Corporate Governance Reforms, Interlocking Directorship and Company Performance in Italy

Drago, Carlo and Millo, Francesco and Ricciuti, Roberto and Santella, Paolo

University of Rome "Niccolò Cusano", Bonfiglioli Riduttori, University of Verona and CESifo, ESMA

10 October 2014

Corporate Governance Reforms, Interlocking Directorship and Company Performance in Italy*

Carlo Drago, "Niccolò Cusano" University, Rome
Francesco Millo, Bonfiglioli Riduttori
Roberto Ricciuti**, University of Verona and CESifo
Paolo Santella, ESMA

ABSTRACT

We analyze the effects of corporate governance reforms on interlocking directorship (ID), and we assess the relationship between interlocking directorships and company performance for the main Italian firms listed on the Italian stock exchange over 1998-2007. We use a unique dataset that includes corporate governance variables related to the board size, interlocking directorships and variables related to companies' performances. The network analysis showed only some effectiveness of these reforms in slightly dispersing the web of companies. Using a diff-in-diff approach, we then find in the period considered a slight reduction in the returns of those companies where interlocking directorships were used the most, which confirms our assumption on the perverse effect of ID on company performance in a context prone to shareholder expropriation such as the Italian one.

Keywords: Corporate Governance, Interlocking Directorships, Social Network Analysis, Empirical Corporate Finance.

JEL codes: C33, G34, G38, L14.

* The opinions expressed do not necessarily represent the view of the institutions to which the authors are affiliated. We wish to thank Dimtri Boreiko, Valentina Colombo, Enrico Gagliardi, Matteo Gargantini, and Maurizio Murgia for their support. We thank Silvia Giacomelli, Frank Hahn, Andrea Polo and a referee for their comments. The paper was presented at the CESifo-Delphi Conference 2010 and at the 6th Conference of the Italian Society of Law and Economics.

** Corresponding author: Roberto Ricciuti, Department of Economics, University of Verona, Vicolo Campofiore 2, 37129 Verona – Italy. Phone : +39.045.8028417 Fax : +39.045.8028529 Email: roberto.ricciuti@univr.it

1. Introduction

The Italian corporate governance system features – at shareholder level - large ownership concentration and the presence of control-enhancing mechanisms in such a way which is conducive to controlling shareholders' dominance at the expenses of minority shareholders (Barker, 2010). In 1998 a structural reform of corporate governance was implemented in order to open up the market for corporate control and to protect minorities (the Draghi Law). At director level, the Italian corporate governance system is characterized by the widespread recourse to interlocking directorships (thereafter ID). In this respect, self-regulation provisions during the period 1998-2007 attempted to reduce interlocking directorships.

The purpose of this paper is to assess the effect of interlocking directorships on company performance (measured by ROE and ROA), and to understand whether the regulatory reforms had any influence on interlocking directorship. Using the instruments of network analysis, we find that after these regulations the concentration of the Italian network of companies decreased only slightly. In particular, the reforms implemented during this period were only partially effective in reducing the pathological cases of interlocking directorships: the companies at the center of the director network managed to reduce their peripheral links while keeping their strategic connections. Moreover, applying an econometric technique (diff-in-diff) that allows to treat reforms as a "natural experiment", we find that, coherently with the our assumptions about the purpose of ID in the Italian stock market of expropriating shareholders, the resilience of a core network of highly interconnected listed companies did not allow such companies to increase their performance. Indeed, in the period considered there was a small significant negative effect on the performance of those companies that relied the most on ID.

This work calls for strengthening the reforms enacted in the 1998-2007 period with further regulation on ID, which actually took place with new law provision in 2011: article 36 of the "Save Italy" Act ruled out interlocking directorships within the same industry, effective from 2012. Further studies will have to tell if the last wave of reforms finally managed to break the perverse

incentives of ID on company performance in Italy. With respect to other works, this is the first study that implements a quasi-experimental technique – which provides causal evidence - to address the impact of this kind of corporate governance reform. This evidence is complemented by a network analysis that, although it cannot provide causal claims, helps to measure and visualize the dispersion of the linkages among interconnected companies.

The paper is organized as follows. Section 2 reviews the characteristics and the legal changes in the Italian corporate governance system, whereas Section 3 discusses the literature on interlocking directorships and company performance and derives the hypotheses to test. Section 4 presents the methodology and data. Results are discussed in Section 5, and robustness checks are provided in Section 6. Section 7 concludes.

2. The Italian corporate governance system: history and reforms

In Italy corporate control is exerted by "industrial families" through alliances based on cross participations, yielding stability in control, in a context in which pyramidal groups have been exploited as a way to separate ownership from control, using capital provided by third parties in order to fund growth. This allows controlling families not only to keep control over the group but also to control the majority of shares in all companies belonging to the pyramid with direct ownership concentrated at the highest level of the control chain, minimizing the amount of capital invested in order to control the whole group. Italian listed companies also issued shares with limited or without voting rights in order to increase capital without diluting the control of the parent company (Zattoni, 1999; Melis, 2000).[1] Furthermore, when additional capital was required, control has been maintained by forming coalitions with other groups (Amadori and Brioschi, 1997; Barca,

[1] Cross-ownership of up to 2% for listed companies and up to 10% for non-listed firms is permitted. Special shares with right to vote only in extraordinary meetings are allowed up to 50% of capital.

1997; Gianfrate, 2007).[2] This is a long-standing feature of the Italian corporate system: Rinaldi and Vasta (2005) document the widespread recourse to director interlocks and to cross-shareholdings for the post-World War II period, Vasta and Baccini (1997) and Drago et al. (2013) provide evidence for the period before World War II, with an emphasis on the bank-industry relationships.

Di Pietra et al. (2008) analyze the effect of interlocking directorships on share prices in a panel of 71 non-financial Italian companies from 1993 through 2000 and find a limited positive effect. Dick and Zingales (2004) emphasize that in Italy private benefits of control are higher than in France, Germany and the UK, due to lower investor protection, poorer accounting rules, lower tax compliance and a less independent press. In Italy, expropriatory high private benefits of control affected the preference of controlling families in keeping control as a tool to guarantee these benefits over time. In order to limit these abnormal benefits of control, corporate governance reform should increase minorities' rights and their enforcement. If this does not happen, ownership does not open up, and firms do not grow.

Two main legislative reforms have characterized the Italian corporate governance system: the Draghi Law[3] (Consolidated Law on Finance, TUF) in 1998 and the Vietti law reform of 2002-4,[4] with some marginal addition by the Law on Savings in 2005.[5]

The Draghi Law was born out of the consolidation of financial market laws into a single act in order to "amend the laws on listed corporations with specific regard to the board of internal auditors, minority shareholder rights, shareholder voting agreements and intra-group transactions, with a view to strengthen the protection of savings and minority shareholders." (Article 21, Para. 4,

[2] However, Faccio and Lang (2002) documented that out of 208 listed firms 12.98 were widely-held, 59.61 family-held, 10.34 state-held and 0.72 held by cross-ownership, therefore emphasizing the role of families and putting aside the role of coalitions.

[3] Legislative Decree No. 58/1998.

[4] Legislative Decrees Nos. 61/2002, 6/2003, and 37/2004.

[5] For overviews of these reforms see Ferrarini (2005), Melis (2006) and Enriques (2009).

Law 52/1996). The Law streamlined the legal framework for securities offerings, takeover bids, disclosure obligations, and audit firms. Minority shareholders representing a minimum threshold (ranging from 1 percent to 10 percent of the outstanding shares) were granted governance rights and remedies previously either unavailable (two-thirds majority required in extraordinary meetings and shareholder representing 5 percent of company's capital may sue directors derivatively) or subject to higher ownership thresholds (shareholders representing 10 percent of company's capital may request that a meeting be convened and shareholders representing 5 percent of company's capital may file a complaint to the Court asking for the appointment of an inspector). Disclosure on ownership structure was extended by requiring full disclosure of all shareholder agreements. A "mini-breakthrough" rule was introduced, declaring shareholder agreements by which parties restrict their own freedom to sell shares ineffective in the event of a takeover bid. The lift of a ban on proxies came together with heavy regulation of proxy solicitation and a provision allowing mail voting on an opt-in basis. As to audit functions, the Law completely reshaped the role, composition, and powers of the board of internal auditors: representation of minority shareholders was mandated, its powers and the powers of individual members strengthened, and its mission clarified by focusing on internal controls. A restyling of the legal regime of audit firms was implemented, by clarifying their tasks. Finally, Consob's statutory objectives in supervising issuers were spelt out (investor protection, efficiency and transparency of the market for corporate control and of capital markets), its regulatory authority broadened and its powers to request information, execute on-site inspections and impose ad hoc disclosure duties extended.

