006.

Moreno, J. L. (1934), Who Shall Survive? Foundations of Sociometry, Group Psychotherapy and Sociodrama. Nervous and Mental Disease Publishing Company, Washington, DC.

Newman, M. E. J. (2001), Scientific collaboration networks. II. Shortest paths, weighted networks, and centrality, Physical Review E, 64.

Nowak, E., O. Ehrhardt, and F. M. Weber (2006), 'Running in the Family': The Evolution of Ownership, Control, and Performance in German Family-Owned Firms, 1903-2003, Swiss Finance Institute Research Paper No. 06-13.

Pappi, F. U., P. Kappelhoff and C. Melbeck (1987), Die Struktur der Unternehmensverflechtungen in der Bundesrepublik. Eine Blockmodellanalyse der Personal- und Kapitalverflechtungen zwischen den größten Unternehmen, Kölner Zeitschrift für Soziologie und Sozialpsychologie 39(4), 693-717.

Sabidussi, G. (1966), The centrality index of a graph, Psychometrika, 31, 581-603, 1966.

Schnyder, G, M. Lüpold, A. Mach and T. David (2005), The Rise and Decline of the Swiss Company Network during the 20th Century, Working Paper, Université de Lausanne.

Snijders, T. A. B. (2005), Models for Longitudinal Network Data, Chapter 11 in Models and

Methods in Social Network Analysis, 215-247, edited by Peter Carrington, John Scott, and Stanley Wasserman, Cambridge University Press.

Terberger, E. (2003), The German financial system: great institutional change and little effect?, Journal of Theoretical and Institutional Economics, 159, 707-716.

Watts, D. and S. Strogatz (1998), Collective Dynamics of 'Small World' Dynamics, Nature 393, 440-442.

Villalonga, B. and R. Amit (2006), How do family ownership, control and management affect firm value?, Journal of Financial Economics, 80, 2, 385-417.

Wasserman, S. and K. Faust (1994), Social Network Analysis: Methods and Applications, Cambridge University Press.

Windolf, P. and J. Beyer (1996), Cooperative Capitalism, British Journal of Sociology 47, 205-231.

Windolf, P. (2002), Corporate Networks in Europe and the United States, Oxford University Press.

Windolf, P. (2005), The Emergence of Corporate Networks in Germany and the United States 1896-1938, Working Paper.

Yafeh, Y., and O. Yosha (2003), Large Shareholders and Banks: Who Monitors and How?, Economic Journal, 113, 128-146.

6 Appendix

Table 8: Probabilities in a Random Network

Conditional Probabilities for each triad type			
$P(003\|0L) = 1$			
$P(012\|1L) = 1$			
$P(102\|2L) = 0.2$	$P(021D\|2L) = 0.2$	$P(021U\|2L) = 0.2$	$P(021C\|2L) = 0.4$
$P(111D\|3L) = 0.3$	$P(111U\|3L) = 0.3$	$P(030T\|3L) = 0.3$	$P(030C\|3L) = 0.1$
$P(201\|4L) = 0.2$	$P(120D\|4L) = 0.2$	$P(120U\|4L) = 0.2$	$P(120C\|4L) = 0.4$
$P(210\|5L) = 1$			
$P(300\|6L) = 1$			
Probabilities that a certain number of links is formed in a triad.			
$P(0L) = \binom{6}{0}p^0(1-p)^6$			
$P(1L) = \binom{6}{1}p^1(1-p)^5$			
$P(2L) = \binom{6}{2}p^2(1-p)^4$			
$P(3L) = \binom{6}{3}p^3(1-p)^3$			
$P(4L) = \binom{6}{4}p^4(1-p)^2$			
$P(5L) = \binom{6}{5}p^5(1-p)^1$			
$P(6L) = \binom{6}{6}p^6(1-p)^0$			

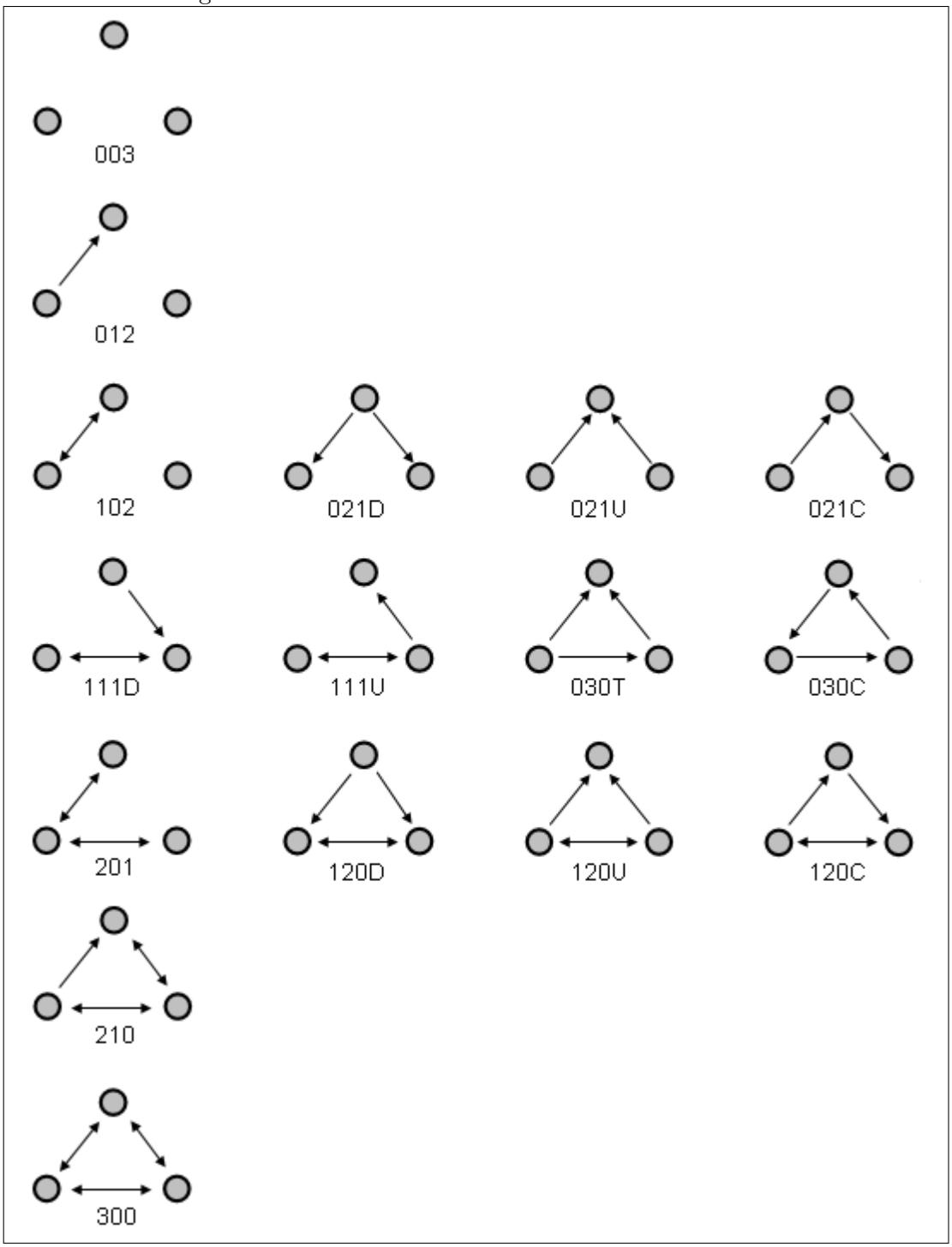
Own Source: A random network is defined as a network where each link has the same formation probability p. In our case $p = \frac{Existing\ Links}{Maximal\ Number\ of\ Links} = \frac{3711}{2784\ 2783} = 0.00047897$. Therefore, the expected number of triads which include many arcs in Table 3, for instance number of 300-triad, 210-triads, etc., is close to zero. 0L=zero links are formed, 1L=one link is formed,. . . ,6L=six links are formed. It holds that $P(2L) = P(102) + P(021D) + P(021U) + P(021C)$ and similar for $P(3L)$ and $P(4L)$.

Table 9: Full Company Names abbreviated in Table 5

Footnote	Company
1)	Fondazione Cassa di Risparmio Verona, Vicenza, Belluno e Ancona
2)	Capital Research & Management Company
3)	Mediobanca Banca di Credito Finanziario S.p.A.
4)	The Mitsubishi Trust & Banking Corporation (Mitsubishi Shintaku Ginko)
5)	Fondazione Cassamarca - Cassa di Risparmio della Marca Trivigniana
6)	Fidelity Management & Research Company
7)	The Dai-Ichi Kangyo Bank, Ltd. (Dai-Ichi Kangyo Ginko)
8)	Allianz Subalpina Società di assicurazioni e riassicurazioni
9)	Deutscher Automobil Schutz Allgemeine Rechtsschutz-Versicherungs-AG
10)	D.A.S. Deutscher Automobil Schutz Versicherungs-AG.

Own Source.

Figure 3: All Triads in the MAN-Classification Scheme



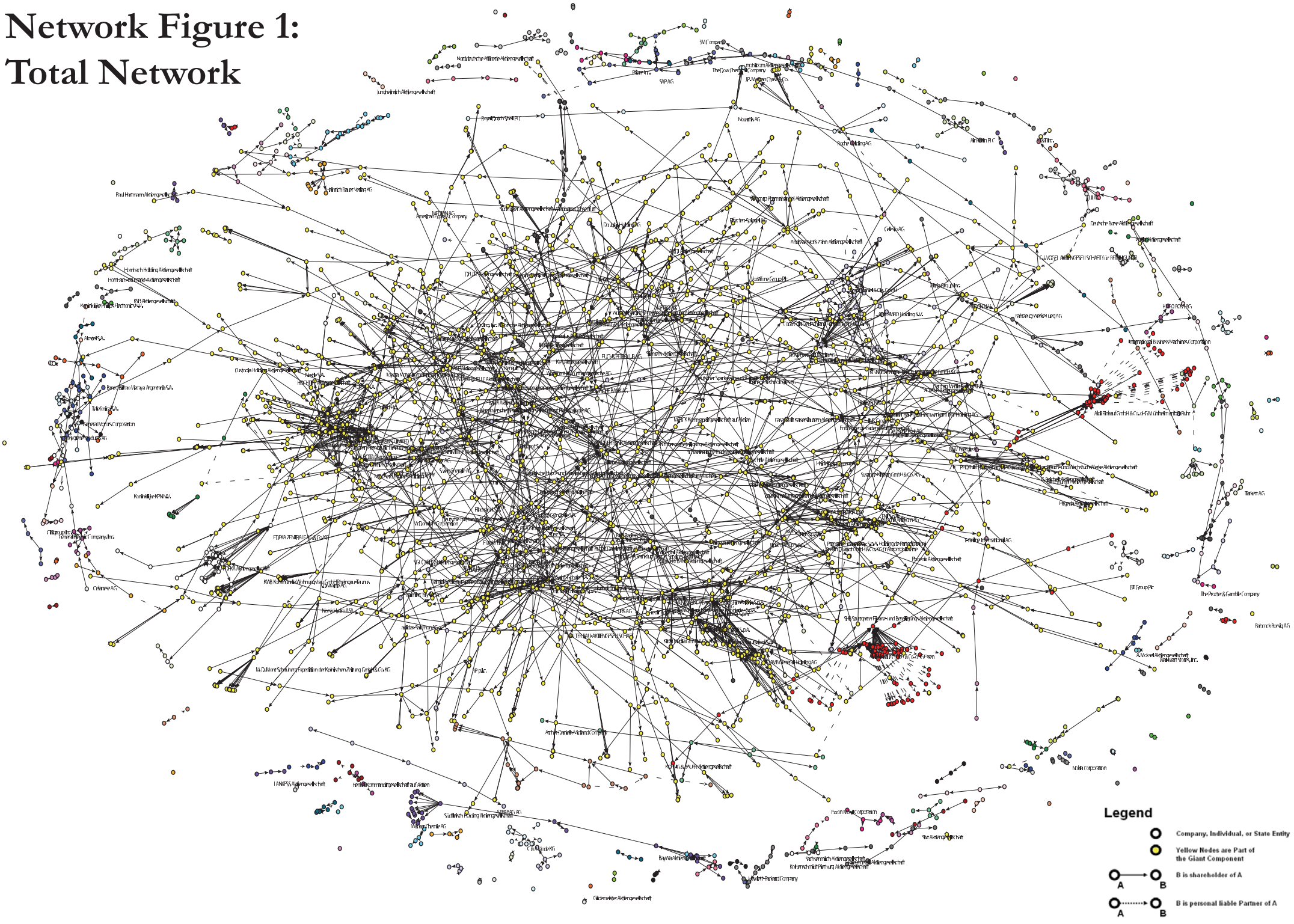
Source: "The triad isomorphism classes (with standard MAN labeling)", Wasserman and Faust (1994), p. 566. The first three number counts the number of mutual dyads M, asymmetric dyads A, and null dyads N. The letter behind the number distinguishes otherwise identical triad formations from each other: D=Down, U=Up, C=Cycle, and T=Transitive.

