From SMEs networks towards collaborative management

Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 13 (2017) 1297–1304

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

Manufacturing Engineering Society International Conference 2017, MESIC 2017, 28-30 June 2017, Vigo (Pontevedra), Spain

From SMEs networks towards collaborative management

A. Villa*, T. Taurino

Politecnico di Torino, Corso Duca degli Abruzzi 24, Torino, 10129, Italy

Abstract

The main problem of small companies in a global market is to be recognized by potential customers and provide them the products at a competitive price. Their small size, in terms of design and production capacity, puts them in crisis (about 30% of small Italian enterprises have disappeared or have been greatly reduced, since 2007). Hence micro and small enterprises are forced to come together in a "enterprises network", to conclude a "network contract" and to evaluate the advantages to be collaborative members of a network. This paper discusses the problem of analyzing the types of Small Mid Enterprises (SMEs) networks that have been be established in some European countries, the evolution in time of their organization, and the contractual arrangements to establish them. A discussion of some performance indicators will show how a collaborative management can improve the SME networks strength, thus giving them a competitive advantage.

Peer-review under responsibility of the scientific committee of the Manufacturing Engineering Society International Conference 2017.

Keywords: small-mid enterprises, network contract, cooperative management

1. Introduction

The European industrial system is composed of about 90% of Small and Medium-sized Enterprises (SME). The increasing globalization of markets gives rise to major crises in these SMEs, due to the strong competition from the Far East companies.

Politecnico di Torino years ago started the European project CODESNET – Collaborative Demand and Supply NETworks, [1] on methods and tools to organize networks of enterprises and to formalize the necessary network

* Corresponding author. Tel.: +39-011-090-7233; fax: +39-011-090-7299.
E-mail address: agostino.villa@polito.it

2351-9789
Peer-review under responsibility of the scientific committee of the Manufacturing Engineering Society International Conference 2017.
10.1016/j.promfg.2017.09.060

agreements. The basic principle is that a group of SME has to sign a specific agreement for joint activities devoted to a common objective as, for example, technological or organizational innovation within a defined time horizon.

The real problem lies in the availability of network members to be cooperative, that means to act for the mutual benefit of the enterprises that compose the network itself [2].

This paper discusses how SME networks can be created, and how their main characteristics can either facilitate or hinder the cooperative relationships between the firms of the network itself. To this aim, first the paper will overview some data characterizing SMEs in a changing Europe, so as to show the necessity SMEs have to aggregate in order to be able to compete in a globalized market (Section2). Then, a vision of how SME clusters and networks have evolved in some European countries over the last two decades will be illustrated (Section 3). Based on data on SME clusters and networks since the CODESNET project development up to now, modeling tools for their performance evaluation will be discussed (Section 4), together with the usefulness of "network contracts" to improve the SMEs collaboration.

2. Small and Medium-sized Enterprises in a changing Europe

Some preliminary data can clarify the type of enterprises which aggregation opportunities will be here analyzed.

According to the European Commission Recommendation 2003/361/EC [3], the SME categories have to be classified as in the following table:

Table 1. EU official classification of SMEs categories [3].

SME category	Employees	Turnover	Balance sheet
Micro	< 10	< 2 million €	< 2 million €
Small	< 50	< 10 million €	< 10 million €
Medium	< 250	< 50 million €	< 43 million €

Accounting for the value added and employment in the non-financial business sector in the EU28, depending on the enterprise size, percentage values during 2015 shows the following composition of the industrial enterprise sector (Table 2).

Table 2. EU data on the composition of the industrial enterprise sector [3].

SME type	Micro	Small	Mid	Large
Micro	92,80 %	6 %	1 %	0,2 %
Small	21 %	18 %	18 %	43 %
Medium	30 %	20 %	17 %	33 %

This two tables gives a clear impression of the importance of SMEs in the European industrial system.

Indeed, according to the Annual Report on European SMEs 2015 / 2016 [4], SMEs form the backbone of the EU28 economy. During 2015, about 23 million SMEs generated €3.9 trillion in value added and employed 90 million people. They accounted in 2015 for two thirds of EU28 employment and slightly less than three fifths of EU28 value added in the non-financial business sector. The vast majority of SMEs are micro enterprises with less than 10 employees – such very small firms account almost 93% of all enterprises in the non–financial business sector.

