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Small Worlds Evolving: Governance Reforms, Privatizations and Ownership Networks in Italy

by

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Abstract

Small Worlds Evolving: Governance Reforms, Privatizations and Ownership Networks in Italy

How do ownership networks among business enterprises evolve over time? What roles do corporate governance reforms and privatization programs play in shaping the structural characteristics of these networks? This paper addresses these questions leveraging on small-world analysis techniques applied to the ownership networks among Italian enterprises in 1990 and 2000. Italy underwent a significant program of privatizations over the decade under study, coupled with changes in the corporate law aimed at strengthening the defense of minority shareholders. The data show signs of significant fragmentation of the overall network, but at the same time of stability in the structure of its main component, as measured by small-world coefficients. Further, the role of the key players in the network seems to remain relatively stable in spite of the major turbulence at the institutional level as well as in the structural characteristics of the complete network.

The analysis of networks of business enterprises has grown to be one of the leading perspectives in the study of business policy, organizational behavior and public economic policy. The wide diffusion of networks of different types among corporations of any size, in virtually any industrial sector and in most cultural as well as institutional contexts commands increasing attention on the part of management scholars. One of the most interesting and least understood questions pertains to the evolution of business networks: How do they change over time? What factors are responsible for their characteristics at any given point in time, as well as for the variations in these characteristics?

This paper focuses on the strongest type of tie that can connect enterprises in a network — the ownership of an equity stake — and on a family of institutional changes that could potentially affect the structure of the network and its evolution over time: the introduction of new governance regulations (in defense of minority shareholders) and the execution of privatization programs. The specific questions we are interested in, therefore, relate to the role of government interventions, both direct (through the divestiture of its ownerships) and indirect (through changes in the corporate governance rules), in shaping the evolution of ties binding enterprises in a given institutional setting.

The study of both phenomena, the evolution of networks of ownership ties and the effectiveness of government interventions, has been identified as necessary to progress since the inception of the literature on social interactions among firms (Stockman et al., 1985; Mizruchi, 1986). More recently, similar calls have been made from scholars studying the impacts of state interventions in the form of privatization programs and corporate governance reforms (Vives, 2000). However, little work of either theoretical or empirical nature has been done to date to respond to these calls to

action (Kogut and Walker, 2001; Powell, White and Kogut, 2001; Windolf, 2002)). Surprisingly, neither the vast literature on privatization processes nor that on corporate governance reforms includes studies on the impact of these institutional interventions on the relational fabric among firms.

In trying to address this gap, we take into consideration the network of cross-ownerships among large companies in Italy in 1990 and 2000. This country and this period have been identified to reproduce an experimental setting where the "treatment" is represented by the combination of the large privatization program and the reforms undertaken by a series of Italian governments during the decade.

Variations in several features of the networks of cross-ownerships among Italian companies across the decade are considered. First, the global configuration of the networks: to this end, changes in network densities are assessed and the structural articulation of the networks in distinct components is analyzed. Components are separate sets of network nodes, whose members are mutually reachable through a sequence of lines; all networks in the context studied result to be dominated by a single large component. The subsequent stage of the analysis focuses on the largest component in each network: here, the small world statistics (clustering and average path length) are computed and their evolution over the observed period is analyzed. Finally, the identity of the most central actors, particularly those with higher dominance in the initial (pre-"treatment") stage, is tracked and changes in their betweenness scores observed.

The data paints a mixed picture of the effects of these interventions on the structure of cross-ownerships among Italian enterprises. Whereas on the one hand one finds signs of significant fragmentation and destructuration of the overall network structure, the characteristics of the core part of the network maintain surprising

stability over the time period, particularly in the centrality of its main actors. Institutional interventions seem to have affected the use of ownership ties among Italian enterprises, but have not affected the structural properties of the inner parts of the network: The upper echelons of Italian businesses were and remain to a large extent a small world.

In the following section, we first elaborate on the theoretical dimensions of the questions at hand, developing expectations of the type of impacts the interventions studied might have on the structural dimensions of the ownership networks. The discussion is then placed within the recent evolution of the Italian economy in order to ground the work in the contextual complexity of the phenomenon studied. We then proceed with the description of the data and of the set of analyses performed to conduct the empirical inquiry. Finally, we conclude with a discussion of some of the implications of the evidence produced, and of the limitations of the present study the need to be addressed in future work.

1. The Impact of Institutional Interventions on Ownership Networks

Why should changes in market regulation and privatization programs influence the way companies manage their relationships with each other? At a first approximation, the answer is easy: because many (although not all) of these interventions have the specific objective to do so. Consider the introduction of new regulation for the protection of minority shareholders, for example. The obligation to disclose any ownership beyond a certain level and to launch a tender offer for the entire capital at an equal price for all shareholders, should a certain threshold be surpassed, impose a much more careful attitude toward the establishment and continuation of ownership positions on the part of large corporations. Shareholdings

that are less than crucial to the strategic plans and positions of the company will likely be dismissed or significantly reduced. On the other hand, small investors will be motivated to enter the equity market and increase the diffusion of ownership capital throughout the financial system. The expected result is a wider diffusion of the ownership titles of corporations among investors as well as other corporations.

Several other regulatory interventions, though, have much less straightforward implications for the management of ownership positions. Regulations designed to curb insider trading and to stimulate or impose higher standards of transparency and corporate governance, for example, do share the goal of improving the functioning of the financial markets (strengthening the trust of small and large investors in the system, lowering price volatility and overall bankruptcy risks, etc.), but have unclear implications for the management of ownership portfolios by companies. Several contrasting effects might be expected, and the resulting implications are far from obvious. For example, higher standards of corporate governance might limit the tendency to expand the scope of the firm for managerial purposes (Amihud and Lev, 1981), but at the same time they might facilitate the increased use of minority ownership ties because of the improved protection from abuses by controlling shareholders.

The case of privatization programs is even more unclear in its effects on the network of ownership ties among companies sharing the same institutional context. First of all, the declared purpose of these programs, particularly in developed economies, is typically related to the solution of public deficit problems and therefore not directly linked to the functioning of the market for corporate control or the financial markets in general. Second, even if the purpose of the privatization program were somewhat linked to the establishment or development of a well-functioning

market for the ownership of equity stakes in publicly listed corporations, the net effect on the degree to which companies will make use of minority investments is not easy to assess. On the one hand, the increased presence of actors in the system creates the potential for increased ties between formerly state-owned companies and the rest of the system. On the other, the typically tightly knit network of cross-ownerships among state-owned companies will be most likely dismantled or significantly reduced, implying lower levels of interdependence among companies in the system as a whole. Furthermore, the net result will be strongly dependent on the type of privatization system pursued (Spicer, McDermott and Kogut, 2000). If the typical solution to the divestment of state-owned enterprises is the placement of shares on the equity market, there is reason to believe that the network of ownership ties throughout the system will be affected one way or another. If, however, the privatization program is typically conducted through the sale of the enterprise to a consortium of private companies, then the network of ownership ties could be greatly enhanced in its density of relationships among co-owners, in the size of the network (its major component, or the largest number of companies tied to all the others through either direct or indirect ties), and in the lower number of steps necessary to go from one company to another in the system (its average path length).

In summary, the answer to the questions posed about the impact of market reforms on the use of ownership ties among business corporations is far from being obvious and of an inherently empirical nature. Despite the vast amount of literature on the introduction of advanced governance rules as well as on privatization programs, the empirical evidence on the impact of these interventions on the structure of the network of interfirm ownership is limited to two cross-institutional comparative analyses. Windolf (2002) studies the link between the presence of advanced

corporate governance regulations in 6 Western countries and 3 former communist countries on the structure of cross-ownerships among business enterprises, and finds that the density of the network is lower when these governance regulations are present. In an older work, Stockman et al. (1985) study the role of state ownership of business enterprises on the structure of ownership networks, and finds that the presence of state ownership is linked to certain typologies in network structure, broadly related to what would later be construed as higher clustering levels.

Interestingly enough, both studies point towards a similar result on the more general linkage between government interventions and the structure of ownership networks among business firms; that is of increasing destructuration of the networks either through lower density levels (Windolf, 2002) or through less structured typologies of network observed (Sotkman et al., 1985). We will take this as a first indication from the received literature on the nature of the structural changes we expect to observe in the context under analysis.

We intend, however, to expand the scope of these initial indications in a number of directions. First, move from a cross-sectional observation of different institutional contexts at one particular moment in time to a longitudinal analysis of the same context. No study that we know of has actually examined the changes in the same network over a given time period and attempted to relate them to government interventions. Second, we want to probe these initial indications of increasing destructuration of the network of ownership ties at lower, and more fine-grained, levels of analysis. The characteristics of the networks examined in prior work have been limited to gross structural measures or even structural typologies, missing the advantages of more sophisticated and detailed dimensions of network analysis currently available. By analyzing the evolution of the structural components of the

networks, as well as of the role of individual actors within them, we should be able to construct a more complete picture of the types and magnitudes of changes observed as a consequence of government interventions.

2. Institutional Interventions and Ownership Networks in Italy

At the beginning of the decade under study, the Italian economy shared a number of features with other developed countries of late industrialization, especially in continental Europe. These features are sometimes subsumed under the label "late capitalism" (Gerschenkron, 1962). They include a relatively high concentration of corporate ownership and low separation of ownership and control; a marginal role of stock markets as sources of capital to business companies; a significant weight of the state as owner of large corporations as well as near-monopolist in entire sectors of the economy, such as banking, energy and defense; and the organization of large enterprises in a complex web of inter-group control syndicates aimed at protecting the interests of the controlling families as well as, allegedly, sheltering the economic system from external influences. Overall, this situation was not too different from that of other countries in continental Europe, such as France, Germany and Spain.