Table 10: Legal Forms of Companies in our Sample

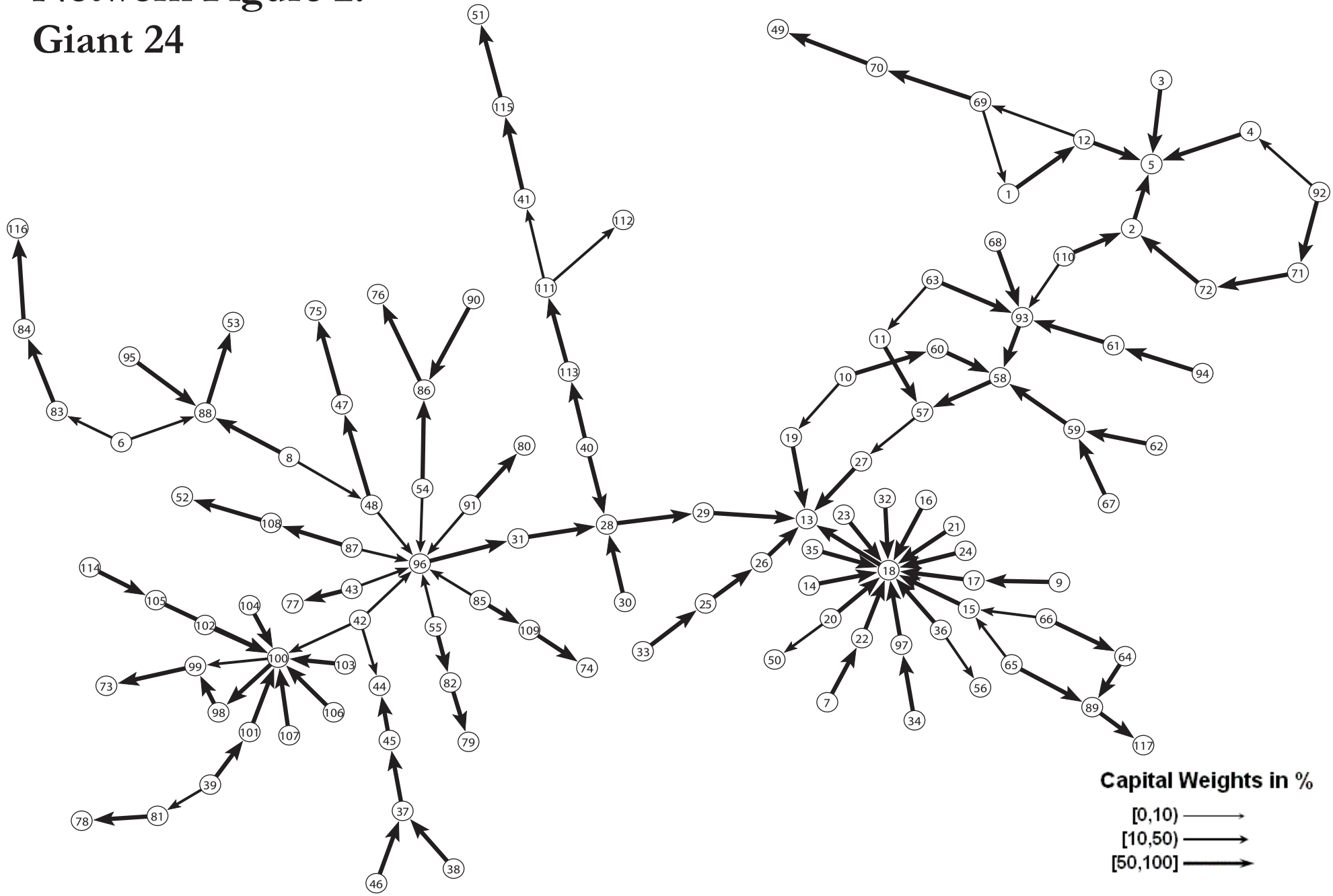
Abbreviation	Countries	Local Name	Group	#Obs
A/S	Denmark	Aktieslskab	Inc.	9
AB	Sweden	Aktiebolag	Inc.	15
AG	Germany	Aktiengesellschaft	Inc.	374
AG & Co KG	Germany		Inc.	16
ASA	Norway	Allmennaksjeselskap	Inc.	2
BV	The Netherlands	Besloten Vennootshap met beperkte aansprakelijkheid	Ltd.	44
CV	The Netherlands	Commanditaire Vennootschap	Partner	2
e.G.	Germany	eingetragene Genossenschaft	Other	26
e.V.	Germany	eingetragener Verein	Other	4
Foundation	Anglo-Saxon		Other	1
GbR	Germany	Gesellschaft des bürgerlichen Rechts	Other	4
GmbH	Germany	Gesellschaft mit beschränkter Haftung	Ltd.	816
GmbH & Co. KG	Germany		Partner	213
GmbH & Co. oHG	Germany		Partner	16
KG	Germany	Kommanditgesellschaft	Partner	43
KGaA	Germany	Kommanditgesellschaft auf Aktien	Inc.	7
LLC	USA	Limited Liability Company	Partner	22
LLP	USA, UK	Limited liability partnership	Partner	3
LP	USA	Limited Partnership	Ltd.	16
Ltd.	UK	Limited	Ltd.	133
NV	Belgium	Naamloze Vennootschap	Inc.	37
	The Netherlands	Naamloze Vennootschap	Inc.	
oHG	Germany	offene Handelsgesellschaft	Partner	4
PLC	UK	Public company limited by shares	Inc.	31
SA	Belgium	Société Anonyme	Inc.	120
	Brazil	Sociedade Anônima	Inc.	
	France	Société Anonyme	Inc.	
	Luxembourg	Société Anonyme	Inc.	
	Portugal	Sociedade Anônima	Inc.	
	Spain	Sociedad Anónima	Inc.	
SARL	France	Societe a responsabilite limitee	Ltd.	14
	Luxembourg	Societe a responsabilite limitee	Ltd.	
SAS	France	Société par Actions Simplifiée	Inc.	7
SCA	France	Société en commandite par actions	Inc.	4
SPA	Italy	Societa per azioni	Inc.	68
Stiftung	Germany	Stiftung	Other	34

Own Source: #Obs signifies the number of observations in the data set.

Network Figure 1: Total Network



Network Figure 2: Giant 24

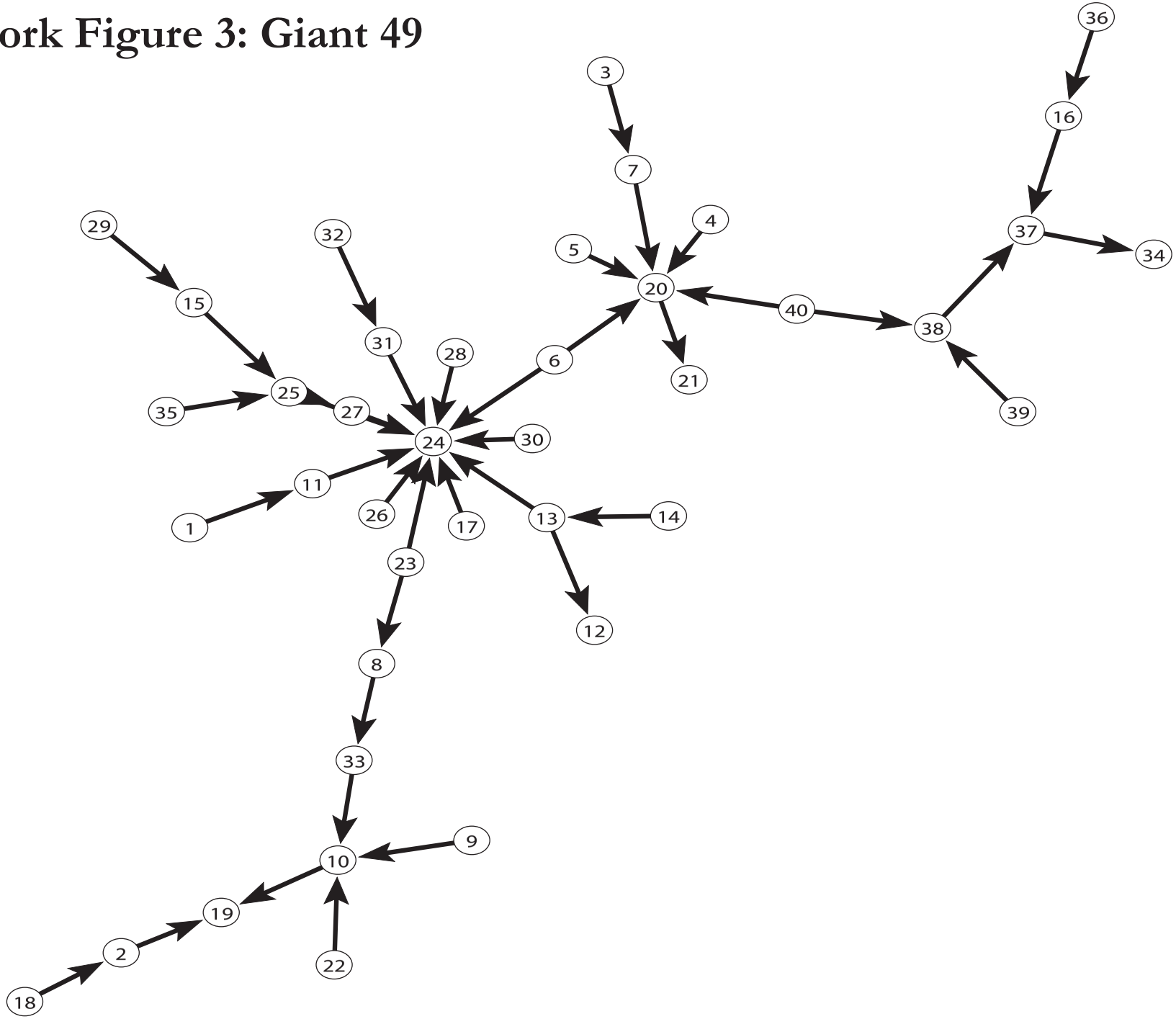


Giant 24

This is the Giant Component of the Complete Network where all links below 24% are deleted.

