Interlocking directorates as a thrust substitute: The case of the Italian non-life insurance industry

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Interlocking directorates as a thrust substitute: The case of the Italian non-life insurance industry

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Abstract. This paper investigates the market structure of the insurance business by analyzing the (interlock) linkages among companies created by their directors. We focus on the non-life business since this is a sector relatively closed with respect to the competition with other financial activities; an absence of industry competition cannot thus be compensated by other agents. We apply the graph theory to describe the network and the principal component analysis to summarize information and verify the correlation between direct interlocking and companies' market shares.

Keywords: Non-life insurance, antitrust, competition, interlocking directorates, network economics.

1. Introduction

An interlocking directorate exists "when one person affiliated with one organization sits on the board of directors of another organization" (Mizruchi, 1996: 271); interlocks between competing firms are called *direct interlocks*. Interlocking directorates occur regularly across industries and have often been praised, since they mobilize a scarce resource: the expertise of senior managers and directors of large corporations.[1] However, the plurality and co-occurrence of positions in the company boards is a *usual suspect* of violation of perfect competition and market concentration, especially in the case of direct interlock. Companies wishing to cartelize a market may try to compensate for an absence of trust among independent companies by creating interlocking directorates, which can create trust at several levels.[2] Interlocking directorates can help minimize trust problems by putting insiders in places where they can monitor and affect what other companies are doing, e.g. in terms of plans to reduce price, expand capacity, or introduce new products. A system based on direct interlocking directorates may thus potentially produce economic inefficiencies.

Interlocking directorates help cartels maintain trust by increasing detection and reducing the gains from defection. Historically, interlocking directorates have played an important role in stabilizing many successful cartels. The most famous American example probably is the *DuPont*'s ownership of *General Motors* shares at a time when the companies shared directors on their respective boards. Similarly, the leader of the international uranium cartel, *Rio Tinto Zinc* (*RTZ*), controlled many of the world's mining concerns through an extensive network of interlocking directorates. The diamond cartel continues to receive much of its stability from a complex web of interlocking directorates. In a recent study, Brunello *et al.* (2000) show that interlocking membership is a common feature of companies listed on the Italian Stock Exchanges. They consider a sample of companies listed on the stock exchanges over the 9-year period 1988-1996 and find that directors hold an average of 1.30 outside directorships.[3]

Dooley (1969), one of the first academic studies regarding the board interlocks, focuses on the relationship between firms and banks. Dooley finds that less solvent firms are likely to be interlocked with banks in the United States. Research on interlocking directorates in North

[1] For studies that have devoted attention to the possible implications of interlocking directorates, see Ecclesm (1981), Mizruchi (1996), Core *at al.* (1999), Heracleous and Murray (2001), Hermalin and Weisbach (2001), Fich and White (2005) and references therein.

[2] First, financial interdependence reduces the risk of one partner selling out the other because each partner has a stake in the financial success of the other one. Second, sharing directors creates transparency among cartel participants since each cartel member has an observer in place observing and monitoring activities that could undermine the cartel agreement.

[3] Other important historical examples include the *American Tin Plate Company*, the *National Steel Company*, and the *American Steel Hoop Company* with their significantly overlapping major stockholders and directors. See, among others, Burt (1983), Mintz and Schwartz (1985), Eccles and Crane (1988).

America, Europe and Asia has burgeoned since this time and is reviewed in Mizruchi and Schwartz (1987), Morck *et al*. (1989), Scott (1991), Davis and Powell (1992), Pettigrew (1992), Berglöf and Perotti (1994), Hallock (1997), Hermalin and Weisbach (2001), Klein (2002), Fich and White (2005).[4] Other authors have underlined an interpretation for interlocking directorates as a manner of monitoring, e.g. Stiglitz (1985), Eisenhardt (1989). These studies are interesting for our perspective since they imply that cartel members can use interlocking directorates to monitor activities of other cartel members that could undermine the cartel agreement.

In the United States, where there is a strong tradition of antitrust policies,[5] the practice of interlocking directorates has been a subject of debate among corporate-governance activists and academics for many decades and still debated especially after the recent corporate governance scandals, which have placed the spotlight on directors with multiple board appointments and raised concerns that corporate misdeeds can be traced across directorships (Weil, 2002).

Nowadays, in the United States, direct interlocks are illegal under the *Clayton Act*, which has been revised in 1990 by the *Interlocking Directorates Act* in a more restrictive direction. Historically, as the Supreme Court began to expand the reach of the *Sherman Act* in the 1910s and 1920s, potential cartel promoters had to find new ways to create sufficient trust to stabilize price-fixing arrangements. With the elimination of trusts, firms eventually turned to interlocking directorates. Interlocking directorates allowed many cartels to establish trust and to flourish. In response, Congress amended the antitrust laws. *Clayton Act* (Section 8) prohibits potentially anti-competitive interlocking directorates among competitors. In particular, it prohibits a person from serving as a director or officer of two or more companies if they are «by virtue of their business and location of operation, competitors, so that the elimination of competition by agreement between them would constitute a violation of any of the antitrust laws». To make up for a lack of trust, companies try to acquire an ownership stake in fellow cartel members. Again, antitrust law plays a role in limiting this trust-facilitating device. When competitors used cross-ownership to circumvent antitrust policies against price-fixing, Congress responded by proscribing anti-competitive common ownership.

By contrast, in the Italian law system there is no explicit reference to interlocking directorates. They can be considered only indirectly in terms of the norms on the conflict of interests that, in case, can

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[4] Two studies for Italy are Salvemini *et al*. (1995) and Bianco and Pagnoni (1997). The former is about the manufacturing sector and the latter about the linkages between banks and firms priced in the stock market. See also Brunello *et al*. (2000).

[5] In 1913, the US Senate Pujo Committee made the first judgment on interlocking directorates by instigating the linkages between the main New York banks (*J.P. Morgan & Co.*, *First National* and *National City*) and the industrial sector. The judgment was negative and trust formation. The works of this committee were the putative father of the consequent *Clayton Act* in 1914.

impeach decisions of the board of directors. However, interlocking directorates, when referred to companies in the same sector, are clearly in contrast to article 2390 of the *Civil Code*, which prevents the co-occurrence directors from competing activities in competitive companies.

This paper aims to study the social network of the insurances in the non-life business sector by focusing interlocking directorates.[6] The science of social networks is an emerging and promising area for economists.[7] A network is simply a list of which pairs of agents are linked to each other with respect to the kind of relationship examined. In other worlds, a social network can be defined as a set of dyadic ties, all of the same type, among a set of actors (persons or organizations), where a tie is an instance of a social relation. Originally developed by sociologists, network analysis has been recently extended to many fields of applications and its formalization deeply refined.