An important and more idiosyncratic feature of Italian capitalism was the presence of special public bodies, blends of a public agency and a state-owned business, to which most of the state interventions in the economy was delegated. These entities grew over the decades following the war, as they functioned as tools of state intervention in any crisis situation of large private enterprises, to account in the late 80s for a significant share of the national economy. Particularly significant among these were Istituto per la Ricostruzione Industriale (IRI) and Ente Nazionale Idrocarburi (ENI). IRI became the largest Italian holding group, ranking among the

top ten largest conglomerates in the world in the 1990 Fortune 500 international, ENI (Ente Nazionale Idrocarburi) took up the leadership in the oil and gas sectors during the 1950s, where it became the virtual monopolist in extraction, refinement and (gas) distribution and by far the most profitable concern in the Italian industrial sector.

As these trends in the role of the state in the Italian economy develop, the ownership of the private sector enterprises takes on an increasingly entrenched posture vis-à-vis all other constituencies: the public sector, foreign competitors and internal minority shareholders. With the banking crisis in the 1930s and the intervention of the state through IRI and the banking law (1936), the large banks had in fact lost any external supervisory role over private business. This emancipation process was strengthened by the diffusion of a plethora of mechanisms designed to enhance and protect the concentration of ownership and control of the firm. Shareholder agreements were allowed to be secret and legally enforceable in any situation (including takeover offers). Mutual shareholdings between different business groups were allowed and welcome on the ground of the need for protection against foreign entries, but in fact impeding local minorities to break into the upper echelons of control. Finally, long chains of financial holdings (so-called "Chinese boxes") owned with bare (51%) majority allowed families to leverage their ownership of the ultimate holding with limited investments and without having to face minority pressures[3].

Interestingly, the State showed no interest in this period to act in order to change the ownership and control arrangements established by the private sector. One reason for this had to do with the fact that policy-makers were skeptical about the role small stockholders could play in sustaining private business growth (de Cecco

[3] See Amatori and Brioschi (1997) and Barca, Bertucci, Capello and Casavola (1997) for detailed accounts on how this system was created and sustained for well over 4 decades after the war.

and Ferri, 1996). The other concern revolved around the appreciation of significant risks connected to the instability of control in private businesses. As a consequence, the often debated reforms of corporate governance rules aimed at empowering the stock market and diffuse the ownership and control of large enterprises were never seriously pursued. The direct intervention of the State through IRI and the other public bodies helped de facto maintaining the stability of control arrangements in the private sector (Mattioli, 1962).

The combination of public sector ownership of crucial portions of the economy and of private sector's entrenchment created an anomalous network structure among Italian business enterprises. Unique case in Stokman, Ziegler and Scott (1985)'s study, the Italian interlocking directorates network in 1976 was shown to split in two centers, which corresponded to state-owned and private-sector companies (Chiesi, 1985). Brioschi, Buzzacchi and Colombo (1990), in a detailed study of shareholdings networks and business groups in the period 1985-1990, documented the role of hierarchical group structure, cross-shareholdings and coalitions, in strengthening firms control despite a growing presence of minority shareholders. For the purpose of our analysis, it is important to note that the structure of the network of enterprise ownerships in Italy at the beginning of the 1990s was characterized by high clustering levels and by the separation between the private and state sector components of the overall network. These were bridged by a few large firms and by intermediaries such as Mediobanca[4], which was nominally controlled by

[4] Mediobanca was established in 1946 as a provider of long-term credit to the industrial sector, but it later took up the role of an investment bank and became the major stabilizer of ownership and control arrangements in the upper echelons of Italian business (Amatori and Brioschi, 1997). At the same time, it acted as a network bridge between these groups and the state-controlled network, being formally owned by the three "banks of national interest" (Banca Commerciale Italiana, Credito Italiano and Banca di Roma), which were in turn controlled by IRI.

State banks but effectively capable of exercising complete autonomy and in fact to position itself at the center of the private sector.

This system came under growing pressures because of the slowdown of economic growth and the oil shocks of the 1970s as well as the burgeoning state deficits throughout the 1980s that raised the stock of public debt to the size of the country's GNP. It was not until the last decade of the century, in fact, that significant institutional change started to occur favored by at least two kinds of conditions: a new internal and international political climate and the financial crisis created by the large stock of public debt. Two major initiatives were undertaken almost simultaneously in the middle of the decade: the privatization of state-owned businesses and the reform of the corporate governance regulations.

Privatization Programs. De Nardis (2000) quantifies the privatizations realized between 1992 and 1999 as 185,000 billion lire (more than €95 billion), which accounts for 12.3% of the GNP in 1992. This gave relief to the State finances, and in this sense it can be considered a success. As De Nardis also notes, however, privatizations did not necessarily translate into a real shift of control over privatized businesses. Privatizations in the industrial sector did involve many cases of actual transfer of control, but in other significant cases the state maintained more than 50% of the shares or minority control shares. The process, however, involved a real shift in the managerial responsibilities, and the transfer of the control share was negotiated at a premium price with selected private shareholders. In December 2002, IRI was officially disbanded after having completed the sale of the entirety of its holdings over a period of 10 years.

Corporate Governance Reforms. The reform of the corporate law has been at the center of the political debate for the better part of the decade, and became

effective at the beginning of 1998. It involved an attempt to shift the balance of power in ownership and control arrangements by improving the protection of minority shareholders. This goal was pursued in three main ways. First, the general improvement of information disclosure requirements. Second, the introduction of restrictive regulations on shareholder agreements; these agreements are to be made public, their duration has to be limited to three years, and they are automatically invalid in case of takeover bids. Third, a new merger regulation was introduced in defense of minority shareholders' interests: any company extending its ownership in another beyond 30% is forced to extend a tender offer to all shareholders at the same conditions[5].

Since the structure of the Italian network of business ownership has been described as linked to the role of the State in the national economy (Chiesi, 1985) and to the lack of advanced corporate governance regulations preventing the entrenchment of ownership and control within the large entrepreneurial families (Barca et al, 1990), it is interesting to study the impact of the two broad institutional initiatives on the part of the Italian government on the structural properties of the ownership network. If the reforms reached their goal of defending minority shareholders' rights, and Windolf (2002)'s analysis is correct, we should be able to witness the rise of a large number of new players in the network taking positions of increasing centrality from previously either peripheral or non-existing roles. At a macro level, we should see a consequent decrease of density and a fragmentation of the structural components of the network.

For what concerns Italian privatization programs, they have had the immediate objective to disband one of the key centers of the network, that one revolving around IRI. The question, of course, is if the change of ownership in these formerly State

[5] These were known as the "Draghi reforms" after the name of Mario Draghi, director general of the Italian Treasury from 1991 to 2001 and formerly executive director at the World Bank.

owned enterprises correspond to the entry of new players in the network, and therefore the decreasing in its density, or rather the strengthening of the central role of incumbent actors, with consequent increasing levels of centrality. More generally, it would be interesting to see whether Stockman et al. (1985)'s thesis relating some of the structural properties of the network to the role of the State and of the large banks is supported in the Italian context.

3. The Data

We analyze shareholdings among large firms in Italy at two points in time: 1990 and 2000. Our sample is drawn from the R&S Annual Directory edited by Mediobanca, the leading Italian investment bank. Each issue of the R&S Annual Directory reports detailed individual information for about 200 companies, the largest and most representative of the industrial and financial groups operating in Italy. This set of companies varies in the 10-year period our dataset spans because of mergers, restructurings of the groups and changes in the selection made by the source. The set of industrial and financial groups owning or participating in the capital of the operating companies is significantly more stable. The companies are both private-sector and state-owned companies, both publicly listed and unlisted companies, both operating and holding companies, representing practically all the main industrial and financial sectors. For each of them the source reports detailed economic and financial information and the identity of the main shareholders, often recorded at the time of the annual shareholders meeting.[6]

[6] This meeting takes place in the second quarter of the year, while the issue of the R&S Annual Directory is usually released in the last quarter and reports the latest information available about each company's shareholders. Thus, for instance, the 1990 issue reports for each company economic and financial data for 1989 (and a few previous years), based on the information that was officially disclosed by the company, along with the most recent shareholders recorded in 1990.

We coded the shareholders reported for all the companies listed in the 1990 and 2000 issues of the directory. In our 1990 survey we coded 817 shareholdings held by 454 shareholders in 212[7] companies; these owned companies included 19 banks and 12 insurance companies. For 2000 we coded 751 shareholdings and 535 shareholders in 207 companies, which included 16 banks and 9 insurance companies. There were 136 companies listed in both issues of the directory.

Reported shareholdings consist only of common shares (*azioni ordinarie),* the category of stock that involves full voting rights, and exclude other categories of stock with limited or no voting rights.[8] After some adjustments to the raw data (described below), the average shareholding was 20.7% in 1990 and 22.7% in 2000. The observed shareholders represented on average 79.9 % of each company shares in 1990, and 82.2 % in 2000.

To ensure consistency, we modified the raw data reported by the source when (a) an individual person was reported as the shareholder and (b) the shareholding was attributed to a business group. Case (a) was a problem because the source listed both families and individuals as shareholders, and this could cause some inconsistency of the data both within and across the two points in time selected for observation. It could happen, for instance, that some of the shares held by Paolo Rossi were attributed directly to him, with the rest being attributed to "Famiglia Rossi," his family. For this reason we aggregated all the individual shareholders in family groups

[7] The companies reported by the source for 1990 were 205. Seven very important state-owned companies were not included in this sample, due to their status as public bodies at that time. In the context of the privatization process of the following decade they were changed into ordinary joint stock companies (*Società per Azioni, S.p.A.*); they were then included in the 2000 sample. To increase the consistency of the datasets across years, we added these companies to the 1990 sample and coded the Ministry of the Treasury as their majority shareholder. These companies are: Enel, ENI, Ferrovie dello Stato, IRI, Poste e Telecomunicazioni, Istituto Bancario San Paolo, and INA.