1 Aktien-Gesellschaft der Dillinger Hüttenwerke
2 ARBED S.A.
3 Arcelor Eisenhüttenstadt GmbH
4 Arcelor Germany Holding GmbH
5 Arcelor S.A.
6 Bayerngas GmbH
7 BKB AG
8 citiworks AG
9 CONTIGAS Deutsche Energie-AG
10 Degussa AG
11 Deutsche Steinkohle AG
12 DHS - Dillinger Hütte Saarstahl AG
13 E.ON AG
14 E.ON Avacon AG
15 E.ON Bayern AG
16 E.ON edis AG
17 E.ON Energie 26. Beteiligungs-GmbH
18 E.ON Energie AG
19 E.ON Finanzanlagen GmbH
20 E.ON Hanse AG
21 E.ON Kernkraft GmbH
22 E.ON Kraftwerke GmbH
23 E.ON Mitte AG
24 E.ON Netz GmbH
25 E.ON Nordic AB
26 E.ON Nordic Holding GmbH
27 E.ON RAG-Beteiligungsgesellschaft mbH
28 E.ON Ruhrgas AG
29 E.ON Ruhrgas Holding GmbH
30 E.ON Ruhrgas International AG
31 E.ON Ruhrgas Thüga Holding GmbH
32 E.ON Sales & Trading GmbH
33 E.ON Sverige AB
34 E.ON Thüringer Energie AG
35 E.ON Wasserkraft GmbH
36 E.ON Westfalen Weser AG
37 EEG - Erdgas Erdöl GmbH
38 EEG - Erdgas Transport GmbH
39 EnergieSüdwest AG
40 Erdgasversorgungsgesell. Thür.-Sa. mbH (EVG)
41 EWE AG
42 Gasag Berliner Gaswerke AG
43 Gasanstalt Kaiserslautern AG
44 Gaz de France Berliner Investissements SAS
45 Gaz de France Deutschland GmbH
46 Gaz de France Produktion Expl. Deutschland GmbH
47 HEAG AG
48 HEAG Südhessische Energie AG (HSE)
49 Jean Lang
50 Kreise
51 Landeselektrizitätsverband Oldenburg
52 Landeshauptstadt Hannover
53 Landeshauptstadt München
54 Mainova AG
55 N-ERGIE AG
56 Öffentliche Gebietskörperschaften
57 RAG AG
58 RAG Beteiligungs-GmbH
59 RAG Coal International AG
60 RAG Projektgesellschaft mbh
61 RAG Saarberg GmbH
62 RAG Trading GmbH
63 RAG Verkauf GmbH
64 Regensburger Badebetriebe GmbH
65 Regensburger Energie- und Wasserversorgung AG
66 Rewag Regensburger Ener.- und Wass. AG & Co KG
67 Rütgers GmbH
68 Saar Ferngas AG
69 Saarstahl AG
70 SHS - Struktur-Holding-Stahl GmbH & Co. KGaA
71 SIDARSTEEL N.V.
72 SIDMAR N.V.
73 Staat Schweden
74 Stadt Chemnitz
75 Stadt Darmstadt
76 Stadt Frankfurt am Main
77 Stadt Kaiserslautern
78 Stadt Landau
79 Stadt Nürnberg
80 Stadt Zweibrücken
81 Stadtholding Landau in der Pfalz GmbH
82 Städtische Werke Nürnberg GmbH
83 Stadtwerke Augsburg Energie GmbH
84 Stadtwerke Augsburg Holding GmbH
85 Stadtwerke Chemnitz AG
86 Stadtwerke Frankfurt am Main Holding GmbH
87 Stadtwerke Hannover AG
88 Stadtwerke München GmbH
89 Stadtwerke Regensburg GmbH
90 Stadtwerke Strom-/Wärmeversorgungsgesell. mbH
91 Stadtwerke Zweibrücken GmbH
92 Stahlwerke Bremen GmbH
93 STEAG AG
94 STEAG Saar Energie AG
95 SWM Versorgungs GmbH
96 Thüga AG
97 Thüringer Energie-Beteiligungsgesellschaft mbH
98 Vattenfall (Deutschland) GmbH
99 Vattenfall AB
100 Vattenfall Europe AG
101 Vattenfall Europe Berlin AG & Co. KG
102 Vattenfall Europe Berlin Verwaltungs-AG
103 Vattenfall Europe Generation AG & Co. KG
104 Vattenfall Europe Generation Verwaltungs-AG
105 Vattenfall Europe Hamburg AG
106 Vattenfall Europe Sales GmbH
107 Vattenfall Europe Transmission GmbH
108 Versorgungs- und Verkehrsgesellschaft Hannover mbH
109 Versorgungs- und Verkehrshold. GmbH Chemnitz (VVHC)
110 Verwaltungsgesellschaft RAG-Beteiligung mbH
111 VNG - Verbundnetz Gas AG
112 VNG Verbundnetz Gas Verwaltungs- und Bet.-GmbH
113 VNG-Erdgascommerz GmbH
114 WEMAG AG
115 Weser-Ems-Energiebeteiligungen GmbH
116 Stadt Augsburg
117 Stadt Regensburg

Network Figure 3: Giant 49

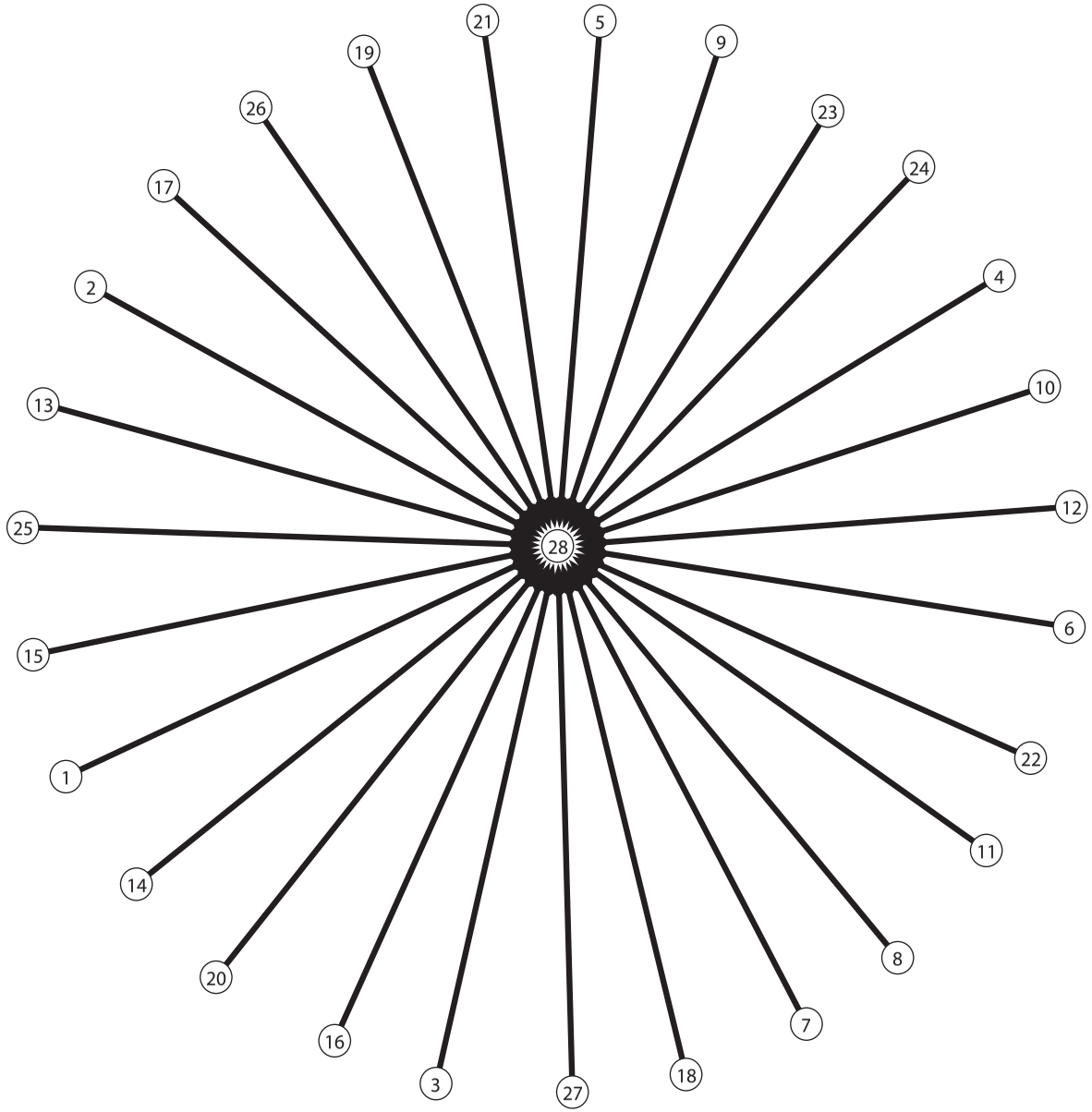


Giant 49

This is the Giant Component of the Complete Network where all links below 49% are deleted.

1 A. Friedr. Flender Aktiengesellschaft
2 Automobiles Peugeot S.A.
3 BBT Thermotechnik GmbH
4 Blaupunkt GmbH
5 Bosch Rexroth Aktiengesellschaft
6 BSH Bosch und Siemens Hausger舩e GmbH
7 Buderus Aktiengesellschaft
8 Faurecia Automotive GmbH
9 Faurecia Autositze GmbH & Co. KG
10 Faurecia S.A.
11 Flender Holding GmbH
12 Fujitsu Ltd.
13 Fujitsu Siemens Computers (Holding) B.V.
14 Fujitsu Siemens Computers GmbH
15 Kabel- und Drahtwerke Aktiengesellschaft
16 Luftschiffbau Zeppelin GmbH
17 Osram GmbH
18 PEUGEOT DEUTSCHLAND GMBH
19 Peugeot S.A.
20 Robert Bosch GmbH
21 Robert Bosch Stiftung GmbH
22 S.I.P. Verwaltungsgesellschaft mbH
23 SAS Autosystemtechnik Verwaltungs GmbH
24 Siemens Aktiengesellschaft
25 Siemens Aktiengesellschaft 㱋sterreich
26 Siemens Beteiligungen Management GmbH
27 Siemens Beteiligungsverwaltung GmbH & Co. OHG
28 Siemens Business Services Beteiligungs-GmbH
29 Siemens Business Services GmbH
30 Siemens Business Services GmbH & Co. OHG
31 Siemens Real Estate GmbH & Co. OHG
32 Siemens Real Estate Management GmbH
33 Sommer Allibert S.A.
34 Stadt Friedrichshafen
35 VVK Vers.-Verm.- und Verkehrs-Kontor GmbH
36 ZEPPELIN GmbH
37 Zeppelin-Stiftung
38 ZF FRIEDRICHSHAFEN Aktiengesellschaft
39 ZF Getriebe GmbH
40 ZF Lenksysteme GmbH

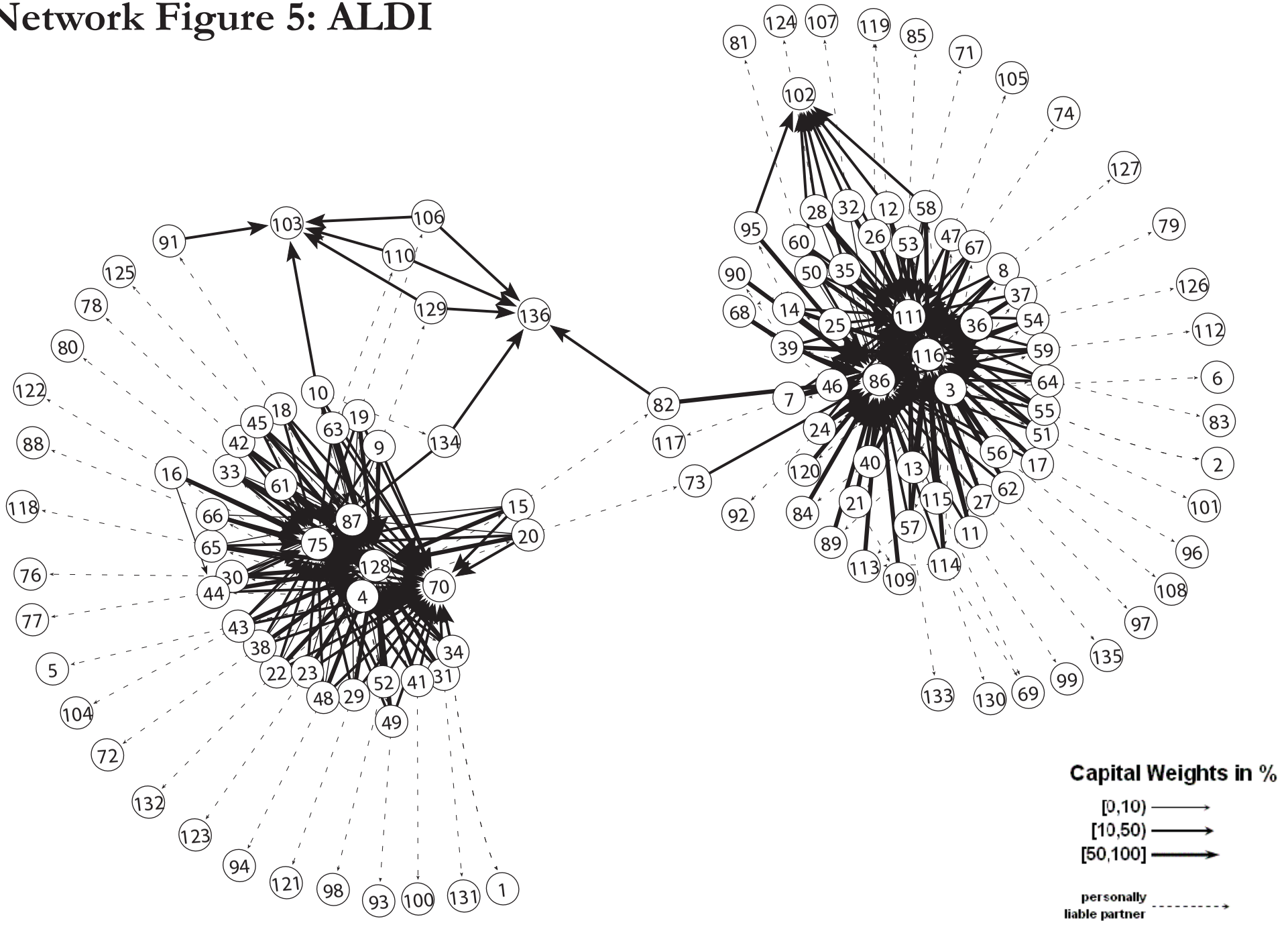
Network Figure 4: Giant 74



This is the Giant Component of the Complete Network where all links below 74% are deleted.

