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C3 Industrial structure and crisis reaction

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Networks of mechanical filiéres before and after the 2008 crisis*

Abstract
The engineering industry in Emilia-Romagna is a strategic asset for the development of Italy, as it emerges from the comparative analysis presented in the "Atlas of economic complexity" (Hidalgo et al 2012). What are the effects of the 2008 crisis on this strategic asset? What were the responses from companies? What questions for public policy emerge from the structural changes occurring in the regional industry? To outline the answers to these questions, in addition to official statistics and previous empirical research, information were drawn from a series of more than forty interviews (carried out between January and April 2011) to 28 engineering companies in the provinces of Bologna and Modena and to business associations in the two provinces. The case studies contribute on the main focus of the analysis: the networks of relationships that characterize the mechanical filiéres in the region. Companies' structural characteristics, their pre-crisis strategies, the effects of the crisis and the post-crisis strategies are examined to shed light on the critical issues and perspectives of local subcontracting companies and their networking on local and global scale. Implications for regional policy, arising in this context of change, are discussed.

Keywords: 2008 crisis, mechanical industry, Emilia-Romagna Region, companies' strategies

JEL classification: L64, R10

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1. The mechanical engineering industry in Europe

After a decade of debate about the decline of Italian manufacturing, it is widely agreed among academics and policy-makers that Italy has a manufacturing structure of significant importance for the global economy, albeit with a number of weaknesses particular to the Italian system that hinder potential growth. The Italian industrial system is somewhat anomalous compared to the ideal version involving large enterprises operating on a global scale[1]. The perceived anomaly of Italian development seems to be more of a product of economic theory – with the assumption that the workings of the market are atomistic at a micro level and imply convergence towards the macro level – rather than of the actual numerous paths to growth that come to light from analysing enterprises (Berger, 2006) and countries (Hausman and Hidalgo, 2011a, 2011b).

To understand Italy's position with regards to these paths to growth, we can make reference to the work carried out by Hausman and Hidalgo (Hidalgo et al, 2007, Hausman and Hidalgo 2011a, 2011b) who analyse the complexity of interactions between the micro level and the macro trends of single national economies and economic areas, considering the know-how network existing in a country as a firmly established strategic asset which is acquired over a medium-long-term period.

In analysing the comparative advantage of countries, Hidalgo *et al.* (2007)[2] construct a representation of "product space", which highlights the interrelationships in the trading flows between countries[3]. A representation of the interrelationships between products is given in the graph produced by Hidalgo *et al*., shown in figure 1.

Fig. 1 Product space according to Hausman and Hidalgo 2011

"Product space" is important because it highlights the connections in the productive interrelations matrix, and not only the general allocation of factors or technology relating to each country, and measures the complexity of the know-how present in each economy[4].

It emerges from this study that the group of 125 products coming under the "machinery" category had the highest level of complexity[5], with a global market share of more than 20%.

[1] The "declinist" debate has been attracting the attention of Italian academics for almost ten years. Numerous contributions by the Bank of Italy's Research Department culminated, in 2009, in the collection of works edited by Brandolini and Bugamelli (2009) which provides a broad overview of the strengths and weaknesses of the Italian manufacturing system and highlights the level of diversity among manufacturing firms. Ginzburg (2009) provides a critical review of the debate. The papers by Cipolletta and De Nardis (2012) and by Coltorti (2012) provide a new interpretation of the figures regarding Italian economic development in the last decade, pointing out the potential for growth – underestimated in the declinist debate – and the critical areas that remain to be tackled in policies for the country's development.

[2] The Product Space Conditions the Development of Nations, C.A. Hidalgo R., B. Klinger, A.-L. Barabási, R. Hausmann, 2007, *Science*, July 2007

[3] Definition of product space, Hirschman and Rosenberg

[4] The hypothesis put forward by Hidalgo *et al.*, which is tested through a comparative analysis of the different types of product space in a number of countries in various economic areas (from Europe to Latin America), is that the countries that have a higher level of productive interrelations in this nucleus of manufacturing industries continue to develop the sectors in which they are more able to maintain their advantage in relative areas of know-how. As part of this interpretation, the authors make a comparative analysis of this product space in the geographic macro-areas: Europe, Asia and Latin America.

The Atlas of Economic Complexity (2011) – drawn up by Hausman and Hidalgo together at the Harvard Center for International Development – shows the figures for single countries in 1968, 1988 and 2008. The hypothesis around which the analysis presented in the Atlas revoves is that "countries move from the products that they already create to others that are "close by" in terms of the productive knowledge that they require", p. 7. Through a measure of the closeness between products in terms of the knowledge required to produce them and their widespread presence in world trade it is possible to make a valuation of the RCA of single products in the countries. The classification of the SICT product in 4 figures shows that the production of special machiner is among the 5 most complex products. Grouping together the 5 thousand products into *communities* that make use of a diversified pool of complementary areas of know-how, it turns out that the product groups under the "machinery" heading stood at first place in terms of complexity (112 product categories in the SITC_4)

Germany, the United States and Japan are leaders in terms of volume of exports of machinery, but if we consider the leading countries in terms of number of products, we find that Germany, Italy and Austria have a comparative advantage (RCA>1) regarding machinery. Italy therefore has a strategic asset – the know-how network in the production of machinery – which indicates a positive path to growth

If we take a look at the European mechanical engineering industries – including the automotive, metalworking and electronics industries as well as the manufacture of machinery, we immediately discover that there are countries and regions with different levels of specialisation. With reference to employment figures, the situation regarding European mechanical engineering for 2008 is shown in Figure 2: 61% of mechanical engineering workers are employed in four countries Germany, Italy, France and the United Kingdom (and which account for 57 % of European mechanical engineering exports).

Fig. 2 Engineering Europe: Germany, Italy, France and the United Kingdom, 2008

There is diversification within these countries, in terms of the quantity of manufacturing employment as a proportion of total employment and the level of mechanical engineering employment in the manufacturing sector. Specifically, focusing attention on Italy and Germany, we see that Italy has a relatively higher level of manufacturing than Germany, but Germany has a higher degree of mechanical engineering than Italy. This situation became more prominent in the decade 1999-2009.

Cluster analysis of mechanical engineering employment data for Italy and Germany (Giampaglia, 2010-11), the results for which are summarised in figure 3, reveals the different intensity of manufacturing and mechanical engineering specialisation in the NUTS 3 territories: there's a huge variety in the intensity of mechanical engineering and manufacturing specialisation in the various NUTS 3 territories in Germany, while in Italy there is a strong specialisation in Milan and Turin (with significant agglomerations in quantitative terms), but a number of other territories also show significant mechanical engineering specialisation.

Fig. 3 Intensity of territorial specialisation. Rate of mechanical engineering and manufacturing employment (2009), NUTS3 Italy and Germany

In Italy there is a greater concentration of mechanical engineering in the northern regions[6], while in Germany the engineering industry is more widely distributed.

Fig. 4 Intensity of specialisation in the NUTS3 territories in Italy and Germany (2009)

With regards to mechanical engineering specialisations, the concentration of the mechanical engineering industry is very strong in northern Italy, where there is a wide range of specialisations in the production of components and complementary processes in highly integrated territorial systems[7], and in southern Germany, where there are the most significant concentrations of the automotive sector.

The two most important mechanical engineering countries in Europe, Germany and Italy, have strong interconnections, largely relating to exchanges of intermediate goods[8]. Almost 71% of mechanical engineering exports from Piedmont, Veneto, Lombardy and Emilia-Romagna are to the German market. The level of concentration is lower in Germany, around 20%, and the areas mainly involved in exchanges with Italy are the Lander regions in the south.

Germany extends its production relations to the Czech Republic, Poland and Romania. It's necessary, however, to point out that in Europe there are significant levels of mechanical engineering employment also in France, the United Kingdom and Spain. A comparison of the mechanical engineering specialisations at the NUTS 2 level (Figure 5) clearly shows that in Italy

[5] Confirming what was already suggested by Nathan Rosenberg in his analysis of the development of the American economy at the end of the 19th century, and Hirshman's observations on upstream and downstream connections

[6] The importance of certain areas in Southern Italy was, on the other hand, clearly evident from the analysis of census data in Russo (2008).

[7] Russo (2008, chapter 3).

[8] See Giampaglia (2010-11) for a detailed analysis

there is a prominent mechanical engineering production area in the northern regions: Lombardy, Piedmont, Veneto and Emilia-Romagna.