The Draghi Law had both signaling and concrete effects. For the former, it improved the perception of Italian capital markets abroad, at a time of increasing competition for capital.[6] Therefore it signaled the new stance on corporate governance that policymakers mostly followed in subsequent reforms. A number of idiosyncrasies characterizing the Italian regulatory framework

[6] Shleifer and Vishny (1997) stated that "[i]n many countries today, the law protects investors better than it does in Russia, Korea, or Italy").

were abandoned in favor of regulations similar to international standards. For instance, the internal board of auditors was retained as a separate body within the company, but its functions were streamlined to replicate those of audit committees in the US and the UK. The takeovers regime was reshaped drawing inspiration from the UK model: first, a complete ban on defensive tactics was replaced by a rule requiring a shareholder meeting authorization to adopt them; second, a mandatory bid rule triggered by the crossing of a 30 percent threshold replaced a mandatory partial bid rule triggered by the acquisition of control. Rules on shareholder agreements, a traditional tool for control in which dominant families and financial institutions have built blocks and cross-holdings in the major Italian listed companies, were weakened by imposing a maximum duration of three years and by introducing a "mini-breakthrough rule" allowing parties of shareholder agreements to freely tender their shares in a takeover by declaring any restriction on share sales in the shareholder agreement ineffective in the event of a takeover bid.

The Draghi Law emphasizes the autonomy of each firm in choosing its corporate governance model. The result was the adoption of the first version of the Italian Corporate Governance Code in 1999[7] (the so-called Preda Code), as a set of self-regulatory best practices to be adopted spontaneously by the Italian listed companies to satisfy company's organizing needs and investors' goals.[8] The basic principle of the Code is "comply or explain", i.e., the company may not comply with the prescriptions of the code if it fits better with its needs, but noncompliance should be clearly explained.

Among other things, the Code emphasizes the role of the Board of Directors in determining and implementing the strategic objectives of the company, the autonomy of its non-executive members and the presence of a sizable number of independent directors. Non-executive directors, with their competences obtained outside the firm, should give a critical assessment of the proposals of the executives in order to align their decisions with the interest of shareholders. Independent

[7] Bianchi et al. (2011) find that in "related party transactions" the adoption is more formal than substantial.

[8] Law No. 262/2005 and Legislative Decree No. 303/2006.

directors should play an important role in board committees. The Code recommends establishing remuneration and internal audit committees, and suggests the setting up of an appointment committee. The Preda Code advises the separation of the roles of the Chief Executive Officer and the Chairman of the Board, but highlights a number of cases in which lack of separation may be accepted because of specific organization needs. In the latter case, the role of the independent and non-executive directors is then the key to protect minority shareholders.

The first version of the Preda Code claimed that "Directors accept the appointment when they believe that they can carefully attend their duties by devoting the necessary effort in terms of time" (art. 1.3), then the 2002 update added to the previous sentence that "[directors accept the appointment] also taking into account the number of directorships they hold either in other listed companies (also abroad) in financial, banking and insurance companies or in large non-listed companies". A further addition stated that "each year the board of directors surveys and gives public information of the directorships held in listed and non-listed companies by their members".[9]

Since 2001 Assonime, the Association of the Italian Joint Stock companies, publishes a report to track the compliance of listed companies with the Preda Code. The first compliance with the Code was not very effective: companies compiled their reports in a quite mechanical way without disclosing significant information (Assonime, 2001: 3-4). However, disclosure improved sharply since the second report (Assonime, 2003: 4).

While according to Enriques (2009) the long period of reforms has produced some improvements in the degree of investor protection, the author also observes that a more radical improvement would only be possible after the enactment of mandatory disclosure and fairness regulation of related-party transactions, which has taken place only on December 1st 2010. Bianco and Bianchi (2008) provide evidence on the actual evolution of corporate governance following the

[9] In the 2006 version a further paragraph was added stating that each board decides how many concurrent directorships a director can hold at the same time that are compatible with the effort required, also discriminating between executive, non-executive and independent members of the board.

legal changes started in the late '90s. They find that while at the beginning of the '90s, pyramids, dual class shares and cross-ownership were widely used, in 2007 their importance was substantially reduced with an increase in another control mechanism: the coalitions among shareholders. Moreover, they observe a lower value of the proxies for control premium, a greater compliance with corporate governance codes, and an increased presence of institutional investors at annual shareholders' meetings.

3. Interlocking directorship networks and performance

ID has been pointed out as the "root of many evils" by Brandeis (1914). Probably because Brandeis was one of President Wilson's counselors, in 1914 the Clayton act prohibited ID among competitors. According to the principle that "no man can serve two masters", IDs were seen as a tool to decrease competition, therefore damaging the market. In the second part of the 20th century, ID have been studied and made the object of several contributions, both theoretical and empirical.

3.1 Interlocking Directorate: Theoretical Framework

Various theories have been advanced to explain the presence of ID on company boards. We classify those theories according to two main streams: the first one sees ID as a relation between institutions; the second one focuses on the relationship among individuals. Divided in these two categories, theoretical contributions can be grouped into seven theories or models: three referring to ID as a link between individuals, and four referring to ID as a link between institutions.

Management Control Model. This is the first model that considers ID as a link among individuals. The model stresses the power of managers in pursuing strategies that are not in line with shareholders' interests. Managers tend to appoint as directors managers from other companies so that they are busy and passive, and do not contradict those who called them in their role. Palmer (1983) investigates what happens when a link between two firms disappears due to the death or retirement of a director. Only a minority of these links are created again after they disappear: if

these links were functional to connect two institutions they would be promptly reconstituted. Ornstein (1984) reports similar results from a Canadian context. According to Koening et al. (1979), managers use ID to increase their power: interlocked directors are often passive and never vote against managers that "hired" them.

Hallock (1997) studies the effect of cross interlocks between CEOs on their compensation. His findings show an increase in CEO salary of about 17% due to the presence of interlocks. Fitch and White (2005) discover a negative relation between the number of interlocks and CEO turnover. This work reaches conclusions closely related to those suggested by Cochran et al. (1985), who finds a positive relation between interlocks and the quality of the "golden parachute" for top managers. Renneboog and Zhao (2011) find that stronger networks allow higher CEO compensation because of information sharing and managerial influence.

Class Hegemony Model. Mills (1956) and Useem (1984) describe ID as the result of a strong social cohesion. Directors contact other directors following a relationship pattern: for example, they go to the same golf or country club, they share the same beliefs and values, and they often have shared political views. In other words, they all belong to the same business elite.

Mizruchi (1992) reports how firms linked by ID are more likely to support the same political view. Keoning et al. (1979) studied the 1972 Nixon Presidential Campaign and observed that those companies belonging to the same network were more likely to contribute to the Nixon Campaign if one of such corporations had contributed before. Etzion and Davis (2008) found that the Bush administration recruited more heavily from corporate officers and directors than the Clinton administration. Moreover, both administrations served as springboards for subsequent corporate board appointments. In particular, all but one of the Joint Chiefs of Staff ended up serving on the board of a military contractor after government service.

Career Advancement Model. Stockman et al. (1988), Zajac (1988) and Perry and Peyer (2005) propose a theory focused on the interest of each single interlocked director. In this model, directors decide to interlock following mainly four drivers: compensation, prestige, future networking and

job opportunities. Directors decide to interlock simply following their individual interest. Institutions, governance or the social context are not relevant.

Resource Dependence Model. The first model that sees ID as an instrument to connect institutions was proposed by Selnick (1947), and was then followed and supported by many other contributors [e.g., Dooley (1969), Pennings (1980), Palmer et al. (1986), Mizruchi and Stearns (1988), Lang and Lockhart (1990) and Cross and Cumming (2004)]. According to this model, companies face enormous uncertainty in their business life. Uncertainty may be about customers, suppliers, competitors, macroeconomic conditions or other features. This model sees ID as a tool to reduce uncertainty. That is why a part of ID brings vertical/horizontal integration or is between institutions belonging to the same industry (Dooley, 1969). The resources firms are looking for when they interlock are also intangible, such as information, business practice or prestige. Maggio and Powell (1983) suggest that a bank is more likely to lend money if the borrower has directors with high prestige and reputation. Geletkanycz and Boyd (2011) find that CEO with outside directorships are beneficial in contexts of low growth, low concentration and less diversified firms. Appointing CEOs or directors that are already central in the network is a signal for corporate governance quality to financial markets, reducing perceived uncertainty (Davis and Robbins, 2005; Westphal and Zajac, 1998).