[8] These are the *azioni privilegiate*, whose voting rights are limited to the *assemblea straordinaria* (an extraordinary meeting of the shareholders that Italian law requires in order to deal with some specific and important issues), and the *azioni di risparmio,* which do not carry any voting rights.

identified by their last names[9]. In cases where more than one person with the same last name was a shareholder of the same company, we summed up their shareholdings into the single one of the family.

Case (b) could be the cause of similar inconsistencies at the company level. For this reason, every time the source reported a business group as shareholder we undertook a search for supplementary information, on the basis of which we disaggregated the group shareholding into those of the individual companies that actually held the shares. If the group that held the share was represented in the R&S Directory, we looked in the directory for information about the shares held by member companies. Other sources of this information were historical accounts and other notes reported in the R&S Directory and another publication edited by Mediobanca, *Il Calepino dell'Azionista*. When the information was not available we attributed the shareholding to the company leading the group.

We analyzed the shareholding data by building two types of networks, similar to what Kogut and Walker (2001) did for the case of Germany. In the owned companies network, owned companies are conceived as nodes and shareholders as ties; here two owned companies are tied if at least one shareholder holds shares in both. In the owners network, owners are conceived as nodes and owned companies as ties; here a tie exists between two owners if they own shares of the same owned company (or of multiple owned companies). Owned companies and owners networks are mathematically represented by binary square matrices (adjacency matrices) that list the same actors (owned companies or owners) along the rows and the columns, and the cell at the crossing of row *i* and column *j* is set to 1 if actors *i* and *j* are tied and to 0 if they are not. These two adjacency matrices and networks are actually dual

[9] This in turn involves the risk of improperly aggregating persons with same last names but from different families; however, a quick examination of the raw list of names showed this risk to be low and acceptable.

transformations (Breiger, 1974) of a single bipartite network that connects owners and owned companies. This network is represented by one binary rectangular matrix (two-mode matrix) that lists the owned companies along one dimension and the owners along the other, and each matrix cell is set to 1 if the shareholder reported on one dimension owns shares of the owned company reported on the other, and to 0 otherwise.[10]

We arranged the shareholdings data for 1990 and 2000 in two-mode matrices and then computed the adjacency matrices for the owned companies and the owners networks. We built these networks both for shareholdings of any size and for those greater or equal to 5% of the owned company stock (more precisely, of their voting rights). In 1990, 392 out of 817 (47.9%) shareholdings were equal to or greater than 5%; the owners who held shareholdings of this size were 273 out of 454 (60.1%). In 2000 the same figures were 395 shareholdings out of 751 (52.6%) and 331 owners out of 535 (61.9%). In both years all the owned companies (205 in 1990 and 207 in 2000) had at least one shareholder owning a 5% or more share.[11] Consequently, the number of companies included in the owned companies networks determined by the large shareholdings (5% or more) does not change, while the number of owners declines from 454 to 273 in 1990, and from 535 to 331 in 2000.

To sum up, for each of the observed years we analyze four networks. The first two are an owned companies network where a tie exists among two owned companies if at least one shareholder holds shares of both (without regard to the size of the

[10] The matrix that results (a) from the matrix multiplication of the two-mode matrix by its transpose and (b) from the dichotomization of the product matrix (all cells greater than 0 are set to 1) is the adjacency matrix either of the companies or of the owners networks. Which of the two depends on whether the two-mode matrix is *pre* or *post* multiplied by its transpose.

[11] The insurance company Assicurazioni Generali, known to be the most publicly owned among large Italian companies (its strong ties to the investment bank Mediobanca are also well known), had Mediobanca as its main shareholder, with shares of 5.55% and 9.26% in 1990 and 2000 respectively. Other shares were all below 5%.

ownership) and an owners network where a tie exists among two owners if they own shares in the same owned company (again irrespective of the size of the ownership). These will be referred to as "all shareholdings" networks. The other two networks are an owned companies network, where a tie exists among two companies if at least one shareholder holds 5% or more in both companies, and an owners network, where a tie exists among two shareholders if both own 5% or more shares of the same owned company.

4. Analysis

The ownership networks described have been analyzed proceeding from a macro to micro level of analysis. In Tables 1, we describe the structural evolution of the complete networks between 1990 and 2000 (see also Figures 1 and 2). We then show the changes in the composition of the networks among their components (Table 2) and proceed focusing on the largest component to explore the dynamics of entry and exit over the period (Table 3). The next step in the study of changes in the main component is to apply small-world analysis[12] (see Tables 4 and 5). In doing so, the focus is placed on the two key dimensions that have been advanced in the definition of small worlds — the tendency of the companies/owners to group in densely knit clusters (clustering coefficient) and to maintain at the same time short connections among the companies/owners through chains of ties (average distance)[13] — (Watts, 1999). Having described the structural features of the networks analyzed, the last step of the analysis consists of a more detailed study of the most central companies and

[12] A *component* is a subset of nodes (companies or owners) in the network any of which is connected to any other in the subset, while no connections exist between nodes in distinct components. The *size* of a component is the number of nodes it includes. From the "all shareholdings" networks, whose largest components were large enough (in absolute terms and compared to the other components) to make the analysis meaningful, we extracted the corresponding subnetworks and performed on them the Small World analysis.

[13] A more complete discussion of the small-world phenomenon is presented in the appendix.

owners found in the 1990 and 2000 networks to determine with more precision the principal actors and eventual changes in their network position over time (see Tables 6 and 7 and Figures 3 and 4).

4.1 Structural changes in the ownership networks

Table 1 describes the networks of the owned companies and of the owners in 1990 and 2000, as determined both by shareholdings of any size and by those greater than or equal to 5%. The second and third columns concern direct ties; the last four columns report on indirect ties.

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TABLE 1 ABOUT HERE

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The densities reported in the third column equal the ratio of the number of observed ties to their theoretical maximum for a given number of actors.[14] The importance of this metric consists in the fact that it allows the comparison among different networks, as well as of the same network at different points in time, since the number of ties is standardized for the size of the network. The percentage of connected pairs (fourth column) differs from the density ratio in that its numerator counts both the pairs of nodes that are directly connected (i.e., the number of direct ties) and the pairs that are indirectly connected by sequences of ties (paths). The number of ties included in a sequence is referred to as its length, and the distance among two nodes is the length of the shortest sequence[15] that connects them.

[14] The maximum number of ties in a network is the number of possible non-ordered pairs among its nodes; if n nodes are included in the network, this is $n(n–1)/2$.
[15] Note that two nodes can be connected by more than one sequence of ties. This is actually the general case.

Summary statistics (average and standard deviation in path lengths) are reported in the last two columns.

The overall picture presented by Table 1 speaks of the fragmentation of the networks. All the networks show decreasing levels of density between 1990 and 2000. This evolution is similar across shareholdings of different size, but it is sharper for the owned companies than for the owners. The percentage of connected pairs also decreases in the examined period for all networks, particularly for the 5%-or-more-shareholdings networks.

Distances show different patterns; they increase in the all-shareholdings networks and decrease in 5%-or-more-shareholdings networks. This can be explained by the greater fragmentation of the large shareholdings networks in 2000. Distances decrease because they are broken into many small components; consequently, only the (short) paths that connect the members of these small components are left in the networks, while longer paths disappear. The all-shareholdings networks instead are still dominated in 2000 by a large component that includes most of the paths connecting the nodes. As the network densities decline and the largest component gets more sparsely connected, nodes are connected through longer sequences of ties and distances increase.

Figures 1 and 2 show the evolution of the all-shareholdings networks that we described above. The figures represent the owners and owned companies networks in 1990 and 2000. The companies/owners that do not hold any tie (isolated) are represented on the left side; components of increasing size are arranged from left to right.[16]

[16] The relative locations of the nodes inside each component are arranged to make their geometric distance in the figure roughly proportional to their (graph theoretic) distance in the network (i.e., to the length of the shortest sequence of ties that connects them).

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FIGURES 1 AND 2 ABOUT HERE

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The figures show that both the all-shareholdings networks (owners and owned companies) are still dominated at the end of the decade by a large component, although fragmentation of the networks is also evident. The owners network (Figure 1) fragments by breaking up into smaller components between 1990 and 2000, however, whereas the companies network (Figure 2) shows a marked increase in the number of isolates.

This evolution of the networks over the decade of observation is shown more precisely in Table 2, which reports on the sizes of the components in all the networks for both years. The central columns of the table report the size of the four largest components of each network, while the last column reports the number of isolates.

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TABLE 2 ABOUT HERE

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Table 2 confirms the trend toward fragmentation and underscores the important difference we noted above between the all-shareholdings and the large-shareholdings networks. The largest component continues to dominate the smaller ones in the first case, but this is not so with the stronger ties. As we noted in Table 1, this is the reason why distances decrease in the 5%-or-more-shareholdings networks. This is consistent also with the fall of the percentage of connected pairs in both the large shareholdings networks, shown in Table 1.

Changes are smoother in the all-shareholdings networks, but here too the trend is one of fragmentation. The larger components are proportionally larger and the

number of isolates lower for owners than for owned companies. Note also that in the owners network the number of isolates remains roughly the same over the decade, and while the size of the largest component decreases other (smaller) components get larger.[17] Instead, in the network of the owned companies, the decline in the size of the largest component roughly equals the growth in the number of isolates.

To sum up, the data shows that the number of ties in these networks decreased relative to the size of the network during the decade; this happened more slowly in the owners networks, where densities, however, were already low compared to the owned companies networks. Despite this fact, owners were always better connected than owned companies by indirect connections through chains of contacts. The decreasing number of ties caused the interruption of these indirect connections, both among owned companies and among owners, and this especially affected stronger and less redundant connections. These strong-ties networks were already very fragmented in 1990, and they splintered further in 2000. On the other hand, the networks that include weaker ties held a basic structural feature, though they too show fragmentation. Both owned companies and owners networks, in this type of ties, keep one dominant connected component. At this level, the network of ownerships is essentially one large block of ties and a good number of isolated companies.