We aim to describe the characteristics of the social network of the insurance sector by considering the relationship between insurance companies in terms of interlocking directorates; we consider two companies connected, if they share at least a member of the board of directors. We build some synthetic network (concentration) indices and verify their correlation with the market share of the companies.

The rest of the paper is structured as follows. Section 2 briefly describes the Italian sector of insurance business and its reforms. Section 3 describes our dataset and methodology. Section 4 reports our results described by graph theory. It also derives some synthetic index of market concentration by using the principal components technique to reduce the sample variables with a minimum loss of variance. It also compares indices to the market company shares. A final section concludes.

2. The Italian insurance system

The Italian insurance industry is government-supervised, and insurers must be authorized to do business. The insurance regulatory body is the *Instituto per Viglanza sulle Assicurazioni Private di Interesse Collettivo* (the Institute for Control of Private Insurance Companies, ISVAP). European Union reporting and other insurance directives are being implemented. A unique and helpful feature

[6] For the sake of brevity, we restrict our analysis to non-life insurances. We choose this case since it is the less competitive (as claimed 11 companies control the 78% of market), more closed with respect to the competition of other financial agents (life insurances compete with other forms of financial investments), more affected by government regulation (a large part of the market is dominated by the compulsory motor insurance). However, in our analysis we also consider data on life insurances in a way that will be later explained.

[7] See Jackson (2006) for an excellent survey. Other interesting examples, describing strategic modeling of networks in cooperative and non-cooperative games, learning on networks, networks in labor economics and industrial organization, farsighted formation of networks, are collected in Demange and Wooders (2004). For recent examples, see also Chwe (2000), Watts (2001), Ioannides and Datcher Loury (2004), Page *at al*. (2005), and Jackson and Yariv (2006).

of Italian insurance company reports is the inclusion of financial statements of major subsidiary or affiliated companies.

The Italian insurance sector shifted from a strong protectionist context to a "free" market system in 1994. By the new directives on life and non-life insurance sector, public authorities can no longer control tariffs and insurance policy conditions.

The reform seriously affected the non-life insurance business, especially the motor insurance, which insurance was made compulsory in 1971 – coverage is also required for aircraft, powerboats, hunters, auditors and yachts. Companies started to be free to fix prices according to customers' risk attitudes, and a new tariff system based on the "bonus/malus" mechanism was introduced. The reform aimed to improve the sector efficiency and performance. The implicit theoretical rationale was that a market-oriented sector should be able to provide a better service at a lower cost. In other terms, it supports the invisible hand process that leads to produce the social optimum.

Although the Pareto optimality nature of the perfect competition is a milestone of the economic theory, its practical implementation is more challenging and controversial, as the one-for-one correspondence between perfect competition and the Pareto optimum only applies to the case of the perfect competition paradigm. Real-life markets feature imperfect or monopolistic competition, oligopoly and monopoly. In all these situations, the condition that ensures Pareto optimality under perfect competition, i.e. equality of price and marginal cost, is violated. Moreover, even if competitive markets are considered, invisible hand only applies under the strong assumptions of symmetric information and absence of externalities and transaction costs.

Of course, the 1994 reform has represented a step in the direction of a competitive market structure, but this does not necessary mean a step in the direction of the social optimum, i.e. a Pareto improvement. As is well-known from the theory of the second best, the central idea of the first theorem of welfare economics is that a competitive equilibrium is Pareto optimal, but we cannot argue that small divergences from perfect competition do lead us far from the Pareto optimum, and that the smaller any divergence is the less we stray from Pareto optimality. In Lipsey and Lancaster's words (1956: 12) "a situation in which more, but not all, of the optimum conditions are fulfilled is necessarily, or is even likely, to be superior to a situation in which fewer are fulfilled."

In the insurance market many of the perfect competition paradigm assumptions are violated. Hence, the superiority of a free-price system over the public tariff is not guaranteed. Regarding the relationship between producer and consumer there is a strong problem of asymmetric information, which has been extensively studied in literature but is outside the scope of the present paper. Moreover, the structure of the market is highly non competitive since the number of insurance companies is often limited. We are interested in this kind of competition violation. Indeed, according to the *Italian Association of Insurance Companies* (ANIA) *Yearbook*,[8] about hundred competitors are active in the market; however, the total share of the market of the first eleven is 78% in the non-life business and about 20 companies sum up a share of 70% in the case of life insurances. By analyzing the dynamics of entry-exit in the motor insurance sector, Turchetti and Daraio (2004) have shown that after 1994 the number of authorized insurers clearly fell (23.8% from 1994 to 2000). The downward trend in the number of competitors is particularly significant, as it comes after a period of almost 15 years of constant growth.

A serious signal of market failure associated to the insurance reform is represented by the action of the Italian Antitrust Authority in 2000. Six years after the deregulation, in fact, quite a large number of companies have been sanctioned by this authority for violation of the competition discipline. The total amount of fines was 361.5 millions of euro.[9]

A more sounding reference on the impact of the deregulation activated in the insurance business in 1994 is the study of Turchetti and Daraio (2004) who analyze the evolution of the number of motor insurers, their entry-exit dynamics, concentration ratios, the trend of premiums, and their relation to legislative events over the period 1982-2000. They provide empirical evidence on how deregulation in the insurance sector has shaped market structure and industry performance.

In 2004, the Antitrust Authority fined the ANIA. The total amount of fines was 2 million of euro. The fine motivation was that the ANIA favored the diffusion of uniform cost parameters for insurance compensations. The Antitrust Authority also obliged the ANIA to interrupt its activity of coordination among insurance companies. In other words, the ANIA was favoring the creation of a cartel among insurance companies by coordinating their price strategies. This highlights another strong violation of the requirements for the free market: the need of lack of agreement among producers.

The coordination through sector associations is, however, not the only form of coordination for a cartel, nevertheless the most important. For instance, company managers can coordinate their policy by informal talks and, less informally, by more binding actions taken in management meetings when they sit in many boards of directors, i.e. when directorates are interlocked. In the rest of the paper we investigate this possibility.

[8] The dataset is described in section 3.

[9] In the same year, the government froze motor insurance tariffs in order to control price and inflation. The decision was censured by many economists and politicians because of its incompatibility with European laws.