Financial Control Model. Capital is one of the most important resources a company needs to run its business. That is why a specific model explains ID as a tool to have easier access to capital. There is high empirical evidence of ID among banks and industrial companies. Dooley (1969), Mizruchi (1998) and Mizruchi and Stearns (1988) found more ID with banks in those companies with an increasing demand for capital. Moreover, often banks have a central role in networks (Davis and Mizruchi, 1999).

Having a banker on the board of an industrial company board reduces information asymmetries between the bank and the industrial company. Companies may benefit in raising more debt capital; in addition, the banker ensures better monitoring during debt life. When this relation follows or

precedes a lending relationship then conflicts of interests arise. The banker faces a conflict: sitting on the board of the industrial company should maximize shareholders' values; at the same time she should maximize bank debt value. A simple way to maximize bank debt value is to reduce company leverage. But reducing company leverage is a benefit for shareholders only if the current leverage ratio is above the optimal level (Modigliani and Miller, 1963). On the other hand, as explained before having a banker on the board may give industrial companies the opportunity to raise more debt. Empirical evidence on the topic is mixed (Byrd and Mizruchi, 2005; Rommens et al., 2008). Dittmann et al. (2010) find that in Germany bankers on the board of non-financial firms promote their banks as lenders and advisors, and help them with funding in difficult times.

The Collusion Model. According to the collusion theory, ID allows the creation of communication channels between companies to make agreements against consumers. Interlocking directorships can be an instrument to cartelize a market because sharing directors allows cartel participants to have an observer in place monitoring activities that could undermine the cartel agreement. A system based on direct IDs may thus potentially produce economic inefficiencies. Pennings (1980) finds a positive association between industry concentration and horizontal ties, while Burt (1983) finds an inverted U-shaped function: in the case of very high market concentration, few producers have little need to interlock to set prices.

Drago et al. (2011) have observed that the features of ID in the Italian stock market do not correspond to any of the previous hypotheses, formulating the **Enlarged Collusion Model**. Differently from the Management Control, Class Hegemony, and Career Advancement models, ID take place in companies that are characterized by concentrated ownership. In contrast with the Resource Dependence and the Collusion models, ID occur in companies that do not necessarily belong to the same business sector. Differently from the Financial Control Model, ID take place also in companies that are not creditors and debtors. According to the authors, ownership concentration, cross-shareholdings, and ID might be functional to the expropriation of minority shareholders.

3.2 Interlocking Directorates and Company Performance

The seven models presented reach different conclusions about the effects of interlocking directorships on company value.

The Resource Dependence Model suggests a positive effect on company performance: the ability to control or at least reduce uncertainty give an advantage. The same conclusions can be drawn from the Financial Control Model: the opportunity to gain easier access to capital markets produces an important advantage for any company. On the other hand, the Management Control Model and the Enlarged Collusion Model suggest a negative effect on company performance. The assumption supporting the first theory is that managers hire interlocked directors in order to have a higher degree of freedom and thus move away from their fiduciary duties towards shareholders, while under the Enlarged Collusion Model the choice of ID is made by controlling shareholders with the purpose to have passive company boards with respect to shareholder expropriation.

The Class Hegemony Model could support positive or negative effects of ID on company performance. According to this theory, directors are not chosen for their competences or skills; therefore they should produce a disadvantage for the company. On the other hand, being part of a business elite could generate new contracts, opportunities and other advantages. The Career Advancement Model supposes a positive effect of ID on company performance. If directors are chosen for their ability and their skills they will bring beneficial effects. The Collusion Model suggests a positive effect of ID on company performance because of higher margins due to lower competition, whereas for the Enlarged Collusion Model the effect is negative through expropriation of minority shareholders.

Table 1 summarizes the expected effects of ID Models on company performance, which are mostly positive.

[Insert Table 1 about here]

While with a Dutch sample, Franses and Non (2007) find a slightly negative effect of a new ID on company performance with a time lag after the link is created, Rommens et al. (2008) find the opposite using a different Dutch sample. Yeo et al. (2003) find a positive relation between the number of links and profitability (ROA). The same conclusion is drawn by Brantleys and Flingstein (1992) with a US sample. Studying samples from different contexts, with different legal or cultural environments, can therefore easily mean studying different ID models.

By considering our discussion of the reforms implemented in Italy in the last fifteen years (namely the Draghi Law and the amendment of the Preda Code aimed at reducing the number interlocking directorships) and our literature review, we can test the following hypotheses:

H1: The reforms have dispersed the board interlocking network.

H2: Reforms have a neutral or negative effect on the returns of the most interlocked companies.

H1 aims to verify whether the limitation to ID introduced in the Preda code had any effects, starting from the anecdotal evidence that has been previously discussed (mainly Enriques, 2009). In particular, we provide quantitative evidence based on the network analysis methodology. In this part of the analysis we will only consider the "center" of the network, that is the main listed companies which account for the bulk of the "relational capitalism" of the Italian families. Moreover, this also reduces the computational problems related with a large network of about 200 companies per year.

H2 is based on the Enlarged Collusion Model which we find appropriate to the Italian specificities described above in Section 2. As long as the reforms did not manage to eliminate a network of highly connected companies, no visible positive effect is to be expected on the profitability of such companies.

4. Methodology and data

We use an original dataset, obtained from two different sources. We gathered information about all the boards of directors for all the companies listed on the Italian stock exchange of Milan from the Italian security and exchange commission (Consob). We collected market and balance sheet data for these companies in the same period (source: Datastream). We consider a ten year period from 1998 to 2007, although the two dataset do not completely overlap.

As for the first part of the dataset, the sample used in the work is related to the listed non-financial companies in Italy from 1998 to 2007, where we refer to board composition as of 31 December of each year. The number of companies belonging to the panel changes over time: 134 in 1998, 147 in 1999, 179 in 2000, 194 in 2001 and 2002, 191 in 2003, 188 in 2004, 201 in 205 221 in 2006, and 239 in 2007. For each listed company we collected the data of board composition from Consob datasets, ordered by company, name and surname. Starting from this matrix, we obtain another matrix in which we consider all directors by the number of directorships in each company (this is called 2-way matrix). Using the Cross-Product Algorithm (Bonnacich, 1972) we transform matrices in 2-way company X directors in 1-way matrices in which we have both in row and columns the same subject: directors X directors, and companies X companies. From these two matrices we run the network analysis for directors and companies, and as a result we obtained some measures of centrality that we consider together with other network features.[10] As for the second part of our dataset, it contains performance measures of the Italian listed companies for seven years (2001-2007). The final merged database consists of two distinct groups of variables: (i) corporate governance variables related to board size and interlocking directorships and (ii) another group of variables related to companies' economic and financial performances. We do not impute the missing values in this dataset. The relevant underlying assumption we consider for the problem of missing data here is that missing data are "missing at random", so we do not consider missed observations. At the same time, data do not show structural phenomena of non-response (so the

[10] Further details are given in Appendix I.

missing value we assume is "at random") for the part of the database related to interlocking directorships. Table 2 provides summary statistics.[11]

[Insert Table 2 about here]

In particular, we collect the number of directors with more than 1, 2, … directorships to build one variables related with ID: the *Number of interlocking directors with more than 5 directorships*. We divide this variable by the board size to obtain the *Share of interlocking directors with more than 5 directorships*, which we believe is a better measure of busyness since it consider the influence of these directors on board size. These variables are similar to those used by Fich and Shivdasani (2006). This variable is called *Dense* in the estimation.

The dependent variables are ROE and ROA,[12] alternatively. Among independent variables, we also consider Financial Leverage:

$$LM_{s,t} = \frac{TL_{s,t}}{TL_{s,t} + MKC_{s,t}} \qquad (1)$$

where *MKC* is Market Capitalization and *TL* stands for total liabilities. The statistical methodology followed in this work is divided into two distinct parts: in the first part, we study the network structure by obtaining some indices of centrality and density. From the social network analysis, we obtain some important insights into the network dynamics over time. Then, we test the hypothesis about network stability over time and the impact of the reforms (H1). In particular, some tests of equality of medians are used to observe that variables related to the number of directors with 3 directorships and more tend to be different year by year (and so they are directly impacted by the considered reforms).

[11] The correlation matrix is available upon request from the authors.

[12] Another candidate would be Tobin's q, but we had very few data in order to estimate meaningful econometric relationships.