The implication of this initial step in the analysis seems to be that the combination of privatization and governance reforms in the Italian context does seem to have a potent destructuration effect, particularly for the networks of stronger (>5%) ownership ties.

[17] The second largest component that gathers 23 owners in 2000 is actually more fiction than reality. It is composed of the Berlusconi family and 22 holding companies that belong to the Berlusconi family. These owners meet as shareholders of Fininvest, the leading company of the Berlusconi group; only four of them hold shares greater than 5%. The datasets might include other cases of similar nature, the diffusion of business groups in Italy making it almost unavoidable. This is, however, by far the most extreme case for the number of owners involved. Despite its pre-eminence in these figures, however, it does not substantially affect any other result.

We now intend to look more in detail at the entry and exit dynamics of the companies included in these networks and, in particular, in their largest components. The focus on the main components will then bring us to the small-world analysis of the core element of these owenership networks.

4.2 The evolution of the largest components

First of all, we are interested in quantifying the nature of the entry and exit of companies in and out of the entire network and, particularly, in and out of its main component. To study this, we focus on the all-shareholders' network of owned companies to track their presence over the two years analyzed. The identification of the single owners over the two years was significantly more uncertain and imprecise given the focus of the source on companies, rather than their owners (particularly in the frequent cases of owners being individuals, families or obscure family-controlled holding companies). Table 3 jointly reports the changes in the composition of the whole network and of its largest component over the decade of observation.

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TABLE 3 ABOUT HERE

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A total of 283 owned companies were observed in 1990 and/or 2000. Of those, 136 companies were included in the network in both observed years, whereas 71 entered the network (i.e. they were not observed in 1990 but were observed in 2000);[18] and 76 companies exited. Not surprisingly, the majority of the entries (46 of

[18] Changes among the owned companies selected in the network between 1990 and 2000 depend both on restructurings, mergers and acquisitions, etc., and on changes that the source (R&S-Mediobanca) autonomously made to the set of companies observed. In this respect we remind that the companies are selected as representative of the main financial and industrial groups operating in the country, and that the investment bank Mediobanca is among the best sources in Italy (until recently it was actually the only one) for this kind of assessment and information.

71) remain outside the main component. We find, however, that the majority of the exits (48 of 76) were companies that belonged to the largest component, which is relatively less intuitive. The most interesting finding is that, despite this significant entry and exit of companies in the network at large, the boundary between the main component and the rest of the network remains very resistant. Only 10 of the 136 companies always present in the network during the entire decade make it into the largest component. Similarly, only 15 companies leave the largest component to become part of smaller components or isolates. On a closer look to the national origin of these companies, no significant entries of foreign-owned companies were observed,[19] with the main component largely dominated in both years by domestic companies.

All together, these results paint a picture of significant stability of the inner composition of the ownership network, despite a significant dynamic in the entire network structure. These initial impressions beg an in-depth analysis of the structural properties of the core component of the network, to verify the degree to which it has withstood the double "treatment" offered by the combination of a large privatization program and the introduction of novel corporate governance rules protecting minority stakeholders. To this end, Table 4 presents the results of a small worlds analysis applied to the all-shareholdings networks under study.

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TABLE 4 ABOUT HERE

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[19] There are no entries of foreign companies in the main component; two foreign industrial subsidiaries, Asea Brown Boveri and Ericsson, actually leave the main component, while the insurance company RAS (Allianz group, Germany) and Nuovo Pignone, a privatized company now owned by General Electric, belong to the main component in both observed years. Three foreign-owned companies do enter the network in 2000, but they are isolates.

The average degree is the average number of ties actors have, and conveys the same information of the density coefficient presented in Table 1, with the difference of being computed only for the companies/owners included in the largest component. Similarly, the distances (fourth column) are now averaged only over pairs of nodes that belong to the largest component.[20] The clustering coefficient measures the extent to which the contacts of each actor are, on average, also tied to each other. This is a measure of the structural tendency of the network towards dense groupings of actors with loose connections across their borders.

An important intuition offered by Watts (1999)'s work is that these two properties of the core component of a network (the average distance and the clustering coefficient) cannot be considered in their absolute levels, but as relative to a random baseline. In order to produce meaningful comparisons across networks with different sizes and numbers of ties, in fact, one needs to derive standardized coefficients computing the ratios of observed coefficients to random benchmarks. The benchmarks are approximations of the average distance and clustering coefficients that are expected for random graphs with the same number of actors and average degree. These values are lower bounds for observed coefficients, and correspond to the absence of structure in the distribution of ties over pairs of actors. The random benchmarks for Table 4 were computed following Watts (1999). The small-world coefficient reported in the last column, then, expresses the extent to which a network embodies the structural features of a small world, i.e. relatively small distances between the actors despite a relatively high tendency for them to belong to densely

[20] All these measures are very similar in values and patterns to those already presented in Table 1 because of the great weight of the largest component over the whole network. We present them here because they are among the ingredients of small-worlds coefficients, reported in the right columns of Table 3.

knitted subgroups. It is computed as the ratio of standardized clustering to standardized distance.

In the Italian owenership networks analyzed, the raw (non-standardized) average distances increase in both networks between 1990 and 2000. Similarly, raw clustering coefficients increase between 1990 and 2000 in both networks. Relative to the random benchmarks, though, the average distance coefficients result to be stable and close to the random number (the ratio varies between 1.267 and 1.429). On the other hand, the standardized clustering coefficients grow from 5 to 6.9 among the owned companies and remained at high levels among the owners (20.4 in 1990 and 21 in 2000). The ratio between the two standardized coefficients, therefore, exhibit a moderate growth in the network of owned companies from 3.925 in 1990 to 5.328 in 2000 and a substantial stability at 16 times the random ratio in the network of owners. In both cases, the data shows that the structure of the main component in both networks resembles that of a small world, and that this condition seems to be remarkably stable across the decade considered.

It might be interesting to compare these results with those obtained by Kogut and Walker (2001) in their study of the German network of ownerships. They also find that average distances are closer than clustering to their random benchmarks. The standardized clustering coefficients, however, are a lot larger in Germany (38.18 for owned companies and 118.57 for owners). The network of company cross-ownerships can be defined as a small world in both countries, but Germany is a significantly smaller world, in this sense, than Italy.

One problem in the analyses presented arises, though, due to the bipartite nature of the ties considered in the ownership data.[21] The standardized clustering and small-world coefficients shown in Table 4 are indeed overestimated, because their computation does not account for the bipartite nature of the data.[22] To correct for this imprecision, Table 5 presents the clustering coefficients standardized against the correct random benchmark, which we computed following Newman, Strogatz, and Watts (2001) and the new small-world coefficients[23].

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TABLE 5 ABOUT HERE

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As expected, new coefficients in Table 5 are lower. For the owners network they are roughly 10% of those reported in Table 4, while they do not change as much in the owned companies network. Both standardized clustering and small-world coefficients decrease over the decade of observation in the owners' network, whereas the dynamic in the companies' one is, again, substantially stable over time. On these bases, the networks studied exhibit several patterns in common, maintaining a (limited) small worlds feature in both years.

4.3 Main actors in the ownership networks

[21] We thank Bruce Kogut and Gordon Walker for pointing out this problem. The correction applied to their German data does not significantly affect the results reported in Kogut and Walker (2001).

[22] Recall that our owned companies and owners networks are dual transformations of a single bipartite network that connects owned companies and owners. This mechanism induces a higher baseline level of clustering into the one-mode transformations of the bipartite network. This is not accounted for by the standard expression of the random benchmark (Watts 1999), because it does not refer to the case of bipartite network data. Consequently, the random benchmark for clustering is underestimated, and both the standardized clustering and the small-world coefficients are overestimated.

[23] Newman, Strogatz, and Watts (2001) actually propose two bipartite corrections. The first one assumes a random graph with a Poisson distribution of the nodes' degrees, and changes the computation of the random benchmark only for the clustering coefficient. The other proposed correction is more general, and changes the computation of the random benchmarks for both the clustering coefficient and the average path length. Since there are, at this time, no software applications including the computation of the more general correction, we have utilized the first proposed solution for the purpose of this paper.

So far we saw that networks based on shareholdings of any size keep being characterized by one dominant component, even though the system tends to fragmentation, especially in the stronger ties. The networks show a good deal of change in their composition over time, but at the same time a substantial stability in the structural characteristics of their main components. In the last step of the analysis, we will shift to finer degrees of granularity to identify the actors that were principally responsible for the connectivity among nodes within the largest components. The objective, of course, is to assess the degree to which their positions in the network changed in the course of the ten years analyzed.

To this end, we computed the betweenness centrality index (Freeman, 1979) for each of the owned companies and owners in the largest components. This index measures the extent to which a company/owner lies on the sequences of ties that connect other companies/owners, and therefore mediates the connection between them. We also identified those companies and owners that were cut-points inside the largest components, i.e., whose removal from the network would cause the largest components to break into smaller ones;[24] their names are reported in bold in tables 6 and 7. Table 6 shows the 20 most central owned companies in the largest components of the 1990 (6a) and 2000 (6b) networks. The betweenness values are expressed in percentage of their theoretical maximum.

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TABLE 6 ABOUT HERE

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[24] The largest component of the owned companies network included 9 cut-points in 1990 and 11 in 2000; in the owners network it included 14 cut-points in 1990 and 23 in 2000. The largest components were robust, however: In all cases the removal of a cut-point would split from the component only a few nodes.

