Automotive Strategy and Organization 1

Automotive in transition
Challenges for strategy and policy

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Introduction

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This work comes from the worthwhile initiative from Andrea Stocchetti and Francesco Zirpoli, that, willing to commemorate the mastership of Bepi Volpato, in the autumn of 2012 collected, in the wonderful background of the Ca' Foscari University in Venice, a pool of scholars and researchers, all devoted since several years to the automotive industry analysis, under different perspectives. This panel, that probably considered it also a moral obligation due to the same Volpato lesson, kindly invited myself, as a practitioner in the area of industrial policy for the automotive sector, in order to try to stimulate their discussion.

I kept very proudly since the first moment the chance to collect a lot of insights and new ideas for my work, and moreover a lot of reflections, questions and answers came to me from the reading of all the chapters of this book.

The main questions that arose since the first meeting were all around the sometimes clear, sometimes less clear, consciousness that we are affording a phase that is surely of crisis for the automotive sector, but, as always in the case of a «transitional» phase, a phase of great opportunities.

All the doubts were posing indeed questions like:

- Are we experiencing the automotive sunset, both like a reference product and a reference industry, for an advanced economy? And, if the answer would be positive, how to explain the rapid growth of the product and the industry in the fast growing economies like China, India, Russia, Turkey, etc.?
- How is the «mobility model» evolving, with reference for example to «individual, or personal, vehicles», and new public transport modes (i.e. car sharing, company cars, etc.), and which is the role of tradi-

tional drivers for the sector like the «driving pleasure», the «freedom feeling» or the «social status» represented by luxury cars?

- Are those technologies like for instance electrification (on the product side), or process flexibility by automation (on the manufacturing side), or ICT and «virtualization» (on the design side), representing an «evolution» or a «revolution» path? And if the answer goes for the latter, why are they exploiting right now, ten or twenty years later their first appearing?
- How are the manufacturing technologies, or those applied to the new product development process (NPD), impacting on work organization inside the car maker (OEM), between it and its suppliers, or even in the framework of the global capital markets?

Only to summarize the most of them…

After having read the different papers it comes to me the reflection that the automotive crisis in the years 2008-2009, that took place at the global level but specially for the countries were a stronger and long-standing tradition in the car making was in place (Europe, USA, Japan) went overlapping afterwards, in those three economies, on three very different phenomena, roughly:

- a general rethinking of the development path in the USA, where the Obama administration gave a clear steer toward manufacturing, from the previous «mantra» of dematerialization and development of the service sector (a refocusing that in Europe has decisively been adopted also from the UK);
- a «systemic» crisis in Japan, strongly related to the China growth, and seriously impacted by the terrific tsunami of 2011;
- the up to now useless effort of Europe to harmonise its very different economies in terms of models and performances.

As one can deduce from the fact that those considerations are at the same time suitable for the automotive sector as well as for the economy as a whole, two main conclusions can at least be sketched out:

- the first one is that the automotive production and market still represent, on the global scenario, one of the most important, if not «the» most important, indicator of the «real economy» trend;
- the second is that the combined effect of globalization and technology innovation has since a four to five years reached the top of the «industrial production pyramid», i.e. the car, that is indeed the industrial

production iconic product, so bringing us in a phase of radical changes as well as in terms of consumption attitudes (the sustainable mobility), technologies (electrification, fuel cells, natural gas, etc.), industry global structure (new Asian or South America entrants, merger and acquisitions, etc.).

Therefore it seems as the present situation shows a series of analogies with that of a century ago, when the car was barely appearing on the world scene. This make very complex and tricky the task for the policy maker, that, as a good theory and practice, should avoid to intervene in those situations characterized by high «uncertainty» (lack of data, or conflicting information) and «ambiguity» (signals with multiple and different interpretations).

On the other side it is true as well that in those situation it is especially needed from the business sector any kind of address or orientation from the policy side, in order to settle out a more clear development path and to ignite with a stronger emphasis a growth dynamic.

Therefore it is worthwhile to mention that in those situation the typical policy measure that is largely spreading, and universally accepted, is that of establishing some form of public-private «fora» from time to time called «industrial (or technology) platforms», «public-private-partnership», «joint technology initiatives», «high-level-groups» and so on (like those for instance launched by the European Commission), or «Councils», or even «Circles» (e.g. the Automotive Council in the UK), where to let «germinate» from the discussion between all the stakeholders, adequately guided and coordinated, those needed indications.

Looking at the Italian case, the above mentioned considerations take an even more net shape (as well outlined by Enrietti and Calabrese): a car market that steadily grew at a good pace for almost forty years, even if with some episodic falls, from time to time sustained by mean of public subsidies,[1] that induced a mobility model dominated by individual private cars (Italy has one of the highest motorization rate in the world, as well as one of the oldest fleet in Europe and one of the smallest company cars fleet in Europe), but also a car market that felt by 48% in the last five years period (but without a sensible effect on the motorization rate!), igniting a production fall of 56% in the same period, also because the

1. A brief reference can be found in the chapter elaborated by Bubbico, with the sole omission of the last one, the scrapping incentives scheme launched in the years 2009-2010, coordinated with those launched almost all over Europe, and that summed up to almost one billion euro of Italian taxpayer money.

same production substantially rely on one single car maker (sole case in Europe), but by apparent paradox maintaining almost unaffected the parts and components industry, that diverted up to 50% of its production to export. Even if, as the work of Enrietti and Calabrese shows, a concentrating trend between the suppliers arose.

The valuable papers of this book can then help in understanding how and why Italy seems to represent, once more, an effective living laboratory, for testing, verifying and validate some trend that are actually in place on the global scale.

For those reasons, the considerations and problems elicited from the present work can became a valid reference for someone with the aim to support the policy making process, specially in the view of the forthcoming «Italian Automotive Council», that has already been announced and should be putted in place in the next months.

One should indeed reflect on the impact over the Italian automotive industry (OEMs and suppliers), its business processes, and its new product development processes, as described by Trombini and Zirpoli, coming from the trend in product platform standardization (e.g. between the ones of Fiat and Chrysler), or on the effect of the stretching of one car model life-cycle, after a longstanding period of further and further reduction, on the market behaviour.

Those trends of course realign the relationship between the sole Italian OEM (that is experiencing a steep drop in production at its Italian plants) and the supply chain operating on the same territory (that, on the contrary, is relying more and more on export markets). Where this realignment seems to act especially on the usual «know-how» flows. Indeed this relationship once acted, at least in some areas of the country (Piedmont, following Pirone), like those of an actual industrial district, where two critical knots were represented by the Fiat Research Center and by Elasys, and it is no coincidence that those were at the same time the largest and best performing private research centres, respectively in the North and in the South of Italy. But again Pirone as well as Bubbico remember us another Italian paradox, represented by the fact that the car making process is by the time based almost exclusively in the centre-south of Italy plants, while instead the supply chain production is mainly based in the centre-north, from which it serve the foreign markets. A kind of geographical distribution that if in the past was also supported by the strong relationship between the southern plants with local research institutions (the Iveco's and Getrag's ones in Puglia, with Politecnico di Bari and Fiat Research Center in the same city; the Fiat plant in Pomigliano with Elasys or the National Research Council - CNR Institute for combustion engines in Napoli), seems today to have weaker roots. But it has to be said, as a proof of the fluid phase in which we live, that some evidence of opposite trends is rising up: like the synergies between a former newcomer supplier like Adler, and the local CNR led technological district for new materials (Imast), that allowed the former to reach a degree of technological excellence on carbon fibre working; or in Abruzzo region, the involvement of Fiat and Honda (motorcycle) plant in the establishment of an «automotive campus» for research and training.

In this scenario some hints for possible change path can be briefly outlined, as, for instance:

- the Fiat decision of investing in some assembling plants in the north of Italy, like that of Grugliasco (Torino) and the one lastly announced in Mirafiori (Torino);
- the above mentioned case of Adler, were a supplier evolve toward a higher technological level (as described by Pirone), and decide to invest in an advanced production plant in Campania (south) to manufacture a hi-tech component (the carbon fibre body) for a car that is assembled in a plant located in the north (Modena).

Finally it come back to me the experience of the Industria 2015 Programme (an industrial innovation public funding policy program, launched in 2008 on five areas, one of which was that of innovative solutions for sustainable mobility, with an endowment of around 200 M€) that succeeded in letting come out the connections, in terms of know-how, between the most important OEM (not only car makers, but also bus, commercial vehicles, offroad vehicles producers) and their most innovative suppliers. Even if those innovation projects afforded some administrative troubles that in some cases vanished the effort of reaching tangible results.

That concept of explicating the know-how relations between OEM and its suppliers as a task for the industrial policy, is the one that Pirone recalls, when he describes the process of mutual learning between the twos and specially when he emphasizes the critical aspect of responsibility over innovation. Only as a hint it seems important to me to underline that indeed the cited Industria 2015 Programme was based on two critical points: the realization of an iconic product (the totem) that should have embody all the innovations distributed along its «Bill of Materials» under the responsibility of any supplier hierarchically organised.

All the problems that the «modularity» approach seems to bring with, furthermore, suggest to us that the OEM dealing with this approach needs a higher control degree over its suppliers, and specially over the knowledge flows inside and outside its supply chain, but this need barely fits with the corresponding need of managing procurements for common platforms on the two shores of the Atlantic Ocean.

The same global trend toward the standardization of product platforms, indeed, finds very different behaviours in the industry, as a proof of concept of the «fluidic» phase which we are dealing with, if one consider for instance the brand proliferation in Volkswagen, as opposite with their shortening in Fiat, or the same Fiat strategic decision to assign to the Italian plants the mission of representing the «luxury pole» in the company framework.

Here the work of Cabigiosu, even if centred on the electric motorization, offers us a proof of how the product architecture reflects on the supply chain architecture, and its organisation processes, leading us again to that «uncertainty and ambiguity» with reference to the product itself, that we can bring back to the organisation model, emphasizing the need, in the actual phase, for institutional bodies where trying to elicit the best models and practices to deal with that uncertainty, like the cited «platforms» or «councils».