The second part of the econometric procedure uses a diff-in-diff (DD) methodology in order to evaluate the impact of the reform (in particular H2). The estimated model using longitudinal data is:

$$R_{s,t} = \beta_0 + \beta_1 After + \beta_2 Dense + \beta_3 After \times Dense + \beta_4 \mathbf{X}_{s,t} + \mathbf{Y}_{s,t} + \varepsilon_{s,t} \quad (2)$$

where $R_{s,t}$ is either ROE or ROA, *After* = 1 after 2004 and zero otherwise, *Dense* = 1 if there are directors with more than 5 ID and zero otherwise,[13] the vector $\mathbf{X}_{s,t}$ includes some control variables such as financial variables (the log of Total assets, Sales-per-share, and Financial leverage), and corporate governance variables such as Board size, $\mathbf{Y}_{s,t}$ are the year-dummies, and $\varepsilon_{s,t}$ is an error term.

Diff-in-diff is a technique which attempts to mimic an experimental research design using observational study data, called "natural experiment".[14] It calculates the effect of a treatment (i.e., an explanatory variable or an independent variable) on an outcome (i.e., a response variable or dependent variable) by comparing the average change over time in the outcome variable for the treatment group to the average change over time for the control group. In our framework, the

[13] We experimented with lower numbers of directorships to construct the dummy, but they were never significant. Results are available upon request form the authors.

[14] A natural experiment is an empirical study in which individuals (or clusters of individuals), exposed to the experimental and control conditions, are determined by nature or by other factors outside the control of the investigators. Thus, natural experiments are observational studies and are not controlled in the traditional sense of a randomized experiment. Natural experiments are most useful when there has been a clearly defined exposure involving a well-defined subpopulation (and the absence of exposure in a similar subpopulation) such that changes in outcomes may be plausibly attributed to the exposure. In this sense the difference between a natural experiment and a non-experimental observational study is that the former includes a comparison of conditions that pave the way for causal inference, while the latter does not.

treatment is the reform, and we are interested in checking whether returns are affected by the reform from 2004 onwards, and whether the companies that relied the most on ID were affected the most.

5. Results and discussion

5.1 Social Network Analysis

The Social Network Analysis is conducted on the interlocking directorship network.[15] In this part of the analysis we only consider the Italian Blue Chip companies, identified according to the MIB 30 Index until 2002 and the S&P-MIB 40 Index, introduced in 2003. In this way, we consider the most capitalized companies of the entire network.

Table 3 shows the centralization and density values for the network, together with their relevant index numbers.[16] Centralization measures the deviation of a network to the "star" network, in which one single node is connected to all the other nodes and they are not connected together. Density describes the general level of linkage among the points in a graph. It is calculated as the ratio between the number of ties and its total possible number (Wasserman and Faust, 1994). A tie is a link between two companies established by sharing one or more directors . The higher the density of a network of companies or directors, the higher the number of links among the companies or directors. Over the nine years considered, the Italian Blue Chips network density decreased of about 50%, which means that in 2007 the system is less interconnected and the network of interlocking directors less dense than in 1998. At the same time, centrality increases, showing that the centre of the system increases its relevance. Appendix 2 shows the networks in selected years of our time-span.

[15] Chiesi (1985) pioneered the use of social network analysis in the study of Italian capitalism. He found that in the '70s two poles co-existed, based respectively on state and on privately owned companies. Some companies, such as Bastogi and Sme, were the bridges between them, since in their boards of directors sat many members of the two poles.

[16] See Appendix 1 for the relevant *formulae*.

The decrease in density seems related with the lower number of multiple directorships due to the revision of the Preda Code and with the undertaken reforms. The two opposite variations in centralization and density are linked: as reforms reduce the number of interlocking directorships, the ones who are abandoned are those relatively less important, connecting members of the network periphery and not the periphery with the centre. Hence centralization increases creating a more hierarchical structure. In the end, the Italian Blue Chips reacted to the changes in the regulatory framework by moving from a model which allowed a high degree of communication among all the Blue Chips to a model which ensures communication through a few key companies (and directors). Such adaptation allowed the Italian Blue Chips to maintain the features of the Italian key listed companies as a network of companies whose decisions are known to each other, and therefore allowing for shareholder expropriation.

We can test H1 in a more formal way. Table 4 shows the equality of medians for the number of directors with more than 1 to 5 directorships. The null hypothesis is the equality between the medians over time whereas the alternative is the difference. The values in the table represent the number of values greater than the median. The null hypothesis of equality of the medians from 1998 to 2007 cannot be rejected for the number of directors with 1 and 2 interlocking directorships, whereas it can be rejected for higher number of directorships. The result is consistent with the previous observation that the network tends to reduce the number of links over time, but this reduction is mainly concentrated on directors with more than 3 directorships.

These results can be interpreted as the impact of reforms over the time, in particular the amendments to the self-regulatory Preda Code that started addressing the issue of ID in 2002 and therefore required some time to be implemented by companies. We observe a differentiated impact of the reforms: they seem not to strictly affect the network structure but to reduce the number of the highest number of linkages. In this respect, we note that the reduction in the number of multiple directorships takes place in 2004-2007, and that since 1998 the Italian regulatory framework gradually emphasizes the need for directors to limit the number of directorships.

Network stability is only partially consistent with Corrado and Zollo (2006), who studied the interplay between privatizations and corporate governance reforms in Italy, finding evidence of destructuration at the macro level of the network, with substantial stability at lower levels of the analysis.[17] These results, however, are not specific to Italy: Davis et al. (2003) find a remarkable network stability of American directors between 1982 and 2001, a period with strong changes in the ranking of firms, in the positions held by individual directors, and in corporate governance practices.

[Insert Table 4 about here]

5.2 Diff-in-diff

To test the significance of the H2 hypothesis we estimate a diff-in-diff model to ascertain the effect of the reform on ROE and ROA. In Table 5 for ROE the variable *Post* is insignificant, showing the absence of an effect of the reform on all companies. However, *Dense* and *After×Dense* are both significant: the first is positive, showing that companies that have a high share of interlocking directors benefit from this feature, the second is negative claiming that the reform had effect on this companies and that their profitability was affected. We need to note that the size of this coefficient is relatively small. These results are consistent across specifications. Looking at the other variables, we find that *Total assets* and *Sales-per-share* are significantly positive, and *Board size* is significantly negative, differently from Di Pietra et al. (2008) where it was not significantly different from zero. The only not statistically significant variable is *Financial leverage*.

As far as the treatment effects are concerned, results for ROA (Table 6) are very much in line with those of ROE. However, *Sales-per-share* and *Board size* are significant but change their signs, and *Financial leverage* turns out to be significantly negative.

[Insert Table 5 about here]

[17] We should note that their results are based on a different definition of network: ownership in their approach, and IDs in ours.

[Insert Table 6 about here]

6. Conclusion

The purpose of this paper is twofold: first, to assess the relationship between interlocking directorships and company performance for the main companies listed on the Italian stock market in the period 1998-2007. Second, to analyze the Italian network of interlocking directorships to verify its structural features over a time period that has been characterized by a changing regulatory framework.

In the period considered a legislative act – the Draghi Act Law - was introduced in Italy to limit shareholder expropriation. Besides, in the successive versions of the Italian corporate governance code (a self-regulation tool) there was an increasing emphasis on the need to limit the number of ID. We find that in the period considered there was only a limited reduction in the concentration of the Italian network of companies. In particular, the reforms implemented during this period were only partially effective in reducing the pathological cases of interlocking directorships: the companies at the center of the director network managed to reduce their peripheral links while keeping their strategic connections. The efficiency in reducing the number of links while keeping the relevance of the main nodes was already shown by Drago et al. (2007). The econometric analysis confirms our original assumption on the negative effects of ID on company performance in the Italian stock market: the companies that over the period considered continued to rely heavily on ID showed a slight decrease in their performance (measured by ROE and ROA). The overall result is consistent with our original model whereby in the Italian stock market ID seems to be instrumental to shareholder expropriation.

Our conclusion is that the reforms implemented in Italy during the 1998-2007 period were only partially effective in the short term. Further studies will have to investigate whether such reforms have been more effective in the medium term, together with more recent reforms on related

party transactions enacted in 2010 (Consob 2010) and the new limitations to ID introduced in 2011. Data for such studies will be available in the coming years to allow for a robust empirical analysis.

We recognize some limitations of this study. Firstly, the results are idiosyncratic to Italy, a country whose listed companies are characterized by a concentrated shareholder base and the recourse to control-enhancing mechanisms in such a way which is conducive to controlling shareholders' dominance at the expenses of minority shareholders. Secondly, there is a latent variable that we cannot observe, the actual participation to board meetings: we expect busy directors to participate less, but we have no evidence for this behavior. Thirdly, and perhaps most importantly, further empirical research should also include the interplay between cross-shareholdings and ID.