Mediobanca leads the ranking for both years and, alone among all owned companies, is a cut-point in both years.[25] Not only that, but it actually increases its degree of betweenness. The other leading groups are all represented throughout the decade. The Agnelli group is present with its main industrial concern, Fiat (rising to the 6th place in the 2000 ranking and becoming a cut-point) as well as other subsidiaries such as Cogefar-Impresit and Magneti Marelli[26]. The second industrial group, Montedison, is represented also by the holding company (Ferruzzi Finanziaria, then renamed Compart[27]) and other subsidiaries (Montefibre). The other recognized "powerhouse" in the private industrial context is Gemina, which is then relabeled HdP (Holding di Partecipazione)[28], rises to the second place in 2000 thanks also to its strong ties with Mediobanca. In the public sector, IRI is represented with some of its subsidiaries (Finmeccanica and Fincantieri in 2000, SIP and the then privatized Banca Commerciale Italiana in 1990). ENI, the energy holding, is present in both years with Saipem and Italgas, relatively small subsidiaries compared to the giant AGIP, but apparently key actors in linking the group to the rest of the core network of cross-ownerships.

More importantly for our purposes, though, is to note that Mediobanca's role as central actor in the network during the decade stretches beyond its direct presence. Many of the companies identified as most central in the network are in fact linked to

[25] Recall that Mediobanca is known to be a key actor in the restructurings and in the control arrangements of the main private-sector groups, many of which are included among its shareholders along with the main state-owned (now privatized) banks.
[26] In 2000 the Agnelli family indirectly controlled 31% of the shares, mainly through the holding companies IFI and IFIL; Mediobanca, Assicurazioni Generali, SanPaolo IMI and Deutsche Bank were the other main shareholders, each with 2% to 3% of the shares.
[27] After the failure of a joint venture in the chemical industry (ENIMONT) with the state-owned oil company ENI, and a scandal that involved important politicians.
[28] The holding company HDP (2nd in 2000) was created in 1997 by acquisition of part of the assets of Gemina (20th in 1990). In 2000 HDP was controlled through a shareholder agreement that involved several important private-sector groups (Agnelli and Pirelli among them), Mediobanca (second largest share after the Agnelli group) and other financial institutions.

Mediobanca by ownership ties. These include the Fiat, Olivetti, Pirelli[29], Generali, Burgo and Gemina groups in 1990, and then Fiat, Montedison, HdP/Gemina, and the insurance companies SAI, La Fondiaria and Generali (the largest) in 2000.

The novelty in the "upper echelons" of the Italian business network is represented by family groups that rise in importance (and size) during the decade, such as those owned by the Berlusconi family (Mediaset and Mediolanum), the Marzotto family (fashion and apparel) and by Mr. Pininfarina (automotive design). Interestingly, the last two are also cut points in the 2000 network.

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TABLE 7 ABOUT HERE

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Table 7 shows the 20 most central owners in the 1990 (7a) and 2000 (7b) networks. Mediobanca is again at the top of the list, rising in fact to the first place in 2000 with a centrality ranking growing from 13.97 to 31.76 (!). The number of companies to which Mediobanca is tied in the network by common ownership of subsidiaries grows in fact from 81 in 1990 to 93 in 2000[30]. Not only then the centrality of the main actor in the Italian network drastically grew during the decade, but it becomes of absolute importance compared to any other actor. The second most central actor in 2000 (Alleanza Assicurazioni) shows in fact a centrality factor less than one third of Mediobanca (10.79).

[29] In 2000 the company was controlled through a shareholder agreement that involved, among others, HDP, SAI, RAS, Assicurazioni Generali and Mediobanca.

[30] This trend is contrasted by a decreasing number of ties in the owned companies network, going from 50 in 1990 to 39 in 2000. This shows that Mediobanca's role as "il salotto buono" (the living room of power), since on its board sit all the key actors in the network, has slightly reduced, whereas that of center of business ownership strengthened during the decade.

This network is characterized by some presence of passive financial investors, either as mutual funds (IMIcapital, PrimeCapital, Fonditalia in 1990, SanPaolo IMI A.M. in 2000), or as trust agents for shareholders (Lombard Odler et Cie. and Chase Nominees in 1990; Bankers Trust in 2000). The lion's share is constituted, however, by the holding vehicles of the core Italian families, as well as commercial banks and insurance companies. Among the families, we find again the Agnelli group (IFI in 1990, IFIL and the family holding in 2000), Ligresti (SAI), Pirelli, Olivetti, Marzotto[31], Berlusconi (Fininvest). This network, however, includes now the Pesenti[32] (Italmobiliare) and the Caltagirone group, both in the construction sector. Needless to say, virtually all these family holding companies are tied to Mediobanca by common shareholding in their operating subsidiaries, and many of them are also tied among themselves in a web of cross-shareholdings.

In addition, Mediobanca maintains linkages with other central actors in the owners' network that are not tied to families. These include Assicurazioni Generali, the largest insurance company, Gemina (in 1990), and the three formerly IRI-owned banks (Banca Commerciale Italiana, Credito Italiano/UniCredito, and Banca di Roma). Interestingly, these banks have historically had joint control of Mediobanca's capital but they have normally acted as subsidiaries, rather than owners, in this respect.

In conclusion, the analysis of the two networks of ownerships shows that, even if the networks tend to fragment and the small-world features of their largest components to slowly decline, the large established actors of the private sector are

[31] Famiglia Marzotto, Fiat and P. Ferrero & C. (the latter two are not included in Table 7) were the only owners that were cut-points in both 1990 and 2000.
[32] In 2000 the Pesenti family owned 42% of the shares, *Mediobanca* and *Assicurazioni Generali* accounted for another 13% and *SAI* owned 3.35%.

still very central to the Italian system. If anything, the most powerful central actors in the system, like Mediobanca, appear to have gained in centrality.

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FIGURES 3 AND 4 ABOUT HERE

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Figures 3 and 4 help visualize the weight of Mediobanca and its contacts inside the largest components of the networks. Privatizations caused the banking system to restructure through a wave of mergers, and the main state holding company (IRI) lost some centrality in the system while the privatizations progressed. However, Mediobanca is still at the very center of both the owned companies and the owners networks in 2000, despite the fact that privatizations are eliminating its bridging role between the private and the state sectors of the economy, and despite the competition of foreign investment banks (*The Economist*, 2001).

5. Conclusions

In this paper we set out to study the influence that two specific types of institutional interventions, governance reforms and privatization processes, have on the characteristics of the network of equity ownerships among business firms. The general result of this work is that evidence of destructuration at the macro level of the network, shown in the decreasing density levels and increasing fragmentation of the components, co-exists with substantial stability in the meso (small world statistics in the main component) and micro levels of analysis (individual companies).

Thus, the development of stronger norms for the protection of minority shareholders, as well as limitation of syndicated control agreements, did have the expected effect of reducing the degree of shared ownership and the use of controlling

blocks on the part of large shareholders, if one looks at the gross characteristics of the network of cross-ownerships. These trends might have been further strengthened by the privatization programs completed by a succession of Italian governments in the mid-1990s. First of all, the groupings related to the large state-owned holding companies (IRI, ENI and EFIM) have been largely dismantled, producing many single or loosely connected actors. Second, few of the privatized enterprises have actually connected with the network of private companies in a significant way. Many of them were simply integrated within the private groups that acquired them and lost the participations in the other formerly state-owned enterprises.

Importantly, however, the significant amount of change in the density and the structural components of the ownership networks did not materially affect some of the key characteristics of the central component of the network: the degree of clustering and the average distance among connected actors, for example. For those who are part of the major grouping of connected owners, in other words, the linkages with other co-owners were equally "closed" among themselves (i.e., their counterparts had ties with other counterparts in the same circle) and equally "close" to each other in terms of numbers of steps necessary to link one another. This resulted particularly evident from the analysis of the centrality (betweenness) of the companies in the main component of the two networks. In spite of the significant increase in its fragmentation at its macro level, therefore, the network of Italian enterprises remains a "small world" in a technical, as well as in a very practical, sense.

To the extent one can generalize from the analysis of the Italian case, it seems that the asymmetry uncovered between the network dynamics at different levels of granularity begs important reflections. Should the resilience of the small world properties in the core component of business networks in the face of significant

institutional change be confirmed, one might need to consider revisitin some of the conclusions drawn on the basis of large scale structural analysis of company networks; at the very least, the work touting the deep implications of institutional change needs to be confirmed with more detailed analyses of the role of single actors within the network over time.

This conclusion, however, needs to be taken with more than a pinch of salt; given the limitations the data utilized in this study exhibits. First of all, the analysis of the evolution of the network of ownerships is done taking only two points in time. Although, this might function well as a quasi-experimental design, future research might try to replicate the analysis with more frequent periods of observation and with a longer time span between the first and the last period. This last point is particularly important for the Italian context, since many of the consequences of the privatization program and of the governance reform initiatives might very well arise in a longer time frame than that one studied. Also important for future research is to adopt a comparative approach to the study of the impact of institutional change on inter-firm networks. The case of Italy compares well with that of Germany (Kogut and Walker, 2001) in terms of the relevance of small worlds structures, but the generalizability of these findings awaits further inquiries. Finally, further work is need to tease out the effects of each of the government interventions studied here. Even more important would be to study the nature of the interdependence among forms of institutional intervention: is a privatization program likely to strengthen or to weaken the effects of a governance reform on the network of business enterprises? Under what conditions one would expect this to happen, and when is it reasonable to expect each type of joint effect?