It is worthwhile to mention under this respect that the «new entrants», like those from the Asian countries, seem to better deal with their products and supply chain management models, under the paradigm of modularization.

The said core problem of the OEM control over the supply chain is then extended by Buzzavo, from the know how flows across the design and manufacturing suppliers, to that of the involvement of the dealers network. And another one should be added that is that of the car makers financial branches, as the USA industry restructuring process teach.

And at this point I'd like to cite a personal experience, when I was involved at the reengineering of the Fiat NPD process. Indeed working on the early NPD process phases, we thought of involving the main dealers by asking them for which contribute they could offer to the process. I was a little bit astonished from the fact that they were really happy for this involvement, that surprisingly had never been tried before, but when we asked for their projection over the next 4 to 5 years, they said that they barely could have predicted the next six months market, and with a really pour confidence over a one year timeline. No chances of assuming by them any responsibility over a longer period, as the car design process claims to the car maker.

But if the uncertainty and ambiguity over the future is the typical situation at the present time, it is as well as true that new technologies applied to the design process, virtual prototyping, and the high flexibility degree reached by the manufacturing process, thanks to automation, could actually give today to the dealers a more proactive role.

It is also by looking at those aspects that a «Council» could represent in Italy a fundamental tool to settle up some kind of «code of conduct» and fundamental governance models, also in the marketing and financial areas.

The present turbulence on the manufacturing side finds its counterpart on the consumption behaviours in the work of Stocchetti, from which it seems to come out, on the one hand, the trend toward «personal vehicles», and on the other hand the growing reliance on mass public transport, with a «niche» for satisfying the usual «driving pleasure» or «freedom feeling» that come from cars.

Here the case of the city of London seems to me emblematic. Indeed the UK and London severe policy against traffic congestion (with the declared aim of making of London a better place where to live, and «to attract» there more citizens! as I could personally ear from recent meeting with local authorities) did not result in a car market depression, but on the contrary were followed by a growing market (the only case in Europe) and a substantial development of car assembling, with a strong export share.

And another important consideration relies in the growing interest of car makers and traditional mobility operators over the car-sharing business model, as the recent acquisition of Zipcar from Avis (as reported by Garibaldo), or the «Car2go» initiative by Daimler, or the same Italian network of such services, largely based on Fiat cars, seems to confirm.

And if it is true that at the last Car Shows in Europe, the «personal vehicles» seemed to represent the only real news, one should also reflect on the not so performing experiences of the Smart by Mercedes, or the C1 by BMW, or even Segway. Not to mention the fact that the year by year growing markets of the emerging countries shows dynamics very close to those of the western economies in the past decades.

Again the role for a place like a Council, where to share and coordinate trends and paths, becomes crucial, as Finotto explains, even when the solution is found on the ground of new entrepreneurship. For instance in the case of new ventures based on new electrification technologies, Finotto reflects on the real case of Pagani, where it is clear the importance of a «traditional» «connective tissue» for the emerging of the new business. And that real case brings to me some critical question about a similar recent case, but failed, that regarded another historical Italian brand, De Tomaso, whom revamping was projected over a new manufacturing technology, quite similar to that of Pagani, and on the intervention of some public policies. The similarities are indeed several, if one reflects over the circumstance that the technology at the ground of the Pagani project had been developed in Lamborghini in the framework of a publicly funded project, and perhaps for that reason considered from the company not so strategic to be developed, as Pagani did by himself. So that one could even consider Pagani as a spin-off favoured by public industrial/research policy.

At the end the role of a Council should be indeed that of creating opportunities for pursuing technological and organisational trials, in order to shed some light over the uncertainty fogs of the present.

And Garibaldo again reminds over the circumstance that any revolving in the sector should be the output of a «collective» process. With which in mind I'd like to recall the objectives of some recent industrial policy initiatives, like the establishment of a «Network Contract» (especially between SMEs), the realization of prototypes (demonstrators) under the cited Industria 2015 Programme, or the establishment of the *Istituti Tecnici Superiori* (ITS – technical schools of tertiary degree) aimed at the valorisation of the longstanding tradition of technical know-how developed in the Italian industrial districts.

And most of those policy measures come back also in the work of Pirone, where he refers to the «enterprise network» or point at the critical issue over the responsibility for innovations in the supply chain.

The importance for a Council finally comes also from the work of Calabrese, from which for instance a reflection arise when it is mentioned the «shock» produced in the French industry, and public opinion, by the somewhat failing of the public policies focused on car electrification. And as a direct actor I can also debate on the very poor appeal of a recent policy measure in Italy, aimed at promoting the substitution of old vehicles used for work purposes by SMEs, craftsmen, taxis etc. with low emission vehicles (*BEC veicoli a Basse Emissioni Complessive*).

The British policies at the end seem instead to be the ones that have reached the best results. And from some recent personal contacts with the UK authorities, the activities pursued under the Council umbrella are going in the direction of attracting new suppliers to produce inside the UK throw:

- the establishment of a sectorial research centre for the whole supply chain (a role that up to few years ago was played in Italy by the Fiat Research Center / Elasys);
- the launching of an agency for attracting investments in the country by foreign suppliers.

The key seems to be that of a stronger and deeper cooperation between the private sector (OEMs), public administrations (Department of Business Innovation and Skills), and public-private partnership like the Technology Strategy Board.

If Italy will apply and customise this strategy it could better play a role also in the European bodies framework, were, as Calabrese reminds us, a stronger work has to be done in order to better harmonise different policies aiming at industry, research, work, welfare, health, environment, climate, only to cite those more close to the automotive industry interest.

Those final considerations moreover would suggest to be more cautious asking, as Bubbico or Garibaldo does, urgent national industrial policies for the sector, and complaining the lacking of coordination for the policies at the local level.

It is worthwhile to mention indeed that most of the local policies cited in those works actually descend from national policies like those elaborated inside the *Accordi di programma* (Programme Agreement), national guidelines or Governmental Agencies, as well as some direct industrial policies were in place in the last years, as from some of the examples cited above.

The actual problem seems to me the one of agreeing on those policies at the different national and local level, and moreover between all the involved stakeholders, before than between the political parties, in order to really put them in place, to pursue the same policies over the years, and to really measure and assess their effects. Not to mention the importance to have a place that can act as a link between the public and the private sector, as well as between the OEMs and the suppliers, and between the European, the national and the local policy level.

For those reasons I believe that an Italian Autmotive Council could be the answer.

Part 1

Perspectives on firms’ strategy and organization in the global automotive industry

1

Innovation processes in the car industry: New challenges for management and research

Giulia Trombini and Francesco Zirpoli

ABSTRACT *Over the past decades the development of a car has become a complex activity involving skills and resources from a variety of industries and actors, and requiring the accomplishment of tight regulatory norms and market needs. Technological and market forces have led incumbent firms to radically change the organization of their innovative activities, shifting from a closed vertically innovation model to a distributed one. The aim of this study is to review the main challenges carmakers are currently facing and the organizational and strategic solutions adopted to perform innovative and development activities within vertically fragmented networks. The chapter casts light on the organizational and strategic challenges of downstream development activities, then it also tries to overview the strategic role of up-front research activities, namely the research activities leading to patenting. The main changes brought by the distributed innovation model on new product development activities are discussed, focusing on the principles guiding outsourcing decisions and the governance mechanisms carmakers use to manage networks of external suppliers. The study, then, reviews the role of patenting in the industry as a means for carmakers to appropriate value from innovation in vertically fragmented networks. Finally, it discusses the changes on the organization of innovation activities that the emergence of the electric car-standard may imply for carmakers' innovation strategy.*

1 Introduction

Over the past decades, the development of a car has become a complex activity requiring skills and resources from a wide variety of actors and industries. Due to the enlargement of the car's technological components (e.g. electronics components) and the rise of new technological trajectories (e.g. the «electrification» trend), carmakers have been increasingly needing to master a wide variety of technological fields in order to stay at the forefront of technological developments (Maxton, Wormald 2004). Moreover, market pressures and tight competition have pushed carmakers to speed up their product development process while constantly reducing costs and improve quality (Clark, Fujimoto 1991).

In order to respond to such twofold (technological and market) challenge, carmakers have revolutionized their product development process. In the first place, they have changed the new product development organization. Starting from the beginning of the 1990s, they implemented solutions such as (1) the *heavyweight* project manager (Wheelwright, Clark 1992), emphasizing the role of the project leader in integrating knowledge and development efforts within teams, (2) multi-project management tools, for reaping the benefit of sharing components across projects (Cusumano, Nobeoka, 1992), and (3) the integrated development of product families, in order to reap economies of scope and scale by leveraging common product platforms (Meyer, Utterback 1993). As a consequence, from an organizational point of view, new managerial roles diffused such as the product manager, platform and program managers (Clark, Fujimoto 1991).

In the second place, carmakers started establishing a large number of external ties with suppliers. Such move not only allowed carmakers to quickly access specialized knowledge, thus facing technological novelty and uncertainty, but also contributed to reduce the development time and costs of new product development activities (Clark 1989; Cusumano, Takeishi 1991; Nishiguchi 1994). The central role of external sources of innovation contributed to complicate integration and coordination problems in new product development process. The most common solution to address such problems was the use of *guest engineering* and new product development teams that involved also suppliers' engineers (Nishiguchi 1994).

On the whole, technological and market pressures have made the process of developing a new car an extremely complex organizational task. Thousands of different parts, often developed and manufactured by suppliers, have to be integrated into a product that must be both highly reliable, e.g. complying with strict regulations, and performing, e.g. matching sophisticated customers' expectations. In this respect, market segmentation and customers' preference volatility have made investments in new product development very risky: time to market reduction, quality improvements and cost cutting have become key variables for reducing the sunk costs related to launching a product that once on the market may not be well accepted by customers.

In light of the rising product development complexity, the aim of this chapter is to provide an overview of the current challenges that carmakers face, taking both the carmakers as well as the broader industry level (i.e. suppliers' networks) as units of analysis. The aim is to describe the organizational solutions adopted by carmakers to carry out both upfront research as well as new product development activity and to understand their link. The chapter, unlike the usual take on innovation processes in the automotive industry, not only casts light on the organizational and strategic challenges of downstream development activities (i.e. the development process of new car models), but also tries to overview the strategic role of up-front research activities (i.e. the research activities leading to patenting). These ones, with few exceptions (Antonelli, Calderini 2008) have not been investigated in the literature. This leaves a gap in our understanding of the contribution of up-front research activity in explaining carmakers' innovative performance.