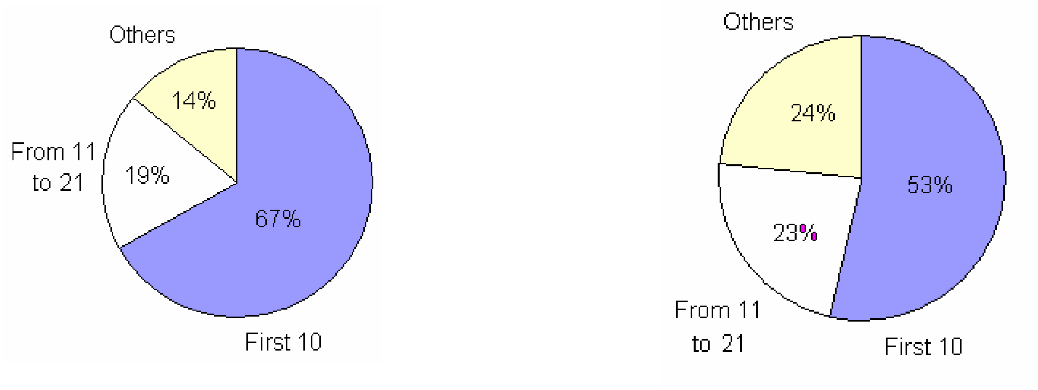
3. Dataset and methodology

3.1 The dataset

We investigate *interlocking directorates* through a dataset built from the 2004 ANIA Yearbook.[10] For *interlocking directorates* among insurance companies we mean that a tie is created between two companies when a person is member of both boards of directors; each case of administrators' co-presence is thus a connection between the companies.

Data about boards of directors has been collected by ANIA directly from insurance companies. The dataset is composed of information on 187 Italian insurance companies operating in Italy on July 10th 2004.

We distinguish between life and non-life insurance sector; 99 companies of the dataset are in the former, 102 in latter; 14 companies are included in both sectors. The dataset also provide information on the market share of the companies, which are summarized by figure 1.



(a) Non-life business (b) Life business

Figure 1

Notwithstanding the fact that about hundred competitors are active in the market, the share of the market of the first ten is 67% (and becomes 78% by considering the first eleven, 86% for the first 21) in the non-life business; the market share of the first ten in the case of life insurances if 53% and about 20 companies sum up a share of 70%.

[10] Regarding the board composition, it does not reflect the situation at the end of the fiscal year (balance approbation), but the more recent as communicated by the companies. ANIA has taken account of all the Legislative Decrees and ISVAP authorizations until the yearbook publication. The survey does not take account of companies (5 companies) operating in a regime called *libertà di prestazione di servizi* and the foreign company representatives (62 companies). For more details, see ANIA (2004).

3.2 The methodology

3.2.1 The general strategy

We use a two-step procedure. First, we analyze the social network of the insurance sector by focusing on the linkages among directors and among companies through the graph theory approach. We thus provide several statistics describing the insurance network. Second, we aggregate the insurance-company network statistics in synthetic indices by using the principal component analysis; we give an interpretation to indices and verify the correlation of these indices with the market shares. In the rest of this sub-section, we discuss data organization and the two approaches.

3.2.2 Network analysis

Graph theory is a graphical representation of the social network, i.e. the representation of the linkages among companies through their common directors. A graph is composed of vertices (or actors or points or nodes) connected by ties (or relations or edges). In our case, the graph represents a single type of relations among the actors (simplex); each tie or relation represents co-occurrence, co-presence, or a bonded-tie between the pair of actors (two companies are connected because they have a common director in their boards or two directors are connected because they are in the board of the same company). Bonded-tie relations are represented with line segments. Two vertices can be tied by one or more co-occurrences (e.g. when more than one director is common in two companies).

An important concept in graph theory is that of ego-network. An ego-network is a section of the whole network, i.e. the part of the network *close* to a given vertex. More formally, a vertex x is considered *ego* (the focal actor) and the adjacency vertices are considered *alters*. Then, the ego-network is composed by ego, alters and all the ties that connect all of them (i.e. ego-alters, alters-alters). Ego-network is important to study the local property of the social network.

We organize data in a matrix form (incidence matrix).[11] Each element of the incidence matrix describes the relation between a director (rows) and a company (columns). The incidence matrix is binary: one indicates that the director is member of the board of directors of the company. We consider three incidence matrices: one for the whole sector, one for the life insurance companies and one for the non-life companies.

Basic statistics are computed on adjacency matrices. Each adjacency matrix describes the ties between directors or companies. In other words, the adjacency matrix of directors indicates the number of boards where two directors are contemporaneously involved. The adjacency matrix of companies indicates the number of common directors of two companies. Of course both are square

[11] In line with the scope of our investigation, we reduce the dimension of the original data from ANIA by eliminating all directors who are members in only one board.

matrices of dimension equal to the number of directors (for the former) and companies (for the latter). Adjacency matrices are derived from incidence matrices; formally, let A being the binary incidence matrix then the adjacency matrix of the directors is AA'; the adjacency matrix of the companies is A'A.

We consider six social networks, by considering the adjacency matrices of directors and companies for the whole insurance sector, non-life business, and life business. Thus we consider the network of (1) insurance company, (2) directors, (3) the life sector companies, (4) life sector directors, (5) non-life sector companies, (6) non-life sector directors. Notwithstanding our interest in the non-life sector only, we consider all the networks for two reasons. First we consider all these aggregation to have a complete general view of the insurance sector. Second we consider both life and non-life business because, e.g., two non-life sector companies can be indirectly connected trough a common director in a life sector company.

On these six networks we compute 13 statistics that are described in box 1.

Box 1 – Statistics on the network

1. *Vertex* indicates the number of vertices in a network.
2. *Density* indicates the number of ties on potential ties; statistic is obtained by a binary graph: we considered just the presence of a tie.
3. *Components* indicates the number of components attended in a graph (network).[12]
4. *Main component* indicates the number of vertices associated with the largest component (main component).
5. *Fragmentation* indicates the number of components divided by the number of vertices attended.
6. *Cliques* is a subgroup with density 100%; in this case a clique is defined by the presence of three nodes (triads) connected and statistics shows the number of cliques (triads) attended in a graph.
7. *Sum degree* is the total number of ties. In this case we consider the valued matrix; i.e. we also considered valued ties (two or more than two co-occurrence).
8. *Mean degree* is the *sum degree* divided by *vertex.*
9. *Degree std dev* is the standard deviation of distribution of the variable *degree.*
10. *Degree min* is the minimum value of degree referred to a vertex x (that is the minimum number of co-occurrence that involved vertex x).
11. *Degree max* is the maximum value of degree referred to a vertex x (that is the maximum number of co-occurrence that involved vertex x).
12. *Centralization* describes vertex structural distribution around a centre; for a given network with vertices $v_1,\ldots,v_n$ and maximum betweeness centrality $c_{\max}$, the network betweeness centralization measure is $\Sigma[c_{\max} - c(v_i)]$ divided by the maximum possible value, where $c(v_i)$ is the betweeness centrality of vertex v_i.
13. *Betweeness (max)*; let b_{jk} be the proportion of all geodesics linking vertex j and vertex k which pass through vertex i. The betweeness of vertex i is the sum of all b_{jk} where i, j and k are distinct. *Betweeness* is therefore a measure of the number of times a vertex occurs on a geodesic path. In this case, betweeness (max) is the vertex maximum value of betweeness.