The implications for public policy are therefore as important as they are difficult to offer on the basis of this analysis. What does this mean for the public policy debate on the appropriate degree of regulation in the use of cross-participation among large enterprises? The picture that emerges from the data is one of an incomplete or only partially successful effect of the initiatives undertaken in the Italian context. However, that can be interpreted in two fairly different ways. The first is that more input is necessary from the institutional actors in order to obtain the desired effect of eliminating opportunities to marginalize or, worse, exploit minority investors. The web of cross-ownerships created to defend the independence and decisional autonomy of the large enterprises is still in large part intact, and only a further dose of regulatory intervention could complete the process. On the other hand, one could read the results of the analysis to reflect the fact that some of the properties of the network of ownerships have a general applicability to social systems and should therefore not be the target of further interventions because these interventions are unlikely to produce the desired effects. The network of cross-ownerships might have generalizable features of a small world, and these features might be sufficiently resilient to institutional change. If this is the case, then the small world of business ownership networks might need to be accepted as a “natural” element of the industrial texture in a given country. There’s no point in trying to fight gravity.

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Table 1
Description of Networks: Owned Companies and Owners

	Number of Owned Companies or Owners	*Ties*[1]	*Density*[2]	*% Connected pairs*[3]	*Max. distance (connected pairs)*[4]	*Av. distance (connected pairs)*	*Std. dev. distance (connected pairs)*
			All shareholdings				
1990 Owned Companies	212	1170	5.2%	37.5%	5	2.412	0.876
2000 Owned Companies	207	527	2.5%	24.2%	7	2.599	0.943
1990 Owners	454	2252	2.2%	50.4%	6	2.817	0.831
2000 Owners	535	2295	1.6%	31.1%	8	2.980	0.985
			5% or more shareholdings				
1990 Owned Companies	212	314	1.4%	6.8%	8	3.176	1.761
2000 Owned Companies	207	112	0.5%	1.1%	7	2.038	1.287
1990 Owners	273	290	0.8%	5.6%	9	3.455	1.794
2000 Owners	331	325	0.6%	1.4%	8	2.450	1.722

1) A tie exists between two owned companies if they share one or more shareholders (owners) and between two owners if both own shares of one or more owned companies.

2) Ratio of the number of observed ties to the number of possible ties (possible pairs).

3) Two owned companies (owners) are connected if a tie exists between them, or if they are mutually reachable through a sequence of ties involving other owned companies (owners).

4) The distance between two owned companies (owners) is the number of ties included in the shortest sequence of ties that connects them, i.e., the minimum number of ties that must be crossed in order to reach one from the other. Distance is meaningful only for connected pairs; only these pairs were considered.

Table 2
Network Components[1]

	Number of Owned Companies or Owners	*Number of Components[1] with size > 2*	*Size[2] of Components*				*Isolated[3] Owned Companies or Owners*
			Largest	*2nd largest*	*3rd largest*	*4th largest*	
			All shareholdings				
1990 Owned Companies	212	4	130	3	3	3	71
2000 Owned Companies	207	2	102	4	2	2	91
1990 Owners	454	10	322	7	6	6	43
2000 Owners	535	31	297	23	8	7	40
			5% or more shareholdings				
1990 Owned Companies	212	10	47	24	15	7	92
2000 Owned Companies	207	11	18	7	6	5	126
1990 Owners	273	21	52	35	8	7	57
2000 Owners	331	42	30	8	8	7	75

1) A component is a group of owned companies (owners) any of which is connected to any other in the group through a tie or a sequence of ties.

2) The size of a component is the number of owned companies (owners) included.

3) Isolated owned companies are those that are not tied to any other owned company; i.e., they do not share any owner with any other owned company in the sample. Isolated owners are those that are not tied to any other owner; i.e., they do not share the ownership of any owned company with any other owner (they are the only owner observed in their owned companies).

Table 3
Dynamics of the owned companies network and largest component, 1990-2000
(all shareholdings network)

		Network			
		Enter[2]	*Leave*[3]	*Stay*[4]	*Total*
Largest Component[1]	*Enter*[5]	25	-	10	35
	Leave[6]	-	48	15	63
	Stay[7]	-	-	67	67
	Always out[8]	46	28	44	118
	Total	71	76	136	283

1) A component is a group of companies connected to each other directly (through a tie) or indirectly (through a sequence of ties).
2) Companies observed in 2000 - not observed in 1990.
3) Companies observed in 1990 - not observed in 2000.
4) Companies observed both in 1990 and in 2000.
5) Companies not in the largest component of the network in 1990, but present in 2000.
6) Companies not the largest component of the network in 2000, but present in 1990.
7) Companies in the largest component of the network both in 1990 and in 2000.
8) Companies not in the largest component neither in 1990 nor in 2000.

Table 4
Small World Analysis
(Largest Components[1], All Shareholdings Networks)

Comment [MSOffice1]: The last two notes are not referenced in the table.

	Number of Owned Companies or Owners in Largest Component[1]	*Ties*[2]	*Av. Degree*[3]	*Av. Distance*[4]	*Clustering*[5]	*Av. Distance (standardized)*[6]	*Clustering (standardized)*[7]	*SW coefficient*[8]
1990 Owned Companies	130	1160	17.846	2.414	0.770	1.429	5.609	3.925
2000 Owned Companies	102	517	10.137	2.602	0.690	1.303	6.943	5.328
1990 Owners	322	2157	13.398	2.820	0.850	1.267	20.428	16.119
2000 Owners	297	1819	12.249	3.002	0.868	1.321	21.046	15.932

1) A component is a group of owned companies (owners) any of which is connected to any other in the group through a tie or a sequence of ties. The largest component of a network is that which includes the largest number of owned companies (owners).

2) A tie exists between two owned companies if they share one or more owners and between two owners if both own shares of one or more owned companies.

3) The degree of an owned company (owner) is the number of other owned companies (owners) linked to it by a tie. The average is computed across all owned companies (owners) in the largest component.

4) The distance between two owned companies (owners) is the number of ties included in the shortest sequence of ties that connects them, i.e., the minimum number of ties that must be crossed in order to reach one from the other. The average is computed across all the pairs of owned companies (owners) in the largest component.

5) The clustering coefficient of the network is the average extent to which the owned companies (owners) tied to each owned company (owner) are also tied to each other.

6) Ratio of the observed average distance to that computed for a randomly generated network with the same number of owned companies (owners) and the same average degree.

7) Ratio of the observed clustering to that computed for a randomly generated network with the same number of owned companies (owners) and the same average degree.

8) Ratio of the standardized clustering to the standardized average distance. The larger the coefficient, the more the network embodies the structural features of a small world.

9) Ratio of the observed clustering to that computed for a randomly generated bipartite network (owned companies by owners) with the same number of owners per owned company (shareholdings per owner); this standardization accounts for the bipartite nature of the data.

10) Ratio of the standardized clustering (corrected for the bipartite nature of the data) to the standardized average distance. The larger the coefficient, the more the network embodies the structural features of a small world.

Table 5
Small World Analysis — Bipartite Data Correction

	Clustering (standardized)[1]	*Clustering (standardized — bipartite correction)*[2]	*SW coefficient*[3]	*SW coefficient (bipartite correction)*[4]
1990 Owned Companies	5.609	4.786	3.925	3.349
2000 Owned Companies	6.943	4.099	5.328	3.146
1990 Owners	20.428	2.640	16.119	2.083
2000 Owners	21.046	2.341	15.932	1.772

1) Ratio of the observed clustering to that computed for a randomly generated network with the same number of owned companies (owners) and the same average degree.

2) Ratio of the observed clustering to that computed for the 1-mode projection of a randomly generated bipartite network (owned companies by owners) with the same number of owners per owned company (or owned companies, i.e., shareholdings, per owner); this standardization accounts for the bipartite nature of the data.

3) Ratio of the standardized clustering (without correction) to the standardized average distance. The larger the coefficient, the more the network embodies the structural features of a small world.

4) Ratio of the standardized clustering (corrected for the bipartite nature of the data) to the standardized average distance. The larger the coefficient, the more the network embodies the structural features of a small world.

Table 6
Betweenness:[1] First 20 Owned Companies, 1990–2000
(All Shareholdings Networks, Largest Component[2])

(a)

1990	
Name[3]	*Betweenness (normalized)*[1]
Mediobanca	15.31
Banca Nazionale del Lavoro (Italian State)	10.38
COGEFAR-IMPRESIT (Agnelli group)	5.67
Assitalia	5.62
SIP (IRI group)	5.35
Montefibre (Montedison group)	5.17
Saipem (ENI group)	4.63
SME (IRI group)	4.35
Banca Commerciale Italiana (IRI group)	4.14
UIR-Unione Italiana di Riassicurazione	4.11
Ferruzzi Finanziaria (Holding of Montedison)	4.06
Italgas (ENI group)	3.75
FIAT (Agnelli group)	3.62
I.M.I.	3.54
Montedison	3.30
Jolly Hotels	3.20
Cartiere Burgo	2.66
Cotonificio Olcese-Veneziano	2.43
Magneti Marelli (Agnelli group)	2.41
Gemina	2.30

(b)

2000	
Name[3]	*Betweenness (normalized)*[1]
Mediobanca	17.28
HDP (formerly Gemina)	14.02
Finmeccanica (IRI group)	11.97
Pirelli & C.	9.28
SAI (Ligresti group)	8.78
FIAT (Agnelli group)	8.33
Mediolanum (Berlusconi group)	7.06
Italgas (ENI group)	6.55
Saipem (ENI group)	5.75
Gruppo Coin	4.35
SanPaolo IMI	3.91
Fincantieri (IRI group)	3.90
Pininfarina	3.62
Mediaset (Berlusconi group)	3.49
Banca di Roma	3.14
Mediocredito Lombardo	3.06
Compart (formerly Ferruzzi Financiaria)	3.05
Banca Nazionale del Lavoro (Italian State)	2.97
La Fondiaria Assicurazioni	2.86
Manifattura Lane G. Marzotto & Figli	2.83

1) The betweenness index measures the extent to which an owned company lies over the sequences of ties that connect other owned companies; the normalized index is the ratio of the observed value to its theoretical maximum expressed as a percentage.