1 Aldi GmbH & Co. KG Adelsdorf
2 Aldi GmbH & Co. KG Altenstadt
3 Aldi GmbH & Co. KG Bingen am Rhein
4 Aldi GmbH & Co. KG Bous
5 Aldi GmbH & Co. KG Donaueschingen
6 Aldi GmbH & Co. KG Ebersberg
7 Aldi GmbH & Co. KG Eichenau
8 Aldi GmbH & Co. KG Geisenfeld
9 Aldi GmbH & Co. KG Helmstadt
10 Aldi GmbH & Co. KG Kerpen
11 Aldi GmbH & Co. KG Ketsch
12 Aldi GmbH & Co. KG Kirchheim an d. Weinstr.
13 Aldi GmbH & Co. KG Langenfeld L. (Rheinland)
14 Aldi GmbH & Co. KG Langenselbold
15 Aldi GmbH & Co. KG Mahlberg
16 Aldi GmbH & Co. KG Mönchengladbach
17 Aldi GmbH & Co. KG Montabaur
18 Aldi GmbH & Co. KG Mörfelden-Walldorf
19 Aldi GmbH & Co. KG Mühlheim an der Ruhr
20 Aldi GmbH & Co. KG Murr
21 Aldi GmbH & Co. KG Rastatt
22 Aldi GmbH & Co. KG Rheinberg
23 Aldi GmbH & Co. KG Sankt Augustin
24 Aldi GmbH & Co. KG Wittlich
25 Aldi GmbH & Co. KG Aichtal
26 ALDI GmbH & Co. KG Regenstauf
27 Aldi GmbH & Co. KG Roth
28 Siepmann Stiftung

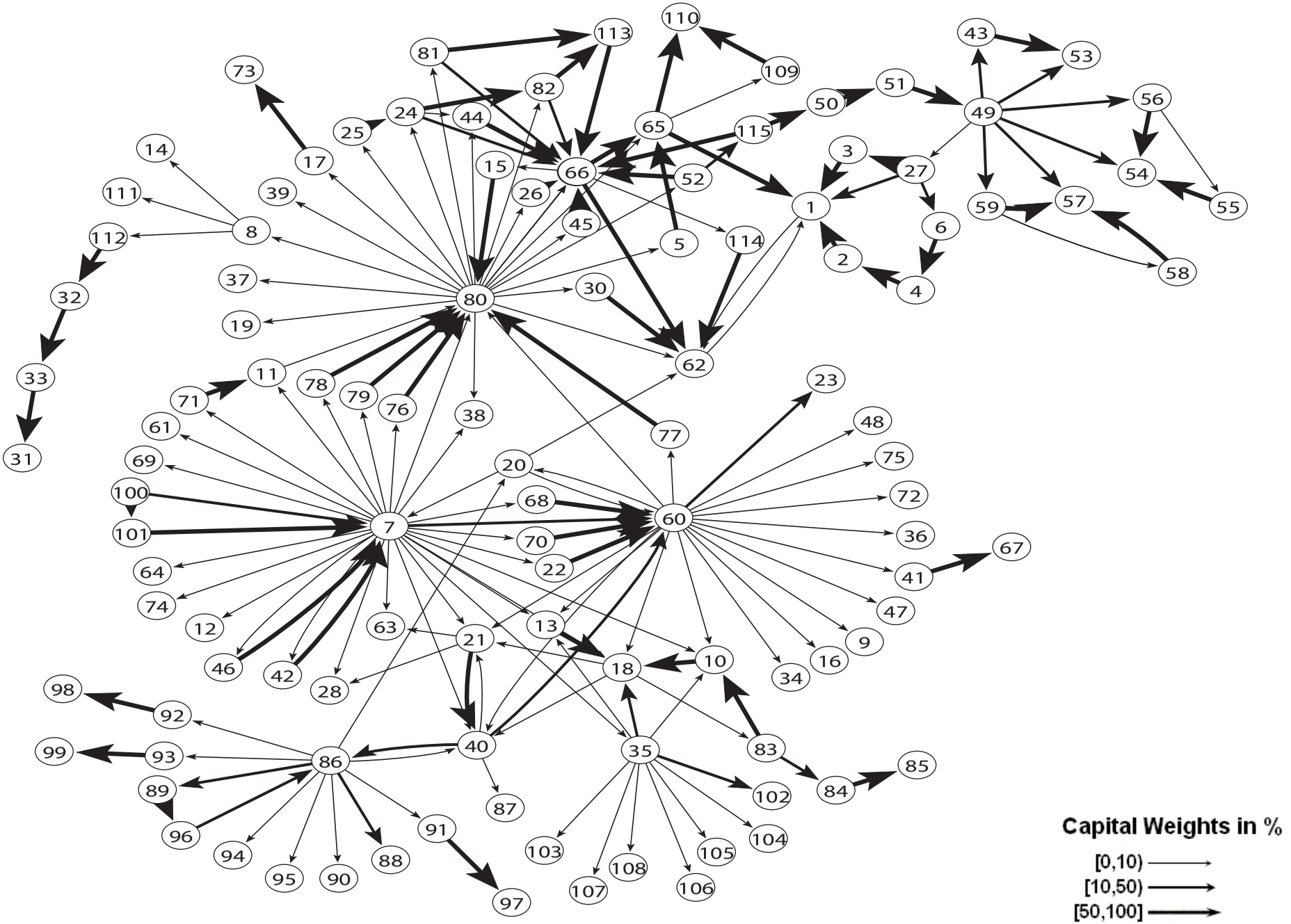
Network Figure 5: ALDI



ALDI

1 A. Dold GmbH
2 Albers GmbH
3 Aldi Einkauf GmbH & Co. oHG Essen
4 Aldi Einkauf GmbH & Co. oHG Mühlheim an der Ruhr
5 Aldi Einkauf GmbH Duisburg
6 Aldi Einkauf GmbH Herten
7 ALDI Gesellschaft & Co. KG Großbeeren
8 ALDI GmbH & Co. Beucha KG
9 Aldi GmbH & Co. KG Adelsdorf
10 Aldi GmbH & Co. KG Altenstadt
11 Aldi GmbH & Co. KG Bad Laasphe
12 Aldi GmbH & Co. KG Bargteheide
13 ALDI GmbH & Co. KG Berlin
14 ALDI GmbH & Co. KG Beverstedt
15 Aldi GmbH & Co. KG Bingen am Rhein
16 Aldi GmbH & Co. KG Bous
17 ALDI GmbH & Co. KG Datteln
18 Aldi GmbH & Co. KG Donaueschingen
19 Aldi GmbH & Co. KG Ebersberg
20 Aldi GmbH & Co. KG Eichenau
21 ALDI GmbH & Co. KG Essen
22 Aldi GmbH & Co. KG Geisenfeld
23 Aldi GmbH & Co. KG Helmstadt
24 ALDI GmbH & Co. KG Herten
25 Aldi GmbH & Co. KG Hesel
26 Aldi GmbH & Co. KG Horst
27 ALDI GmbH & Co. KG Hoyerswerder
28 ALDI GmbH & Co. KG Jarmen
29 Aldi GmbH & Co. KG Kerpen
30 Aldi GmbH & Co. KG Ketsch
31 Aldi GmbH & Co. KG Kirchheim an der Weinstraße
32 ALDI GmbH & Co. KG Könnern
33 Aldi GmbH & Co. KG Langenfeld Langenfeld (Rheinland)
34 Aldi GmbH & Co. KG Langenselbold
35 ALDI GmbH & Co. KG Langenwetzendorf
36 Aldi GmbH & Co. KG Lehrte
37 ALDI GmbH & Co. KG Lingen (Ems)
38 Aldi GmbH & Co. KG Mahlberg
39 ALDI GmbH & Co. KG Meitzendorf
40 ALDI GmbH & Co. KG Mittenwalde
41 Aldi GmbH & Co. KG Mönchengladbach
42 Aldi GmbH & Co. KG Montabaur
43 Aldi GmbH & Co. KG Mörfelden-Walldorf
44 Aldi GmbH & Co. KG Mühlheim an der Ruhr
45 Aldi GmbH & Co. KG Murr
46 ALDI GmbH & Co. KG Nohra
47 Aldi GmbH & Co. KG Radevormwald
48 Aldi GmbH & Co. KG Rastatt
49 Aldi GmbH & Co. KG Rheinberg
50 Aldi GmbH & Co. KG Rinteln
51 Aldi GmbH & Co. KG Salzgitter
52 Aldi GmbH & Co. KG Sankt Augustin
53 ALDI GmbH & Co. KG Scharbeutz
54 Aldi GmbH & Co. KG Schloß Holte-Stukenbrock
55 ALDI GmbH & Co. KG Schwelm
56 ALDI GmbH & Co. KG Seefeld
57 ALDI GmbH & Co. KG Seevetal
58 ALDI GmbH & Co. KG Werl
59 ALDI GmbH & Co. KG Weyhe
60 ALDI GmbH & Co. KG Wilsdruff
61 Aldi GmbH & Co. KG Wittlich
62 ALDI GmbH & Co. KG Wittstock
63 Aldi GmbH & Co. Kommanditgesellschaft Aichtal
64 Aldi GmbH & Co. Kommanditgesellschaft Greven
65 ALDI GmbH & Co. Kommanditgesellschaft Regenstauf
66 Aldi GmbH & Co. Kommanditgesellschaft Roth
67 Aldi GmbH u. Co. KG Notdorf
68 Berger GmbH
69 Berthold Albrecht
70 Billen GmbH
71 Brehm GmbH
72 Bröker GmbH
73 Burgard GmbH
74 Buttkus GmbH
75 Carolus-Stiftung
76 Daniel GmbH
77 David GmbH
78 Delschen GmbH
79 Diekhaus GmbH
80 Drees GmbH
81 Ebel GmbH
82 Eck GmbH
83 Eden GmbH
84 Ekrot GmbH
85 Elsner GmbH
86 Familie Albrecht
87 Fenten Gesellschaft mit beschränkter Haftung
88 Feucht GmbH
89 Frank Schröder GmbH
90 Gerdes GmbH
91 Goetsch GmbH
92 Günther GmbH
93 Hahn GmbH
94 Hake GmbH
95 Heckl GmbH
96 Heußinger GmbH
97 Hirtz GmbH
98 Hoffmann Beteiligungsgesellschaft mbH
99 Holger Schmidt GmbH
100 Holger Schneider GmbH
101 Iders GmbH
102 Jakobus-Stiftung
103 Karl Albrecht
104 Kehl GmbH
105 Kenzler GmbH
106 Kießl GmbH
107 Langenstroeher GmbH
108 Larberg GmbH
109 Lessner GmbH
110 Liebisch GmbH
111 Lukas Stiftung
112 Markhoff GmbH
113 Markus Kaffee GmbH
114 Markus Kaffee GmbH & Co. KG Herten
115 Markus Kaffee GmbH & Co. KG Weyhe
116 Markus Stiftung
117 Michalek GmbH
118 Müller GmbH
119 Neubold GmbH
120 Noack GmbH
121 Otte GmbH
122 Penkert GmbH
123 Polossek GmbH
124 Reitzig GmbH
125 Robinson GmbH
126 Roettgen GmbH
127 Sander GmbH
128 Siepmann Stiftung
129 Steinbrenner GmbH
130 Theo Albrecht jun.
131 Thull GmbH
132 Thunig GmbH
133 Tölle GmbH
134 Vollmer GmbH
135 Weiland GmbH
136 Oertel-Stiftung