Fig. 5 Intensity of mechanical engineering intensity in the NUTS 3 territories in Europe (2009)

What figure 5 fails to show is how much these territories are integrated together, as revealed from an analysis of the location of production specialisations and of final products and components (carried out on the 2001 census data)[9]. The mechanical engineering platform in Europe extends to other territories, and this is perhaps an aspect which demands greater attention. Within this mechanical engineering platform in Europe there are territories with a strong manufacturing tradition – and the mechanical engineering industry in particular – and the Emilia Romagna region (in the Modena, Bologna and Reggio Emilia provinces) there is a significantly higher concentration of mechanical engineering employment.

From studies of industrial districts[10] we find that the economic and social transformations after the Second World War generated business systems characterised by strong vertical disintegration and high specialisation in one or a small number of production phases. That vertical disintegration of the enterprises was made efficient thanks to production integration inside the local system of business relations in which the companies operated. In the context of strong demand at a global level, that mix of specialisation and vertical disintegration led to a high rate of growth in a number of Italian industrial segments, including the mechanical engineering industry, which played a prominent role not only in terms of levels of exports, but also in terms of the ability to support the innovation of other production systems[11]. From the 1980s, the network of relations linking mechanical engineering companies operating in the mechanical instrumentation supply chain extended to much of North Italy: it is this supply chain that Hausman and Hidalgo (2011) identify as the product *community* with the highest degree of complexity, and in which Italy has a comparative advantage, being second only to Germany. The supply chain diversified into a huge range of types of machinery used by a multitude of industries (from the pharmaceutical industry to the food industry), with articles produced to order and often unique pieces. These are important factors for understanding the mechanisms that govern the particular innovative dynamism of this supply chain[12]. Vertical disintegration and production specialisation are key elements that generate technological convergence[13] between many sectors specialised in the production of different types of machinery, which require an extraordinary variety of technologies to produce the components to use in the production of the machines. Specialisation on the part of the producers of each of these components, or the specialisation of processing phases in the production of these components, means that use is made of a variety of technologies which is transferred into the specialised companies in the production of single machines for special uses.

The enterprises manufacturing those materials, that design their use, that develop the machines for the production of a particular component contribute to making innovations that stimulate the demand for highly advanced know-how. This demand spreads through the supply chains because the enterprises specialised in production phase equipment or in the production of components work for a number of customer sectors at the same time. The main characteristic of the regional

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[9] Russo (2008)

[10] See the works of Brusco (1987, 2008) and the collection of papers on industrial sectors in the *Handbook of Industrial Districts* (edited by Becattini, Bellandi, and De Propris, 2009).

[11] See the contributions of Paterlini, Pirani, Rinaldi and Russo in the volume edited by Russo (2008) and Menzani (2011).

[12] Take, for example, a pharmaceutical company that orders two machines for packing the same medicine in two factories, one situated in China and one in India. It will need the same model of machine, but the two machines produced by the Emilian company that received the order may not be identical: the differences that come into play to satisfy the particular production contexts in which the machines will be used make it necessary to design and produce many unique pieces. If we consider that those unique pieces relate to possibly only 10% of the components (out of thousands of components necessary for a packing machine which, for example, is used to put pulls into a blister pack and then to put the blister pack into a packet), it is easy to imagine the implications in terms of changes in the design and in materials and technologies used in the upstream and complementary production processes.

[13] See N. Rosenberg (1987) for a definition of technological convergence.

mechanical engineering production system is still that of possessing a broad range of know-how which engineers, technicians and workers can exploit in order to find, test and apply the most effective innovate technology that meets the needs of the end users of the machines in a better way or before other technologies. These technological innovations rarely originate from patents. How is this type of innovation generated? What are the conditions that make it possible to respond to the increasingly sophisticated needs of customers operating all over the world? How has the crisis affected this strategic asset for Italy's economic development?

Research on subcontracting in the mechanical engineering industry in Emilia-Romagna offers an interpretation of the effects of the crisis on the system of production chains and goes some way to responding to these questions in two directions. The first is the level of degeneracy of the system; the second relates to the links between education, innovation and research as social processes which involve interactions at many levels in society and in institutions.

2. The mechanical engineering industry in Emilia-Romagna

Mechanical engineering is the leading manufacturing sector in the Emilia-Romagna region: it provides employment for half of the manufacturing workers, accounts for over half (56.4%) of exports and makes a very important contribution to the trade balance, contributing 70.4% of the trade surplus of the manufacturing sector (2011 figures).

Emilia-Romagna mainly manufactures capital goods, besides components and automobiles, luxury sports cars which are famous all over the world. The variety of products and the supply chains that characterise Emilian mechanical engineering involves different forms of specialisation in the three most important provinces: Bologna, Modena and Reggio Emilia. The production of machines and mechanical devices is significant in all the three provinces, but they have different specialisations which are even more clearly evident if we consider the particular types of machine that make up the 'machinery and equipment" group of products. The automotive sector, on the other hand, is more prominent in Modena, and partially in Bologna, and less present in the province of Reggio Emilia.

Exports have driven the growth of the regional mechanical engineering industry: a peak was reached in 2008, followed by a sharp fall in 2009 and a slight recovery in 2010. In the first half of 2011 mechanical engineering exports increased substantially, though there was a slowdown in the second part of the year.

Emilia-Romagna mainly exports machinery and equipment and imports a relatively high quantity of intermediate products: this is an aspect that has always characterised this industry at a regional level and distinguishes it from national industry, since the average importance of machinery and equipment in the mechanical engineering industry as a whole is decidedly lower. With regards to the customer markets for exports, the comparison with Italy reveals how the key markets for the Emilian mechanical engineering industry are more diversified; in particular, the level of exports to Asian countries, especially China, is higher. With regards to the national situation, the most important key markets include the Asian area, North America and in particular, the USA. The level of exports to countries in the European Union of 27 member states remains significant, but has fallen over time.

With regards to imports, again in this case, mechanical engineering imports to Emilia-Romagna from Asian countries are higher than the national average, and from China in particular. This share of imports has grown the most in the last few years, and if we take out the automotive industry, the imports for which arrive mainly from Europe, the relative importance of the Asian countries would increase further, reaching 30%. The region's mechanical engineering industry has therefore managed to diversify customer markets and to latch on to the growth of the most dynamic markets at an international level, but has also opened up its own sources of supply with reference to foreign markets.

Types of enterprises, production phase specialisations and interaction between supply chains

One important aspect of the Emilian mechanical engineering industry is the high level of specialisation of enterprises in the production processing phases and in the manufacture of particular components. This high specialisation in the Emilian mechanical engineering production system involves a systematic reorganisation of what appears to be a division of labour between final enterprises, contracting enterprises and service companies. Final enterprises– which may be large, medium or small-sized - design and sell the product as well as carrying out part of the production. Contracting enterprises – generally smaller than final enterprises – carry out processing work or make parts of a product on account of other mechanical engineering companies, against drawings, to order or through tolling agreements. Service companies – generally with 15-20 workers – offer final enterprises and contracting enterprises a vast range of services (from logistics to installation, maintenance, repairs, to the management of flows of digital information). Final enterprises, contracting enterprises and service companies are all essential players in the region's production chain: they contribute to the manufacture of the finished product in each chain; they diffuse know-how between chains, and support the processes of innovation.

Within the supply chains, the final enterprises differentiate according to the degree of vertical disintegration. Where there are very complex products, composed of a very high number of components, a part of which are produced against customer specifications – such as, for example, in the machinery sector.. - final enterprises outsource a higher proportion of production externally (80%, also up to 100%), and therefore have a higher level of vertical disintegration. These enterprises are also more likely to have a hierarchical type of organisation, organised into a number of levels, in which there is a subcontractor able to offer a complex module or even a finished machine, and which in turn organises a network of subcontractors at a second or third level, which make the various parts and components.

Fig. XX Level of vertical integration

In the supply chains in which the products are to a certain degree less complex, composed of a smaller number of components, the enterprises are more vertically integrated (with internal production departments that carry out a large part of the production and with less outsourced production). In this case, subcontracting is not organised by levels, and there is less interaction directly concerning the relationship between customer and subcontractor (for processes and components) or service business.

In the Emilian mechanical engineering industry, subcontractors are able to work for different customers, and also for different departments at the same time[14], a fact which has always been a point of strength in the mechanical engineering sector and particularly in the Emilian mechanical engineering sector since, in working at the same time for different departments or supply chains, the subcontractor not only manages to reduce the risk of variability in the demand of end-user markets, in the sense that a solution which has been found in working on one type of product may be rapidly transferred to another type of product, contributing in this way to the spreading of innovation and production improvements within this supply chain system[15].