The chapter is organized as follows. First, we highlight the major challenges carmakers face in adopting a distributed innovation model. Specifically, as far as new product development activities are concerned, we focus on integration and coordination problems with external sources of innovation and the related organizational solutions OEMs adopt in order to benefit from division of labour while minimizing the risks of decay in technological competences and architectural knowledge. Then we shift our focus to the role of upfront research leading to patenting and review the role of patenting in the industry as a means to appropriate returns from innovation in fragmented vertical networks. Finally, the study reviews the potential impact on the organization of innovative activities that the «electrification» of the car may cause. The chapter concludes by drawing the managerial implications emerged from the analysis and highlighting avenues for future research.

2 Organizational challenges

2.1 Division of labour within the industry value chain

As mentioned in the introduction, the car is a multi-technology product, namely an artefact made up of components that embody a number of technologies. Components are distinct portions of the product that perform specific functions and are linked to each other through a set of interfaces defined by the product architecture (Brusoni, Prencipe, Pavitt 2001). In the past decades, the range of disciplines relevant to the design, development and manufacturing of a car has largely expanded in both breadth – the number of relevant fields – and depth – their specialization and sophistication (Wang, von Tunzelmann 2000). Given the increasing expansion of the set of knowledge and resources, carmakers rely on specialized suppliers in order to complement their research and development efforts and to cope with the increasing product and technological complexity. The outsourced activities comprise different phases of the innovative process, from design to engineering and production tasks.

Managerial literature outlines that relying on a network of external suppliers provides OEMs with several benefits that, ultimately, positively impact the firms' innovative performance (Clark 1989). Indeed, suppliers' involvement in the innovation process provides access to specialized and tacit knowledge that for OEMs would be difficult to replicate in-house. Further, supplier's expertise and comparative advantage in the performance of specific tasks decreases the costs and time of design and engineering phases of the development process. Finally, by relying on a network of several suppliers, firms have access to heterogeneous and diversified technological competences.

Despite the outlined benefits, the division of labour along the industry value chain poses important challenges to carmakers. Firstly, firms have to govern multiple and concurrent ties in order to access external knowledge and skills; OEMs have to manage complex portfolios of relations with external suppliers, selecting appropriate governance mechanisms to boost inter-firm collaboration while minimizing partner's opportunistic behaviour. Secondly, they face a key organizational decision: which components/capabilities should be outsourced and which should be retained internally? In the next sections, we will analyse both issues and describe the organizational solutions helping firms to benefit from a distributed innovation model while coping with its complexity.

2.2 Coordination and governance mechanisms

Managing a network of external suppliers requires carmakers to identify the efficient governance mechanism in order to access external knowledge and skills while avoiding issues of opportunism, knowledge leakage and appropriability. The choice of the governance mechanism is key in determining partners' incentive to cooperate. Under specific circumstances, different governance forms might lead to heterogeneous performance outcomes in terms of partners' coordination, knowledge sharing and innovation output. As outlined by the broad literature on alliances (Colombo 2003; Oxley 1989), contingent on the motives and content of the exchange, some organizational forms are more suitable than others in easing and coordinating partners' interaction.

Transaction costs literature pinpoints that the choice of the governance structure is dependent on the contractual and appropriability hazards firms face in the technology exchange (Oxley 1997). The higher the complexity and specificity of the exchanged product, the more likely that the relationship is governed by a hierarchical mechanism in order for partners to align incentives to cooperate and cope with product complexity (Kogut 1988). Hierarchical forms, such as joint ventures, provide firms with the opportunity to restrain opportunistic behaviour and hold-up issues. Similarly, when appropriability concerns threat the exchange, transaction costs literature predicts that firms will recur to hierarchical governance structures in order to monitor knowledge flows and avoid unintended knowledge spillovers and innovation circumvention issues.

Another stream of research – the competence perspective literature – argues that the choice of the governance mechanism is dependent on the degree of overlap between the technological competences of the partners involved in the transaction (Colombo 2003; Mowery Oxley, Silverman 1996). A high dissimilarity in partners' technological bases hinders the exchange and learning opportunities, leading partners to choose a hierarchical governance form based on tight coordination mechanism in order to optimize the technology absorption process and hence the knowledge transfer.

Traditionally, in the automotive industry, OEMs manage networks of external suppliers through a diversified portfolio of contractual arrangements, ranging from traditional arm's length market transactions to more hierarchical governance mechanisms such as formal alliances and joint ventures. Bensaou (1999), in reviewing the type of carmaker-supplier relationships, proposes four modes of exchange: market exchanges, captive buyer tie, strategic partnership and captive supplier tie. The former – market exchange – is used for highly standardized products based on mature technologies that require little engineering efforts and expertise from the supplier. Given the standardization and maturity of the underlying technology, these ties require neither idiosyncratic investments on both parties to the transaction nor coordination and knowledge sharing mechanisms.

Unlike market-based exchanges, captive buyer relationships are characterized by an asymmetric commitment of the partners: the carmaker is held hostage by the supplier. Suppliers typically control a proprietary technology and benefit from a strong bargaining power over the OEM (Bensaou 1999). These are contingencies where the exchange involves complex components that require customization, but do involve stable technologies (e.g. bearings, glass products). The carmaker heavily depends on the supplier specialized skills and assets.

Strategic partnerships are usually associated to the exchange of highly customized and complex components/subsystems, for instance the breaking system or the air-conditioning system. Due to the technology and capabilities requirements, both the OEM and the supplier put highly specific assets into the relationship. On its side, the carmaker has to undertake tangible and intangible investments relative to the supplier's component, given the high interdependence between these components and the rest of the vehicle. Suppliers, on their side, develop design and production skills tailored to the buyer's requirements. Hence, due to the undertaking of co-specialized investments on both sides of the transaction and the need of extensive coordination mechanisms to cope with technological complexity, partners recur to strategic partnerships to manage the tie.

Finally, captive supplier ties refer to those asymmetric relations where the supplier is held «hostage» by the carmaker and commits large specific investments to hold the customer and stay in the market. The exchange involves complex subsystems based on a new technology typically developed and owned by the supplier but whose commercialization depends on the carmaker.

In light of these different outsourcing modes, the choice of governance structure to manage the supplier relationship greatly influences the capability of the carmaker to involve external knowledge sources in its innovation activities. A mismatch between the type of relationship and the content of the exchange might produce negative effects from outsourcing, hindering the ability of carmakers to benefit from an open innovation model. Such «matching» is indeed very complex as carmakers often cooperate with the same supplier on a set of multiple and concurrent projects, each featuring different level of involvement of the supplier in the new product development process of the carmaker (Zirpoli, Caputo 2002). In this respect, the matching of the governance structure and the type of relationship must be managed at the level of the single project rather than at the firms' one.

2.3 *Outsourcing decisions and the scope of the knowledge base*

The second key challenge posed by an open innovation model is related to carmakers' decision on which disciplines and components should be developed and produced in-house and which ones are to be contracted out to suppliers. In performing innovative activities, OEMs face two divergent objectives. On the one hand, they aim at exploiting flexibility and economies of specialization by outsourcing design and engineering of components/subsystems to suppliers. On the other hand, they need to base their competitive advantage on the capability to introduce breakthroughs and new product architectures. Indeed, firms need to reconcile economies of specialization while remaining integrated in the knowledge domain (Brusoni et al. 2001).

In the past, management scholars proposed modularity as the guiding principle in outsourcing decisions (Sanchez, Mahoney 1996). Through the specification of standardized components interfaces, carmakers could outsource the design and development of entire subsystems and reduce the coordination mechanisms with the suppliers for the development activity. Further, through modularity, firms could increase the specialization of their knowledge base and focus on the product-architectural knowledge, since the component-specific knowledge was left to the specialized supplier.

Recent studies, however, pinpoint the limits of modularity and the threats it poses to carmakers in effectively relying on external sources of knowledge (Macduffie 2012). Many carmakers incurred negative effects when implementing design and engineering outsourcing. In this respect, Fiat is a leading example. During the 1990s, the heavy reliance on external suppliers in the engineering and design phases of new product development activities led the firm to a gradual decay in technological and component specific skills, which ultimately hurt its capability of managing component interdependencies and above all product performance. Zirpoli and Becker (2011) pinpoint two main reasons for the negative effect of outsourcing activities based on the modularity principle. The first one is related to the intrinsic features of the car, whose product architecture is characterised by persistent integrality. This restrains the degree of «modularization» of the product. The overall performance of a car, in fact, is not dependent only on the performance of the specific components but also on how these different components/subsystems interact with one another. Hence, it is risky to outsource activities on the basis of the product architecture, since vehicle-level performance cannot be attributed to particular components.

The second reason is related to competence accumulation issues. Due to the distributed learning process characterizing the automotive industry, the carmaker acts as system integrator: it coordinates the work of suppliers and manages the relevant technological and organizational interfaces (Brusoni et al. 2001). However, by heavily outsourcing the design and engineering of specific components and subsystems, OEMs loose knowledge and familiarity with component-specific technologies. This loss hinders their understanding of potential product interdependencies, ultimately weakening their capability to act as system integrator. Hence, the key challenge carmakers face in their innovative activity is the following: how to benefit from outsourcing while concurrently feeding internal knowledge domains both in component and architectural knowledge?

The achievement of a balance between economies of specialization and competence accumulation is non-trivial. However, according to recent studies in innovation management (Brusoni, Prencipe 2006; Zirpoli 2010), this challenge can be accomplished through the adoption of specific solutions in the organization of innovation activities. OEMs need to maintain in-house technological and engineering capabilities in order to effectively coordinate the work of suppliers, and this calls for organizational solutions that favour the accumulation of competences. In this respect, the division of innovative labour between the OEM and its suppliers should be based on this principle rather than on pure product architecture and cost-efficiency principles, traditionally proposed by the modularity literature (Sanchez, Mahoney 1996). The division of labour should be such that guarantees the system integrator opportunities of learning-by-doing in component-specific knowledge as well as capabilities to introduce new product architectures. Organizational solutions that favour in-house learning opportunities on key components and subsystems allow the OEM to experiment on component interdependencies and the vehicle overall performance while concurrently benefiting from the involvement of suppliers in the innovation process.