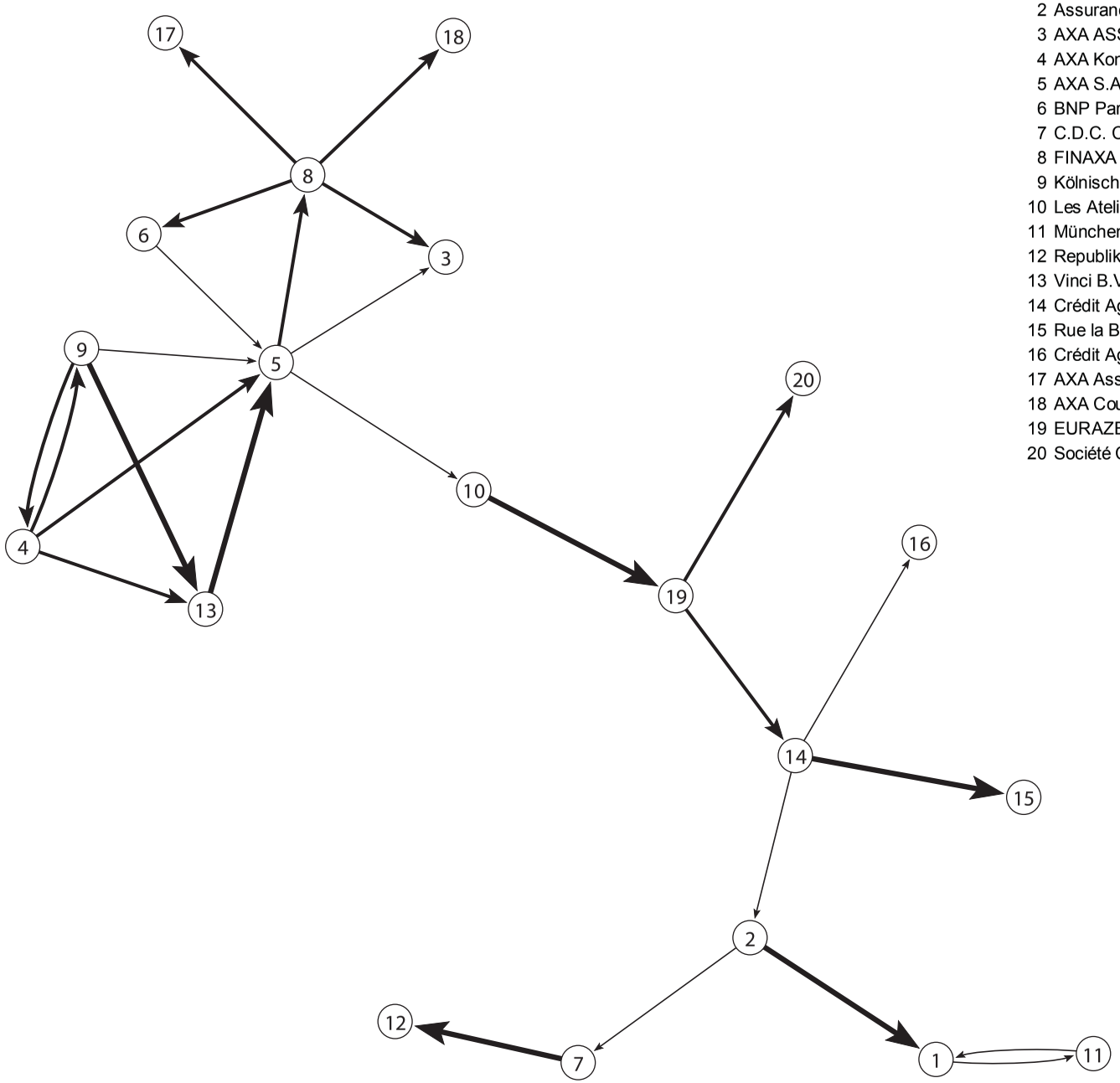
Network Figure 6: AMB Generali



AMB Generali

1 Allianz Aktiengesellschaft
2 Allianz Deutschland AG
3 Allianz Finanzbeteiligungs GmbH
4 Allianz Lebensversicherungs-Aktiengesellschaft
5 Allianz Subalpina Società di assicurazioni e riassicurazioni
6 Asopos Vermögensverwaltungsgesellschaft
7 Assicurazioni Generali S.p.A.
8 AVIVA Plc.
9 B and B Investissement S.C. Immobilière
10 Banca di Roma S.p.A.
11 Banca d'Italia S.p.A.
12 Banca Mediosim Banca della Rete S.p.A.
13 Banco di Sicilia S.p.A.
14 Barclays PLC
15 Bayerische Hypo- und Vereinsbank Aktiengesellschaft
16 Caisse Centrale des Assurances Mutuelles A.S.M.
17 Capital Research & Management Company
18 Capitalia S.p.A.
19 Carimonte Holding S.p.A.
20 COMMERZBANK Aktiengesellschaft
21 Compagnia di Assicurazione di Milano S.p.A.
22 Compass S.p.A.
23 Consortium S.r.l.
24 D.A.S. Deutscher Automobil Schutz Allgemeine R.-V. AG
25 D.A.S. Deutscher Automobil Schutz Versicherungs-AG
26 DKV Deutsche Krankenversicherung Aktiengesellschaft
27 DRESDNER BANK Aktiengesellschaft
28 EFFE Finanziaria S.p.A.
29 ERGO Versicherungsgruppe Aktiengesellschaft
30 Europäische Reiseversicherung Aktiengesellschaft
31 Fidelity International Limited
32 Fidelity Investments International
33 Fidelity Investments International Limited
34 Financière du Perguet S.A.S.
35 FinecoGroup S.p.A.
36 FINSAI INTERNATIONAL S.A.
37 Fondazione Cassa di Risparmio di Torino
38 Fondazione Cassa di Risparmio Verona. Vicenza. B. e A.
39 Fondazione Cassamarca -Cassa di Risparmio della M. T.
40 Fondiaria - SAI S.p.A.
41 GAN S.A.
42 Generali Vita S.p.A.
43 Grisfonta AG
44 Hamburg-Mannheimer Sachversicherungs-AG
45 Hamburg-Mannheimer Versicherungs-Aktiengesellschaft
46 Ina Vita S.p.A.
47 Italcementi Fabbriche Riunite Cemento S.p.A.
48 Italmobiliare S.p.A.
49 KARSTADT QUELLE Aktiengesellschaft
50 KARSTADT QUELLE Kunden-Service GmbH
51 KARSTADT QUELLE Service GmbH
52 KarstadtQuelle Lebensversicherung Aktiengesellschaft
53 Leo Herl
54 Madeleine Schickedanz
55 Madeleine Schickedanz Vermögensverwaltungs B. GmbH
56 Madeleine Schickedanz Vermögensverw. GmbH & Co. KG
57 Martin Dedi
58 Martin Dedi Vermögensverwaltungs Beteiligungs GmbH
59 Martin Dedi Vermögensverwaltungs GmbH & Co. KG
60 MEDIOBANCA Banca di Credito Finanziario S.p.A.
61 Merrill Lynch Investments Managers Group Ltd.
62 Münchener Rückversicherungs-Gesellschaft AG
63 Novara Vita S.p.A.
64 Po Vita Compagnia di Assicurazioni S.p.A.
65 RAS Riunione Adriatica di Sicurtà S.p.A.
66 RB Vita S.p.A.
67 Republik Frankreich
68 Sade Finanziaria S.p.A.
69 SIAT - Società Italiana Assicurazioni e Riassicurazioni - p.A.
70 Società per Amministrazioni Fiduciarie SPAFID S.p.A.
71 Società per la Bonifica dei Terreni F. e per le I. A. - S.p.A.
72 Société der Participation Financière Italmobiliare S.A.
73 The Capital Group Companies Inc.
74 The Lawrence Re Ireland Ltd.
75 Tradinglab Banca S.p.A.
76 Unicredit Banca d'Impresa S.p.A.
77 Unicredit Banca Mobiliare S.p.A.
78 Unicredit Banca S.p.A.
79 Unicredit Private Banking S.p.A.
80 UniCredito Italiano S.p.A.
81 VICTORIA Lebensversicherung Aktiengesellschaft
82 VICTORIA Versicherung Aktiengesellschaft
83 Roma Vita S.p.A.
84 Toro Assicurazioni S.p.A.
85 DE AGOSTINI S.p.A.
86 Premafin Finanziaria - S.p.A. Holding de Partecipazioni
87 Finadin - S.p.A. Finanziaria di Investimenti
88 Compagnia Fiduciaria Nazionale S.p.A.
89 Banca del Gottardo S.A.
90 Sinergia Terza S.p.A.
91 Canoe Securities S.A.
92 Hike Securities S.A.
93 Limbo Invest S.A.
94 Immobiliare Costruzioni IM.CO. S.p.A.
95 SAIFIN - SAI Finanziaria S.p.A.
96 Schweizerische LV. - und Rentenanstalt
97 Giulia Maria Ligresti
98 Jonella Ligresti
99 Gioacchino Paolo Ligresti
100 AMB Generali Holding AG
101 Generali Beteiligungs-GmbH
102 F. Mandori
103 M. Ardesi
104 Familie Schickedanz
105 Putnam Investments. LLC
106 Soc. Reale Mutua di Assicurazioni
107 C. Gestioni
108 A. Spaggiari
109 Crédit Industriel d'Alsace et de Lorraine S.A.
110 Crédit Industriel et Commercial (CIC)
111 Legal & General Group PLC
112 Fidelity Investments Ltd.
113 ERGO Achte Beteiligungsgesellschaft mbH
114 MR ERGO Beteiligungen GmbH
115 KarstadtQuelle Finanz Service GmbH

Network Figure 7: AXA

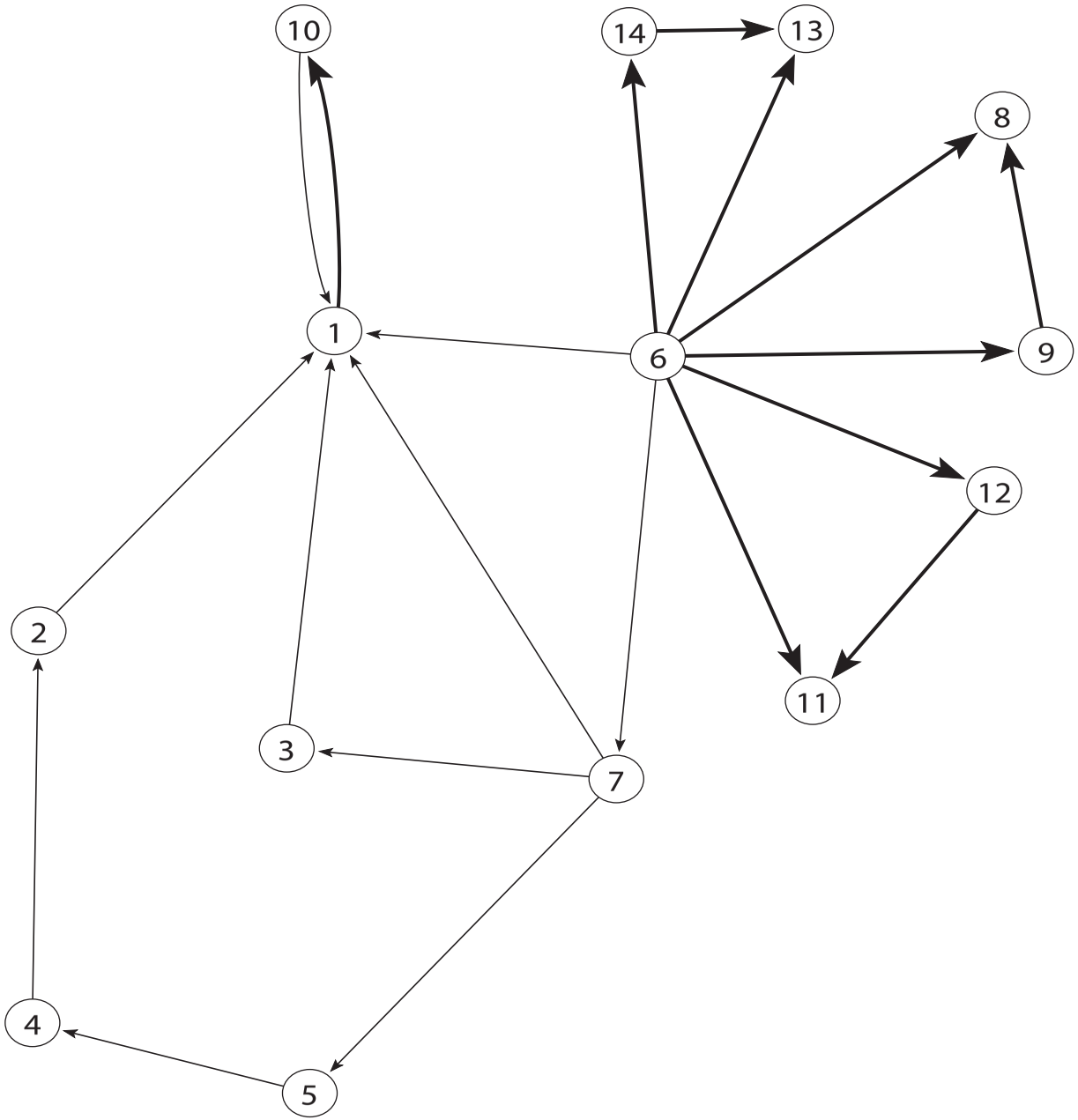


1 Allianz Aktiengesellschaft
2 Assurances Générales de France S.A.
3 AXA ASSURANCES VIE MUTUELLES
4 AXA Konzern Aktiengesellschaft
5 AXA S.A.
6 BNP Paribas S.A.
7 C.D.C. Caisse des Dépôts et Consignations
8 FINAXA SA
9 Kölnische Verwaltungs-AG
10 Les Ateliers de Construction du Nord de la France S.A.
11 Münchener Rückversicherungs-Gesellschaft AG
12 Republik Frankreich
13 Vinci B.V.
14 Crédit Agricole S.A.
15 Rue la Boétie SAS
16 Crédit Agricole Transactions SNC
17 AXA Assurances IARD Mutuelle S.A.
18 AXA Courtage Assurance Mutuelle
19 EURAZEO SA
20 Société Civile Haussmann Percier