14 The findings of the Metalnet survey of the mechanical engineering industry in the Modena province (2005) has allowed for an accurate estimate of the number of different types of enterprise for each mechanical engineering supply chain taken into consideration in the empirical findings. The figures can be found in the file www.metalnet.unimore.it/specializzazioni_macrofiliere_cp_ct_servizi.pptx. See also Bigarelli and Russo (2009) and Russo and Whitford (2009).

15 That the supply chain has a systematic nature can also be deduced from the activity of an organisation such as CRIT: the multinational companies that have set up this technological brokering firm belong to different supply chains (from packaging to the production of machinery for the ceramics industry, to automobiles, tractors etc.) and use CRIT as a point of contact between themselves, subcontractors and research centres for foods for the creation and diffusion of new know-how to be then applied in the local production system. This is a way of operating in which the Emilian mechanical engineering industry's district production system model is considered as a point of reference for innovation (see Russo and Whitford, 2009; Sardo, 2009; Rossi *et al*., 2010)

Vertical relations are not only those between customers and subcontractors and service companies. There are also vertical and horizontal relations between subcontractors which collaborate with each other, both to offer a finished component and therefore a more complete service to the customer, and to share orders, if the internal production capacity is insufficient or inappropriate. Within the supply chain we currently find a non-hierarchical form of organisation, while hierarchical models are somewhat rarer.

Since a subcontractor is able to work for a number of supply chains at the same time, they can find themselves as the supplier at first level for one enterprise and a supplier at the second level for another enterprise. A subcontractor can therefore have a number of roles within supply chains, not linked to a single type of relations model between subcontractor and customer.

Product complexity, innovation and series length

Although we do not have a comparative analysis on a national scale, research on the effects of the crisis on mechanical engineering subcontractors in Emilia-Romagna – presented in this paper – provides a picture of the variety of business strategies and of the implications that those strategies have for regional development.

Metalnet's work (2005 and 2007)[16] gives us an idea of the variety of product supply chains in Modena, of specialisations in the provinces of Modena, Reggio Emilia and Bologna, and of organisational models that characterise relations between enterprises in the mechanical engineering production system. These analyses have made it possible to identify a series of cases that we have examined in more detail through interviews with mechanical engineering firms in Modena and Bologna, selected partially through the collaboration of business associations, extending the sample by means of *snowball sampling*. While focusing the analysis on the effects of the crisis on subcontractors, interviews have also been carried out with customer firms. As with the other surveys in the Metalnet project, the variety of cases examined has also taken account of the different types of enterprises: final enterprises, subcontractors and service companies.

The results of the analysis – which we will describe in detail in this paper – regard two elements that characterise relations between enterprises: product complexity and series length. The interpretation of the effects of the crisis on mechanical engineering subcontracting focuses on the change in relations between enterprises.

If we consider product complexity (schematized also in terms of the different phases and number of parts of products for each sector), the levels of innovation and of the length of production series, and classify specialisations in the Emilian mechanical engineering industry in this way, we can create an identikit of mechanical engineering production in Emilia-Romagna: it is specialised in small-series productions, unique pieces, very personalised products, characterised by a limited number of competitors precisely as a result of the high level of personalisation of these products. Alongside these niche products, the variety of products also includes ones with a lower level of complexity, or which are made in longer series.

Models of relationships between enterprises

The analysis of a number of large customer enterprises that make final products and of firms specialised in various phases allows us to understand not only the variety of products in the Emilian mechanical engineering industry, but also the variety of organisational models, also within the same sector. Let's take, for example, the packaging sector: companies with very similar specialisations and also very similar dimensions have different organisational models with regards to control, collaboration, and orders between customer and supplier. In general, we have not found convergence towards a single organisational model either within single supply chains or between supply chains.

[16] The results can be found on-line in the Metalnet project portal "Struttura e dinamica delle relazioni tra imprese meccaniche" (Structure and dynamics of relations between mechanical engineering firms), www.metalnet.unimore.it. See Ginzburg e Bigarelli (2008) on the mechanical engineering industry in the province of Reggio Emilia.

Among enterprises that use a hierarchical model (in which the main customer for the order decides what and how to produce, for which markets and under what conditions) there are enterprises that have suppliers which are not particularly dependent on the enterprise's orders and, in this case, relations are on a contractual basis. For other enterprises with a hierarchical relationship model, relations with their subcontractors are closer, based on partnership-type agreements, and in this case the suppliers are highly dependent on the enterprise's orders, despite the fact that they also work for other customers. There are enterprises which, on the other hand, do not have a hierarchical model, but instead have a very high number of suppliers and opt for a relationship model in which the subcontractor is dependent to a very low extent on the enterprise's orders and has relationships only of a contractual nature. Finally, in other cases, the customer enterprise has a very strong control over the subcontractor, either because the latter is very dependent on the customer's orders or because the relationship is in the nature of a partnership.

There are differences in other supply chains, also in the absence of hierarchical relationship models with subcontractors: as well as customer enterprises that opt for relations with third parties with a low level of dependence, there are enterprises that have more dependence-based relations with a number of strategic third parties, and firms that have decided to have corporate control over certain subcontractors considered particularly strategic.

Relationship networks extend beyond national boundaries and generate internationalisation strategies. Some of the most important enterprises operating in the packaging sector have opened production sites abroad in the more promising markets, especially in the Asian markets, making direct investments, but also purchasing components made to their design in low cost foreign countries. Other enterprises, on the other hand produce entirely in Italy and have not, until now, pursued or incorporated internationalisation in production terms in their strategies.

Generally speaking, productions in small series of very complex or highly innovative products are less subject to delocalisation to low cost foreign countries. On the other hand, productions in large series or with a lower level of innovation have by now been delocalized to foreign countries with low cost labour for more than a decade. Internationalisation processes are, however, also under way for small series productions and for productions that are not necessarily of a low technological level, which involve the opening of Emilian enterprises' production sites in foreign markets, in order to manufacture locally products intended for those countries. They are mostly Asian countries, especially India and China, and the opening of these sites creates in those countries the opportunity to set up local supply networks. It's an expansive investment policy, but one which often shifts the enterprise's centre of attention towards the new production sites opened in the foreign markets. This type of operation involves foreign revenues from foreign operations, and are not therefore characterised by trade flows recorded at a national or regional level.

3. The crisis: the effects on enterprises and their responses.

The effects of the crisis

The crisis which exploded in 2008 in the financial sector involving subprime mortgages hit the real economy as soon as the second half of 2008 (rif BdI). At the time the Emilian mechanical engineering industry was enjoying a positive trend in growth in demand in foreign countries and in innovation, both on a regional[17] and national scale (Breda Cappariello 2010, BdI 2011).

What were therefore the effects of the crisis on the Emilian mechanical engineering industry? As a response to this question, we can observe the trend in exports at an overall level, which shows

[17] See Bigarelli and Russo (2009), Russo Whitford (2009) who interpret the results of interviews in the Metalnet study "Struttura e dinamica delle relazioni tra imprese meccaniche" (Structure and dynamics of relations between mechanical engineering firms), 2005and 2007. The results can be found on-line in the Metalnet project portal: www.metalnet.unimore.it

a fall. This situation is made up of effects of different intensity and nature in the various sectors and types of enterprise.

The crisis did not affect different supply chains in the same way. Among the sectors that suffered the drop in foreign demand to a lesser degree were, above all, the packaging machinery sector, in which there are companies that have had, by and large, quite limited falls in turnover and some have even increased turnover, having acquired long-term orders. In the hydraulics sector, enterprises have, on the contrary, suffered very sharp downturns, since their products are mainly intended for sectors that have been heavily downsized, such as lifting and handling machines, the demand for which is strongly linked to the trend in the building sector.

Besides the differentiated effects of the crisis in the region's supply chains, the conduct of customer enterprises has also been somewhat uneven. In enterprises that have internal production departments, for example, not all of them have chosen to bring inside processing work normally carried out externally. Those enterprises without internal production departments – such as highly disintegrated customer enterprises which are leaders in the packaging supply chain, – have obviously not introduced production re-entry policies. Production re-entry policies for processing work have also been introduced by first-level suppliers; it's a mechanism that has had repercussions within the supply chain, and if we assume a fall in turnover of around 30% in final enterprises, this results in a slightly larger fall for first-level suppliers or for strategic suppliers, which have been more protected by the policies of customer enterprises. Dramatic falls in turnover and in production activity has occurred, on the other hand, in second-level subcontractors or in firms that are considered as non-strategic, and which have been heavily hit by this transfer of the crisis along the production chain.