In order to investigate the possible violation of the competitive market assumption, we focus on the adjacency matrix (social network) of companies. We focus on the whole sector to capture also the indirect links discussed above. We give a visual description of this network by using the standard

[12] A component is composed by vertex connected directly (adjacent) or indirectly by other vertices.

representation by ties and vertices. Then we focus on the single companies composing the network considering the variables indicated by the following box.

Box 2 – Social network variables

1.	*Degree* indicates the number of nodes adjacent to a given node.
2.	*Size* of ego-network describes the number of actors (alters) that ego is directly connected to.
3.	*Ties* of ego-network describes the total number of ties in the ego-network without counting ties involving ego.
4.	*Pairs* is the total number of pairs of alters in the ego-network, i.e. potential ties.
5.	*Broker* measures brokerage in ego-network, brokerage occurs when, in a triad of nodes A, B and C, A has a tie to B, and B has a tie to C, but A has no tie to C, in other words, A needs B (ego) to reach C.
6.	*Egobet(weeness)*: let b_{jk} be the proportion of all geodesics linking vertex j and vertex k which pass through vertex i (Ego). The betweeness of vertex i is the sum of all b_{jk} where i, j and k are distinct. Betweeness is therefore a measure of the number of times a vertex occurs on a geodesic path. In this specific case Betweeness is calculated on Egonetwork.
7.	*Cliques* measures the presence in cliques of each vertex; a clique is a maximally complete sub-graph (in this case density is 1). The statistic counts the number of actors in clique composed by three nodes.
8-15.	*Distance j* indicates the proportion of nodes reached for distance *j (from 1 to 8)*; we consider distances up to 8. That is, *distance 3* indicates the proportion of nodes reached for distance 3*; distance 7* indicates the proportion of nodes reached for distance 7.
16.	*Betweeness*: in this case betweeness is calculated on the whole network and referred to each vertex x.
17.	*Betweeness strong ties*: we dichotomize adjacency matrix of company network. In this case, value greater than 2 become 1; values less 2 become 0. In fact, betweeness is always calculated for binary data. In this case, we consider just strong ties (higher than 2).

The variables above are useful to investigate two main conceptual dimensions of the inter-organizational ties among companies: a) *centrality in proximity* and b) *network centrality*. The former is defined by centrality indices computed on short paths, stressing the relevance of *close* connections. The latter is defined by centrality indices computed on long distance paths, which emphasize the role played by *very* indirect connections.

The variables related to centrality in proximity are degree, size, ties, pairs, broker, ego betweeness, cliques, and distance 1-3. Network centrality derived from the whole network is measured by the following statistics: distance 4-8, betweeness and betweeness (strong ties). Distance 2-4 can be referred to both centrality dimensions.

3.2.3 Synthetic indices derivation and market share analysis

We use variables described in box 2 to derive synthetic indices of network properties by the principal component analysis. The underlying idea of the principle component analysis is to reduce the dimensionality of a dataset that may contain correlated variables by retaining its variability as much as possible. Formally, principal component analysis searches for a few uncorrelated linear combinations (principal components) of the original variables that capture most of the information in the original variables.

For instance, considering an extreme example, suppose to study the height of a group of people in inches and centimeters, so to have two variables that measure height. If in future studies, we want to research, for example, the effect of different nutritional food supplements on height, considering both measures should be useful since height is one characteristic of a person, regardless of how it is measured. Hence variables can be redundant with respect to the available information and, in some circumstances, a large number of indicator utility.

In the bi-dimensional case, one can summarize the correlation between two variables by a scatter plot and a regression line. The regression line represents the *best* summary of the linear relationship between the variables. If we could define a variable that would approximating the regression line, that variable would capture most of the *essence* of the two original variables, i.e. the dataset. The subjects' single scores on that new factor, represented by the regression line, could then be used in future data analyses to represent that essence of the two items. In a sense we have rebuilt the two variables to one *factor* or *component* – the factor is in fact a vector made up of two numbers that can be conceived as weights on the former variables. Note that the new factor is actually a linear combination of the two variables and its significance increases in the two-variable correlation.

The example described above, which combines two correlated variables into one factor, illustrates the basic idea of principal components analysis. If we extend the two-variable example to multiple variables, then the computations become more involved, but the basic principle of expressing two or more variables by a single factor remains the same. By considering more than two variables, we can think of them as defining a space, just as two variables defined a plane. Thus, when we have three variables, we could plot a three-dimensional scatter plot, and, again we could fit a plane through the data (a plane will individuate by *two* orthogonal lines). In the principal components analysis, after the first factor has been extracted, that is, after the first line has been drawn from the data, we continue and define another line that best fits the remaining variability, and so on. In this manner, consecutive factors are extracted.

The principal component analysis can be performed by considering centered and non- centered data. In the latter original data are used. In the former entries of matrix data are transformed in deviations from the mean of the variables. The difference between the two procedures is however not trivial and we need to discuss it as it is relevant for our investigation. Non-centered principal components analysis implies an all-zero point (vector) of reference: no interlock linkages. By contrast, centering on, or normalizing by, some variables shifts the reference points to a hypothetical average stand.[13] We consider non-centered analysis since our benchmark is the zero vector, which economically represents the competitive market requirements in terms of information structure, i.e. the case of no interlocking directorates.[14]

[13] See Di Bartolomeo and Marchetti (2003) for a discussion and comparison of the two procedures in the case of information disclosure by a central bank. See also Noy-Meir (1973) for a general discussion.

[14] See also Noy-Meir (1973) for a more technical discussion about between and within heterogeneity.

4. Empirical results

By considering adjacency matrices of companies (companies linked to companies) and directors' boards (directors linked to directors) in insurance sector, non-life business and life business, we can individuate six social networks. Table 1 provides statistics reported in box 1 for all the networks, which are numbered from one to six.

		Vertex	Density	Components	Main component	Fragmentation	Cliques	Sum degree	Mean degree	Degree Std Dev	Degree min	Degree max	Centralization	Betweeness (max)
1	network (companies)	187	0,028	51	109	0,27	63	1800	9,61	7,92	0	29	19,06	3362
2	network (directors)	246	0,034	18	155	0,07	99	3478	14,14	8,13	2	47	15,74	4841
3	life (companies)	99	0,031	35	25	0,35	26	544	5,49	5,06	0	16	2,79	144
4	life (directors)	223	0,033	22	55	0,10	63	2016	9,04	6,01	1	31	2,83	722
5	non-life (companies)	102	0,033	39	56	0,38	27	600	5,88	6,00	0	21	15,97	839
6	non-life (directors)	217	0,036	18	127	0,08	67	2114	9,74	6,73	1	31	12,30	2946

Table 1 – Network statistics

Structural features of company network do not are significantly different when we consider the aggregate sector (network 1), the life business (network 3) or the non-life business (network 5); networks 2, 4 and 6 do not also differ much in their features.