Capital Weights in %

[0,10) ⟶
[10,50) ⟶
[50,100] ⟶

Network Figure 8: BMW

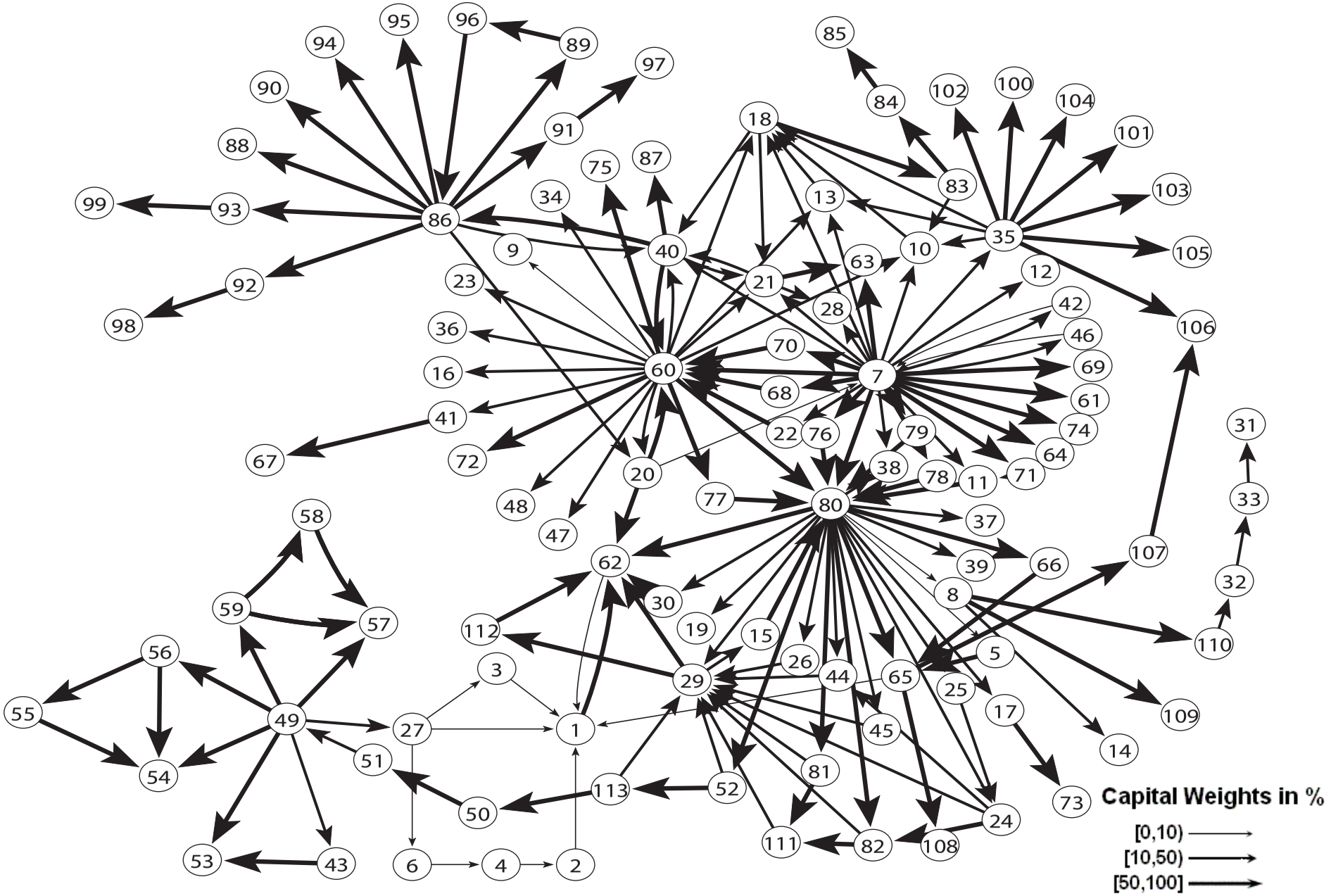


1 Allianz AG
2 Allianz Deutschland AG
3 Allianz Finanzbeteiligungs GmbH
4 Allianz Lebensversicherungs-AG
5 Asopos Vermögensverwaltungsgesellschaft
6 Bayerische Motoren Werke AG
7 DRESDNER BANK AG
8 Johanna Quandt
9 Johanna Quandt GmbH & Co. KG für Automobilwerte
10 Münchener Rückversicherungs-Gesellschaft AG
11 Stefan Quandt
12 Stefan Quandt GmbH & Co. KG für Automobilwerte
13 Susanne Klatten
14 Susanne Klatten GmbH & Co. KG für Automobilwerte

Capital Weights in %

[0,10)
[10,50)
[50,100]

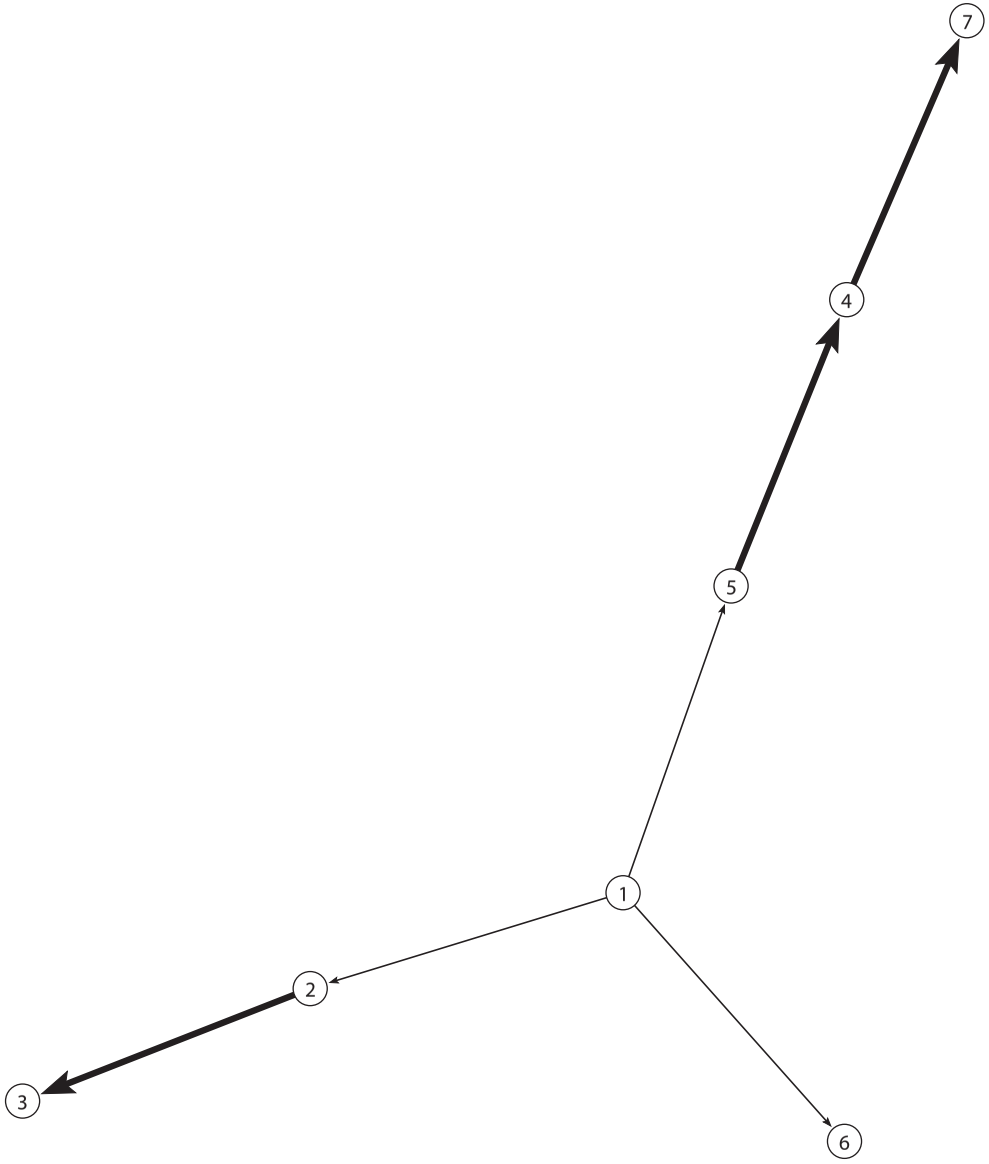
Network Figure 9: Commerzbank



Commerzbank

1 Allianz AG
2 Allianz Deutschland AG
3 Allianz Finanzbeteiligungs GmbH
4 Allianz Lebensversicherungs-AG
5 Allianz Subalpina Società di assicurazioni e riassicurazioni
6 Asopos Vermögensverwaltungsgesellschaft
7 Assicurazioni Generali S.p.A.
8 AVIVA Plc.
9 B and B Investissement S.C. Immobilière
10 Banca di Roma S.p.A.
11 Banca d'Italia S.p.A.
12 Banca Mediosim Banca della Rete S.p.A.
13 Banco di Sicilia S.p.A.
14 Barclays PLC
15 Bayerische Hypo- und Vereinsbank AG
16 Caisse Centrale des Assurances Mutuelles A. S. M.
17 Capital Research & Management Company
18 Capitalia S.p.A.
19 Carimonte Holding S.p.A.
20 COMMERZBANK AG
21 Compagnia di Assicurazione di Milano S.p.A.
22 Compass S.p.A.
23 Consortium S.r.l.
24 D.A.S. Deutscher Automobil Schutz Allgemeine RV-AG
25 D.A.S. Deutscher Automobil Schutz Versicherungs-AG
26 DKV Deutsche Krankenversicherung AG
27 DRESDNER BANK AG
28 EFFE Finanziaria S.p.A.
29 ERGO Versicherungsgruppe AG
30 Europäische Reiseversicherung AG
31 Fidelity International Limited
32 Fidelity Investments International
33 Fidelity Investments International Limited
34 Financière du Perguet S.A.S.
35 FinecoGroup S.p.A.
36 FINSAI INTERNATIONAL S.A.
37 Fondazione Cassa di Risparmio di Torino
38 Fondazione Cassa di Risparmio Verona. Vicenza. B. e A.
39 Fondazione Cassamarca -Cassa di Risparmio della M. T.
40 Fondiaria - SAI S.p.A.
41 GAN S.A.
42 Generali Vita S.p.A.
43 Grisfonta AG
44 Hamburg-Mannheimer Sachversicherungs-AG
45 Hamburg-Mannheimer Versicherungs-AG
46 Ina Vita S.p.A.
47 Italcementi Fabbriche Riunite Cemento S.p.A.
48 Italmobiliare S.p.A.
49 KARSTADT QUELLE AG
50 KARSTADT QUELLE Kunden-Service GmbH
51 KARSTADT QUELLE Service GmbH
52 KarstadtQuelle Lebensversicherung AG
53 Leo Herl
54 Madeleine Schickedanz
55 Madeleine Schickedanz Vermögensverw. Beteil. GmbH
56 Madeleine Schickedanz Vermögensverw. GmbH & Co. KG
57 Martin Dedi
58 Martin Dedi Vermögensverwaltungs Beteiligungs GmbH
59 Martin Dedi Vermögensverwaltungs GmbH & Co. KG
60 MEDIOBANCA Banca di Credito Finanziario S.p.A.
61 Merrill Lynch Investments Managers Group Ltd.
62 Münchener Rückversicherungs-Gesellschaft AG
63 Novara Vita S.p.A.
64 Po Vita Compagnia di Assicurazioni S.p.A.
65 RAS Riunione Adriatica di Sicurtà S.p.A.
66 RB Vita S.p.A.
67 Republik Frankreich
68 Sade Finanziaria S.p.A.
69 SIAT - Società Italiana Assicurazioni e Riassicurazioni - p.A.
70 Società per Amministrazioni Fiduciarie SPAFID S.p.A.
71 Società per la Bonifica dei Terreni F. e per le I. A. - S.p.A.
72 Société der Participation Financière Italmobiliare S.A.
73 The Capital Group Companies Inc.
74 The Lawrence Re Ireland Ltd.
75 Tradinglab Banca S.p.A.
76 Unicredit Banca d'Impresa S.p.A.
77 Unicredit Banca Mobiliare S.p.A.
78 Unicredit Banca S.p.A.
79 Unicredit Private Banking S.p.A.
80 UniCredito Italiano S.p.A.
81 VICTORIA Lebensversicherung AG
82 VICTORIA Versicherung AG
83 Roma Vita S.p.A.
84 Toro Assicurazioni S.p.A.
85 DE AGOSTINI S.p.A.
86 Premafin Finanziaria - S.p.A. Holding de Partecipazioni
87 Finadin - S.p.A. Finanziaria di Investimenti
88 Compagnia Fiduciaria Nazionale S.p.A.
89 Banca del Gottardo S.A.
90 Sinergia Terza S.p.A.
91 Canoe Securities S.A.
92 Hike Securities S.A.
93 Limbo Invest S.A.
94 Immobiliare Costruzioni IM.CO. S.p.A.
95 SAIFIN - SAI Finanziaria S.p.A.
96 Schweizerische LV- und Rentenanstalt
97 Giulia Maria Ligresti
98 Jonella Ligresti
99 Gioacchino Paolo Ligresti
100 F. Mandori
101 M. Ardesi
102 Familie Schickedanz
103 Putnam Investments. LLC
104 Soc. Reale Mutua di Assicurazioni
105 C. Gestioni
106 A. Spaggiari
107 Crédit Industriel d'Alsace et de Lorraine S.A.
108 Crédit Industriel et Commercial (CIC)
109 Legal & General Group PLC
110 Fidelity Investments Ltd.
111 ERGO Achte Beteiligungsgesellschaft mbH
112 MR ERGO Beteiligungen GmbH
113 KarstadtQuelle Finanz Service GmbH