3 Strategic challenges

3.1 Beyond economies of scale: the strategic implications of raising complexity

Exploiting scale efficiencies, a traditional driver of competitive advantage in the automotive industry, plays a less relevant role in a world that has turned towards a distributed innovation model. In the new business ecosystem, there are many evidences showing that the key challenge for carmakers will be to handle complexity in new forms.

First, as manufacturing, design and engineering of cars are not performed any more in vertical integrated companies but in highly fragmented vertical networks, flexibility of cost structure at carmakers' has increased, but so has organizational and strategic complexity. As a consequence, while the need for standardization within each single model design engineering and production is much less pressing nowadays, OEMs must face new threats. In fact, outsourcing has produced the consequence of (1) increasing competitive tensions within the value chain (with suppliers' bargaining power growing) and (2) complicating integration and coordination among a higher number of actors (car makers, first- and second-tier suppliers, research centres, etc.). In such a scenario, strategic success is a consequence of the ability of firms to device organizational solutions consistent with their strategy and less dependent on traditional strategic levers, such as economies of scale. At the moment, only few producers – notably Toyota – have been able to take full advantage of a more distributed mode of production in the industry with some, like Fiat, forced to back source design and engineering activities after having experienced the complexity of managing a distributed product development process (Becker, Zirpoli 2003; Zirpoli 2010) or GM and Chrysler forced to bankruptcy.

Secondly, the minimum optimal dimension of plants due to the adoption of flexible manufacturing systems and lower product development costs due to the introduction of virtual simulation tools in product development has, once again, reduced the strategic role of pure «scale» considerations but augmented the level of complexity to be managed. As far as manufacturing is concerned, new production technologies have eased the joint production in the same plant and with the same tools and equipments of different models lowering break-even points. For example, thanks to the flexibility of production technology, Fiat and Ford produce in the same plant the Fiat Panda, the Fiat 500 and the Ford Ka. On the other hand, the complexity in managing operations has grown accordingly. As far as product development is concerned, the growing use and accuracy of virtual development and simulation tools has been a major source of novelty in the overall product development strategy of firms. Traditionally, literature has associated with the use of virtual development tools (1) the reduction of experimentation costs due to the speeding up of the testing phase, (2) the reduction of the number of costly physical prototypes and redesign linked to their fast obsolescence, and (3) the improvement of design quality via the availability of information very early on in the development process (front loading problem solving, Thomke 1998). More recently, however, literature has observed how virtual tools help engineers to *observe* phenomena that are much less readily observable otherwise enabling almost infinite iterations of the same experiment and, importantly, isolating one parameter in each run. As compared with physical experimentation, they therefore approach a «laboratory-type controlled environment». In this way, virtual experimentation allows testing hypotheses that are not constrained by the logical bounds of the premises one starts from. It thereby enables a non-conservative design, which is important in order to achieve distinctive new designs (Becker, Salvatore, Zirpoli 2005). These features provide carmakers with the opportunity for enlarging and differentiating their product portfolios without scarifying efficiency. However, also in this respect, it is important to note that the sustainability of an aggressive marketing strategy based on the proliferation of niche models and model variants is premised on the sharing of components and platforms across these models. Only this measure would contain the industrial costs to a sustainable level. To do so, the challenge is leveraging economies of scope on both competences and components. This is, once again, a hard and complex task from an organizational point of view. In order to develop models that share components and systems of components without sacrificing their differentiation for customers, company must introduce several constraints to design, engineering and manufacturing activities and manage a tight organizational integration between internal functions, product development platforms and external suppliers. So far, few carmakers have fully succeeded on this pattern (e.g. Toyota and Volkswagen), especially due to its ensuing organizational complexity.

Overall, considering the new modes of designing, producing and marketing cars, there is consensus that the key challenge has switched from managing product development activities (and manufacturing efficiency) by leveraging economies of scale, to governing complex value chain relationships and integrating new product development efforts.

3.2 Leveraging patents across firm's boundaries

In the previous paragraphs, we examined the organizational solutions OEMs implement in order to access and integrate external knowledge into internal innovative activities and the strategic challenges brought by the raising organizational complexity of product development. However, along with the organizational challenge of how to reconcile division of labour and competence accumulation, it is to emphasize that firms also face a key strategic issue: how to profit from innovation? Due to the distributed innovation process and the high competitive pressure in the current industry scenario, it is key to identify and analyse the mechanisms carmakers have at their disposal in order to appropriate the returns from innovation.

Past innovation literature pinpoints several modes through which firms may appropriate value from research investments: secrecy, lead time, patents, and complementary assets (Cohen, Nelson, Walsh 2000; Teece 1986). The effectiveness of these modes is clearly dependent on the appropriability regime of the industry – namely a set of environmental factors that influence an innovator's ability to capture the profits generated by its invention (Teece 1986, p. 287). Relative to this issue, past studies highlight that the tighter the appropriability regime, the higher the strength of patents, allowing firms to effectively appropriate returns from their inventions and to earn monopoly profits.

In the automotive industry, major carmakers traditionally implement aggressive patent strategies through up-front research, applying for patents worldwide and investing large amounts of resources in maintaining and renovating their patent portfolios. This is particularly true for the large incumbents of the industry. For instance, Toyota applies 1,000 patents per year on average. Other large competitors implement similar patent strategies – Volkswagen is an example.

At first, such a recurrence to patenting might indicate that firms use them for profiting from innovation: patents protect the profits directly accruing from the commercialization of the patented innovation. Despite the intense patenting activity of carmakers, a survey investigating the mechanisms firms use to profit from innovation shows that, in the industry, patents are rarely employed as appropriation mechanisms (Cohen et al. 2000). Firms strongly prefer secrecy, lead time, and the control over strategic complementary assets such as manufacturing and commercialization infrastructures. Many patents, in fact, can be invented around at modest costs and they are ineffective at protecting process innovations, which represent a large share of OEMs' innovation outputs. Hence, the questions to be posed are the following ones: what is the role of patents in the industry? Why do carmakers adopt aggressive patent strategies, despite reporting that patents are ineffective in appropriating returns from innovation? We believe that the strategic reason has to be found in the organization of the innovation activity itself.

Given the distributed innovation process and the fact that the car is a complex multi-technology product, it often incorporates several innovations not directly controlled by the carmaker, but rather by external suppliers and competitors. In this context of distributed and highly partitioned knowledge, building up large patent portfolios might serve OEMs the achievement of three main objectives. First, they serve as isolating mechanisms in order to protect the firm's competitive advantage. Patents provide firms with an exclusionary right: they can exclude others from the development, use and sale of the patented invention. Given the costs of applying and maintaining patents, a proprietary patent strategy is likely to be pursued for technologies with high «strategic stakes» for the carmakers. In order to build effective barriers to imitation, firms frequently build overlapping and complementary patents to minimize the chances that the technologies are invented around (Somaya 2012). In this respect, an example is provided by the patent strategies implemented by Fiat during the past decade. In order to protect key core technologies, such as the multi-jet and subsequent multi-air technology, Fiat applied for families of patents worldwide and hired legal experts to ensure that the patents were legally robust in order to effectively protect core technologies for the firm's competitive positioning. These patents were then carefully maintained over the patent life-period.

Another frequent mechanism through which firms pursue a proprietary patent strategy is co-patenting with suppliers – the patented innovation is assigned both to the carmaker and the supplier. Since it is frequent the case that competing OEMs share suppliers for specific components/technologies, it is key to overcome issues of unintended knowledge leakage and threats of invention re-engineering by competitors. By sharing the proprietary rights with the supplier and integrating the joint patenting contract with specific clauses (Hagedoorn 2003), the carmaker can overcome these risks. It can effectively control the use the supplier makes of the technology, for instance monitoring and limiting the diffusion of the technology to competitors through licensing.[1]

The second function of patents from a carmaker's standpoint is that of a defensive strategy tool. Through patenting, OEMs aim to acquire freedom to operate and to avoid expensive litigation costs and delays in product development and launch, by directly controlling several proprietary technologies included in the final product. Firms build large patent portfolios in order to avoid the risk of being held up for instance by competitors and to prevent potential patent disputes with competitors. Patent infringement – the use or sale of a patented invention without the applicant's permission – in fact is a recurrent event in the industry.

Finally, large patent portfolios might serve to reinforce the bargaining power of the carmaker in the distributed innovation process. By guaranteeing patent coverage, for instance on a core technology that other firms are using or developing and on which there are sufficient costs and risks in working around the firm's patents, the patent gives the firm the bargaining power vis-à-vis users of the technology through the threat of patent litigation (Somaya 2012).

In light of the current organization of innovation activities within the industry, it emerges the importance for carmakers to strategically manage their patent portfolios both for defensive as well as leveraging purposes. The IP management issue becomes central in order for firms to protect their competitive position (Reitzig 2004). As management scholars have outlined, in this context, supporting organizational conditions such as patent knowledge in the top-level management and optimal

1. Literature on co-assigned patents reports that, in the past, firms considered co-patenting as a second-best solution, since under specific regimes (like in the US), the co-assigned patent can be used or licensed by both assignees without approval from the other. However, firms over the years have gained experiences with forging additional contracts in order to better monitor the use of the invention by the co-assignee (Hagedoorn 2003).

cross-functional coordination between legal and technical experts (Reitzig, Puranam 2009) become key organizational capabilities to enhance performance and appropriate returns from innovation.

4 The challenges to innovation processes brought by the «electrification» of the industry

Recently the potential technological discontinuities brought by the new hybrid and electric power-train technologies have been indicated as a potential trigger of a relevant change in carmaker strategic approach, industry dynamics and new product development. At the moment, as a high number of supply and demand factors can potentially influence the evolution of the technological trajectory of hybrid and electric vehicles, it is extremely difficult to evaluate the relative importance of each factor in isolation as well as its interaction effects (see also Errichiello, Zirpoli 2013).