It can be asserted that the re-entry of processing work has been a common aspect , but there has also been conduct of an opportunistic and speculative nature, as in the case of multinationals – not only foreign, but also Italian ones – which, for example, have not collected orders which had already been executed, putting their suppliers into serious difficulty. There has also been an extension in payment terms and a reduction in prices imposed on suppliers, with requests for significant discounts.

The brunt of the crisis – which, as we have seen, hit the Emilian mechanical engineering supply chains in different ways – has generally hit the subcontractors, with the risk of endangering their survival and, in the medium-term, of changing the regional mechanical engineering production system along the sector's two strategic axes: the workforce and the relationships between customer enterprises and subcontractors.

With the extensive use of temporary state layoff funds and similar government subsidised instruments for redundancies, in 2009 the balance of employment in the Emilian mechanical engineering industry was negative: around 12 thousand workers, equal to a sixth of the workforce employed in the sector. The jobs which this sector lost over in just one year relate to the so-called "flexible" workforce, composed workers with fixed-term contracts which were not renewed. We don't know what proportion of the workers were immigrants or what were their strategies for staying in the area while waiting for an economic recovery. A productive sector in which skills are acquired over a long period alongside more experienced workers and in which there is reciprocal fine tuning between workers and the organisation in which they are inserted, may suffer a very significant systemic effect if these workers abandon the region, provoking in the medium-term further labour shortages, a phenomenon which had already characterised the period before the crisis.

There's an observation about the relations between enterprises that Sebastiano Brusco makes in characterising the "Emilia model". According to Brusco: "business crises are much lighter in a highly integrated industrial context" (1989, p.). But what happens when the relations with end-user markets involve very distant end-user markets (and not only geographically, but socially and culturally, as is the case for China and India, and for other reasons for Mediterranean countries)? What happens when the difficulties of expansion into these markets affects the customer enterprises

of many of the local subcontractors? What happens to the relationships between final enterprises and subcontractors? The information flows that govern enterprises' investment and production choices and – in the Emilian productive context – the possibility of offering innovative proposals to the final markets, become significant factors. The choice to internalise processing work which before was carried out externally has been a solution chosen by many final enterprises as a way to face the crisis, with the objective of reducing the use made of redundancy measures. This approach has been the result of different motivations and had various effects. The motivation did not only relate to benefits in the short-term. For example, in the case of enterprises owned by multinationals, this choice has allowed management to respond to the top management instructions, safeguarding jobs and the survival of the site in Italy. One of the effects of the re-entry of processing work is that recourse to redundancy measures is passed on to the subcontractors. The re-entry of processing work into the customer enterprises, however, also interrupts the flow of information along the production chain. The subcontractor loses the work of those customers, but most of all, loses information regarding the changes in progress in final markets. In this way not only is the position of trust which encourages a more fluid flow of knowledge affected. The information flow generating know-how and trust is interrupted. A systemic view of the production structure has led us to examine these effects, analysing enterprises' responses also with regards to these structural transformations in the production system.

Responses to the crisis

Foreign trade figures show that a number of supply chains and specific sectors had already returned to pre-crisis levels in 2011, while others had only partially recovered. Inside the various sectors, however, final enterprises and subcontractors reacted in different ways.

Final enterprises focused on extending their sales markets, with the aim of getting a foothold in the fastest growing markets. A number of mechanical engineering final enterprises have reduced the outsourcing abroad of processing work and the production of components due to the drop in the level of activity since 2008. They have focused their efforts on innovation, identifying niche markets, especially abroad. There has, however, been little investment in new machinery for processing technologies that generate cost advantages: the technologies in use are already highly advanced in this respect and margins for cost reductions have been achieved by reorganising internal production processes and relations with subcontractors. Final enterprises have accelerated their internationalisation processes, both through a strengthening of commercial networks and through direct investments in productivity.

Subcontractors have been hit worst by the crisis and for many of these enterprises trust in their traditional customers has fallen sharply; the re-entry of processing work and the failed collection of orders have not just been a mark of the difficulties faced by their traditional customers, but have also put those customers in a new situation, in which they are no longer able to guarantee secure prospects for the future and the possibility of a return to pre-crisis activity levels. Most subcontractors have searched for new customers and new market opportunities. The strategies of these enterprises can basically be divided into two types: repositioning of the supply chain and improvement in the services offered.

Subcontractors reposition the supply chain mainly through aggregations, with different partnerships arrangements: with other types of enterprise or with other subcontractors. In seeking to operate on their own account, with a reduction in outsourcing, aggregations of subcontractors often also include service companies or small final enterprises. Through aggregations of subcontractors the aim, on the other hand, is to achieve a more complex level of supply, for example, becoming suppliers able to guarantee a finished module or a finished machine, in order to acquire more contractual power with the purchasing enterprise and the final customer. Both these strategies are aiming at an extension of market opportunities, therefore involving the search for buyers and final customers outside the regional and national context.

A number of subcontractors, on the other hand, maintain a position on the supply chain at a local scale, by trying to offer better services to their local customers: they offer free deliveries, accept increasingly small and fragmented orders in rapid response times, etc. They make every effort to improve efficiency, quality and service.

Subcontractors unable to pursue these strategies risk marginalisation and closure

Structural characteristics and emerging critical areas: a systemic interpretation

Generally speaking, the crisis has accelerated a selection process which was already in progress within the regional mechanical engineering subcontracting industry. There have also been crises in specific sectors, with cases or significant downsizing, such as, for example, in the automotive sector in Bologna. Among the processes that characterise current trends in Emilian mechanical engineering, the most significant, however, seem to relate to both internationalisation and to production repositioning.

Internationalisation processes have involved significant growth in exports to the BRIC countries, as well as the delocalisation of production towards foreign countries with high potential growth (an already existing phenomenon which was accelerated by the crisis). The repositioning to more complex productions and greater innovation is an approach adopted most of all by final enterprises, but has also characterised the strategies of subcontractors freed from dependence on customers. A process which has been going on for some time, from before the crisis, is the downsizing of a part of local productions with lower added value, with repercussions on local subcontracting work (a rather significant phenomenon in quantitative terms).

One effect of the crisis, common to most enterprises, is the shortening of planning timescales, with an increase in the variability of demand, together with the requirement for a rapid response to the market. This effect of the crisis has led to a reorganisation of the supply networks at a global and local level.

In this context, there are common critical areas in the mechanical engineering industry in this region and in the Italian manufacturing industry in general: the burden of bureaucracy that hinders value creating transformations, the flat internal demand, without the stimulation of significant investments aimed at relaunching growth, the lack of a clear direction in industrial policy and a territorial governance which is not always able to sustain local development processes.

Then there is the problem of credit, which has particular significance in the production structure that we have described. Enterprises need, most of all, need to be able to organise in a flexible manner the fragmented and complementary production processes that characterise the most innovative mechanical engineering production systems in the region[18]. It is therefore necessary to have the effective means to sustain commercial credit, and not only venture capital or private equity, which is often cited among the critical areas of the financial intermediation system supporting innovation.

All the companies interviewed emphasised that one of the important problems for the prospects and future of the mechanical engineering industry in this region is the difficulty of finding young technicians, wither high school leavers or graduates, with a suitable background. It's not only a problem of a shortfall in quantitative terms, but is also a problem of poor training provided by the technical secondary education institutes and by engineering departments. There is a human resources problem. The leading companies in this sector affirm that if this problem is not solved, the competitiveness of the entire mechanical engineering industry in the region could be compromised.

This problem is the main threat to one of the country's strategic assets. If the skills acquired in the secondary and tertiary education system and in professional training are ineffective when applied within the production system, the growth and innovation driving the mechanical engineering industry is inevitably weakened.

There are also specific problems affecting various operators involved in the regional mechanical engineering supply chains. The reference to these problems and critical areas

[18] See Canovi *et al*. (2011) regarding the financial structure of enterprises in the Region.

encapsulates important themes in the different types of enterprise and supply chain, with which the volume will deal in detail, offering a systemic analysis of the effects on single operators and supply chains.

Firms at the end of the various supply chains in the Emilian mechanical engineering industry owe their strength on a global scale to the possibility of exploiting the integration of the regional production system (in which they have a position of power with respect to a number of subcontractors) composed of more than ten thousand subcontractors and final enterprises specialised in the production of single components.