Following a number of years of poor economic performance, EU28 SMEs experienced in 2015 good growth in value added for the second year (3.8% in 2014 and 5.7% in 2015). For the first time since the recession, SME employment grew in 2014 (1.1%). In 2015, SME employment increased by 1.5%.

As a result of robust growth over the past two years, the level of value added generated by EU28 SMEs in 2015 in the non-financial business sector was almost 9% higher than in 2008. In sharp contrast, EU28 SME employment was still about 2% below its 2008 level.

Employment performance of EU28 SMEs in 2014 and 2015 reveals a great diversity across sectors:

- a few small sectors (such as advertising and market research, legal and accounting services, office administration and support and other business services, services to buildings and landscaping, and employment activities) show growth of more than 5% in employment.
- in contrast, a number of larger sectors such as, for example, retail trade, wholesale trade and construction, which together account for 30% of total EU28 SME employment, recorded employment growth of about 2.0% or less in 2015.

The population of SMEs, particular micro SMEs, changes constantly, with many new businesses being born every year and many ceasing to operate. In particular young and small firms show high mortality rates.

Due to the growing and growing globalization of markets of goods and the large disequilibrium between the labor markets of the European Countries, on one hand, and of the "Far East Countries", among which China, India and the "Asian Tigers", on the other, a large part of European SMEs can no more be competitive in terms of labor's cost and goods' prices.

We have to understand the effects of the two phenomena that are changing the European industrial systems, because, on one hand, new big trade flows from Far East to Europe affect the prices of goods markets; on the other hand, productions of high-quality and refined style, offered by small industrial companies, linked to each other in networks, survive and successfully oppose commercial attacks and financial crises in the world.

To survive, SMEs must aggregate together.

Recently we have seen the rise and decline of a number of "old" industrial districts, those born around large enterprises for which the conditions for an expanding demand growth fallen, because of the recent financial crisis. On the other side, it is occurring a recent growth of "balanced SMEs networks", based on collaboration agreements that, in some cases, come to the mutual support of SMEs in the networks in temporary difficulty.

The evolution of these collaborative networks in the near future has to be studied, by identifying some development lines e.g. by analyzing a large number of "network contracts".

3. A brief European vision of SME clusters and networks

Every European nation shows its own way in which small businesses seek to create aggregations: everywhere, this depends on the history of the local industrial systems.

The **U.K. cluster experience** in enterprise aggregation has a long tradition. Already during 1890, Alfred Marshall presented a first description of geographical concentrations of specialized industrial companies [5]. According to Marshall's idea, if a enterprises' concentration is created, it autonomously reinforces itself by attracting other companies in a cluster gradually transformed into a supply chain.

During last decades, aggregations of enterprises in U.K. have taken on different characteristics, depending on the region (see the European Cluster Observatory and to the Europe INNOVA Cluster Mapping Project, European Cluster Observatory, [6], either (a) concentrations of interdependent companies and institutions, connected by commercial links; or (b) geographic agglomerations of firms, or groups of industries and organizations, linked by a common goal or practice; or (c) groupings of industries linked through vertical (buyer/supplier) or horizontal (common customers, technology, channels) relationships.

The **French industrial system** is characterized by the tradition of supporting the emergence of cluster or networks through government funded projects, thus creating "pôles de compétitivité" as documented in the PME 2015 – Rapport Annuel sur l'Evolution des PME, DGE – Direction Générale des Enterprises of the Ministère de L'Economie e des Finance, [7]. Each pole of competitiveness is managed by a proper juridical entity including industrial, scientific and academia personalities. Usually, a pole includes in the average about 200 members, but ranging from 100 to more than 1000.

Clusters in **Germany** means "Competence Networks", that are groups of enterprises created by regional government initiatives Initiative Competence Networks Germany [8], in the form of "top-down externally-started

networks", with managers nominated by the public promoter and with an evolution strongly dependent on public funding. (70% of total). Alternatively, there exist "bottom-up networks", whose coordinator is usually selected by members, and which can operate with low political influence.

As detailed in [9], the strategy of creating clusters in **Greece** is particularly inspired by the idea of the science and technology park (STEPA), for transferring the scientific and technological knowledge from the research institutes and universities to enterprises. The approach is indirect: to use research centers and universities as innovation engines and to organize centers - STEPAs - where enterprises, especially start-ups, can find a stimulating environment to grow.