Similarly, it is not easy to predict the potential changes that the «electrification» of the industry might bring to the organization of innovation activities in the automotive industry. So far, the picture that emerges on the power train technology of the future, its evolution, firms' strategies and appropriability regimes is characterized by high «structural uncertainty» (Knight 1921). The technology is still in the phase of «variation» and technological ferment – with electric power train competing with many hybrid technologies and they altogether competing with other «green» and perhaps more efficient solutions (EUCAR 2009). In this situation, the mechanisms leading to a «selection» of a dominant design and the consequent «retention» of a specific value network and community organization configuration (Rosenkopf, Tushman 1998) are far from being clearly defined. Under the current scenario where a dominant design has not yet emerged, we would expect firms' innovation activities to be mainly devoted to upfront research activities in order to explore and seize (through patents) the benefits of a new standard. In this phase, firms are likely to experience a period of exploration in order to experiment with the different technological solutions and gain capabilities on a wider set of technological domains in order to effectively react to an eventual technological shift towards the «industry electrification». However, so far we do not have systematic empirical evidence showing that carmakers and suppliers are carrying out such a type of research activity and, hence, no accounts of its effects. Moreover, in case of emergence of the electric car as a dominant technological paradigm, we expect to observe a re-organization of the automotive value chain and a re-assessment of the value distribution along the supply chain. The electrification of the industry might indeed favour the entry of new players in the industry (e.g. electricity providers, battery suppliers, etc.) with important consequences for what concerns the value creation and value appropriation strategies of leading carmakers in the organization of innovative activities. On the contrary, if the electric car will remain confined to a niche-market, no relevant changes in the organization of new product development are expected and industry incumbents will be in a position to rapidly switch to alternative and less disruptive solutions without loosing the knowledge-base they have accumulated over the years.

5 Final remarks

In the past decades, technology and market factors led to a radical re-organization of innovative activities within the automotive industry, with a shift from a closed-innovation model to a distributed one. The aim of this chapter was to identify and discuss the main organizational and strategic challenges in innovation activities that industry incumbents are currently facing in light of this radical change.

From an organizational point of view, the analysis pinpoints the centrality for carmakers to effectively manage networks of external suppliers both for what concerns the mechanisms through which govern external ties as well as the type of activities to allocate to external partners. On the one side, the choice of the governance mechanisms – from arm's length market transaction to strategic partnerships – appears to be key in order for carmakers to access external specialized knowledge while avoiding issues of partner's opportunism, knowledge leakage, and appropriability. The analysis casts a light on the importance of selecting the governance relationship by taking as primary unit of analysis the project-level rather than the partner's one. Carmakers, in fact, often cooperate with the same supplier in a set of different and concurrent projects. It is therefore key to choose the partnering mode that at a project level guarantees the effective and efficient involvement of the supplier in the internal development activity.

Another major challenge brought by a distributed innovation model is the scope of the knowledge base carmakers should master. In order to effectively act as system integrators, carmakers need to properly balance economies of specialization with competence accumulation. In this business context, division of innovative labour should hinge on where system integrators experience learning opportunities both in component-specific knowledge as well as architectural knowledge. The chapter highlights that outsourcing decisions should be based on a competence accumulation principle rather than on pure product architecture and cost-efficiency principles as past modularity literature has proposed.

From a strategic point of view, the chapter reviews the role of economies of scale within a business environment characterised by a distributed and highly partitioned knowledge. The study sheds light on the fact that, due to a set of different factors – increasing flexibility of carmakers' cost structure, decrease in the minimum optimal dimension of plants, etc. – the key strategic challenge has shifted from managing product development activities by leveraging economies of scale to governing complexity in value chain relationships and integrating new product development efforts.

Secondly, the chapter clarifies the role of up-front research leading to patenting and the use of patents in the industry, highlighting the strategic function large patent portfolios may play in favouring carmakers to appropriate value in fragmented vertical networks. By providing firms with exclusionary rights, patents represent defensive and isolating mechanisms to protect core innovations of the technology portfolio as well as to protect firms from the risks of being held-up by competitors and incurring into long and expensive patent disputes.

The analysis put forward highlights clear avenues for future research. First, in light of the likely technological shift the industry may face in the next years, future studies should focus on the technological competences carmakers are currently accumulating through their patenting upfront research activity. The analysis would clarify the type and scope of technologies carmakers are currently experimenting and may provide empirical insights on the technological standard that is likely to emerge and the likely incumbents that, under this standard, may dominate the market. Moreover, future studies should also attempt to model the different industry scenarios and hence patterns of division of innovative labour that may emerge under the different technological standards. This would clarify the future organizational and strategic challenges carmakers will face in the coming years.

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2
Are carmakers ready for the «peak car»?

Andrea Stocchetti

ABSTRACT *This chapter investigates the problem of the so called «peak car», that is: the possible structural decline of cars' demand. Specifically, we try to investigate to what extent the «peak car» in Europe finds it premises in the evolution of the principles and policies for sustainable urban mobility (SUM), here including innovative principles of design and use of urban space. Our hypothesis is that significant progresses are taking places in the overall perception of utility derived from owning a private car and in the concept of quality of life related to urban living. The ongoing change is also reflected in the principles stated by documents that outline EU policies in the field of sustainable mobility, were an evolution of the approach to the traffic and congestion issues can be read over time.*

1 Introduction

The hypothesis that car demand could begin to shrink and that the car as a product itself can enter into a life-cycle stage of decline has never been taken into serious consideration for a very long time. The widespread belief, more or less implicit, was that once the market saturation is reached, car demand would settle relatively flat. However, since 2007 the European demand for cars has fallen steadily, and after seven years of persistent decline that belief falters.

Starting from the empirical evidence of a significant and diffused reduction in car use in Europe and the USA, some authors have started to foreshadow different scenarios that postulate the decline of the car. Such hypothesis is often referred to as «peak car» (or «peak car use», or «peak car travel», or similar words) and it has become an object of systematic analysis only in recent times.

This chapter proposes a brief overview of the main contributions on this subject. It will also investigate to what extent the increasing relevance and spread of policies for urban sustainable mobility have an impact on such phenomenon. We will try to investigate to what extent the «peak car» in Europe finds its premises in the evolution of the principles and policies for sustainable urban mobility (SUM), here including innovative principles of design and use of urban space. Our hypothesis is that significant progresses are taking places in the overall perception of the utility deriving from owning a private car and in the concept of quality of life related to urban living. Such ongoing change is also reflected in the principles stated by documents that outline EU policies in the field of sustainable mobility, were an evolution of the approach to the traffic and congestion issues can be read over time.

In our opinion the topic is important in order to evaluate carmakers strategies and to understand some of the most recent competitive dynamics in car industry. Peak car determinants are at the basis of the profound social renewal oriented towards different and more sustainable living principles. These principles strongly refuse the negative aspects related to car use (among which pollution is only one out of many and perhaps less important today than in the past). A car-free society is unlikely, but a legitimate question is: to what extent the present industry can downsize? To what extent present city-car concepts fit the actual orientation of mobility demand? Twenty years ago very few people would have bet on the disappearance or on the reduction of house goods like televisions and telephones. But this is exactly what is happening today with the emergence of different lifestyles triggered by social development and progresses in the field of mobile devices, web, multimedia and so on. Nowadays carmakers are still having a traditional approach to car design and production facilities, while the European urban society is probably more inclined to Personal Mobility Vehicles (PMV)[1] than to city cars, even electric ones. Perhaps the contributions that have studied the phenomenon of peak cars can help give an answer to such questions.

Since 2006 the growth of new car registrations in Enlarged Europe[2] has decreased, except for a limited revival around 2009, driven by the incentives for scrapping introduced in several European countries. In

1. PMVs are commonly intended as small-size electric vehicles designed for individual use (one or two people) in short urban journeys and/or in large indoor places like airports, railway stations, plants, malls, etc. PMVs were originally intended for assisting people with limited movement capability, but then they evolved towards a wide variety of concepts. Although almost all carmakers often present very innovative and efficient PMV prototypes, no concrete efforts to develop marketable models in this field have been made by carmakers. Segway Inc. is presently the only PMV producer operating on a global scale.

2. In this chapter we refer to EU27+EFTA3 as «Enlarged Europe», and to EU15+EFTA3 as «Western Europe».

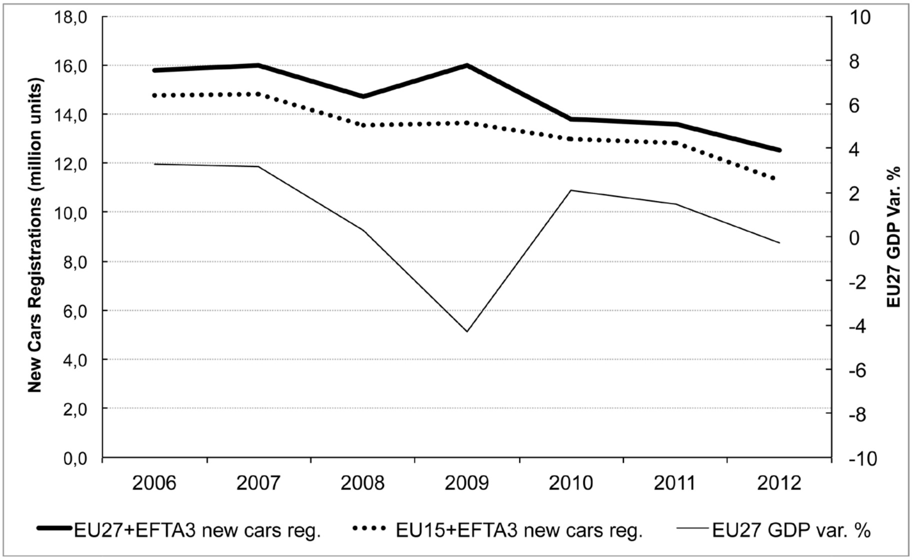

Fig. 1. New cars registrations and GDP variation in Europe 2006-2012.
Sources: ACEA, Eurostat.