Medium and large-sized final enterprises have the problem of further extending foreign markets, of increasing efficiency and the ability to respond to customer demands, offering increasingly personalised products and maintaining R&D at a high level. There is therefore a substantial confirmation of their pre-crisis strategies, even though they are investing much more in efficiency and flexibility, and this has had an effect on the organisation of the supply chain, both at a global and regional scale. A fundamental problem still remains: this group of enterprises is not large enough, and is often not sufficiently dynamic, to guarantee a level of local demand able to act as a driving force for the entire system.

Small-size final enterprises are more vulnerable to downturns in the internal market; they have greater difficulty in extending sales markets and in financing R&D. There is a problem of generational turnover in a number of these firms and the crisis is having a particularly strong effect on enterprises that failed to tackle this problem before the crisis: today this is very difficult to do when the prospects for company development in the short term are not very positive; what is needed is for a medium-long-term approach, which a generation of new managers and businessmen could provide.

Subcontractors are suffering from a drop in orders from local customers, which are demanding better services, but also lower prices. This leads to a resulting fall in margins and in profitability for this group of enterprises. They find it difficult to extend their geographical markets, even though this is one of the objectives of the strategies adopted by many company aggregations set up in recent years. These enterprises also have a generational turnover problem.

4. Implications for regional policies

Four stereotypes that influence the debate

What are the implications for regional policies arising from this outline of the Emilia Romagna mechanical engineering industry structure? In answering this question, we would like to make reference to a number of key themes in industrial policy, highlighting four stereotypes around which policies tend to be formulated. These stereotypes have one element in common: they focus on single enterprises, rather than on relations between enterprises.

One affirmation, nowadays taken as “true”, since it is repeated in the public statements of regional policy-makers, is that 30% of the Emilian mechanical engineering enterprises will survive, while 70% are destined to close. This viewpoint focuses on the future of the mechanical engineering sector as if it was an aggregate of isolated enterprises; as if there were no differences between territories and specialisations. Empirical research, on the other hand, has shown that it is precisely these differences which make it possible to identify the critical areas present in a number of production specialisations and in certain relationship structures involving dependent subcontractors in a number of supply chains in the region.

A second stereotype assumes that in order to “survive” (enterprises, however, want to grow and develop, not survive) it is necessary for an enterprise to be of a certain size. This assumption confirms the focus of attention on isolated enterprises and above all on one aspect: technological economies of scale in production, which is seen as the significant factor in increasing productivity. This may not be an effective interpretative approach for a production structure which specialises in small series of products and prototypes, which has a high volume of exports precisely in the

production of machinery, and mechanical parts and components manufactured to satisfy niche markets. Economies of scale do have an important effect, but for cases of standard products manufactured in long series, and this is not the prevalent type of mechanical engineering production in Emilia-Romagna. We have sought to point out, on the contrary, that there are two contexts in which the size of an enterprise is, in fact, a problem. The first context relates to many final enterprises that struggle to reach a size that would allow them to operate with more success on global markets. A second context relates to enterprises involved in interim phases of production which want to get free of their dependence on local customers. In both cases the choice of setting up networks could serve to significantly strengthen size and growth potential.

Another stereotype is that in the future there will be less industry and more services, forgetting that the interplay between services and manufacturing is an essential transformation that has already accompanied changes in mechanical engineering production in Emilia-Romagna: the rates of growth achieved in past years would never have been achieved without the development of services that have enhanced manufacturing activities.

A final stereotype relates to the conflict between export sales and domestic sales. Foreign markets are considered as a fundamental element for enterprises' ability to grow[19], ignoring the fact that many small enterprises do not export, yet are an essential part of the relationship networks that support the production processes and innovation of other enterprises that are, on the other hand, renowned for their high rates of exports[20]. These small enterprises therefore make an indirect contribution to exports (see Breda and Cappariello, 2010).

Are public policies needed?

The interviews with mechanical engineering enterprises in Emilia-Romagna point to a strong demand for public action. The questions involved require policies aimed at reducing the tax burden, at a drastic reduction in bureaucracy, at directing private investment towards the Horizon 2020 objectives. As well as policies on a national scale, however, there need to be policies on a regional scale focused on three areas: research, training and generational turnover.

Public action must implement research and innovation policies alongside the training of workers (as occurs in Emilia-Romagna). Faced with growing international competition, mechanical engineering enterprises in the region have responded by increasing their capacity to produce for niche markets, products with increasingly personalised characteristics, also seeking to increase productivity through investments in rapidly expanding countries. They try to compete by innovating. What is needed in order to continue to sustain the rate of innovation that characterises the regional mechanical engineering industry? Incremental innovation is essential because it enables enterprises to respond to the needs of customers for whom machines are produced for special uses. We know, however, that incremental innovation also has a big defect: we can't predict when it will be achieved, and by whom. There is therefore the need for an extraordinary level of know-how among workers in design, production and testing; know-how which it is necessary to enrich and consolidate through public policies that improve the education and training system (also technical and professional) whether at secondary or at tertiary level. For such policies to be effective, there must also be industrial policies, and policies for social inclusion and social welfare that gives impetus to local development. Policies are needed on a national and regional scale, but it is also necessary to formulate policies acting on an interregional scale, on territories such as that of the vast mechanical engineering production system in the north of Italy.

Training, it should be said, must be technical, but not only: to extend markets it's necessary to widen knowledge of the culture of the countries in which production units are to be set up or where products are to be sold. This is because the search for new customers is not based only on technical skills, but also on marketing skills, regarding which the universities in the region are already

[19] The degree to which the domestic market could play an important role in the country's growth is often undervalued.

[20] See the data referred to in note 14.

offering appropriate training. There is also a need for training for the management of enterprise networks: this is a strategy for sustaining enterprises' growth, not only in business partnerships, but also involving projects, and the managers of these networks are new nuclei of special skills required to exploit the project capabilities of enterprise networks[21].

In general, investments are needed – and not only public investments - for the effective transfer of codified knowledge acquired through the education system and of tacit skills learned through working alongside more experienced workers in production areas. The problem is not only the contents of studies. School-leavers and graduates need to be introduced into production contexts suitable to their qualifications, and enterprises' ability to exploit the potential of recruits in line with their training must be supported. The issue is understanding how to effectively integrate those skills inside the enterprise. The Law on apprenticeships could open the way for new programmes which are able to reconnect enterprises and society.

It's necessary to support generational turnover, a problem which has been around for at least twenty years in the context of small family-oriented enterprises. This turnover relates to managers, technicians and factory workers, but also to businessmen at the helm of family enterprises. There is, however a new phenomenon which is particularly worrying: the lower level of dynamism in the creation of new enterprises compared to the past. Mechanical engineering in Emilia-Romagna has always had the ability to create new businesses, which generate new processing specialisations and the production of new components or final products. If new enterprises are not set up, there's an overall deterioration in the production system due both to the loss of production capacity and the loss in variety and flexibility that stimulates the innovative potential of the system. Enterprises that don't get created and enterprises that close down are two phenomena that could be the focus of joint action. As Lena Ferrari, owner of a small mechanical engineering processing company in Modena writes; "Every company that closes is a squandered asset; it's a slice of know-how that goes to waste. Yet there are some really bright young people leaving university and technical institutions, who are able and with plenty of drive and enthusiasm. Why not get them working alongside a businessman who has problems in going forward with his enterprise? Put them into a business context in which they can introduce innovation and technology; perhaps, together with the businessman, who passes on his know-how, they can achieve new things and – I would go so far as to say – find new ways of doing business" (Ferrari, 2012). Trying new ways of doing business calls for an openness to change which needs to be wisely nurtured and which takes time to gain acceptance.

Generally speaking, the aim is to reinforce the "training" processes in society as a whole: it's necessary, in fact, to set up a multitude of channels that encourage a mutual understanding of needs and of the potential benefits deriving from networks of skills able to exploit new opportunities. Among these channels, we would cite *Officina Emilia* as an effective means for interaction between schools, families and businesses.

A final remarks deals with an open question: the appropriate scale of industrial policies. Emilia-Romagna can do much through policies on a regional scale, but the view of the production structure discussed above highlights the need for a systemic interpretation of regional action within the national and European scale. The Region must be able to take part in a dialogue with Europe; otherwise its policies will be less effective than they have been in the past, before Lisbon 2000, when the Emilia-Romagna Region contributed to planning community policies that subsequently directed regional policies. It's necessary to reactivate that virtuous circle of policy indications and measures, conceived on a European scale, in order to outline a European strategy that aims at creating a European platform for the mechanical engineering industry, of which Emilia-Romagna and the north Italian regions form a part, and in which they can play a directing role. In this framework, the regional and local measures set up could be more effective.