The adjacency matrix of insurance companies (life and non-life sector) is made up of 187 vertices. There are no 187 isolated, competitive enterprises but 51 components – the main component has 109 vertices. We found 63 cliques. Every enterprise is connected with others by 9.626 degrees (in this case degree is represented by a director who sits on the board of two or more companies); the total sum of degrees is equal to 1800. In a full competitive system there should no interlocking directorates; thus sum degree, degree and cliques would be equal to zero.

According to our relational perspective an index of competitiveness is fragmentation, i.e. the proportion of number of components on total number of vertices. Of course, in a competitive environment the number of components is equal to the number of nodes since all the companies are isolated and fragmentation is equal to 1, which is the maximum value for the index (the minimum value depends on the number of nodes, which in our case is 0.0053), whereas fragmentation is 0.2727.

By disaggregating, in the company network of life business density is 0.031. There are 26 cliques composed by three nodes. There are 35 components; the main component is composed by 25 vertices. Fragmentation is equal to 0.35. In non-life sector there are 102 vertices and 39 components. The main component is composed by 56 nodes.

The director network is made up of 246 nodes, representing members present in more than one board of directors. The director network system is characterized by *strong connection* for interlocking, structured around a main component that collects about half of nodes of the reticulum. There are 99 triads of cliques. The average degree connection for a node is 14.138.

The competitiveness gap associated with the company network is 73%. The gap is the percent distance between the competitive case and the actual value of fragmentation.[15] By disaggregating the sector the gap in the life business is 66% and in the non-life business 62%. This means that indirect links across companies of the non-life sector by companies in the life business are relevant. The director networks are also associated with competitiveness gaps, computed in a similar manner. The gaps in the director networks have a similar pattern.[16]

In our investigation we focus on the company network (network number 1 in table 1) since we are interested in the direct and indirect relations among companies. Although we focus on the non-life sector, as already said and supported with sector fragmentation, we consider that two companies operating in the non-life sector can be also connected by an indirect link through a common director in a life sector company. An illustration of company network is provided by figure 2.[17]

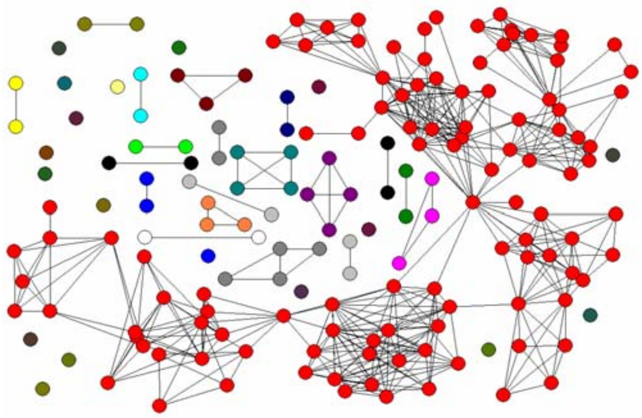


Figure 2 – The social network of insurance companies

The figure gives an immediate image of statistics reported in table 1. It shows the high degree of *social concentration* in the sector. In a competitive market one should expect a picture composed by

[15] Formally it is equal to the maximum value of fragmentation (one) minus fragmentation divided by maximum value of fragmentation (one) minus the minimum value of fragmentation (one divided the number of nodes).
[16] The gap in the sector is 93%, in the life business 90%, in the non-life business 92%.
[17] The graphical representation of the directors' network can be found in the appendix.

only isolated point. Figure 2 clearly describes a strongly interconnected picture with some interconnected clusters of companies and only marginal situations of quasi-isolated companies.

In order to have some measures of concentration in the company network (figure 1), we aggregate the network variables (our dataset) described in box 2 by principal component analysis. We thus build some uncorrelated synthetic indices by reducing the dataset dimension with a minimum loss in terms of variance. We detect three components that explain 91.45% of total variance. The components respectively explain 72.15% (72.15), 12.15% (84.31%), 7.15% (91.46%) of variance; numbers between brackets indicate cumulative percentages.

The variable loadings are reported in table 2 below,[18] the principal component analysis individuates three indices of centrality that can be interpreted as follow.

Since in the first index all variables enters with a positive weight and almost in a uniform manner and the variance of weights is low (i.e. 0.002, whereas the variance of other components weights is about 0.062), the first component can be considered as an index of the (potential) collusiveness by tacit agreements, since all the variables are measures of distortions in the ideal view of agents independence (as said, perfect competition requires that all of them are equal to zero). The first ten companies in the collusiveness index[19] are *Europ Assistance*, *Assicurazioni Generali*, *Sistema*, *Assitalia*, *SARA*, *Dialogo Assicurazioni*, *Nuova Tirrena*, *Compagnia di Assicurazione di Milano*, *Genertel*, and *Risparmio Assicurazioni*. These companies are 9% of the firms operating in the sector but have a total market share equal to 30%.

In the second index, variable weights are more volatile. The company's score is high if broker, ego-bet and betweeness are high; by contrast it is low for high value of distances 6-8. Hence, a company will have a high score if it is in the center of ego-network, without long connections where alters are not connected one with the other directly. The index measures the crucial centrality of the company in a concentrated ego-network since alters can be connected only by the ego. The second index individuates two groups of insurances. Il *Duomo, Assitalia*, *Le Assicurazioni d'Italia*, *Dialogo Assicurazioni*, *Compagnia di Assicurazione di Milano*, *Allianz Subalpina* are the center of their respective ego. By contrast, *Compagnia Assicuratrice LINEAR*, *Aurora Assicurazioni*, *Cattolica Aziende*, *DAS*, *Augusta Assicurazioni*, *Alleanza Assicurazioni*, *Bernese Assicurazioni* By contrast, *Antoniana Veneta Popolare Assicurazioni*, *Gruppo AXA*, *Carlink Assicurazioni*, *Friuli_Venezia Giulia Assicurazioni La Carnica* are not in the center of their ego-network

[18] The loadings (i.e. weights of the indexes) are computer on the basis of the similarity matrix reported in the appendix. The scores (of companies) are also reported in the appendix.
[19] The scores of all companies in the three indexes are reported in the appendix.