2012 carmakers have sold almost 3.3 million cars less than six years before (-20,6%) and the forecast for 2013 signals a further decrease.

The negative trend is even more evident considering the Western Europe, where the effect of incentives in major countries (Germany, UK, France, Italy and Spain) has been barely sufficient to slow the decline (fig. 1).

Common sense suggests that the present trend has been determined mainly by the financial crisis and by its effects on the overall macroeconomic context since there is a remarkable similarity between the evolution of GDP and that of the demand (fig. 1). On the other hand, a series of profound changes are taking place in the social and technological context of the car market. Such changes trigger a series of questions about the possibility that, beyond the traditional income-based explanation, other variables are having a role in reshaping the structure of car demand and patterns of use. In particular, a central question is if this is just an adjustment within a period of permanently mature demand or it is the signal of a major discontinuity. Indeed, a turnaround has been hypothesized for what concerns the intensity of use of the car, supposedly declining after decades of steady growth (Puentes, Tomer 2009; Newman, Kenworthy 2011; Goodwin, 2012b).

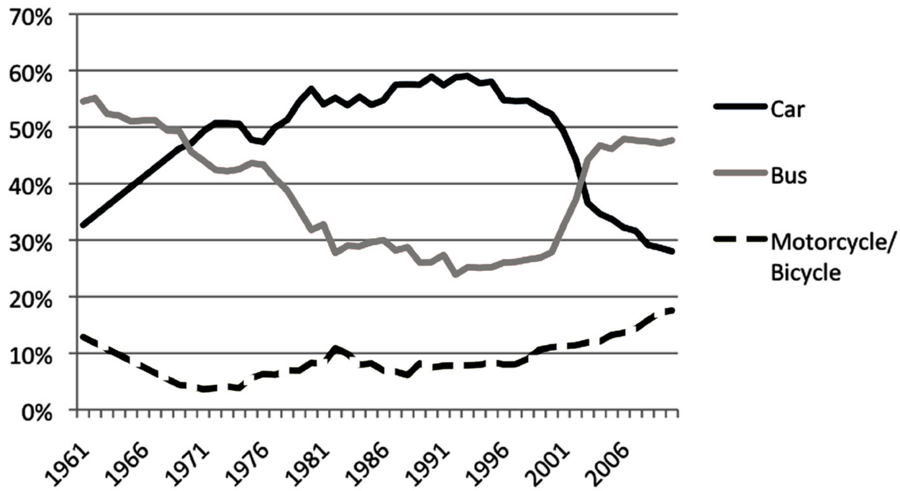

Fig. 2. People entering in central London in the weekday morning peak-road traffic by mode of traffic.
Source: Londontransportdata.wordpress.com.

To our knowledge the issue and the expression «peak car» was raised for the first time – with statistical support – in 2006, in an article published by the magazine *Local Transport Today* (LTT 2006). The article reported the results of a survey developed in 21 British urban areas showing that in the previous ten years a significant reduction of private car use occurred. In London, for instance, the car incidence in total traffic has decreased from a 60% peak in the beginning of the 1990s to less than 30% in 2011 (fig. 2). London and the UK are a somehow paradigmatic case of urban transport development. The post-war reconstruction and transport planning revolved around the prediction of increasing car traffic and around a policy of providing adequate road network as an answer to an increasing population and to a forecast of increasing demand for private transport (Banister 2002; Metz 2012).

This approach to transport planning, called «predict and provide», has been the dominant one at least until the 1970s and it is still highly influential in European countries that are particularly backward in the field of sustainable mobility as, for instance, Italy. On the contrary, in the UK and the USA the traditional transport planning analysis has been harshly criticized since the end of the 1970s and overturned from mid 1980s (Banister 2002; Vigar 2002; Imrie, Lees, Raco 2009). London city transports has therefore been originally planned in a context where car

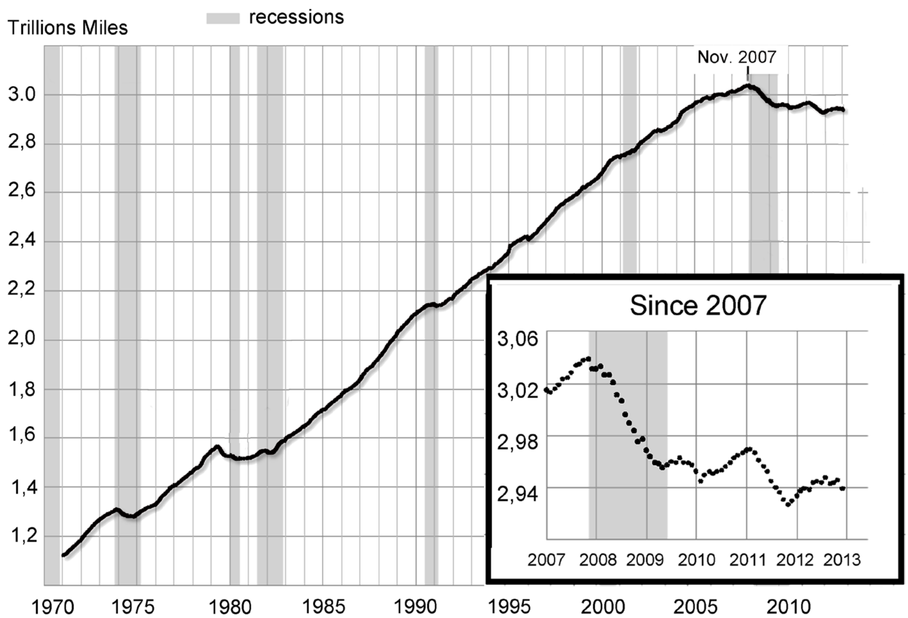

Fig. 3. Estimated vehicle miles driven on all roads in the USA, 1970-2012 (twelve month moving average).
Source: Advisor Perspectives Inc., courtesy of dshort.com.

was dictating the rules of planning. But in the early 1990s the town's transport plan has been subject to a general re-orientation from private to public transportation and to walking and cycling (Middleton 2009).

Nowadays a very similar situation is detected in the United States and in Great Britain. In both countries the estimated total miles driven has started to decrease from 2007, after decades of steady growth (figures 3 and 4). It is noteworthy that, even in previous recessionary phases, in the USA there has never been a so evident decline in mileage (fig. 3).

Although several sources and contributions are available about trends in car market, very few contributions present a systematic analysis of trends in the use of car and of the possible determinants of its variation.

Newman and Kenworthy (1989, 2006, 2011) demonstrated the inverse correlation between the urban density and the reduction of «automotive dependence» of urban systems. According to these authors, the intense use of car is mainly triggered by urban sprawl and the lack of efficient urban mobility systems. On the other hand, a high level of urban density is a crucial factor to the development of efficient urban transport systems

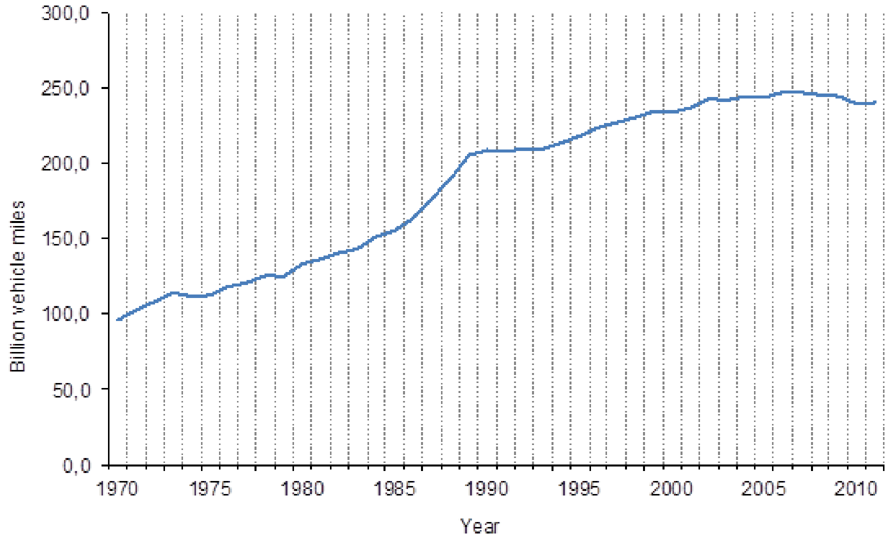

Fig. 4. Estimated vehicle miles driven on all roads in Great Britain, 1970-2012 (twelve month moving average).
Source: GB National Road Traffic Survey, Department for Transport.

and this encourages commuters to use public transport instead of private cars, particularly in a context of increasing gasoline costs. Puentes and Tomer (2009) dispute a prevailing effect of gasoline costs and point the fingers at a different model of urban development and to the related emerging lifestyle, metropolitan growth and development trends:

> Overall, cities are growing and downtowns have been improving in the past twenty years [...] especially noteworthy is the revival of young adults seeking urban living. In turn, urban residents are more likely to use alternative modes of transportation than automobiles [Puentes, Tomer 2009, p. 4].

Maybe because of its recent origin, to our knowledge the phenomenon peak car (intended as a major discontinuity in car demand and pattern of use) is explicitly denied in very few contributions. However, there are also relatively few contributions that investigate it, as well as those that analyse the possible causes in a systematic way.

Metz (2012) deeply analyses the case of the UK and London; he shows that not only the car use, but the whole demand for personal daily transfers has ceased to grow especially in those areas that experienced an urban revival according to new planning criteria. The author presents specific examples, e.g.: «The relegation of the car is most marked in the urban regeneration that has taken place in the former Docklands area, particularly on the north side of the River Thames to the east of central London» (p. 23). Transport systems are, therefore, designed to wrap mobility around the more valuable areas of the towns, thus excluding cars from the inner urban zones.

Newman and Kenworthy (2011) analyse several available sources and claim that the peak of the distance travelled per car has been already attained and that from now on car use will decrease as a result of the different orientation toward mobility. According to these authors, the raising in oil prices and the overall costs of operating a car are only minor factors. The reorientation of urban planning and design from car-based criteria towards sustainable mobility-based priorities – that consider transit, walking and cycling on top of the list – can spark a virtuous circle of increasing efficiency in time and money use that could bring to an «exponential decline» in car use (Newman, Kenworthy 2011).