REFERENCES

Amatori, F. and Brioschi, F. (1997), Le grandi imprese private: famiglie e coalizioni, in: Barca, F. (Ed.) Storia del Capitalismo Italiano, Roma: Donzelli.

Assonime (2001), Prima analisi dello stato di attuazione del Codice di Autodisciplina delle società quotate. Note e studi, 21.

Assonime (2002), Analisi dello stato di attuazione del Codice di Autodisciplina delle società quotate (Anno 2002), Note e studi, 45.

Barca, F. (1997), Compromesso senza riforme nel capitalismo italiano, in: Barca, F. (Ed.) Storia del capitalismo italiano, Roma: Donzelli.

Barker, R.M. (2010), Corporate governance, competition, and political parties. Oxford: Oxford University Press.

Bianchi, M., Ciavarella, A., Novembre, V., and Signoretti, R. (2011), Comply or explain: investor protection through the Italian corporate governance code. Journal of Applied Corporate Finance, 23: 107-121.

Bianchi, M. and Bianco, M. (2006), Italian corporate governance in the last 15 years: from pyramids to coalitions? ECGI - Finance Working Paper No. 144/2006.

Bonnacich, P. (1972), Techniques for analyzing overlapping memberships, in: Costner, H. (Ed.) Sociological Methodology, 176-185, San Francisco: Jassey-Bass.

Brandeis, L. (1914), Other people's money and how bankers use it. New York: F.A. Stokes.

Brantley, P. and Fligstein, N. (1992), Bank control, owner control, or organizational dynamics: who controls the large modern corporation? American Journal of Sociology, 98: 280–307.

Byrd, D.T. and Mizruchi, M.S. (2005), Bankers on the boards and the debt ratio of firms. Journal of Corporate Finance, 11: 129-173.

Chiesi, A. (1985), Property, capital and network structure in Italy. In: Stokman, F.N., Ziegler, R. and Scott, J. (Eds.), Networks of Corporate Power, 199-214, Cambridge: Polity Press.

Cochran, P. L., Wood, R.A. and Jones, T.B. (1985), The composition of boards of directors and incidence of golden parachutes. Academy of Management Journal, 28: 664-671.
Consob (2010), Regolamento operazioni con parti correlate, n. 17221, 12 March 2010.
Corrado, R. and Zollo, M. (2006), Small worlds evolving: governance reforms, privatizations, and ownership networks in Italy. Industrial and Corporate Change, 15: 319-352.
Cross, R. and Cummings, J.N. (2004), Tie and network correlates of individual performance in knowledge-intensive work. Academy of Management Journal, 47: 928-937.
Davis, G.F. and Mizruchi, M. (1999), The money center cannot hold: commercial banks in the U.S. system of corporate governance. Administrative Science Quarterly, 44: 215-239.
Davis, G. F., Yoo, M. and Baker, W. E. (2003), The small world of the American corporate elite, 1982-2001. Strategic Organization, 1: 301-326.
Davis, G.F. and Robbins, G. (2005), Nothing but net? Networks and status in corporate governance. In: Knorr-Cetina, K. and Preda, A. (Eds.) The sociology of financial markets. Oxford: Oxford University Press.
Di Pietra, R., Grambovas, C.A., Raonic, I. and Riccaboni, A. (2008), The effect of board size and 'busy' directors on the market value on Italian companies, Journal of Management and Governance 12: 73-91.
Dittmann, I., Maug, E. and Schneider, C. (2010), Bankers on the Boards of German Firms: What They Do, What They Are Worth, and Why They Are (Still) There. Review of Finance, 14: 35-71.
Drago, C., Polo, A., and Santella, P. (2007), The Italian Chamber of Lords sits on listed company boards: an empirical analysis of Italian listed companies boards from 1998 to 2006. MPRA paper n. 2265.
Drago, C., Manestra, S., and P. Santella, P., (2011), Interlocking Directorships and Cross-Shareholdings Among the Italian Blue Chips, European Business Organization Law Review 12, 4, 619-645.
Drago, C., Ricciuti, R., Rinaldi, A. and Vasta, M. (2013), A counterfactual analysis of the bank-industry relationship in Italy, 1913-1936, DEMB Working Paper Series n. 13, Università di Modena e Reggio Emilia.
Dyck, A., and Zingales, L. (2004), Private benefits of control: an international comparison, Journal of Finance, 59: 537-600.
Dooley, P.C. (1969), The interlocking directorate. American Economic Review 59, 314–323.
Enriques, L. (2009), Modernizing Italy's corporate governance institutions: mission accomplished? European Business Organization Law Review 10, 477-513.
Etzion, D. and Davis, G.F. (2008), Revolving doors? A network analysis of corporate officers and U.S. government officials. Journal of Management Inquiry 17, 157-161.
Faccio, M. and Lang, L.H.P. (2002), The ultimate ownership of western European Corporations, Journal of Financial Economics, 65: 365-395.
Ferrarini, G.A. (2005), Corporate Governance Changes in the 20th Century: A View from Italy, in Hopt, Wymeersch, Kanda e Baum (a cura di), Corporate Governance in Context: Corporations, States, and Markets in Europe, Japan, and the US, Oxford University Press, p.31-52.
Fich, E. and Shivdasani, A. (2006), Are busy boards effective monitors? The Journal of Finance, 61: 2, 689–724.
Fich, E. M. and White. L.J. (2005), Why Do CEOs reciprocally sit on each other's boards? Journal of Corporate Finance, 11: 175–195.
Franks, J., Mayer, C., Volpin, P. and Wagner, H.F. (2008), Evolution of family capitalism: a comparative study of France, Germany, Italy and UK. Mimeo.
Franses, P. H. and M. Non (2007), Interlocking boards and firm performance: evidence from a new panel database. Working paper, SSRN 978189.

Geletkanycz, M. A. and Boyd, B. K. (2011), CEO outside directorships and firm performance: a reconciliation of agency and embeddedness views. Academy of Management Journal, 54: 335-352.
Gianfrate, G. (2007), What do shareholders' coalitions really want? Evidence from Italian voting trusts. Corporate Governance: An International Review, 15, 122-132.
Hallock, K. F. (1997), Reciprocally interlocking boards of directors and executive compensation. Journal of Financial and Quantitative Analysis, 32: 331-344.
Lang J.R. and Lockhart, D.E. (1990), Increased environmental uncertainty and changes in board linkage patterns. Academy of Management Journal, 33: 106–28.
Melis, A. (2000), Corporate governance in Italy. Corporate Governance: An International Review, 8, 347-355.
Melis, A. (2006). Corporate Governance Developments in Italy, in Mallin C.A. (ed.), Handbook of International Corporate Governance: Country Analyses, Edward Elgar, pp: 45-68.
Mizruchi, M.S. (1992), The structure of corporate political action. Cambridge: Harvard University Press.
Mizruchi, M.S. and Stearns, L.B. (1988), A longitudinal study of the formation of interlocking directorates. Administrative Science Quarterly, 33: 194-210.
Modigliani, F. and Miller, M.H. (1963), Corporate Income taxes and the Cost of Capital: a Correction. American Economic Review 53, pp: 434-443.
Palmer, D., Friedland, R., Singh, J.V. (1986), The ties that bind: organizational and class bases of stability in a corporate interlock network. American Sociological Review, 51: 781–96.
Pennings, J. M. (1980), Interlocking directorates. San Francisco: Jossey-Bass.
Perry, T., and Peyer, U. (2005), Board seat accumulation by executives: A shareholder's perspective. Journal of Finance, 60: 2083–2123.
Rinaldi, A. and Vasta, M. (2005), The structure of Italian capitalism, 1952-1972: new evidence using the interlocking directorates technique. Financial History Review, 2: 173-198.
Rommens, A., Cuyers, L., and Deloof, M. (2008), Interlocking directorates and business groups: Belgian evidence. Paper presented at the annual meeting of the Financial Management Association, Prague.
Renneboog, L., and Zhao, Y. (2011), Us knows us in the UK: On director networks and CEO compensation. Journal of Corporate Finance, 17: 1132–1157
Shleifer, A. and Vishny, R.W. (1997). A Survey of Corporate Governance. Journal of Finance, 52: 737-783.
Stokman F.N., Van der Knoop, J., and Wasseur, F.W. (1988), Interlocks in the Netherlands: stability and careers in the period 1960–1980. Social Networks, 10: 183–208.
Useem, M. (1984), The inner circle: large corporations and the rise of business political activity, New York: Oxford University Press.
Vasta, M. and Baccini, A. (1997), Banks and industry in Italy, 1911-36: new evidence using the interlocking directorates technique. Financial History Review, 4: 139-159.
Wasserman, S. and Faust, K. (1994), Social Network Analysis. Cambridge: Cambridge University Press.
Westphal, J. D. and Zajac, E. J. (1998), The symbolic management of shareholders: corporate governance reforms and shareholder reactions. Administrative Science Quarterly 43: 127–153.
Yeo, H.J., Pochet, C., and Alcouffe, A. (2003), CEO Reciprocal interlocks in French corporations. Journal of Management and Governance, 7: 87–108.
Zajac, E.J. (1988), Interlocking directorates as an interorganizational strategy. Academic Managerial Journal, 31: 428–438.
Zattoni, A. (1999), The structure of corporate groups: the Italian case. Corporate Governance: An International Review, 7: 38-48.