		Axis 1	Axis 2	Axis 3
1	Degree	0.245	-0.015	0.152
2	Size	0.279	0.042	0.081
3	Ties	0.255	0.025	0.310
4	Pairs	0.260	0.230	0.148
5	Broker	0.222	0.415	-0.053
6	Egobet	0.169	0.472	-0.323
7	Cliques	0.232	0.104	0.236
8	Distance 1	0.279	0.041	0.080
9	Distance 2	0.273	-0.016	-0.015
10	Distance 3	0.275	-0.060	-0.023
11	Distance 4	0.269	-0.172	-0.086
12	Distance 5	0.261	-0.244	-0.145
13	Distance 6	0.250	-0.290	-0.194
14	Distance 7	0.245	-0.307	-0.203
15	Distance 8	0.242	-0.312	-0.204
16	Betweeness	0.162	0.409	-0.383
17	Betweeness (strong ties)	0.149	0.043	0.622

Table 2 – PCA variable loadings

The third index measures the degree of concentration in an ego-network. Differently from the previous case, here a company will have a high score if its ego-network is concentrated (low values for the variables distances 7-8) and formed by companies much interconnected both directly and indirectly and in a strong manner, i.e. each ties is associated with more than one director. The third index also individuates two groups of insurances. *Genertel*, *FATA*, *SARA Assicurazioni*, *Dialogo Assicurazioni*, *Assitalia, Le Assicurazioni d'Italia*, and *Assicurazioni Generali* are concentrated and interconnected with other companies. By contrast are rather isolated in their ego-network *Compagnia di Assicurazione di Milano*, *Compagnia Assicuratrice UNIPOL*, *Allianz Subalpina*, *Europ Assistance Montepaschi Assicurazioni Danni*, and *Antoniana Veneta Popolare Assicurazion*i. For companies scoring a high first component, as e.g. *SARA Assicurazioni*, *Europ Assistance*; *Assicurazioni Generali*; *Compagnia di Assicurazione di Milano*; *Genertel,* the third index may represent a different management strategy in the control of the ego-network, i.e. clustered, or centralized, control (high scores) instead of a vertical, or hierarchical, control (low scores).

Summarizing the first index measures how much a company does not satisfy the competitive paradigm assumption of (atomistic) isolation in terms of boards of directors; the second index measures how much a company is central in its ego-network; the last index measures how much a company is an interconnected and concentrated component.

The relations among components are represented in figure 3. Representations of second and third components on the first are similar, while the scatter plot between the second and the third is much dispersed.

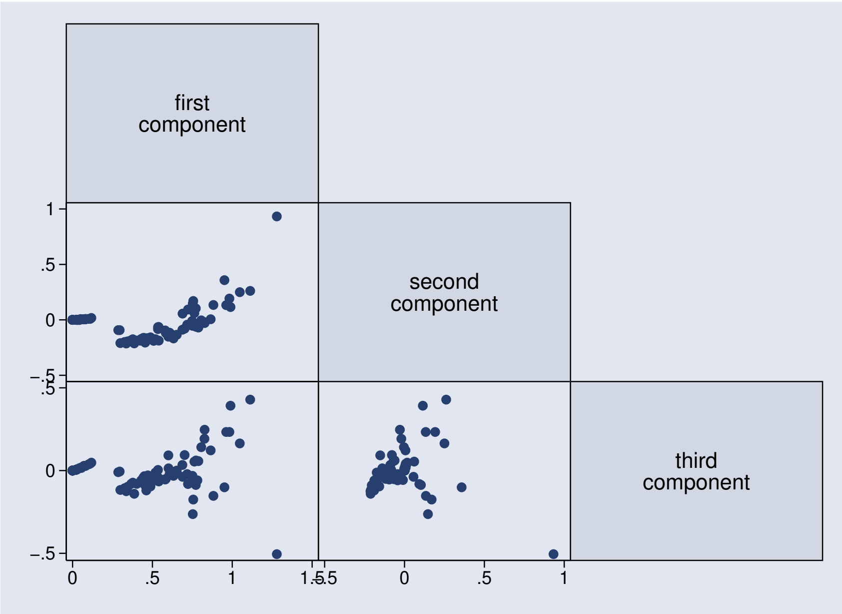


Figure 3 – Components scatter plots

It is finally worth noticing that there are only 20 companies fully satisfying the information requisite in terms of boards of directors associated with the competitive paradigm (i.e. a zero score in all the indices). These companies are *ARAG*, *Assicuratrice Edile*, *Assicuratrice Milanese*, *Assicurazioni Rischi Agricoli*, *Bipiemme Vita*, *Direct Line Insurance*, *Euler Hermes Siac*, *Faro*, *Filo Diretto Assicurazioni*, *Global assistance*, *IMA - Italia Assistance*, *Net Insurance*, *Padana Assicurazioni*, *Progress Assicurazioni*, *Sace BT*, *SEAR*, *SLP*, *UCA*, *Unionvita*, and *Viscontea Coface*. Although they represent the 18% of companies, their aggregate market share is negligible, about 0.02%.

We have discussed the concentration of directors in the boards. This is an important signal of a violation of the assumption of the absence of agreement among companies, but interlocking directorates are not of concern *per se*, as their mere existence cannot be taken neither as a proof of an active relation nor as an abuse of market power. Interlocks are indicators of *potential* thrust among companies and the existence of such relationships thus cannot be one-for-one interpreted as the fact that directors exploit networks of board memberships merely because such potential exists. In this section we further investigate the point.

A first draft measure of a possible relationship between the existence of linkages and perfect competition violation is correlation; correlations between the three indices and the market share are positive (0.407, 0.1988, and 0.167, respectively). Figure 4 shows the relationship between companies' concentration, i.e. the first component, (horizontal axis) and the market share (vertical axis). More in detail, companies are ranked by the first component score along the horizontal axis and associated to their market shares reported vertical axis.

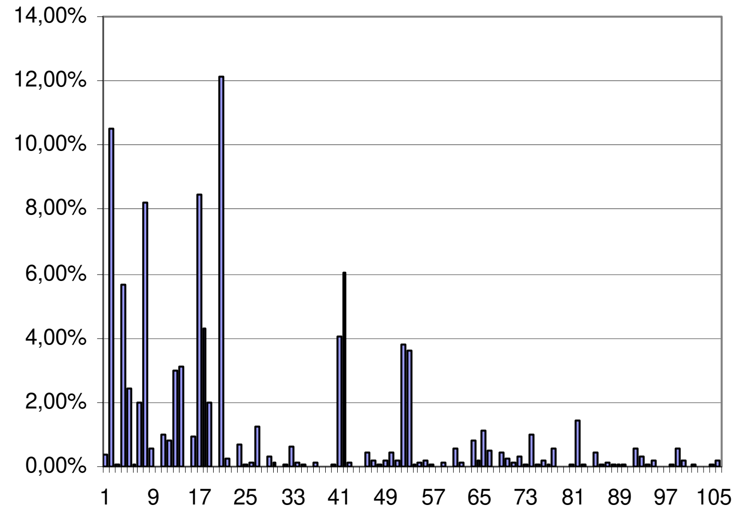


Figure 4 concentration and market shares

From the figure there is clear the suspect that concentration matters for market share.