A particular evolution of SMEs can be found in **Ireland**, since a very large quantity of foreign investment in the 1990's gave rise to manufacturing systems that was dominated by large multinational companies (see also in [9]. The Irish SMEs typically participate in virtual networks through outsourcing contracts with these multinational companies.

During the development of the EU Collaborative Action CO-DESNET [1] a data base including more than 150 European industrial districts has been created, and the data collection evolved in the years.

The SMEs aggregation in the **Italian industry networks** can be considered a as a voluntary decision to constitute a network or to join an existing one. The Italian Association of SME Networks, ASSORETIPMI [10], in a report of December 2016, has found a constant growth of networks of micro, small and mid-enterprises, the constituted networks in December 2016 where 3,243 with the engagement of 16,587 companies. In the contract of the last month of 2016, the average number of firms per each network was double with respects of the average number of firms in the previous months.

The phenomenon of SME networks mainly affected industrial sectors characterized by high-intensity manufacturing processes and low automation. Other characteristics that can be found are a limited requirement of capital, poor economies of scale and innovation mainly introduced with a learning by doing approach [9]. Examples of products where the production systems present these characteristics are household goods (furniture, ceramics), glasses, jewelry, clothing, and machinery used for their production.

4. Tools for SME network performance evaluation

4.1. Graph-based models of SME networks

Utilization of a graph formulation appears to be the first tool both to provide a graphical illustration of a SME network, and to offer a starting point for modeling and analyzing flows and connections between the companies belonging to the network.

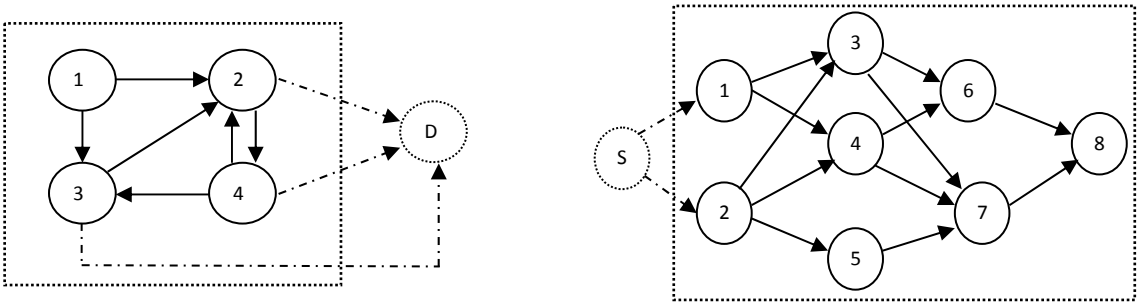
The most common configuration is denoted as "marshallian-Italianate network" [11], characterized by a set of SMEs, each one of them can both provide and receive material/information from the others. Examples are the Gold District Valenza (North-Italy) and the Shannon Soft, network of Software activity in the Shannon Region in Ireland. This network is characterized by a set of SMEs, each one of them can both provide and receive material/information from the others (Figure 1.a).

A second type of SME aggregation has been identified as "multi-stage supply chain" [12]. An example of this organization is the Footwear District (DistrettodelleCalzature di Fermo), located in the Center of Italy, specialized in the production of shoes (Figure 1.b). In a multi-stage supply chain products are differentiated in order to cover different market stratification (shoes for man, women and child): to this aim, the chain is composed by stages with a number of parallel SMEs.

Some SME aggregations can be modelled in terms of "hub-and-spoke" configuration [13], owing to the presence of a leader in the network that will affect the decisions of all other partners (Figure 2.a). The Eyewear District (Distrettodell'Occhiale di Belluno) in North Italy has a similar configuration: there are 5 leading firms corresponding to important brands of international fame, and around them a network of 1.500 small and medium enterprises specialized in the production of components or in particular production processes.

In addition to these three models that represent very fixed and ruled interactions among SMEs, could be found another kind of aggregation, mainly exploited by high-tech production and/or service supply, named "scientific

park" (or "pole of competitiveness" in France). In terms of graph representation (Figure 2.b), the nodes can be considered as inserted in a pre-existing network (light gray in the picture) of services that can create contacts between enterprises joining the scientific park. In this configuration, connections are very flexible and more informal than in the others.