TABLE 1 - Summary of the models

Model	Effect on firm performance
Management Control	Negative
Class Hegemony	Mixed
Career Advancement	Positive
Resource Dependence	Positive
Financial Control	Positive
Collusion model	Positive
Enlarged Collusion Model	Negative

TABLE 2 – Summary statistics

Variables	Mean	Std. Dev.	Min	Max
Total assets	13.016	1.821	7.474	18.507
Sales-per-share	12.525	68.033	0.003	953.205
Board size	8.990	3.251	2	21
Financial leverage	0.521	0.236	0.009	0.994
Dense	0.653	0.476	0	1
Post	0.0222	0.147	0	1

Summary statistics for the sample of the listed non-financial companies in Italy, where we refer to board composition as of 31st December of each year. The number of companies belonging to the panel changes over time: 134 in 1998, 147 in 1999, 179 in 2000, 194 in 2001 and 2002, 191 in 2003, 188 in 2004, 201 in 205 221 in 2006, and 239 in 2007.

TABLE 3 – Centralization and density of the network

Year	Centralization	1998=100	Density	1998=100
1998	7.34	100	0.031	100
1999	7.72	105	0.030	98
2000	6.07	83	0.032	103
2001	8.19	112	0.031	99
2002	8.42	115	0.032	103
2003	6.29	86	0.033	108
2004	7.26	99	0.033	108
2005	9.20	125	0.027	89
2006	9.52	130	0.024	77
2007	9.34	127	0.021	68

Network measures computed on the sample of 30 blue-chips listed in the Italian Stock Market (MIB 30 Index until 2002 and the S&P-MIB 40 Index).

TABLE 4 - Equality tests for the medians

Greater than the median	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Number of directors with one directorship											
No	78	93	110	129	118	108	103	114	137	156	1,146
Yes	56	54	69	65	76	83	85	87	84	83	742
Pearson $\chi^2(9) = 11.2522$ $p = 0.259$											
Number of directors with two directorships											
No	69	86	114	113	115	127	124	116	140	142	1,146
Yes	65	61	65	81	79	64	64	85	81	97	742
Pearson $\chi^2(9) = 12.8150$ $p = 0.171$											
Number of directors with three directorships											
No	94	112	134	149	162	129	137	142	155	175	1,389
Yes	40	35	45	45	32	62	51	59	66	64	499
Pearson $\chi^2(9) = 18.2287$ $p = 0.033$											
Number of directors with four directorships											
No	117	122	162	154	161	162	150	163	181	181	1,580
Yes	17	25	17	40	33	29	38	38	40	40	308
Pearson $\chi^2(9) = 15.8715$ $p = 0.070$											
Number of directors with five directorships											
No	116	133	154	181	173	177	164	162	197	234	1,691
Yes	18	14	25	13	21	14	24	39	24	5	197
Pearson $\chi^2(9) = 44.9377$ $p = 0.000$											

The median in each year is zero.

TABLE 5 – The effect of reforms on ROE

	(1)	(2)	(3)	(4)
Total assets	0.1219	0.1068***	0.1261***	0.1375***
	(0.091)	(0.0813)	(0.0815)	(0.0848)
Sales-per-share	0.1869***	0.1928***		0.1832***
	(0.0189)	(0.0018)		(0.0021)
Board size	-0.1694***			-0.1765***
	(0.0468)			(0.0539)
Financial leverage	-0.9547	0.7919	0.5547	
	(0.8333)	(0.8351)	(0.8503)	
After	0.2122	0.1600	-0.1713	0.1600
	(0.6051)	(0.6057)	(0.6245)	(0.6057)
Dense	0.1774***	0.1716***	0.1634***	0.1734***
	(0.0122)	(0.0121)	(0.0124)	(0.0114)
After×Dense	-0.3974***	-0.1033***	-0.1052***	-0.1384***
	(0.0160)	(0.0160)	(0.0165)	(0.0161)
Constant	-1.3600***	-1.3117***	-1.6138***	-1.4183***
	(0.1154)	(0.1151)	(0.1146)	(0.1258)
Observations	1645	1645	1645	1645
R^2	0.3304	0.3250	0.2758	0.3484

Year-dummies are not shown. p-values are indicated by stars (* p<0.05, ** p<0.01, *** p<0.001). The results are corrected for heteroscedasticity.

TABLE 6 – The effect of reforms on ROA

	(1)	(2)	(3)	(4)
Total assets	0.0152***	0.0173***	0.0163***	0.0152***
	(0.0019)	(0.0017)	(0.0016)	(0.0019)
Sales-per-share	-0.00009**	-0.00010**		-0.00009**
	(0.00004)	(0.00004)		(0.00004)
Board size	0.00232**			0.00232**
	(0.00099)			(0.00099)
Financial leverage	-0.1401***	-0.1430***	-0.1495***	
	(0.0174)	(0.0174)	(0.0173)	
After	0.0052	0.0134	0.0174	0.0052
	(0.0261)	(0.0259)	(0.0258)	(0.0261)
Dense	-0.0392***	-0.0359**	-0.0357**	-0.0392***
	(0.0128)	(0.0127)	(0.0127)	(0.0128)
After×Dense	-0.0702**	-0.0652*	-0.0642*	-0.0702**
	(0.0343)	(0.0343)	(0.0343)	(0.0343)
Constant	-0.0347*	-0.0413*	-0.0263*	-0.0347*
	(0.0241)	(0.02406)	(0.0233)	(0.0241)
Observations	1669	1669	1669	1669
R^2	0.0994	0.0970	0.0941	0.0984

Year-dummies are not shown. p-values are indicated by stars (* p<0.05, ** p<0.01, *** p<0.001). The results are corrected for heteroscedasticity.

APPENDIX I – NETWORKS CALCULATIONS

A network $G=(V, E)$ is a set V of vertices or nodes (q) that link a set E of edges or ties. Networks are usually represented by an adjacency matrix B_{ij} where $B_{ij}=1$ if there is an edge, $B_{ij}=0$ if not. If an edge connects every vertex V, a graph (or a network) G is complete. The set of the neighbors (nodes) of q is $N_G(q)$ and they are connected to q by an edge. To represent the network over time, initially we have a data matrix A_1 referring to the entire database:

$$A_1 = \begin{pmatrix} d_{1,1} & c_{1,2} & a_{1,3} & \dots & a_{1,k} & t_{1,z} \\ d_{2,1} & c_{2,2} & a_{2,3} & \dots & a_{2,k} & t_{2,z} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ d_{n,1} & c_{n,2} & a_{n,3} & \dots & a_{n,3} & t_{n,z} \end{pmatrix} \quad (1)$$

Where $d_{i,1}=\{"director_1", "director_n"\}$, $i = 1,...,n$; $c_{i,2}=\{"company_1","company_n"\}$, $i = 1,...,n$; $a_{i,3...k}=\{"attribute_{1,3...k}","attribute_{n,3...k}"\}$, $i = 1,...,n$; $t_{i,z}=\{year_1, \dots, year_t\}$, i = 1998...2007.
The statistical unit (represented by the row of the matrix 1) is the directorship. Each director $d_{i,1}$ may have n multiple directorships where the same directorship is characterized by $k-2$ qualitative attributes $a_{i,3...k}$ over time $t_{i,z}$. From (1) we obtain an affiliation matrix (company-director) A_2 and then we partition it by year t_i, obtaining nine affiliation matrices ($A_{2,t=1998...2007}$) characterized by row by the same director i and in column by the company c. The term $dir_{j,q}$ represents the existence of a directorship. Every year t_i the number of the companies (in columns) and directors (in row) change due to new listed companies, delisting, and so on.

$$A_{2,t} = \begin{pmatrix} dir_{1,1} & dir_{1,2} & \dots & dir_{1,W} \\ dir_{2,1} & dir_{2,2} & \dots & dir_{2,W} \\ \dots & \dots & \dots & \dots \\ dir_{J,1} & dir_{J,2} & \dots & dir_{J,W} \end{pmatrix} \quad (2)$$

Where: $dir_{j=J\ w=W}=\{0,1\}$, j =1...J , w =1...W; $w=\{company_1,...,company_w\}$; $j=\{director_1,..., director_J\}$; $t_i=\{year_1, \dots, year_n\}$, i = 1998...2007.