[21] In enterprise networks what counts is the project: in this sense the crisis has already accelerated transformations in knowledge terms (the structure of meanings on the part of single decision-makers: company owner, their children, etc) and in organisational terms.

Bibliography

Ahrweiler, P., 2010. *Innovation in complex social systems*, London; New York: Routledge.

Arrighetti, A. & Ninni, A., 2012. German and Italian manufacturing performances: a premise to a comparison. *Economia e Politica Industriale*, (2), pagg.5–16.

Becattini, G., Bellandi, M. & De Propris, L. cur., 2009. *A handbook of industrial districts*, Cheltenham ; Northampton (MA): Edward Elgar.

Berger, S. & Industrial performance center, 2006. *Mondializzazione : come fanno per competere? : cosa stanno facendo le imprese di tutto il mondo per vincere le sfide della nuova economia*, Milano: Garzanti.

Bianchi, P. & Labory, S., 2011. Industrial policy after the crisis: the case of the Emilia-Romagna region in Italy. *Policy Studies*, 32(4), pp. 429–445.

Bigarelli, D. & Russo, Margherita, 2009. Specializzazioni e reti di relazioni nel sistema produttivo della meccanica a Modena. *ERE Emilia-Romagna Europa*, (3), pp. 105–114.

Bonifati, G., 2012. Exaptation and emerging degeneracy in innovation processes. *Economics of Innovation and New Technology*, pp.1–21.

Brandolini, A. & Bugamelli, M., 2009. Report on trends in the Italian productive system. *Questioni di Economia e Finanza*, (45), pag.169.

Brusco, S., 2008. *I distretti industriali : lezioni per lo sviluppo : una lettera e nove saggi, 1990-2002* A. Natali, M. Russo, & G. Solinas, cur., Bologna: Il mulino.

Brusco, S., 1989. *Piccole imprese e distretti industriali : una raccolta di saggi*, Torino: Rosenberg & Sellier.

Cipolletta, I. & De Nardis, S., 2012. L'Italia negli anni duemila: poca crescita, molta ristrutturazione. *Economia Italiana, rivista quadrimestrale di Unicredit*, (2).

Coltorti, F., 2012. L'industria italiana tra declino e trasformazione: un quadro di riferimento. *QA Rivista dell'Associazione Rossi-Doria*, pp.7–51.

Feltrin, P. & Tattara, G., 2010. *Crescere per competere : le piccole e medie imprese in un mondo globale*, [Milano]: B. Mondadori.

Ferrari, L., 2012. Un'imprenditrice meccanica racconta. Available at: http://www.ingenere.it/finestre/unimprenditrice-meccanica-racconta [Consultato Agosto 27, 2012].

Giampaglia, A., 2010. *Analisi comparata sull'industria metalmeccanica in Italia e in Germania: agglomerazione spaziale, specializzazioni e performance*. Modena: Università di Modena e Reggio Emilia.

Ginzburg, A., 2009. Detriti tossici, sistemi territoriali aperti, nuove impalcature. *Il Ponte*. Available at: http://www.ilponterivista.com/article_view.php?intId=140 [Consultato Giugno 27, 2011].

Ginzburg, A. & Bigarelli, D., 2008. Le nuove Pmi. Available at: http://www.r-i.it/doc/LenuovePMI.pdf.

Giunta, A. cur., 2011. Reti di imprese e territorio. Tavola rotonda con A. Zazzaro, L. Cannari, R. Rabellotti e G. Viesti per la presentazione del volume «Ret di imprese e territorio» a cura di Alberto Zazzaro, il Mulino, Bologna, 2010. *QA Rivista dell'Associazione Rossi-Doria*, pp.113–142.

Hausmann, Ricardo et al., 2011. *The Atlas of economic complexity : mapping paths to prosperity*, Cambridge, Mass.: Center for International Development, Harvard University : Harvard Kennedy School : Macro Connections, MIT : Massachusetts Institute of Technology. Available at: http://www.hks.harvard.edu/centers/cid/publications/featured-books/atlas.

Hidalgo, C. A. et al., 2007. The Product Space Conditions the Development of Nations. *Science*, 317(5837), pp. 482–487.

Lane, D.A., 2010. Innovazione e distretti industriali. In *Processi di innovazione e sviluppo locale : teorie e politiche*.

Manello, A. & Rolfo, S., 2012. La meccanica strumentale in Germania e Italia: due modelli a confronto. *Economia e Politica Industriale*, 39(2), pp. 139–161.

Menzani, T., 2011. *La macchina nel tempo : la meccanica strumentale italiana dalle origini all'affermazione in campo internazionale*, Bologna: Clueb.

Russo, M. cur., 2008. *L'industria meccanica in Italia. Analisi spaziale delle specializzazioni produttive 1951-2001*, Roma: Carocci.

Russo, M. cur., 2010. *Processi di innovazione e sviluppo locale : teorie e politiche*, Roma: Donzelli.

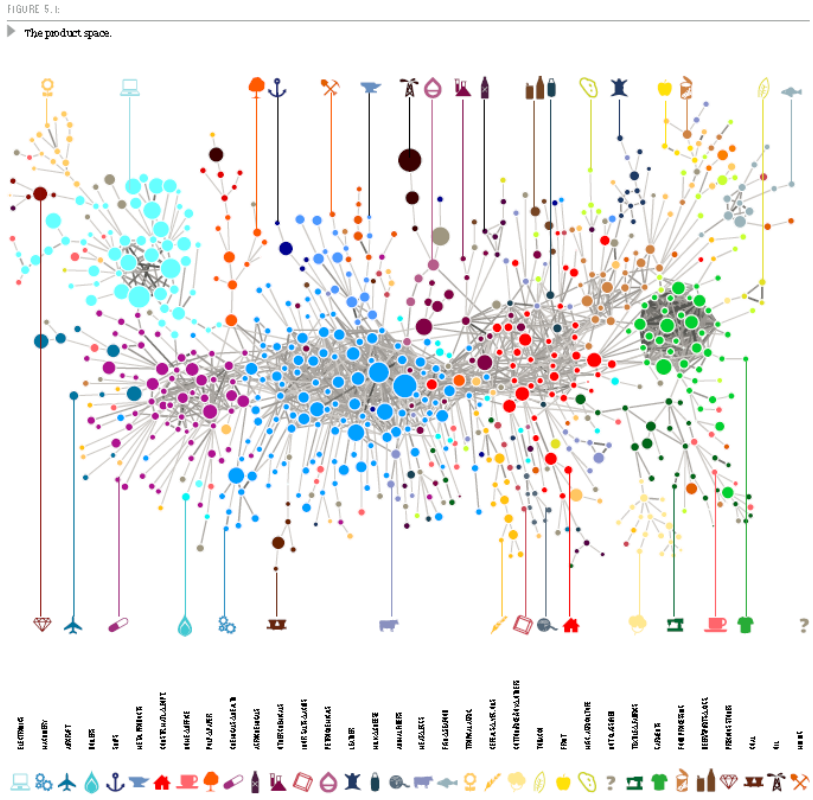
Russo, M. & Whitford, J., 2009. Industrial districts in a globalizing world: A model to change or a model of change? Available at: http://merlino.unimo.it/campusone/web_dep/materiali_discussione/0615.pdf.

Sardo, S., 2009. Brokeraggio tecnologico nel settore metalmeccanico in Emilia-Romagna: dal Parco Scientifico Tecnologico ex-SIPE a CRIT srl. Available at: http://merlino.unimo.it/campusone/web_dep/materiali_discussione/0614.pdf.

Whitford, J., 2005. *The new old economy : networks, institutions, and the organizational transformation of American manufacturing*, Oxford; New York: Oxford University Press.