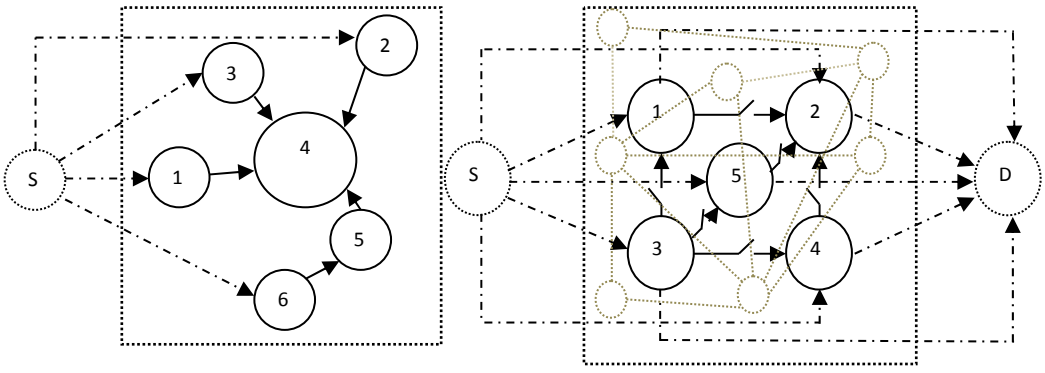


(a) (b)

Fig. 1. (a) Graphs of a Marshallian-Italianate network; (b) Multi-stage Supply chain network.

As illustrated in Figures 1 and 2, from the structural point of view, a SME network can be represented in terms of a graph G=(V,E), where V is the set of vertices and E is the set of edges or arcs. Typically, a vertex can be referred to a component SME, while an edge can represent a SME-to-SME connection [14]. For the scope of the present analysis concerning manufacturing SMEs networks, the graph under consideration is referred to the physical part flows (i.e., the logistic connections among SMEs). If so, the following different types of matrix representations could be identified for a graph G [6] modeling of a considered real SME network,

- the incidence matrix M [nodes vs edges] that identifies the links outgoing from each node, i.e. the existence of output flows from a given SME;
- the adjacency matrix R [nodes vs nodes] that specifies the existence of all the connections among the nodes, i.e. the existence of flows from a SMEs towards another SME;
- the path matrix P [paths vs edges], that specifies the input-output flows of parts for a pair of SMEs operating as suppliers and customers;
- the distance matrix L [nodes vs nodes], where each element is a certain "magnitude" associated to each edge, e.g. geographic distance, economic cost or time.



(a) (b)

Fig. 2. (a) Graphs of a Hub and Spoke network; (b Scientific Park.

This set of matrices allow to recognize some conditions of either strong or weak collaboration of SMEs together, according to Key Performance Indicators as the following ones:

- network connectivity index (NCO), i.e. the number of non-null elements in matrix R, corresponding to the number of connections among SMEs;
- network utilization balance (NUB), in terms of the percentage number of SMEs for which the difference between the computed production capacity (at step 2) and the actual capacity value (type b data) is greater than a given "sufficient utilization" lower bound;
- network separation into chains (NSC), i.e. percentage number of recognized independent supply chains, if any, referred to the number of component SMEs;
- network chains independence (NCH), in terms of the percentage number of links (i.e., cut sets dimensions) connecting the recognized supply chains, if any;
- number of network bottlenecks.

These KPIs can support a SME manager in selecting an existing SME networks to which the request for inclusion could be given [14]. Referring to the Marshallian-Italianate network type, an evident measure of potential strong collaboration among SMEs is the high number of connections, then high value of NCO. A significant number of non-null element in the path matrix P makes evidence of several loops, then another indication of good collaboration. In a Multi-Stage network, each stage is a set of "parallel" SMEs, and each SME in a same stage could implement different work phases. Then, different parallel supply chains could exist, thus corresponding to low value of the NCH indicator and high value of the NSC one. In any type of SME network, existence of independent supply chains can be a cause of a network subdivision into potentially competing and conflicting parts. A different situation occurs in case of a Hub-and-Spoke network, where partial chains could exist, but all converging on a same hub SME. Then, the NSC indicator will be low. Specific considerations are required by the Scientific-Park type network, where two graphs exist: one composed by the SMEs already operating, and the other defining the set of all links that the park management committee can make at disposal of other new SMEs (i.e. an underlying network whose links can be activated in the future). The former network can have small NCO and almost null NSC. The underlying network, on the contrary, must be characterized by high NCO.