The directorships (either for each year and globally) over the period considered by each director d_j are obtained from the affiliation matrix $A_{2,t=1998...2007}$:

$$DIR_d = \sum_{t=1998}^{2007}\left(\sum_{w=1}^{W} dir_{j,w}\right)_t = \left(\sum_{w=1}^{W} dir_{j,w}\right)_{1998} + \left(\sum_{w=1}^{W} dir_{j,w}\right)_{1999} + \dots + \left(\sum_{w=1}^{W} dir_{j,w}\right)_{2007} \quad (3)$$

$d = 1, \dots, n$ Similarly, from the affiliation matrix it is possible to obtain the number of directors by company during the period 1998-2006.

The matrix (2) represents a two-mode network (we consider either the director j and the company w at time t_i). Alternatively, we can build one more network matrix by year t, either for companies or for directors. In the case of companies we have them in the rows and in the columns and the general term of the square matrix $u_{i,k}$ represents the number of directors in common between company i and company k. In this way we obtain the matrix (4):

$$A_{3,t} = \begin{pmatrix} - & u_{1,2} & \dots & u_{1,n} \\ u_{2,1} & - & \dots & u_{2,n} \\ \dots & \dots & \dots & \dots \\ u_{n,1} & u_{n,2} & \dots & - \end{pmatrix} \quad (4)$$

By recoding the matrix (existence of the relationship =1, nonexistence =0) we obtain the adjacency matrix $B_{4,t}$. In the same way we obtain the matrix for the network of the directors. We refer to a particular network at t 1998...2007 either for companies and for directors. We then transform the data matrix (4) in a longitudinal dataset of network data. In this way we are able to study the persistence of connections over the time.

From the affiliation matrix (2) each director $d_{i,1}$ at the time t may sit on n different boards (represented in columns). As we know from (3) the directorships by year are obtained by the affiliation matrix:

$$DIR_{d,t} = \left(\sum_{w=1}^{W} dir_{j,w}\right)_t, d = 1, \dots, n \quad (5)$$

As components of the network, we define sets of nodes in which it is possible to reach other nodes. A Graph (or network) is defined as connected when there is only one component. In a connected Graph any pair of connected nodes of a network i is the set of companies in (4) characterized by: $\sum_{i=1}^{n} u_{i,j} > 0$, then d($q$) > 0.

Density E_t is computed by considering the $u_{i,j}$ elements of the adjacency matrix $A_{3,t}$ or $B_{4,t}$ divided by the number of nodes in a network t :

$$E_t = \frac{\left(\sum_{i=1}^{n}\sum_{j=1}^{n} u_{i,j}\right)}{n(n-1)} \quad (6)$$

If $E_t = 1$ there is perfect network connection.

Centrality represents the most important indicator of relevance and power of a node q in the network. Each node (either the company or in a different context the director) is characterized by the Freeman Degree, FD_t which is the sum of the links by node q:

$$FD_t(q) = \sum_{i=1}^{n} dir_{i,j} \quad (7)$$

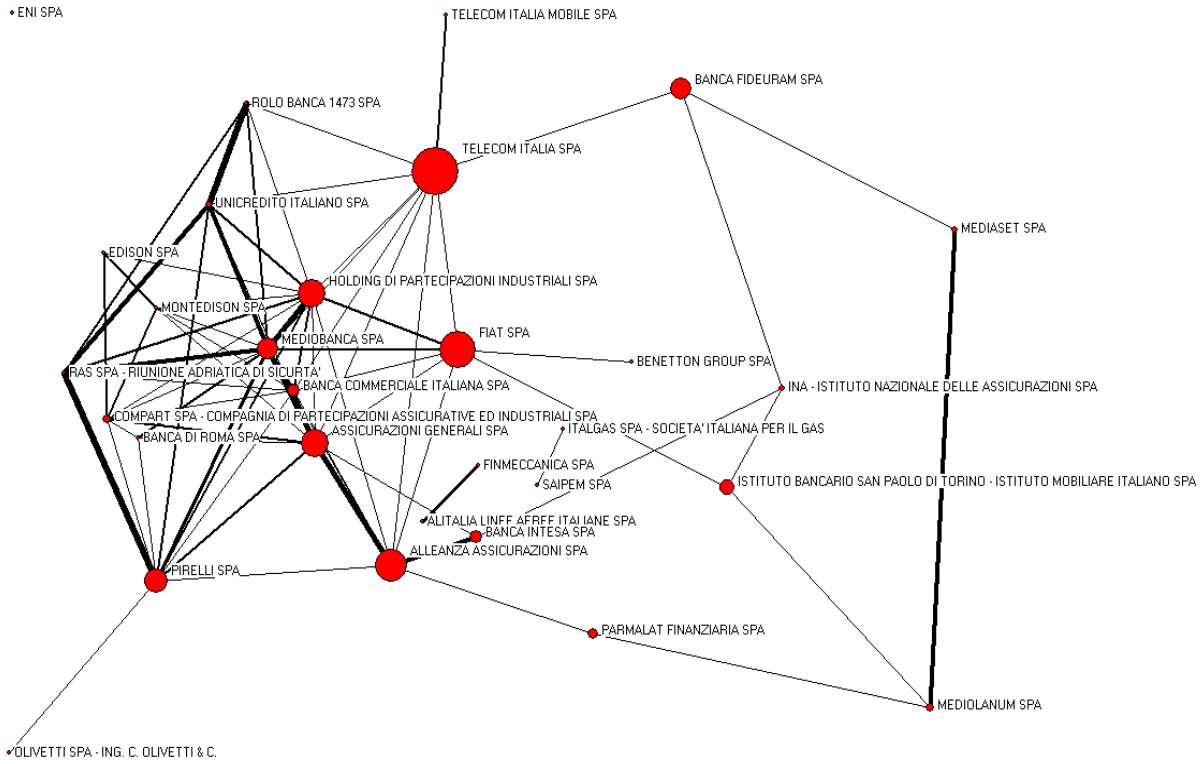
with j =1,…,W for the directors or j =1,...,J for the companies using the matrix (2). The Freeman Degree can be considered as a measure of local centrality. We measure centrality in a network by the actual value Freeman Degree compared with the maximum value it can achieve:

$$CN_t = \frac{\sum_{t=1}^{n} FD_{max} - FD_i}{max\left[\sum_{i=1}^{n}(FD_{max} - FD_t)\right]} \quad (8)$$

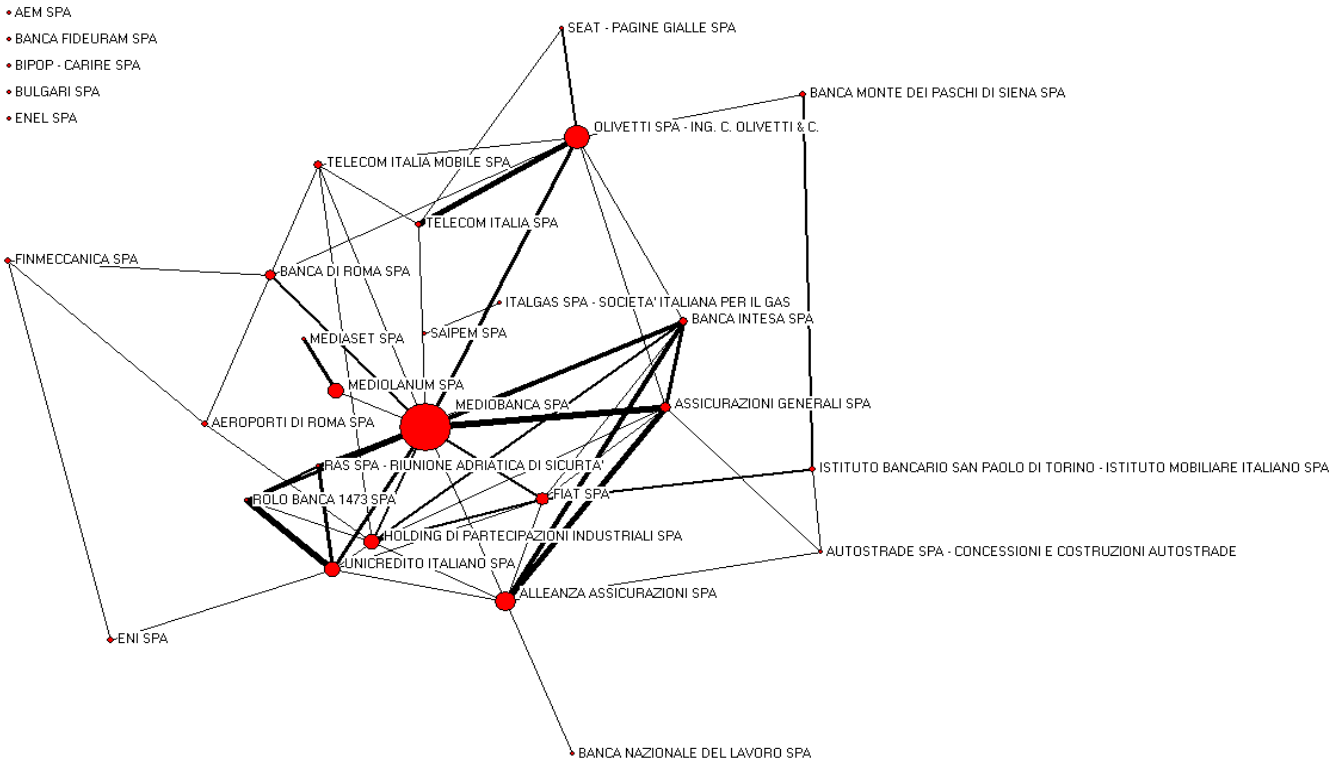
Maximum centrality is reached in a star network, therefore this index measures the distance of the actual network to the star network.