The suspect of a link between interlocking and market concentration is further investigated in table 3 that summarizes the results of an ordinary least square regression of the market share on the components.[20]

	coefficient	*std. err.*	*t-value*	*P > |t|*	[95% *confidence interval*]	
1 comp	2.3257	0.5800	4.01	0.000	1.1752	3.4762
2 comp	1.5615	1.3453	1.16	0.248	-1.1068	4.2299
3 comp	2.7864	1.7604	1.58	0.117	-0.7053	6.2781
constant	0.1198	0.3047	0.39	0.695	-0.4846	0.7241
Number of observations = 106						
F(3, 102) = 8.25		prob. > F = 0.0001		$R^2 = 0.1952$	adj. $R^2 = 0.176$	

Table 3 – OLS market share regression on principal components

All component coefficients are positive, as expected, but only the concentration index (first component) is significant. Variable deletions do not affect our main results. Interlocking concentration is strictly related to market concentration as figure 4 visually depicts.

[20] Notice that components are uncorrelated by construction. No autocorrelation is computed since it is a cross-section analysis.

Interlocking directors seem to be used by insurance companies to support a large cartel that dominates the market. Cartels stability is assured by the trust generated by the interlocking directorates, placing a director on a cartel partner's board, each cartel member has an observer in place who can monitor activities such as plans to reduce price, expand capacity, or introduce new products that could undermine the cartel agreement (notice that price policy is not the only policy that a cartel may aim to set in a cooperative manner, see Motta *et al*., 2005). Interlocking directorates can help minimize trust problems by putting insiders in places where they can both monitor and affect what other companies are doing.

5. Concluding remarks

The Italian insurance industry is characterized by a low degree of competition. This paper provides some evidence to the idea that the absence of competition is due to a violation of a basic assumption of competitive markets, namely the absence of tacit agreements. The paper also suggests that insurance companies collude in an institutionalized manner: collusive agreements are not the result of collusive (formal or informal) activities among agents but they are the result of a system of interlocking directorates where the same person sits at two tables playing against her-herself/him-himself.

More in details, by combining the graph theory with the principal component analysis, we find evidence of a channel of trust formation by interlocking directorates. Our results contrast part of empirical evidence stressing that indirect interlocks are only diffused between financial and non-financial companies and, thus, underling that they are not relevant for competition policies. In the Italian insurance industry, in fact, the interlocking directors seem to be a forceful thrust-formation instrument used by the insurance cartel to maintain its stability.[21]

By considering the social network of insurances we have derived some indices of concentration related to interlocking-directors and comparing them with the company market shares we have found correlations and strong suspects of causality. Companies that have director boards satisfying the atomistic assumption of competitive paradigm are 18%, but their aggregate market share is only about 0.02%. By contrast, 30% of the market is shared by a strongly interconnected small group of firms, which represents only the 9% of the number of companies preset in the industry.

The policy implications of our analysis are simple. As pointed out by Adam Smith, centuries ago, "People of the same trade seldom meet together, even for merriment and diversion, but the

[21] Cartels are inherently unstable and problems of cartel stability are related to trust; for a cartel to be formed, each participant must trust its cartel partners not to do two things: cheat on the agreement, e.g. by charging less than the fixed price or other firm's policy.

conversation ends in a conspiracy against the public, or in some contrivance to raise prices. It is impossible indeed to prevent such meetings, by any law which either could be executed, or would be consistent with liberty and justice. But though the law cannot hinder people of the same trade from sometimes assembling together, it ought to do nothing to facilitate such assemblies; much less to render them necessary."[22] Therefore, since direct interlock is a way to link together "people of the same trade" and there is the evidence that this "assembling together" affects the market shares and sector competitiveness, direct interlocking directorates have to be forbid, as in the United States. Moreover, since we also find that indirect interlocking linkages by companies operating in the life-business sector seem to be relevant to reduce the market degree of competitiveness, indirect interlocking linkages have also to be regulated; in particular, interlocking directorates that indirectly link competitors must be sanctioned.

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[22] Smith (1776: I.10.82).

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Appendix

Table A1 – Similarity matrix.

degree	1,000																
size	0,884	1,000															
ties	0,799	0,934	1,000														
pairs	0,775	0,938	0,926	1,000													
broker	0,617	0,785	0,690	0,912	1,000												
ebet	0,418	0,594	0,446	0,725	0,906	1,000											
cliques	0,765	0,823	0,775	0,824	0,739	0,428	1,000										
d1	0,883	1,000	0,934	0,937	0,784	0,593	0,823	1,000									
d2	0,807	0,907	0,826	0,830	0,696	0,526	0,722	0,907	1,000								
d3	0,795	0,908	0,829	0,824	0,680	0,502	0,747	0,908	0,972	1,000							
d4	0,766	0,880	0,798	0,753	0,578	0,419	0,687	0,881	0,935	0,976	1,000						
d5	0,733	0,846	0,746	0,692	0,517	0,365	0,651	0,847	0,880	0,925	0,978	1,000					
d6	0,700	0,806	0,687	0,628	0,459	0,326	0,597	0,807	0,833	0,873	0,941	0,986	1,000				
d7	0,691	0,787	0,665	0,601	0,431	0,304	0,573	0,788	0,814	0,846	0,920	0,971	0,995	1,000			
d8	0,692	0,781	0,659	0,592	0,420	0,298	0,561	0,782	0,805	0,837	0,913	0,964	0,990	0,998	1,000		
bet	0,396	0,514	0,329	0,583	0,762	0,824	0,420	0,514	0,608	0,553	0,455	0,380	0,332	0,311	0,301	1,000	
bets	0,459	0,511	0,629	0,559	0,389	0,131	0,490	0,511	0,545	0,525	0,442	0,365	0,307	0,293	0,287	0,158	1,000
	degree	Size	ties	pairs	broker	ebet	cliques	d1	d2	d3	d4	d5	d6	d7	d8	bet	bets

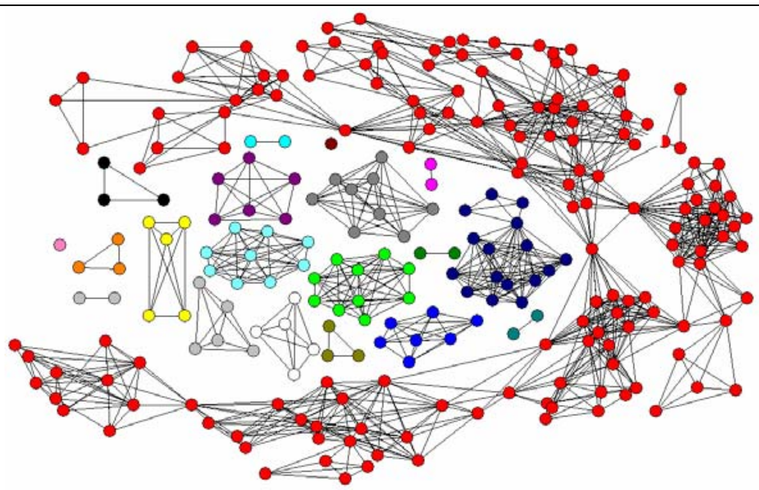

Figure 1A – The network of insurance directors (life and non-life sectors)