Goodwin (2012a) examines the three most commonly acknowledged hypothesis about the trend in car use (interrupted growth, saturation and peak car, this one intended as the overall result of people's choice about car) at the light of the various data and phenomenon observed in transports statistics and the related possible inferences. His conclusions are that presently available statistics do not allow to discriminate between those three different hypothesis. The same author (2012b) also concludes that, although not indisputable, the hypothesis of peak car is anyway more plausible than that of a temporary decline.

On the other hand, Le Vine and Jones (2012) deny the existence of peak car; they claim that the peak car is evident only for specific groups and areas, while the overall decrease in car use and travelled distance is an effect of economic recession and regards almost exclusively company cars, while the use of private cars remains stable. They also dispute the methodology used to measure the intensity in car use, claiming that population-adjusted data give different feedbacks in different areas.

2 The causes of peak car

Authors who endorse the hypotheses of a discontinuity in the trend of car use and the related peak car hypothesis identify several causes for this phenomenon, both traditional and relatively «original» ones. E.g.: traffic management policies, the increasing incidence of home working, economic crisis, a shift from privately owned cars towards car rental and car sharing, demographic changes in license owners composition, and so on.

Of course, traffic restrictions are the first suspects in such a context, but a systematic review on available evidence comes to the conclusions that the evidence base for the effectiveness of such interventions is weak (Graham-Rowe et al. 2011).

An early work by Daniel Jones (1981) identified the mix of market saturation, transport policies, car operating costs and urbanization as possible factors bringing the European demand for cars to an early maturity: «In Europe the greater population density and urbanization, the more extensive provision of public transport facilities and the much higher cost of buying and running a car all result in maturity being reached at lower levels of car density than in North America» (Jones 1981, p. 8). Although this prediction about the evolution of car density have not come true at that time, it might have come true now. According to Eurostat, in 2008 the number of passenger cars per 1,000 inhabitants in Europe was 470, higher than the Japanese (454) and the USA (444).[3] Interestingly, the key variables for the saturation mentioned by Jones (urbanization, population density and public transportation) are nowadays considered priority goals in the urban mobility system planning.

Goodwin (2012a) doesn't admit explicitly the existence of a peak car intended as the beginning of a downward spiral in car use, but he acknowledges a decreased use of cars and classifies the possible factors responsible for that in a series of categories. Together with the economic motivation related to costs, prices and income, other important categories are a) quality and reliability of public transport systems, b) new policy trend in land use that reduces urban sprawl and increases the quest for the benefits related to central area locations, c) social and technological changes that affect people preferences and behaviours as for patterns of work, use of leisure time, way of shopping and so on. Finally, d) also the opportunities offered by mobile Internet technologies have a role insofar they increase the accessibility of public transport and offer an alternative way (productive or entertaining) of using time while commuting.

Newman and Kenworthy (2011) identify six causes for the peak car use, three of which (the growth of public transport, the reversal of urban sprawl, the increase in fuel price) re-propose more or less the concepts expressed by Goodwin. The other three elements are: a) the increase in

3. Here we specifically discuss passenger cars, therefore pick-ups, vans, and duty vehicles are excluded. Other sources (i.e.: worldbank) wrongly use the term «passenger cars» to indicate: «road motor vehicles, other than two-wheelers, intended for the carriage of passengers and designed to seat no more than nine people (including the driver)». We do not adopt this definition since we consider it misleading for the analysis of the car industry.

the average age of people living in the cities, b) the growth of a culture of urbanism, intended as the tendency to move from suburbs to the inner city to take the opportunities that urban centres offer, and c) the hitting of the «Marchetti's wall», that is the reaching of a development condition that puts severe limitations to the growth of urban areas and that can be overcome only through the construction of transport systems much faster than car in a context of urban traffic.

Marchetti's wall is the limit to the growth of an urban centre that is determined by the means of transport available to move within the town. Such limit refers to a theory deriving from both empirical observations and conceptual analysis of people attitude towards travel, a theory known as «Marchetti's constant». Such theory states that the amount of time or effort that people spend in daily transfer is constant and the actual travelled distance depends on the used mean of transport (MARCHETTI 1994). According to this author, the historical analysis of human settlements and of human instincts shows that people tend to move and to establish their activities within an area defined by a limit of one hour travelling time (the Marchetti's constant). Such behaviour has anthropological determinants and it regulates towns and cities path of development in relation with the distance that people can reach within an hour. For instance, if the average speed of a car in urban traffic is 30 Km/h, the Marchetti's wall will be an area with a radius of 30 Km. This theory has several implications; specifically, it identifies the radius of attraction of urban amenities as a function of the mean of transport available. This limit would be able to influence, among the rest, the individual choices of localization and the choices of destinations for daily activities, thus the urban development. In fact, the Marchetti's constant is often used in the analysis of possible peak car determinants.

Kenworthy and Laube (1999) have measured the average journey-to-work trip time in 46 cities in the USA, Western Europe, Canada, Australia and Asia; the average values are between 22 and 35 minutes for trip, while minimum and maximum are respectively around 20 and 40 minutes. Schafer and Victor (2000) come to the same conclusions of Marchetti through a statistical analysis; they claim that, on average, not only the time devoted to travel is fixed (about 1,1 hours), but also the share of income allocated on travel is fixed and follows the income trend.

Newman and Kenworthy (2006) assume Marchetti's constant principles and evidences from the catchment area of main urban attractors to detail the accepted time and distance in a journey from the start to the destination (like, for instance, an urban service, transport nodes, amenities and so on) and to consequently identify principles of urban planning capable of reducing car dependence.

Metz (2010, 2012) identifies a mix of causes at the basis of the peak car, all referable to the saturation of the demand for daily travel, which on its turn derives from two joint factors: 1) the improved mobility systems, providing high levels of access and destinations' choice at a higher speed; 2) the fixed «budget» (in terms of time and costs) that individual allocate to daily travel and that drives people to live in a range (generally, less than one hour of travel) not exceeding a predetermined distance away from the main daily activities, work being typically the first of these one.

Jones (1981), discussing the early-1980s car crisis, has been somewhat visionary in identifying the critical factors that could have brought to a saturation of car demand other than market-driven, and specifically: a) the relevance of population density and of urban transport policies on car demand, b) the overall cost efficiency (both «internal» and «external») of the car with respect to other means of transport. The issues related to these two elements (urban transport policies and car overall efficiency) have actually risen to reference point in both national and European transport policies and are commonly referred to as problems of sustainable mobility.

In one way or another all these authors assign a significant role to the urban mobility systems development, moderated or enhanced by a behavioural component which refers to demographic variable and/or to subjective attitudes. However, none of them makes an explicit reference to a possible relationship between the SUM policies and the reduction in car use. Several scholars, as we have seen, take into account the change of attitude towards the use of the car by people, but none of them explicitly highlights or otherwise assumes an impact of SUM policies on behaviours and, therefore, on the peak car phenomenon.

This is quite surprising since there is a very evident overlapping between the peak car triggering factors and the set of priorities established in the policies of European States for SUM. In our view, this is one of the main variable affecting car demand in recent times, both from the qualitative and the quantitative point of view. In other words, we think that SUM policies might have gone far beyond spreading the acceptance of traffic restrictions, but they might have familiarized a generation with a different concept of lifestyle that breaks the long-standing relationship between income, motorization and private mobility.

3 The ouster of the car by the quest for sustainability

It is reasonable to assume that the various factors mentioned in the previous literature review are cooperatively responsible for reshaping the car demand determinants. In hindsight, however, the sum of those determinants is entirely consistent with the commonly acknowledged roots of the quest for a more sustainable transport. External and indirect costs, impact on quality of life, the growing importance of alternative urban models and related lifestyles are found at the same time within sustainability policies and among the factors determining the peak car. In other words, the quest for efficiency and sustainability put the car at the border of the range of mobility solutions. Car is a very low energy efficient vehicle; private car use, specifically, is far from being economically efficient from the point of view of individual owners, due to managing costs and related external costs which are going to be more and more addressed to drivers through charges (for instance, the «London fee» for entering in central city). Moreover, the saturation of a private car by an individual driver is far from being convenient with respect to car sharing and car rental. In the medium term it would be reasonable to expect an increasing use of car from fleets rather than exclusively owned cars.

Car use is, therefore, under attack from a variety of significant battlefronts; this contrasts with the major emphasis given to the pollution issue, often perceived as the most important, sustainability-related problem in car use. Previously reviewed contributions show indeed that the transport mode choice is affected by several «contingencies» that might have as an outcome a significant increase in the number of people who waive owning a private car, at least among those living in high-density urban centres. In some cases (Marchetti 1994; Schafer, Victor 2000) it emerges that it's not a matter of contingencies at all. On the contrary, some authors claim that the daily mobility behaviour follows criteria rooted in the human anthropological nature and there is no guarantee that the car is always the best way to satisfy them. Even traffic control measures have not proven to be as effective in reducing car use as one could think (Graham-Rowe et al., 2011). Finally, the acknowledged principles of sustainable city development explicitly oust cars (Kenworthy 2006).

The actual discontinuity, if there is one, is that the possession of a car may seem much less attractive than ever. In the past, the ultimate answer to personal travel needs was the ownership of a car and the discriminating factor for its access was the available income or wealth. The oil crisis in the 1970s has placed a greater emphasis on car running costs, but the overall association between car ownership and wealth has not been questioned until recent times. Nowadays it has been demonstrated that wealthier societies have the higher transit use per capita while in major cities there is no correlation between car use and wealth (Kenworthy, Laube 1999; Le Néchet 2012). The emergence of a broader vision that tries to assess also the sustainability aspects of human activities has made popular models of costs-benefit analysis including aspects of the overall car impact (i.e.: Mayeres, Ochelen, Proost 1996; Sælensminde 2004; Lemp, Kockelman 2008). All contributors in this field identify more or less the same set of disadvantages in relation with car dependence. In short: a) quality of life decreases in relation with emissions and related health damages, b) traffic congestion creates discomfort and disadvantages related to loss of time, c) high social and private costs are related to car crashes and minor accidents, d) other societal, environmental and economic disadvantages are related to global warming and environment detriment, d) land use and the disadvantages related to the infringement of other possible use of the space occupied by the vehicles and the required infrastructures, e) negative effects of various kinds associated to a sedentary lifestyle.