Network Figure 10: DaimlerChrysler

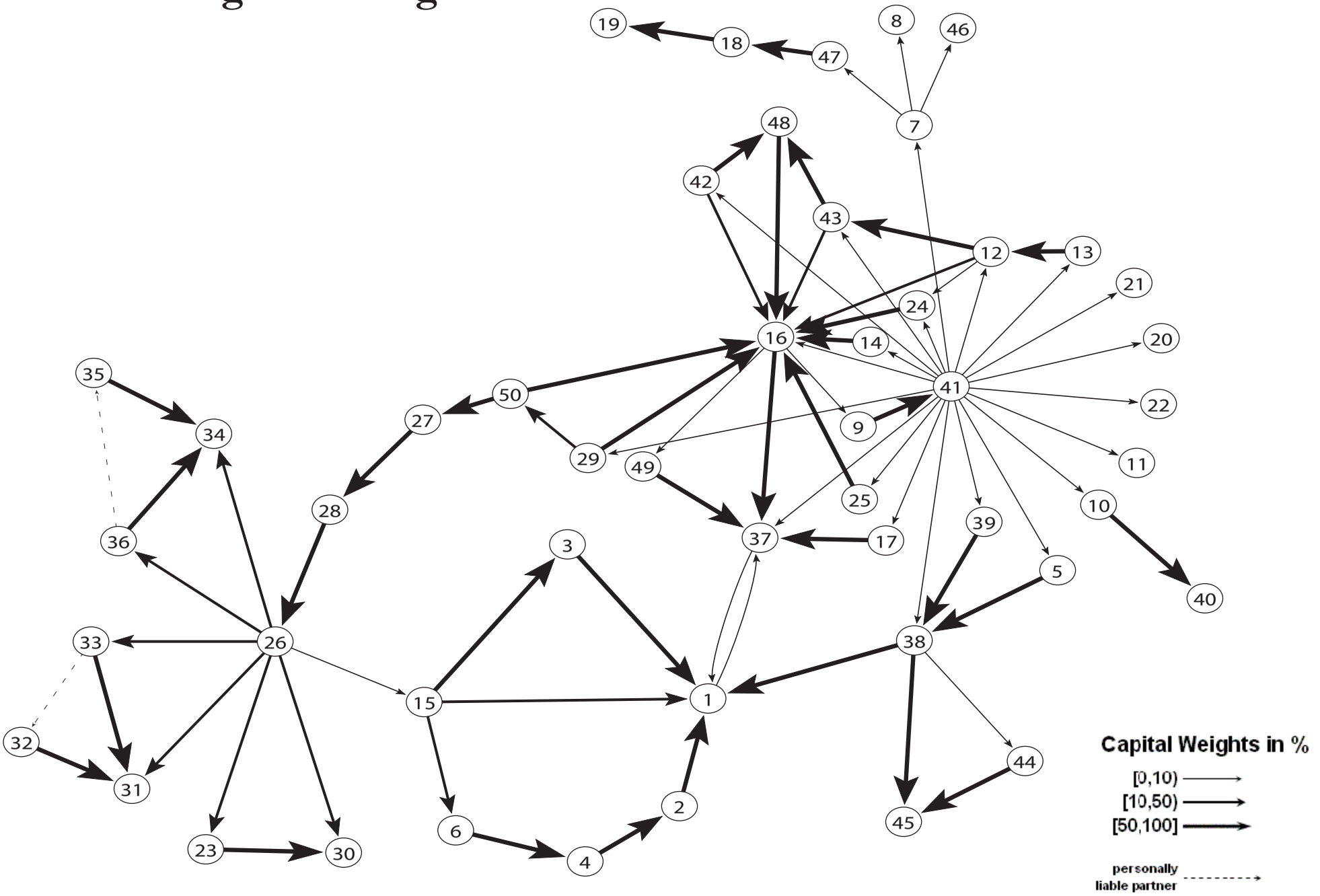


1 DaimlerChrysler AG
2 DB Value GmbH
3 Deutsche Bank AG
4 Dubai Holding Ltd.
5 Dubai International Capital Ltd.
6 Emirat Kuwait
7 Mohammed bin Rashid AL Maktoum

Capital Weights in %

[0,10)
[10,50)
[50,100]

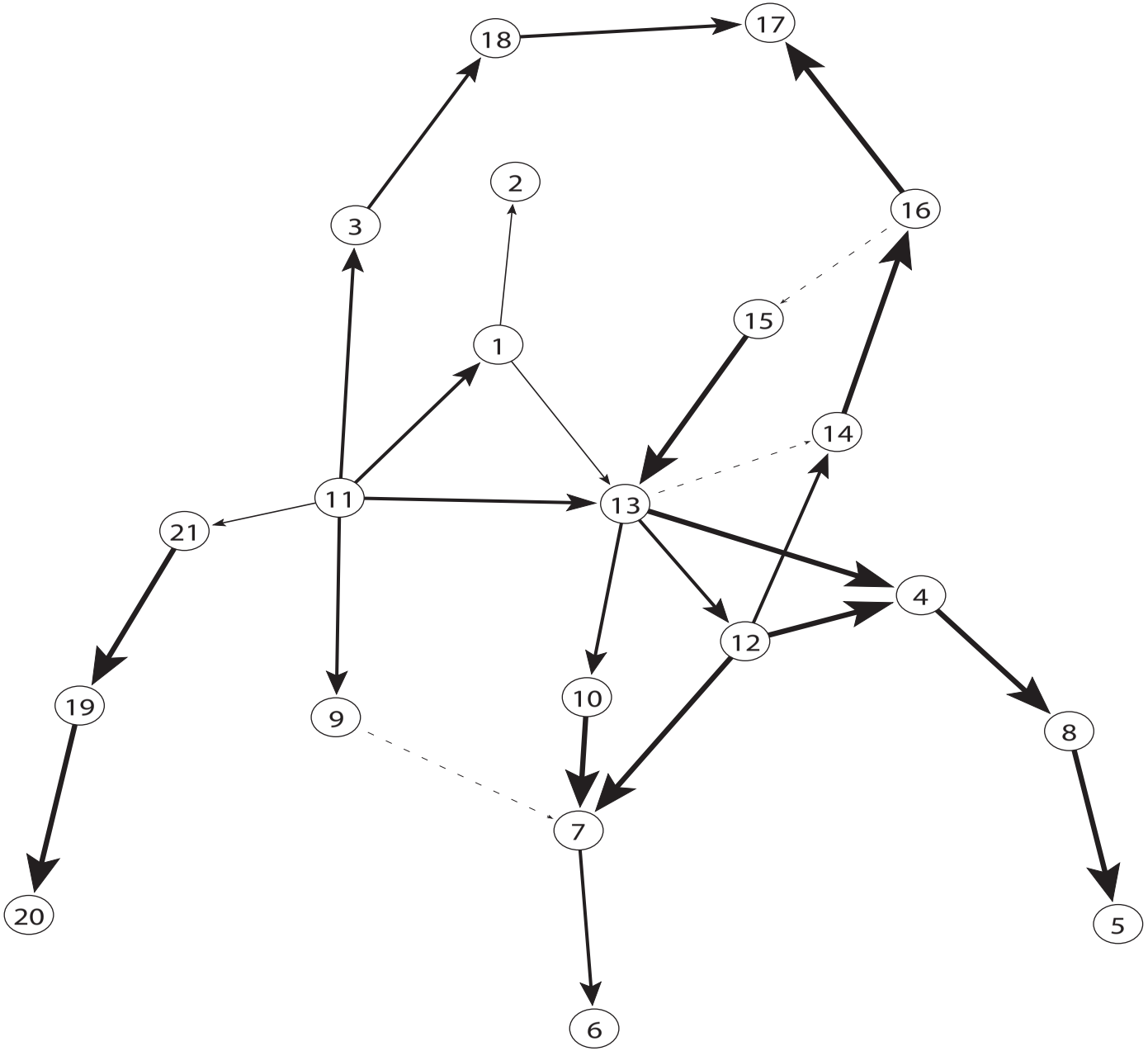
Network Figure 11: Ergo



Ergo

1 Allianz AG
2 Allianz Deutschland AG
3 Allianz Finanzbeteiligungs GmbH
4 Allianz Lebensversicherungs-AG
5 Allianz Subalpina Società di assicurazioni e riassicurazioni
6 Asopos Vermögensverwaltungsgesellschaft
7 AVIVA Plc.
8 Barclays PLC
9 Bayerische Hypo- und Vereinsbank AG
10 Capital Research & Management Company
11 Carimonte Holding S.p.A.
12 D.A.S. Deutscher Automobil Schutz Allgemeine Rechtsschutz-Versi
13 D.A.S. Deutscher Automobil Schutz Versicherungs-AG
14 DKV Deutsche Krankenversicherung AG
15 DRESDNER BANK AG
16 ERGO Versicherungsgruppe AG
17 Europäische Reiseversicherung AG
18 Fidelity Investments International
19 Fidelity Investments International Limited
20 Fondazione Cassa di Risparmio di Torino
21 Fondazione Cassa di Risparmio Verona, Vicenza, Belluno e Ancona
22 Fondazione Cassamarca -Cassa di Risparmio della Marca Trivignian
23 Grisfonta AG
24 Hamburg-Mannheimer Sachversicherungs-AG
25 Hamburg-Mannheimer Versicherungs-AG
26 KARSTADT QUELLE AG
27 KARSTADT QUELLE Kunden-Service GmbH
28 KARSTADT QUELLE Service GmbH
29 KarstadtQuelle Lebensversicherung AG
30 Leo Herl
31 Madeleine Schickedanz
32 Madeleine Schickedanz Vermögensverwaltungs Beteiligungs GmbH
33 Madeleine Schickedanz Vermögensverwaltungs GmbH & Co. KG
34 Martin Dedi
35 Martin Dedi Vermögensverwaltungs Beteiligungs GmbH
36 Martin Dedi Vermögensverwaltungs GmbH & Co. KG
37 Münchener Rückversicherungs-Gesellschaft AG in München
38 RAS Riunione Adriatica di Sicurtà S.p.A.
39 RB Vita S.p.A.
40 The Capital Group Companies Inc.
41 UniCredito Italiano S.p.A.
42 VICTORIA Lebensversicherung AG
43 VICTORIA Versicherung AG
44 Crédit Industriel d'Alsace et de Lorraine S.A.
45 Crédit Industriel et Commercial (CIC)
46 Legal & General Group PLC
47 Fidelity Investments Ltd.
48 ERGO Achte Beteiligungsgesellschaft mbH
49 MR ERGO Beteiligungen GmbH
50 KarstadtQuelle Finanz Service GmbH