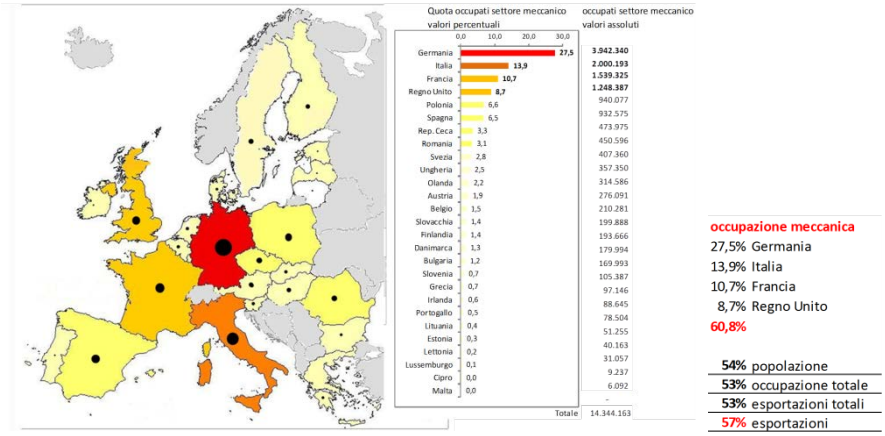
Zazzaro, A. cur., 2010. *Reti d'imprese e territorio : tra vincoli e nuove opportunità dopo la crisi*, Bologna: Il Mulino.

Fig. 1 Lo spazio dei prodotti: analisi del vantaggio comparato dei paesi secondo Hausaman e Hidalgo (2011, p. 45)



Fonte: The Atlas of Economic Complexity

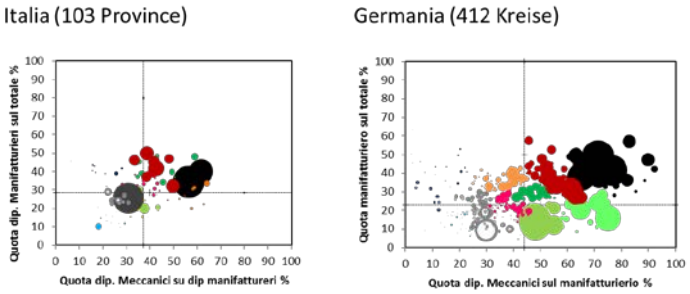
Fig. 2 L'Europa metalmeccanica: Germania, Italia, Francia e Regno Unito, 2008



Mappa realizzata con Philcarto (http://philcarto.free.fr)

Fonte: Elaborazione dati Eurostat_SBS | A. Giampaglia e M. Russo 2011

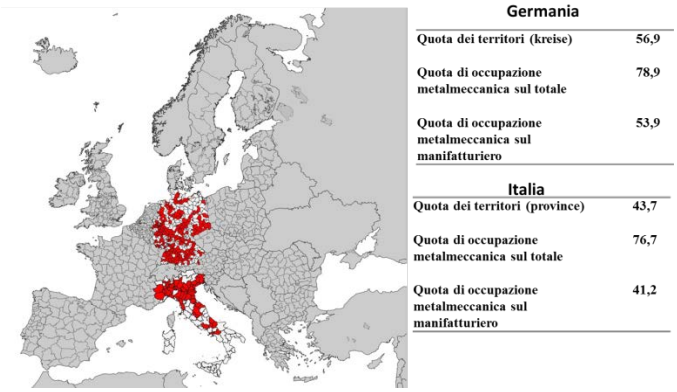
Fig. 3 Intensità di specializzazione dei territori Quota di occupazione meccanica e manifatturiera (2009), NUTS3 Italia e Germania



Nota: La superficie dei cerchi è proporzionale alla quota di occupazione metalmeccanica in ogni territorio sul totale dell'occupazione metalmeccanica nazionale. Le rette indicano il valore medio nazionale. Il colore dei cerchi fa riferimento alla tipologia di *cluster* di appartenenza

Fonte: Elaborazione dati Eurostat_SBS | A. Giampaglia e M. Russo 2011

Fig. 4 Intensità di specializzazione dei territori NUTS3 Italia e Germania (2009)

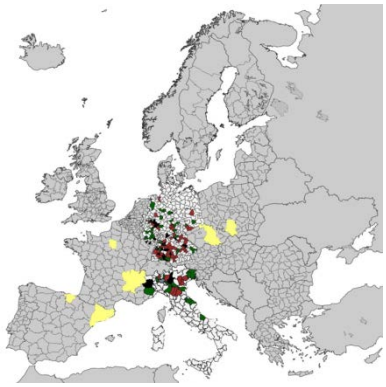


Germania	
Quota dei territori (kreise)	56,9
Quota di occupazione metalmeccanica sul totale	78,9
Quota di occupazione metalmeccanica sul manifatturiero	53,9
Italia	
Quota dei territori (province)	43,7
Quota di occupazione metalmeccanica sul totale	76,7
Quota di occupazione metalmeccanica sul manifatturiero	41,2

Nota: sono rappresentati i territori con la maggiore quota di occupati metalmeccanici/manifatturieri

Fonte: Elaborazione dati Eurostat_SBS | A. Giampaglia e M. Russo 2011

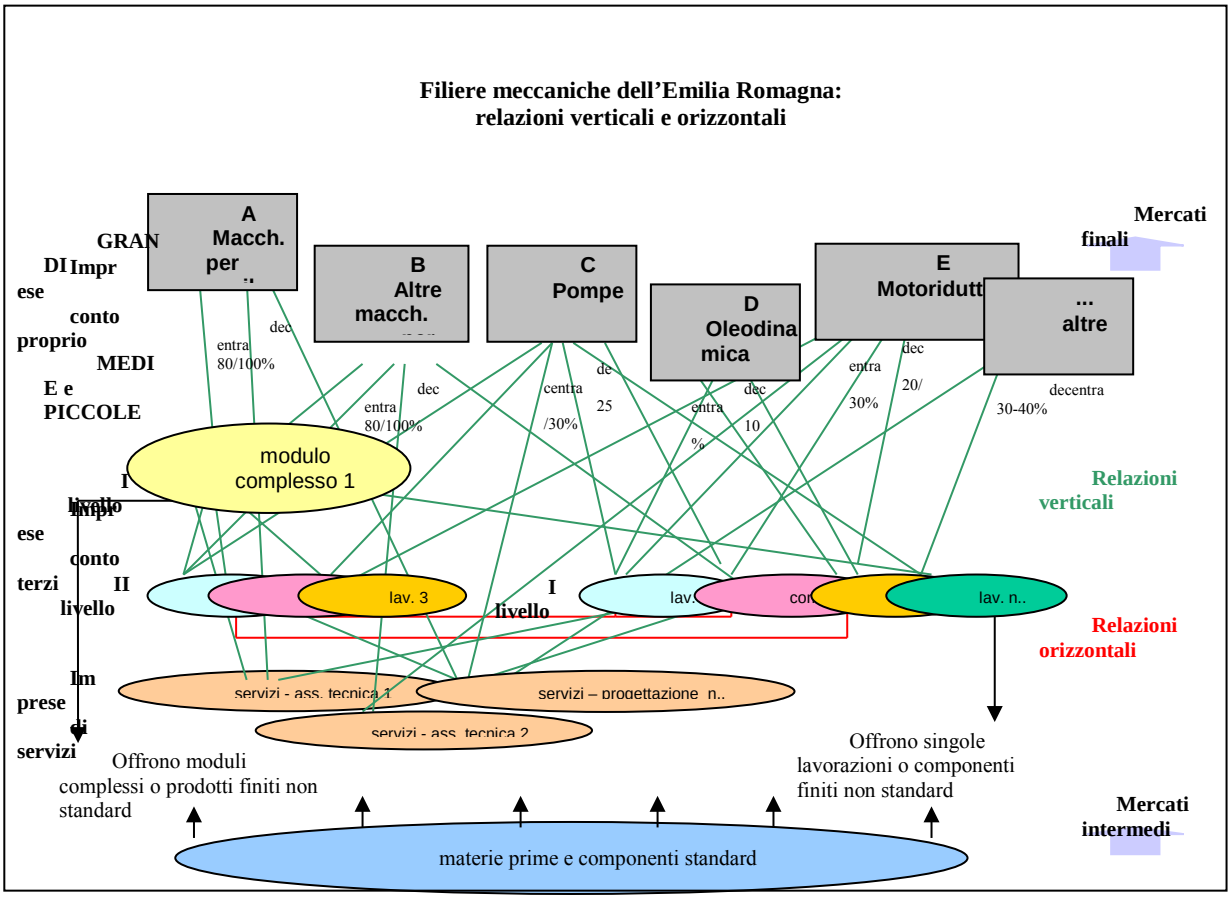
Fig. 5 Intensità di specializzazione meccanica dei territori NUTS3 in Europa (2009)



In Italia e Germania sono evidenziati in nero, verde e marrone i cluster 1, 2 e 3 che hanno la massima specializzazione manifatturiera e meccanica