Table 2A – Scores of companies

	Axis 1	Axis 2	Axis 3
ALA Assicurazioni	0.508	-0.189	-0.060
Alleanza Assicurazioni	0.519	-0.174	-0.012
Allianz Subalpina	0.753	0.147	-0.263
Antoniana Veneta Popolare Assicurazioni	0.367	-0.183	-0.080
ARAG	0.000	0.000	0.000
ARCA Assicurazioni	0.031	-0.001	0.009
Assicuratrice Edile	0.000	0.000	0.000
Assicuratrice Milanese	0.000	0.000	0.000
Assicuratrice Val Piave	0.056	0.005	0.016
Assicurazioni Generali	1.112	0.261	0.429
Assicurazioni Rischi Agricoli	0.000	0.000	0.000
Assimoco	0.025	0.000	0.006
Assitalia - Le Assicurazioni d'Italia	0.989	0.115	0.392
Augusta Assicurazioni	0.452	-0.173	-0.048
Augusta Vita	0.455	-0.173	-0.047
Aurora Assicurazioni	0.471	-0.165	-0.029
AXA Assicurazioni	0.424	-0.188	-0.069
AXA Carlink Assicurazioni	0.402	-0.186	-0.080
Azuritalia Assicurazioni	0.044	-0.001	0.015
Bernese Assicurazioni	0.377	-0.175	-0.073
Bipiemme Vita	0.000	0.000	0.000
Cardif Assicurazioni	0.022	0.000	0.005
Carige RD Assicurazioni e Riassicurazioni	0.022	0.000	0.005
Cattolica Aziende	0.632	-0.168	-0.032
CBA Vita	0.345	-0.194	-0.098
Centrovita Assicurazioni	0.022	0.000	0.005
Commercial Union Assicurazioni	0.295	-0.093	-0.006
Commercial Union Italia	0.286	-0.093	-0.010
Compagnia Assicuratrice LINEAR	0.443	-0.163	-0.043
Compagnia Assicuratrice UNIPOL	0.756	0.170	-0.175
Compagnia di Assicurazione di Milano	0.882	0.134	-0.153
Creditras Assicurazioni	0.535	-0.065	-0.052
Credritas Vita	0.539	-0.064	-0.045
DAS	0.447	-0.172	-0.046
Dialogo Assicurazioni	0.962	0.133	0.233
Direct Line Insurance	0.000	0.000	0.000
Egida	0.689	0.056	-0.038
Ergo Assicurazioni	0.069	0.006	0.026
Euler Hermes Siac	0.000	0.000	0.000
Europ Assistance Italia	1.279	0.933	-0.505
EuropaTutela Giudiziaria	0.751	-0.054	-0.032
Faro	0.000	0.000	0.000
FATA	0.826	-0.020	0.192
Fideuram Assicurazioni	0.022	0.000	0.005
Filo Diretto Assicurazioni	0.000	0.000	0.000
Fineco Assicurazioni	0.025	0.000	0.006
Fineco Vita	0.025	0.000	0.006
Fondiaria – SAI	0.749	-0.010	-0.057
Friuli_Venezia Giulia Assicurazioni 'La Carnica'	0.462	-0.190	-0.120
GAN Italia	0.110	0.008	0.042
Genertel	0.865	0.006	0.122
Genialloyd	0.584	-0.118	-0.050
Global Assistance	0.000	0.000	0.000
HDI Assicurazioni	0.326	-0.199	-0.106
Il Duomo	0.772	0.103	-0.087

Table 2A – Scores of companies (continued)

IMA - Italia Assistance	0.000	0.000	0.000
Italiana Assicurazioni	0.653	-0.134	0.000
ITAS - Trentino Alto Adige per Assicurazioni	0.081	0.004	0.028
ITAS Assicurazioni	0.118	0.017	0.048
La Difesa	0.336	-0.213	-0.125
La piemontese Assicurazioni	0.623	-0.134	-0.007
L'Assicuratrice Italiana Danni	0.535	-0.083	0.004
Le Assicurazioni di Roma	0.386	-0.212	-0.140
Liguria	0.022	0.000	0.005
LLOYD Adriatico	0.488	-0.158	-0.096
Mediolanum Assicurazioni	0.031	-0.001	0.009
Mondial Assistance	0.723	0.093	-0.081
Montepaschi Assicurazioni Danni	0.340	-0.199	-0.103
Mutuelle du Mans Italia Assicurazioni e Riassicurazioni	0.072	0.006	0.028
Mutuelles du Mans Italia	0.072	0.006	0.028
National Suisse	0.022	0.000	0.005
Navale Assicurazioni	0.443	-0.163	-0.043
Net Insurance	0.000	0.000	0.000
Nuova Tirrena	0.951	0.358	-0.101
Padana Assicurazioni	0.000	0.000	0.000
Progress Assicurazioni	0.000	0.000	0.000
Pronto Assistance	0.540	-0.187	-0.066
RAS Tutela Giudiziaria	0.580	-0.096	-0.054
RB Vita	0.454	-0.205	-0.089
Rem Assicurazini	0.600	-0.152	0.092
Risparmio Assicurazioni	0.827	-0.029	0.247
Risparmio e Previdenza	0.773	-0.062	0.061
Riunione Adriatica di Sicurtà	0.763	0.061	0.054
Sace BT	0.000	0.000	0.000
SARA Assicurazioni	0.982	0.192	0.233
SARA Vita	0.718	-0.043	-0.021
SASA	0.806	-0.004	0.141
SEAR	0.000	0.000	0.000
SIAT - Società Italiana Assicurazioni e Riassicurazioni	0.608	-0.116	-0.021
SLP	0.000	0.000	0.000
Società Cattolica di Assicurazione	0.788	-0.069	0.057
Società Reale Mutua di Assicurazioni	0.782	-0.043	-0.059
Swiss LIFE - Infortuni e Malattie	0.082	0.009	0.029
Systema Compagnia di Assicurazioni	1.047	0.250	0.164
Toro Assicurazioni	0.430	-0.172	-0.059
Toro Targa Assicurazioini	0.446	-0.173	-0.051
Tua Assicurazioni	0.601	-0.139	0.014
UCA	0.000	0.000	0.000
UMS Generali Marine	0.688	-0.089	0.034
UNI ONE Assicurazioni	0.702	-0.079	0.094
Unionvita	0.000	0.000	0.000
Uniqa Assicurazioni	0.299	-0.210	-0.117
Unisalute	0.450	-0.163	-0.034
Viscontea Coface	0.000	0.000	0.000
Vittoria Assicurazioni	0.050	0.007	0.017
Zurich International Italia	0.101	0.008	0.038