2) A component is a group of owned companies any of which is connected to any other in the group through a tie or a sequence of ties. The largest component of a network is that which includes the largest number of owned companies.

3) Owned companies reported in bold characters are cut-points. A cut-point in a network is a node (owned company) whose removal interrupts all the sequences of ties that connect two or more groups of nodes (owned companies), i.e., a node whose removal increases the number of components in the network.

Table 7
Betweenness:[1] First 20 Owners, 1990–2000
(All Shareholdings Networks, Largest Component[2])

(a)		(b)	
1990		***2000***	
Name[3]	*Betweenness (normalized)*[1]	*Name*[3]	*Betweenness (normalized)*[1]
ImiCapital	17.85	Mediobanca	31.76
Mediobanca	13.67	**Alleanza Assicurazioni**	10.79
Assicurazioni Generali	9.28	UniCredito Italiano	10.15
Italmobiliare (Pesenti family)	8.02	Assicurazioni Generali	9.75
R.A.S. (Allianz group)	6.37	**SanPaolo IMI Asset Management SGR**	9.24
Banca d'Italia (Italian State)	5.98	Bankers Trust Co.	7.61
Banca Popolare di Milano	5.97	**Famiglia Caltagirone**	6.62
Banco di Roma (IRI group)	4.57	**Banca Commerciale Italiana**	6.34
I.R.I. (Italian State))	4.51	**Istifid**	5.92
Lombard Odier & Cie	4.43	**Banca d'Italia** (Italian State)	5.30
PrimeCapital	4.39	**Fininvest** (Berlusconi family)	5.11
Gemina	4.22	Giovanni Agnelli & C. S.a.p.a.	5.05
Credito Italiano (IRI group)	4.19	**Famiglia Marzotto**	3.99
Pirelli & C. (Pirelli family)	4.03	**R.A.S. (Allianz group)**	3.92
Banca Nazionale del Lavoro (Italian State)	4.00	I.R.I. (Italian State)	3.51
I.F.I. (Agnelli family)	3.95	Societa Reale Mutua di Assicurazioni	3.36
Credipar (Italian State)	3.94	**IFIL** (Agnelli family)	3.33
SAI (Ligresti family)	3.61	**Olivetti**	3.29
Chase Nominees Ltd.	3.51	Banca di Roma	3.02
Fonditalia	3.46	Milano Assicurazioni	2.86

1) The betweenness index measures the extent to which an owner lies over the sequences of ties that connect other owners; the normalized index is the ratio of the observed value to its theoretical maximum expressed as a percentage.

2) A component is a group of owners any of which is connected to any other in the group through a tie or a sequence of ties. The largest component of a network is that which includes the largest number of owners.

3) Owners reported in bold characters are cut-points. A cut-point in a network is a node (owner) whose removal interrupts all the sequences of ties that connect two or more groups of nodes (owners), i.e., a node whose removal increases the number of components in the network.