Fonte: Elaborazione dati Eurostat_SBS | A. Giampaglia e M. Russo 2011

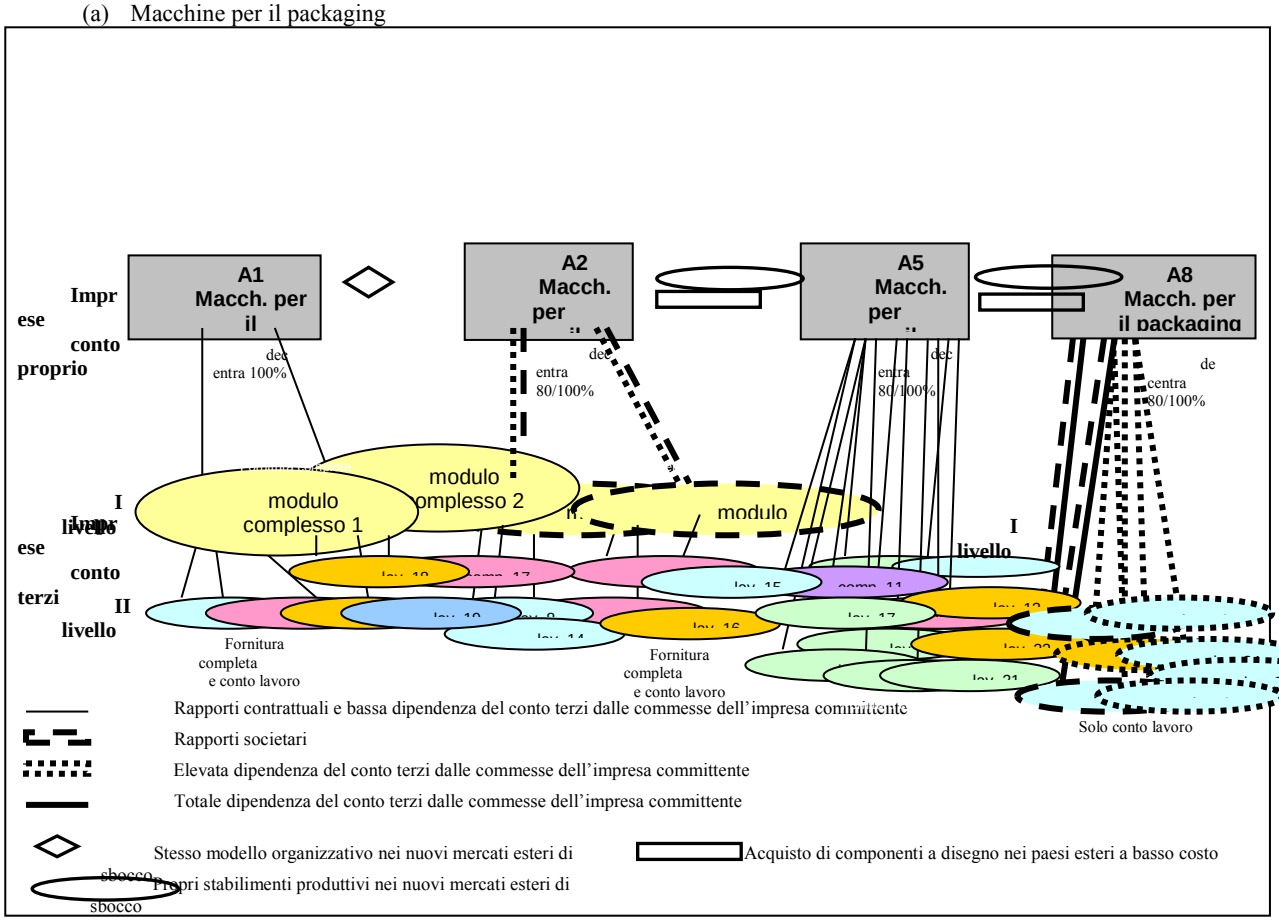
Fig. XX Filiere meccaniche dell'Emilia Romagna: relazioni verticali e orizzontali



Fonte: Fonte: Unimore-R&I, L'impatto della crisi internazionale sulla subfornitura meccanica in Emilia Romagna, 2011

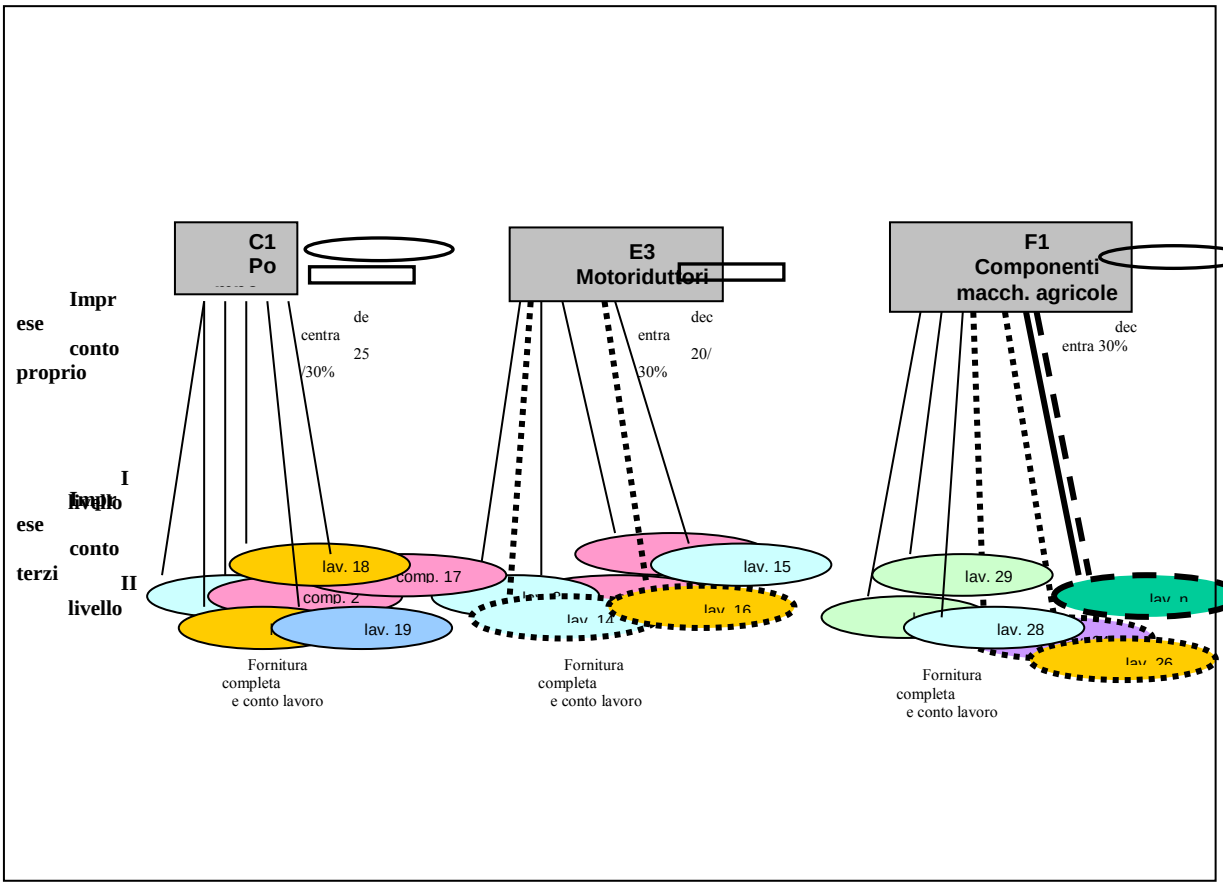
Filiere meccaniche dell'Emilia Romagna: modelli organizzativi e di integrazione verticale

(a) Macchine per il packaging



Fonte: Unimore-R&I, L'impatto della crisi internazionale sulla subfornitura meccanica in Emilia Romagna, 2011

(b) Pompe, motoriduttori, componenti per macchine agricole: casi aziendali



legenda

Rapporti contrattuali e bassa dipendenza del conto terzi dalle commesse dell'impresa committente

Rapporti societari

Elevata dipendenza del conto terzi dalle commesse dell'impresa committente

Totale dipendenza del conto terzi dalle commesse dell'impresa committente

Stesso modello organizzativo nei nuovi mercati esteri di sbocco

Propri stabilimenti produttivi nei nuovi mercati esteri di sbocco

Acquisto di componenti a disegno nei paesi esteri a basso costo

Fonte: Unimore-R&I, L'impatto della crisi internazionale sulla subfornitura meccanica in Emilia Romagna, 2011