Network Figure 12: Metro



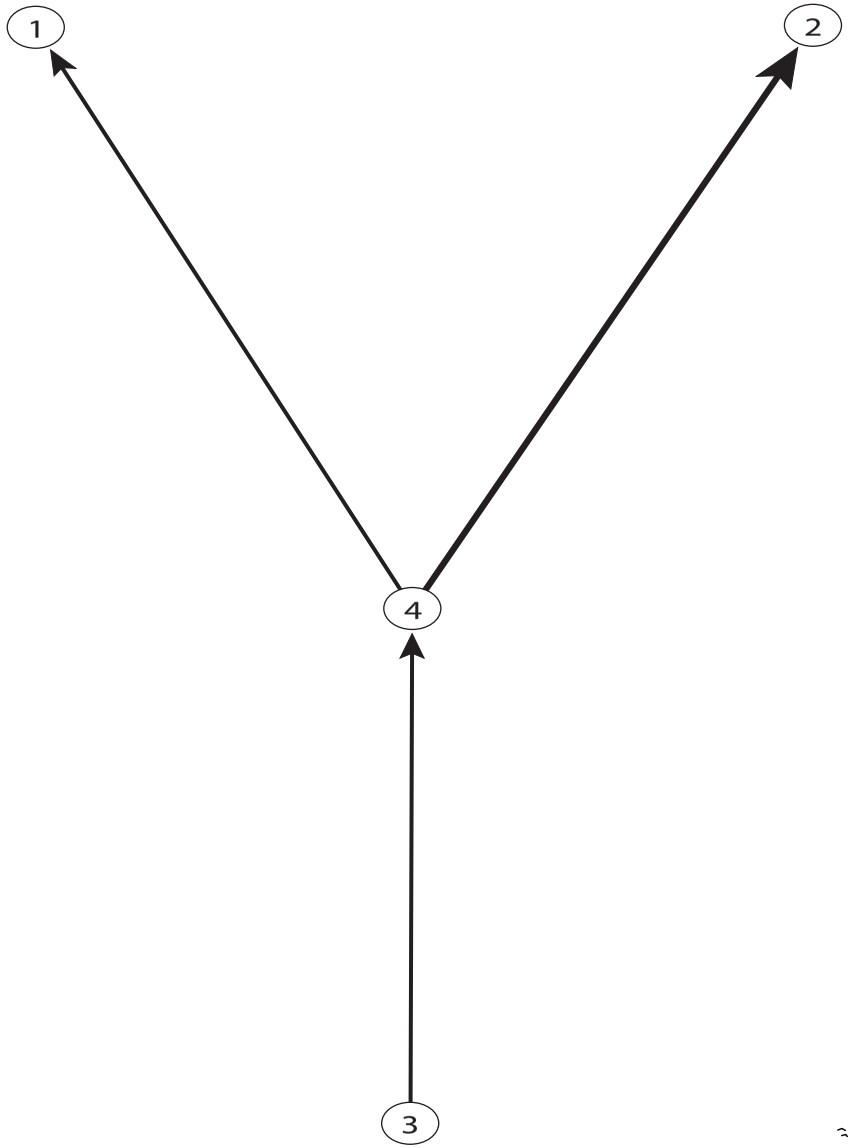
1 1. HSB Beteiligungsverw. GmbH & Co. KG
2 1. HSB Verwaltung GmbH
3 Beisheim Holding GmbH
4 BVG Beteiligungs- und Verm.verw.GmbH
5 Dr. Michael Schmidt-Ruthenbeck
6 Familie Haniel
7 Franz Haniel & Cie. GmbH
8 Gebr. Schmidt GmbH & Co. KG
9 Haniel Finance B.V.
10 Haniel Finance Deutschland GmbH
11 METRO AG
12 Metro Vermögensverw. GmbH
13 Metro Vermögensverw. GmbH & Co. KG
14 O.B. Betriebs GmbH
15 O.B.V. Vermögensverw. mbH
16 O.B.V. Vermögensverw. mbH & Co. KG
17 Prof. Dr. Otto Beisheim
18 Prof. Otto Beisheim-Stiftung
19 SUPRA Holding AG
20 Supra Trust
21 Suprapart AG

Capital Weights in %

[0,10)
[10,50)
[50,100]

personally liable partner

Network Figure 13: Deutsche Post



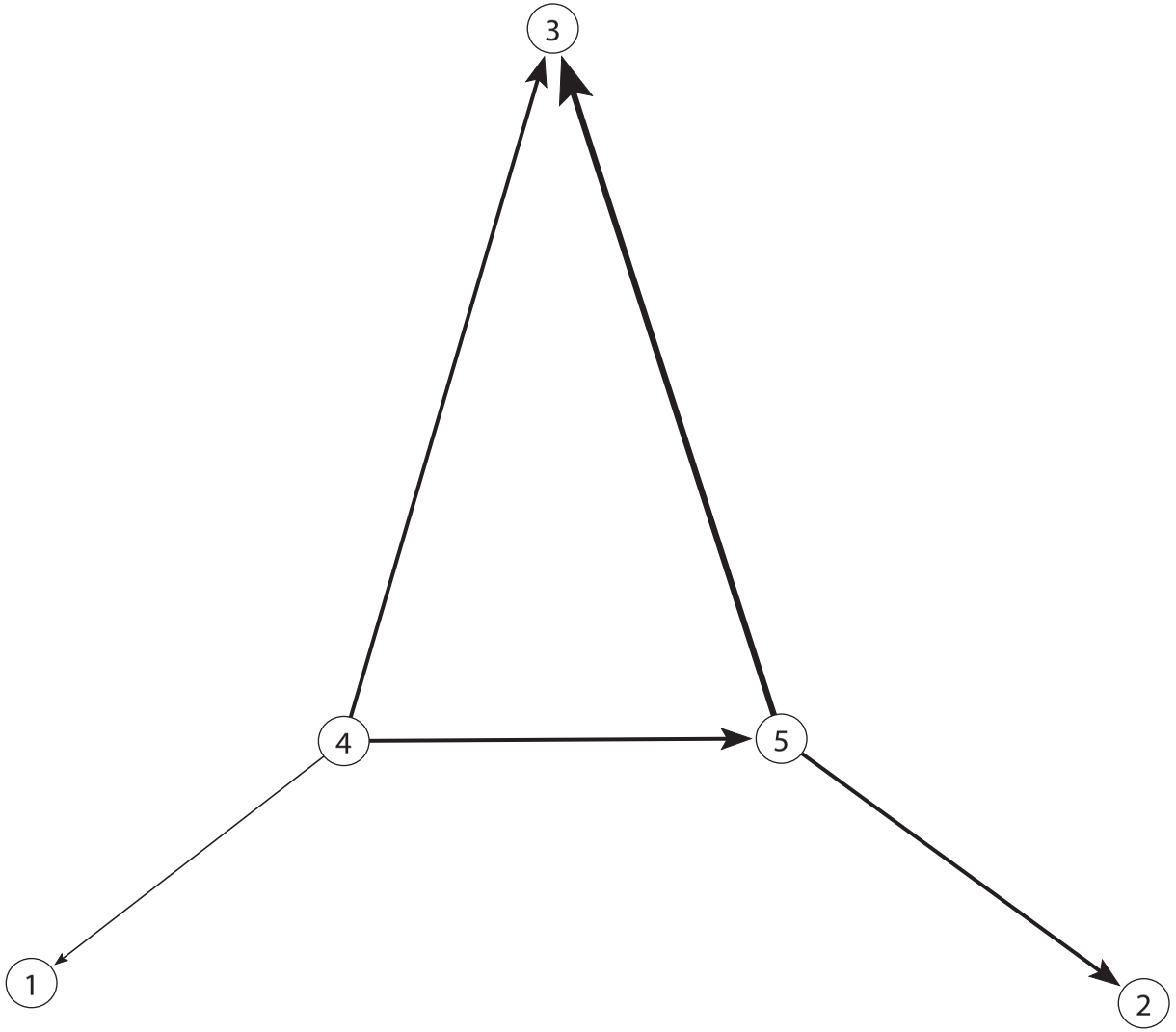
1 Bundesländer
2 Bundesrepublik Deutschland
3 Deutsche Post AG
4 KfW Bankengruppe

Capital Weights in %

[0,10)
[10,50)
[50,100]

Network Figure 14: Deutsche Telekom

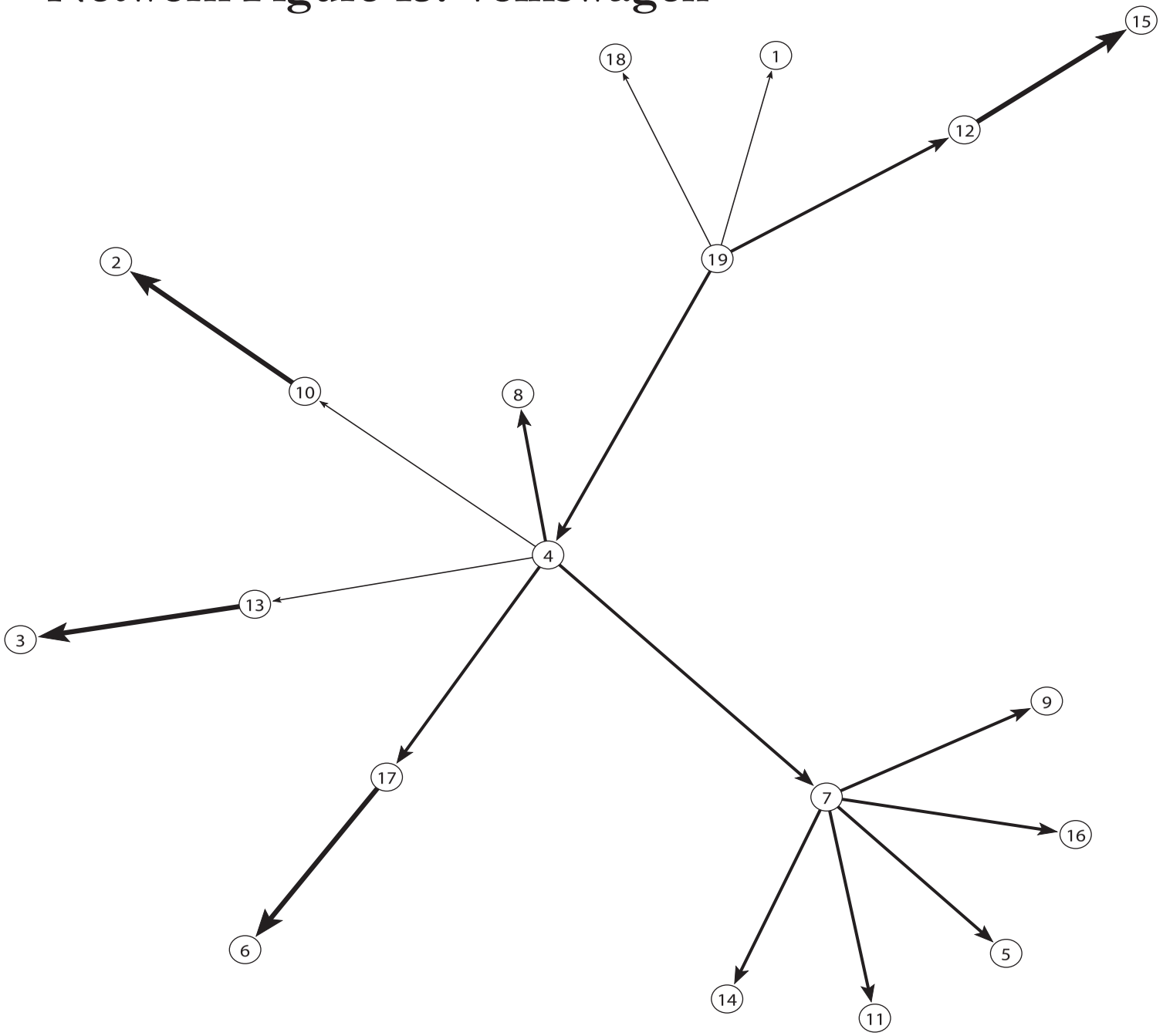
1 Blackstone Group L.P.
2 Bundesländer
3 Bundesrepublik Deutschland
4 Deutsche Telekom AG
5 KfW Bankengruppe



Capital Weights in %

[0,10)
[10,50)
[50,100]

Network Figure 15: Volkswagen



1 Brandes Investment Partners Inc.
2 Dr. Ferdinand Piëch
3 Dr. Hans-Michel Piëch
4 Dr. Ing. h.c. F. Porsche Aktiengesellschaft
5 Dr. Wolfgang Porsche
6 Familie Porsche
7 Familie Porsche Beteiligung GmbH
8 Familien Porsche-Daxer-Piëch Beteiligung GmbH
9 Ferdinand Alexander Porsche
10 Ferdinand Piëch GmbH
11 Gerhard Porsche
12 Hannoversche Beteiligungsgesellschaft mbH
13 Hans-Michel Piëch GmbH
14 Hans-Peter Porsche
15 Land Niedersachsen
16 Louise Daxer-Piëch
17 Porsche GmbH
18 The Capital Group Companies Inc.
19 Volkswagen Aktiengesellschaft

Capital Weights in %

[0,10) ——→
[10,50) ——→
[50,100] ——→