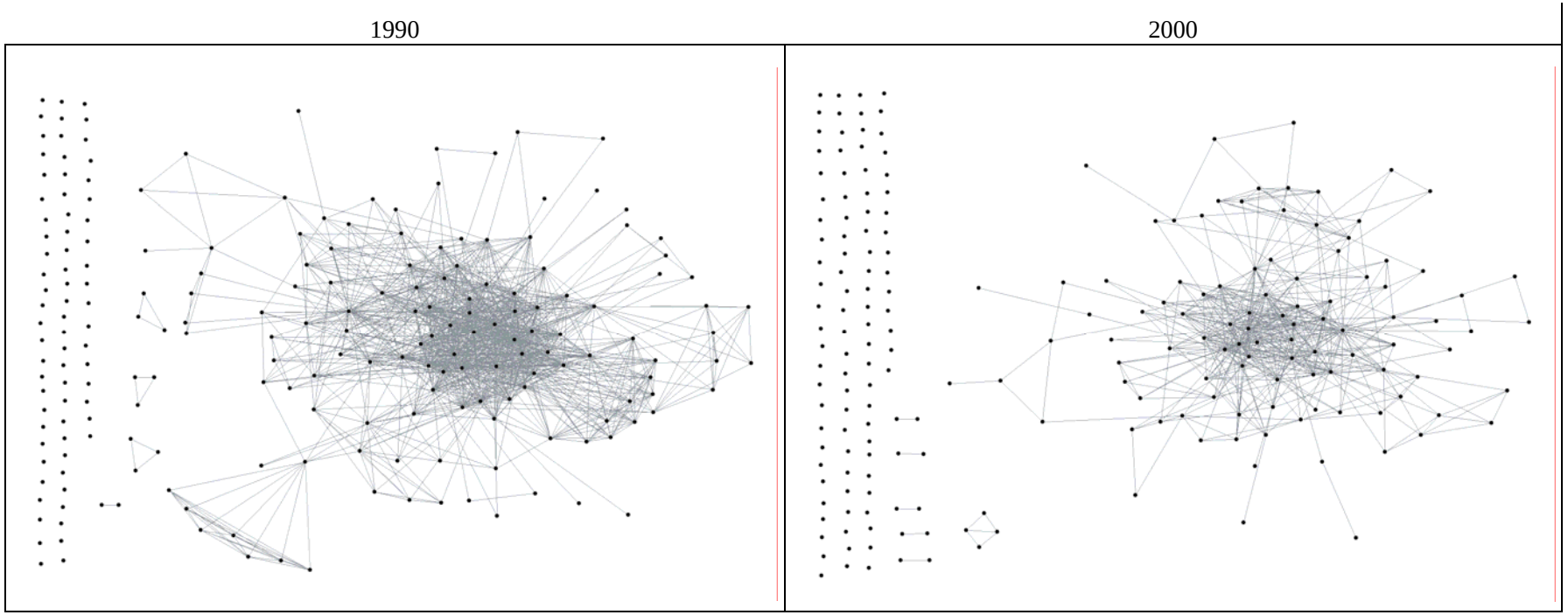

Figure 1
Owned Companies Network, 1990–2000

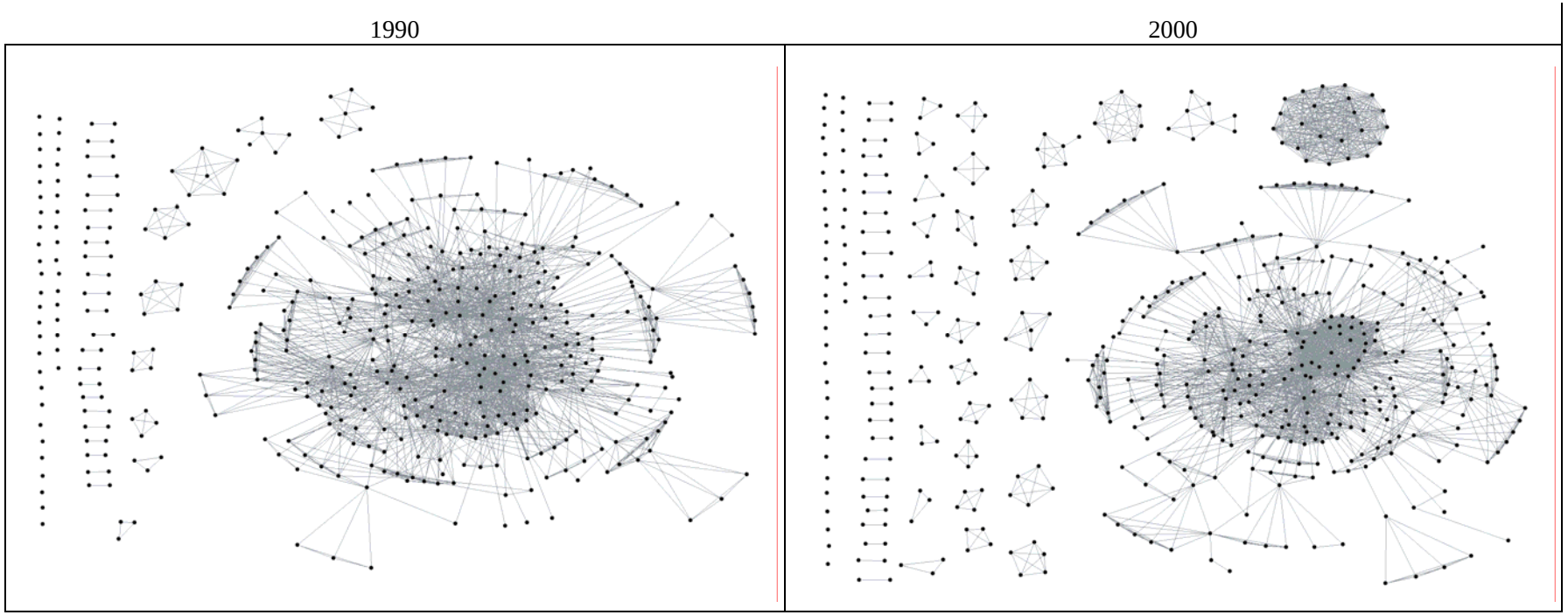

Figure 2
Owners Network, 1990–2000

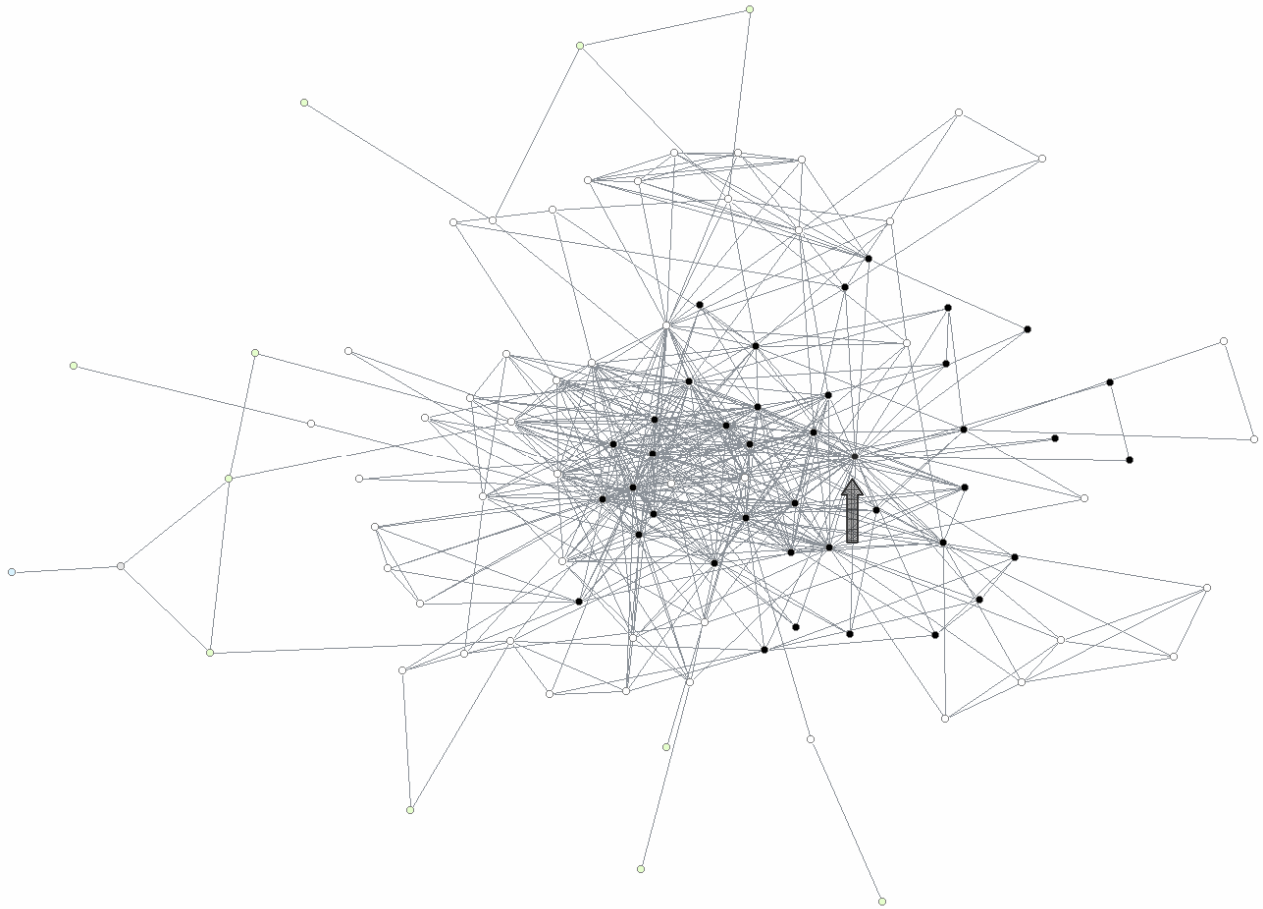

Figure 3
Owned Companies in the Largest Component[1], and the Mediobanca Network, 2000[2]

1) A component is a group of owned companies any of which is connected to any other in the group through a tie or a sequence of ties. The largest component of a network is that which includes the largest number of owned companies.

2) The arrow locates Mediobanca. Dark dots represent the owned companies that share one or more of their shareholders with Mediobanca.

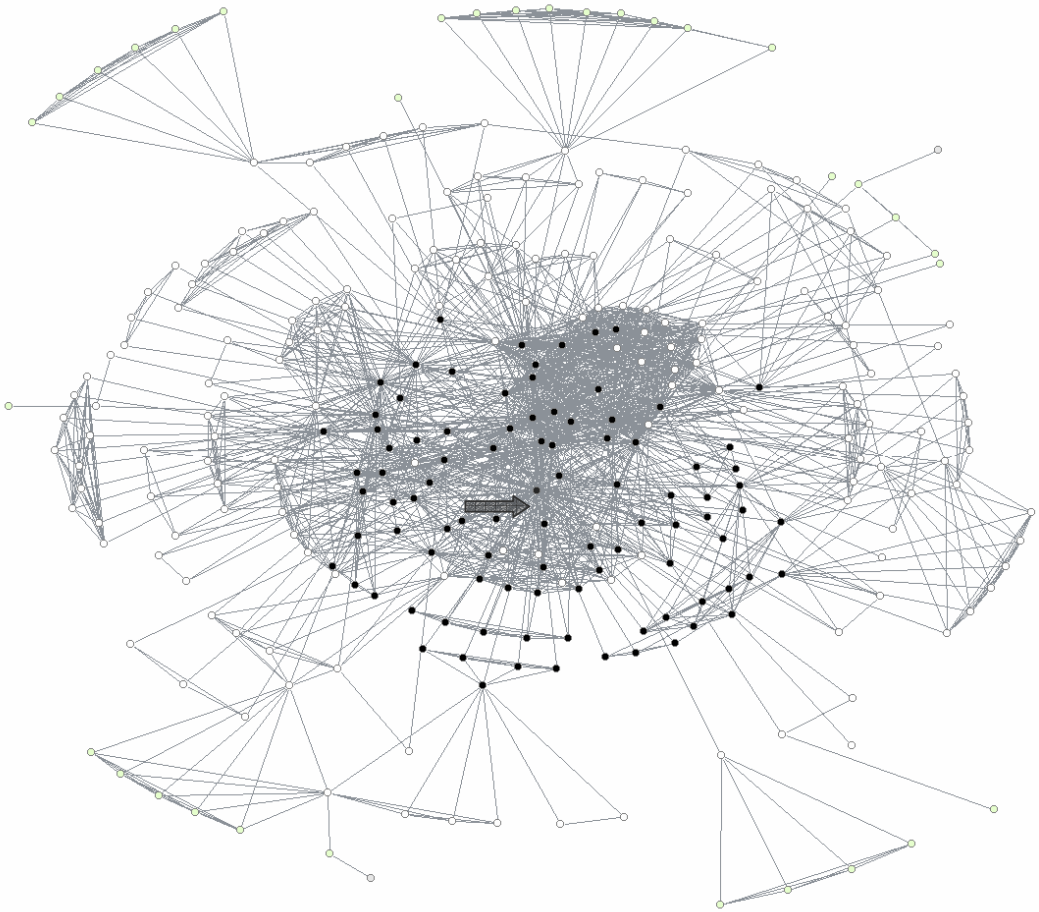

Figure 4
Owners in the Largest Component[1], and the Mediobanca network, 2000[2]

1) A component is a group of owners any of which is connected to any other in the group through a tie or a sequence of ties. The largest component of a network is that which includes the largest number of owners.

2) The arrow locates Mediobanca. Dark dots represent the owners that hold shares in one or more of the owned companies where also Mediobanca is shareholder

Appendix — Small Worlds

The small-world concept focuses on the structural features of large and sparse networks; it became popular in the 1960s with the research carried out by Milgram (1967). Milgram showed that chains of acquaintanceship ties connecting pairs of individuals were far shorter than expected, given the large size and low density of the network. The content of the small-world idea was initially based on the sole evidence of *short network distances*, where the distance between two actors is the smallest number of ties one of them has to cross to reach the other (this distance is infinite if the actors are not connected by any sequence of ties). Though intuitive, this idea needs refinement, because the evidence of short distances is not striking in itself even in large and sparse networks. The theory of random graphs (Erdös and Rényi, 1959; Bollobás 1985) indeed shows that short network distances are typical for ties randomly and independently distributed over pairs of actors.

More recent research extended and recast the small-world concept in more rigorous terms (Watts and Strogatz, 1998; Watts, 1999; Newman, 2000). This extension involves contrasting two structural properties of networks, *average distance* and *clustering*, and two ideal classes of networks, *random* and *ordered* structures. It is shown that real networks of many kinds show patterns that do not correspond to either class of structures; these patterns define a third class of networks, small worlds.

Sparse random networks with independent probabilities of the ties show both low average distance and low clustering; this class of networks represents the absence of structure. The clustering of a network expresses the extent to which actors cluster in groups whose members are tightly connected with each other and loosely connected to nonmembers. It can be measured as the probability of a tie that connects two actors that share one network contact. In random networks the probability of one such tie is not greater than that of any other tie (low because the network is sparse). On the other side, low clustering implies that the network contacts of actor A tend to be different from the contacts of A's contacts. In other words, A's contacts connect A to otherwise disconnected actors. Consequently, the set of actors to which A is indirectly tied through chains of

contacts quickly enlarges as the length of the chains grows. It follows that relatively short chains of contacts tend to connect any two actors in the network.

A second class of structures is in some sense the opposite of these random structures; networks in this class are indeed examples of highly ordered structures. In these networks actors cluster in many small and densely knit groups, each of which is loosely connected across its boundaries to the few other groups near it according to an ordering of the actors (the network's nodes). In these highly clustered structures the sparseness of the ties that bridge distinct clusters causes large network distances between the actors.

These two broad classes of sparse networks, located at the extremes of the theoretical continuum between ordered and random structures, describe a trade-off between average distance and degree of clustering. Short average distance is accompanied by low clustering in random networks, while high clustering corresponds to high average distance in highly ordered structures. Within this theoretical context, many real networks are said to be small worlds because they simultaneously show high clustering and low average distance among the actors. This paradoxical pattern locates these real networks somewhere in the continuum between random and ordered structures.

Watts (1999) and Watts and Strogatz (1998) explored small-world network structures. They started from an ordered structure and added some randomness by randomly rewiring a number of ties; they showed that for intermediate levels of random rewiring the degree of clustering tends to remain high, while the average distance quickly lowers; the resulting network is a small world. Newman (2000) reviewed recent research on small worlds and suggested other ways in which these structures may arise.