4.2. The "network contracts" for supporting collaborative management

In 2009, in Italy, a law defined the "enterprise network contracts" in order to formalize the strategic goals and the mutual activities of SMEs that want to build a network. Network contracts can help SMEs to overcome limitations due to their dimension without losing their legal independence, and it enables them to collaborate with firms of different dimensions.

Even if the Italian law represents a novelty in Europe and may offer new challenges and hints for future discussion at international level, it still presents some lacks in its formulation.

To overcome these problems, a formal model to support the design of a SME network contract, by providing both an ontology-based model to help the definition of the contract in a structured way, and a basic workflow which identifies the two important phases of the network design, i.e., the feasibility study and the negotiation [15].

The Italian "enterprise network contract", Law 99 of July 23rd 2009, allows two or more enterprises to jointlyperform one or more economic activities falling within their social objects in order to increase their mutual innovation capacity and competitiveness in the market. The essential requirements of the network contract include:

(A) the statement of the strategic goal and common objective isto reach the improvement of innovative capacity and competitiveness for all the SME in the network;

(B) the identification of a program for the development of the network such to detail the activities and investments needed for the implementation, together with a set of indicators useful to measure the network performances;

(C) the rights and duties assumed by each participant;

(D) the establishment of a common fund, managed by amanagement body composed by SME representatives, aimed at pursuing the strategic goal;

(E) some entry and exit rules for the SME and conditions to dissolve the network.

Based on this law, a set of some simple rules can be stated and also represented in a UML class diagram of the Italian enterprise network contract (developed in [15]) to be sued as a "guide" for managers aiming to evaluate the opportunity to ask for being included in a SME network.

5. Some concluding remarks

What is useful to evaluate is how common goals could drive SMEs to be collaborative

According to the 2016 Report of the Chambers of Commerce of Italy [16], from 2010 to the end of 2016, in Italy, 14.861 enterprises have signed a network contract giving rise to 2.846 different SMEs networks. By analyzing all SME network contracts, it is possible to see that industry and services are the most present sectors with a global 70% of network contracts (Figure 3)

Neglecting the typical goal of expanding markets, present in the 38% of signed contracts, the aim of SMEs is to collaborate in order to increase their innovation strength (17%) such to increase production capacity (20%) and their ability to compete (15%). These objectives are easier to be reached in the industrial service sectors. Some critical aspects should be underlined: only 7% of contracts are devoted to improving quality and certifications and a small 3% to share know-how and skills, the typical aspect of modern sharing economy.

Then, referring to the network contract, the **average number of enterprises for each network** is less than 5 with the 26% of network contracts with 3 enterprises (Figure 3). This is an important evidence that when relationships are formalized, the effort to cultivate them is so strong that it is not possible to have a high number of partners to interact with (Figure 4)

Even if the network contract is thought also to push collaboration among enterprises from different territorial area, an analysis on the regions where the enterprises work shows that more than the 70% of network contracts is constituted by enterprises coming from the same region.

By analyzing the available data, it is not possible to say that the network contracts have generated a positive reaction of the managers to face the crisis periods, since the law of the network contract has been introduced in 2009 and the first contracts have been signed in 2010.

Anyway, it is interesting to see that **the trend of the number of contracts** is increasing since 2008, with only a small decrease in 2013: this is because the typical duration of the contract is of 3 years and in 2013 a lot of signed contracts have been expired and a technical period for the renewal was required.

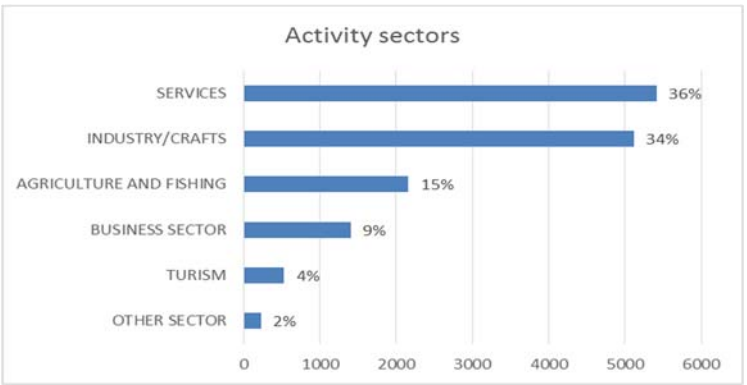


Fig. 3. Percentage of SME networks per activity sectors.