APPENDIX 2 – Networks in selected years

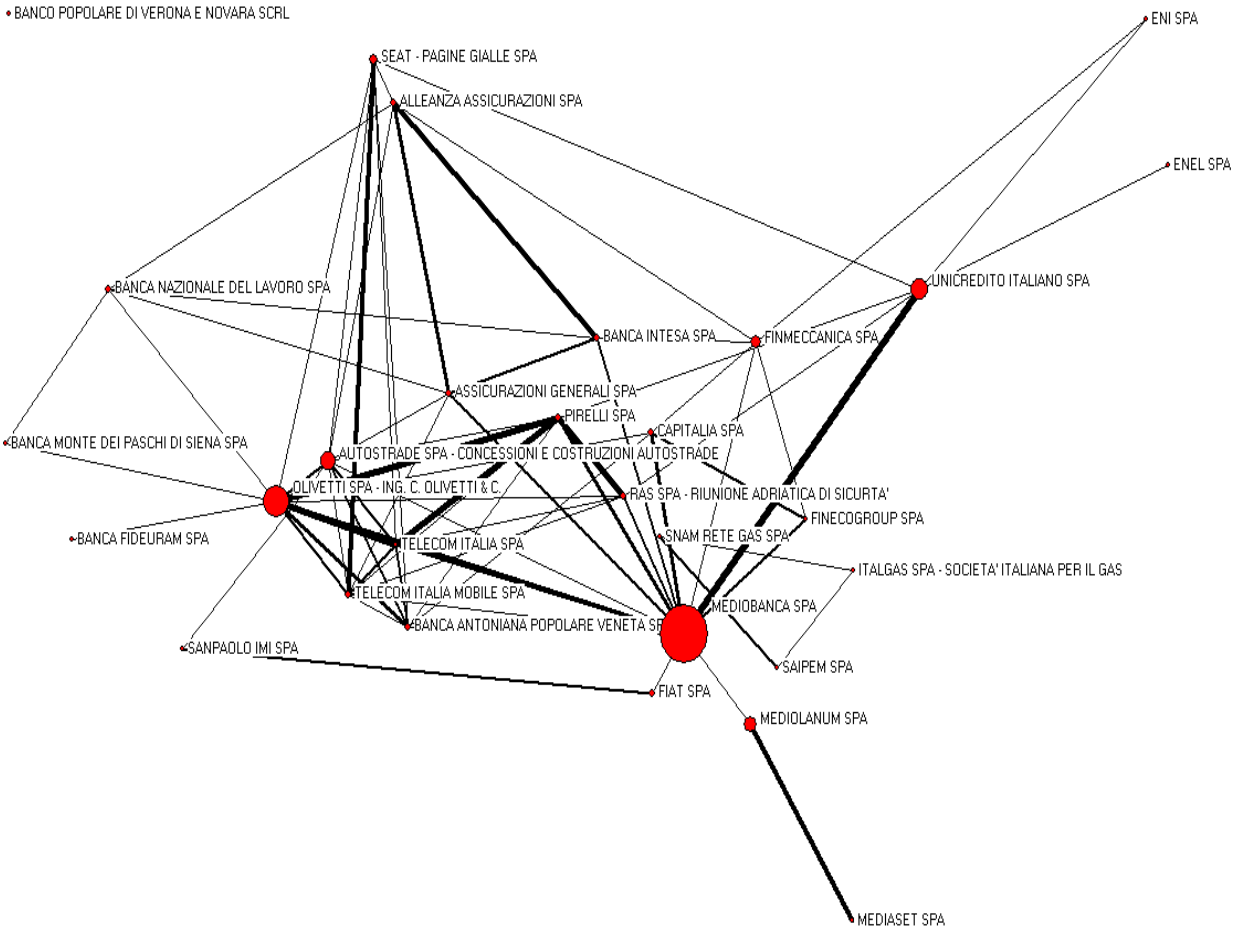
Interlocking Directorship Network, 1998.



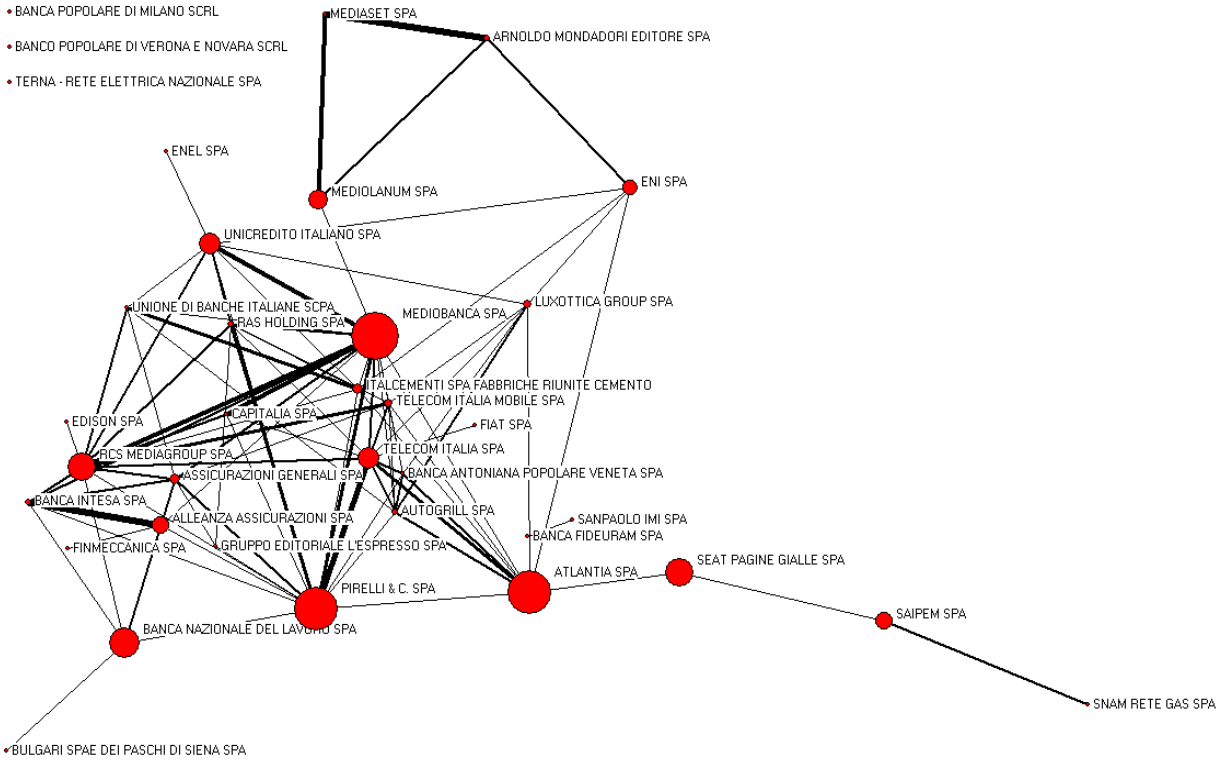
Interlocking Directorship Network, 2000.



Interlocking Directorship Network, 2002.



Interlocking Directorship Network, 2004.



Interlocking Directorship Network, 2006.