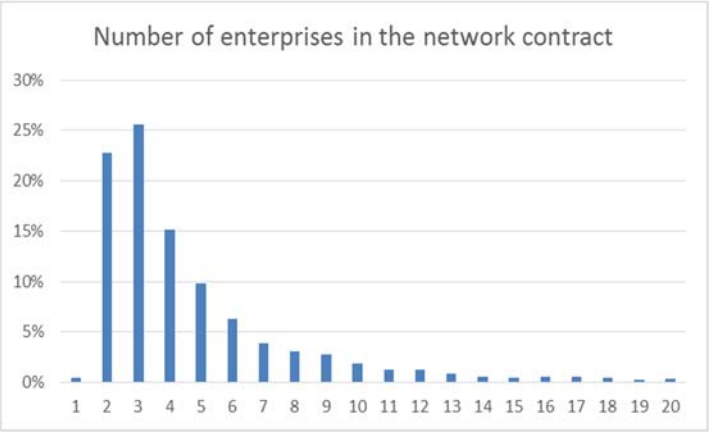


Fig. 4. Number of SMEs per network contract.

Anyway, to make at disposal of SME managers easy-to-use tools and rules for creating aggregations of micro and small enterprises, and also mid if convenient, is mandatory, for both industrial organizations and regional governments.

Recently, a new research and development program of Politecnico di Torino is trying to make agreements of universities (that could offer to SMEs their experience in technical and organizational projects) with banks (that could make at disposal not only funding, but also experience in solving hard financial problems). This line is expected to open future interesting opportunities for SME networks.

References

[1] CO-DESNET – Collaborative Demand and Supply NETworks, Coordination Action, Commission of the European Communities, Directorate General Information Society, Contract Number 506673, May 2004.
[2] D. Antonelli, T. Taurino, Int. J. of Netw. & Virt. Org. 9 (2011) 382-402.
[3] European Commission Recommendation of 6 May 2003 concerning the definition of micro, small, and medium-sized enterprises. (2003/361/EC), Official Journal of the European Union, L 124/36, 20 May 2003.
[4] Annual Report on European SMEs 2015 / 2016 - SME recovery continues, SME Performance Review 2015/2016, Contract number: EASME/COSME/2015/012, 2016.
[5] Marshall, Alfred. 1890. Principles of Economics.London: Macmillan and Co., 1890.
[6] European Cluster Observatory and to the Europe INNOVA Cluster Mapping Project, European Cluster Observatory, www.clusterobservatory.eu.
[7] PME 2015 – Rapport Annuel sur l'Evolution des PME, DGE – Direction Générale des Enterprises of the Ministère de L'Economie e des Finance, /www.economie.gouv.fr/cedef/chiffres-cles-des-pme .
[8] Initiative Competence Networks Germany, /www.research-in-germany.org.
[9] A. Villa (Ed.), Managing Cooperation in Supply Network Structures and Small or Medium-sized Enterprises: Main criteria and tools for managers, London: Springer-Verlag, ISBN/ISSN: 9780857292421, 2011.
[10] ASSORETIPMI, www.retipmi.it.
[11] A. Markusen, Econ. Geo. 72(3) (1996), 293-313.
[12] A. Villa, T. Taurino, W. Ukovich, J. of Int. Manuf. 25 Feb (2011) 1-10.
[13] T. Taurino, D. Antonelli, An insight into Innovation Patterns of Industrial Districts. In: 6th CIRP International Conference on Intelligent Computation in Manufacturing Innovative and Cognitive Production Technology and Systems, 2008, Naples, Italy, 23-25 July 2008.
[14] D. Antonelli, G. Bruno, T. Taurino, A. Villa, Int. J. of Prod. Res. 53(20) (2015) 6198-6209.
[15] A. Villa, G. Bruno, Int. J. of Prod. Res. 51(23-24) (2013) 7439-7447.
[16] CdC, Camera di Commercio di Firenze, 2015. Il ruolo delle reti d'imprese in un'economia alle soglie della ripresa: base di partenza o punto di arrivo per un rilancio della crescita locale? (in Italian), http://www.starnet.unioncamere.it/download.php?id=36373.