Kenworthy and Laube (1999) demonstrate that there is no economic advantage for the collectivity in developing car dependence. In fact, the evaluation of external/social costs of transport modes bring to evidence higher costs of car than other transport modes. Several authors tried to estimate the external costs of vehicle ownership (Lemp, Kockelman 2008; VTPI 2011), that is, social costs not directly borne by the owners. According to a review by Lemp and Kockelman (2008) the overall sum of external car use costs vary from 0.16 to 0.27 euro per mile driven, according to car type and size. This would mean an external total cost in Europe for each car on the street between 2,400 and 4,000 euro per year. In a city like London, for instance, where 350,000 cars are estimated entering the central area every day, external costs would be from 2.3 to 3.8 million euro per day.

At this stage a legitimate question is: what if the car ceases to be considered a benefit independently from regulatory restrictions and even from the point of view of the individual? The greater emphasis given over time to the collective disadvantages associated with the use of the car may have drastically changed the individual assessment of the trade-off between the «costs» and the benefits of owning a car. Furthermore, this trade-off further worsens due to the contribution of other factors. New alternatives, other than car ownership, are available to have a means of mobility when needed (such as short- or long-term rental and car sharing), and such alternatives are getting more and more efficient with respect to the costs of operating a car at the usual rate of saturation, which is usually very low.[4] At the same time, several other forms of use of the time spent driving are offered, in particular using mobile devices during transit (which today is like or very similar to having social relationships) or doing physical activity walking and biking.

In all this, policies to make cities attractive and sustainable environments – in terms of mobility but also in terms of a series of other activities related to sociality and leisure – are perhaps the main antagonist of the car. In other words, our impression is that the environmental and functional performance of the car are not challenged (or they are not the only ones), rather the car patterns of use and the overall benefits of car owning with respect to alternatives choice for individual mobility are. More specifically, our hypothesis is that the widespread orientation of local, national and European policy makers towards sustainable mobility practices will tend to marginalize the car far beyond the traffic restriction actions and affecting the overall evaluation of the product «car» in its present configuration. In the following part of this chapter we will try to demonstrate the plausibility of this hypothesis through a summary of how the priorities set by the SUM plans reinforce the elements that the literature places at the base of the peak car.

We think that such topic is of some interest for the automotive industry. Seemingly, carmakers' panacea to urban mobility issues is almost exclusively intended along the dimensions of the electric engine and of the small size. But in light of the above discussion this approach appears far too simplistic.

4 The shift in the attitudes that will take carmakers off guard

The pillars of EU policies for SUM are stated in a series of documents (COM 2001; COM 2007; COM 2009) that show over time a shift from a mainly regulatory perspective focused on technical aspects of transport, towards a holistic view which integrates the development of societal desirable aspects. This change reflects and probably amplifies, through a dissemination of values, an emerging trend that has already been noticed in some of the contributions that have investigated the causes

4. According to ACEA the average annual distance travelled by a car in the EU is about 14,000 km/year. This implies that the average daily mileage is below 40 Km or, in urban environment, no more than 1,3 hours per day. AAA Association (2012) estimates that the actual yearly cost of running a medium sedan car at such mileage is about 8,000 euro (car depreciation included), that is 0,57 €/Km. These estimates refer to the costs for the owner. Additional external or social costs are not directly borne by the owners, but in a sustainability perspective they should be included in the overall evaluation of car efficiency.

of peak car. The importance of these documents in the debate is in fact twofold. Not only the European Commission is the EU executive arm and proposes new European legislation, but it is also in charge of carrying out consultation among stakeholders. It is legitimate to acknowledge in these documents widespread orientations, at least among the countries' institutional representative bodies and local authorities.

Together with the specific policies aiming at reducing car dependence, the European Commission documents related to mobility state several priorities indirectly addressed to car use reduction. In short: 1) the overall transport demand reduction, 2) the cutback of urban sprawl and the implementation of innovative criteria in the design and use of urban space, 3) the development of integrated mobility systems.

These priorities set the pathway for the implementation of the smart mobility in urban environment, triggering principles that are coherent with the sustainability philosophy and that tend to penalize car use as a means of private mobility, for several reasons that can be summarized as follows:

1. The traditional «predict and provide» approach to transport planning is abandoned and a «sustainable transport» planning approach is adopted.[5] In this vision the car ceases to be the input data for allocating investments in road construction; car traffic is considered an element to be managed and possibly to be minimized, while the car in itself has an inherently negative connotation.
2. The development of an energy-efficient mode of transport is a cornerstone in urban planning. Since car is at the bottom of the efficiency scale, transport systems push towards making its role as marginal as possible and to exploit the advantages of urban density.
3. A key priority is the integration of urban and metropolitan mobility tools. Several projects have been implemented and are developing right now with the intent to increase the accessibility of the overall systems of urban mobility tools in an area through the integration of fares and tools of payment. In such scenario the use of the car could reasonably be considered a second-best option, probably a decreasing option as the integration process goes on together with the focused improvement of urban mobility systems.

5. «There is a permanent contradiction between society, which demands ever more mobility, and public opinion, which is becoming increasingly intolerant of chronic delays and the poor quality of some transport services. As demand for transport keeps increasing, the Community's answer cannot be just to build new infrastructure and open up markets» (COM 2001, p. 6, policy guidelines section).

4. The attention towards social sustainability involves safety, health and segregation issues. Planning principles tends therefore to enhance and make as pleasant as possible the role of walking and cycling as ways to reduce health problems (cardiovascular disease, obesity, etc.), to spread the presence of people in all areas, thus improving urban safety through social control, and finally to avoid the creation of differently-accessible areas, precursors of ghettos and of social segregation.

In our opinion these traits endorse the idea that EU SUM policies are moving towards an approach which is far different from a mere restriction-to-traffic one and put the basis for self-reinforcing mechanism of gradual, voluntary reduction in the use of the car.

These premises are not obvious. In fact, the 2001 White Paper on European transport (COM 2001) is based on rather different premises. The 2001 White Paper section dedicated to the policy guidelines points the finger at balancing the contradictions between different portions of the society that require different forms of development. Economic development and sustainability are in fact presented as a trade-off and the title itself («Time to decide») clearly recall a regulatory need. The section devoted to «The need for integration of transport in sustainable development» is in fact entirely focused on the technical – not values-related – aspects of sustainability: GHG reduction, fuel dependency and energy efficiency. Car is widely acknowledged at the bottom end of the scale in all these aspects (Lefèvre 2009), so it is not surprising that the path identified is «to break the link between transport growth and economic growth and make for a modal shift» (COM 2001, p. 10). While the imposition of traffic limitations at the local level is considered infeasible, the adoption of charges related to the type of road is seen as a possible incentive to multimodality. In the section devoted to the rationalization of urban transport, the suggested measures are mainly those encouraging alternative fuels, stimulating demand for hybrid and zero emissions vehicles.

Following EU documents on urban mobility (COM 2007; COM 2009) set a significant discontinuity in what puts the mobility in urban areas in the leading positions on the political agenda, taking into account the economic and social relevance of the urban contribution to European population settlements and to the generated GDP. Moreover, these documents hint at a different development process in relation to mobility management, a kind of process that goes beyond the traditional idea of regulation for several aspects that increase the predictable acceptability of the transformations, and specifically:

1. the proposal of a holistic project of urban lifestyle, leveraging on emerging social trends and thus bringing the debate to a level of overall project of life rather than triggering negotiation processes closely related to restrictions;
2. a long-term orientation towards goals whose implementation requires the application of new and/or advanced knowledge, in this creating opportunities for new research and new business rather than precluding the development of existing ones.

The holistic approach emerges from specific statements, like for instance: «The choices that people make in the way they travel will affect not only future urban development but also the economic well-being of citizens and companies» (COM 2009, p. 2). The underlying idea is that of a «new culture of urban mobility» which makes of a less car-dependent life-style an explicit objective, driving policies guidelines oriented towards a car-free desirable urban lifestyle. This triggers a change in behaviours and perceptions where the reduction of car use comes from a deliberate choice rather than as the outcome of regulations. This is a remarkable step forward with respect to the early view of the problem, circumscribed to the pollution issue and congestion issue. In such context, traffic restrictions are considered «individual laudable actions» but not an ultimate solution since they might reduce harmonization and interoperability across Europe (COM 2007, pp. 10-11).

White paper 2011 clearly addresses a future urban mobility, which is expected to be largely composed by fleets (that can be read as collective cars) and Personal Mobility Vehicles (PMV),[6] concepts that nowadays are rarely known and seen, but that should probably be in the priority agenda of carmakers: «The use of smaller, lighter and more specialised road passenger vehicles must be encouraged. Large fleets of urban buses, taxis and delivery vans are particularly suitable for the introduction of alternative propulsion systems and fuels» (COM 2011, p. 8).

5 Conclusions and implications

Several authors agree about the decreasing of car dependence in Europe and the USA; such phenomenon is positive in its economic and societal consequences and is commonly acknowledged and pursued by European and local authorities as well. In this trend, a role has prob-

6. On PMV see footnote 1.

ably to be assigned to new concepts of urban mobility that are developing in the European cities. Sustainable Urban Mobility Plans (SUM) are nowadays a priority both for the European Union Agenda and the local authorities agenda of all European countries. All key EU documents related to urban mobility identify traffic, and specifically car traffic, as the major problem related to urban living. Consequently, main concerns in SUM plans are all, more or less, orienting policy towards the exclusion of cars from the urban environment.

Carmakers should take peak car into consideration as a real issue for the next future, since it appears as a change towards a different conception of the use of car. Presently, the attention is almost exclusively devoted to pollution, car-size and, in general, land consumption issues. But we think that this perspective is simplistic and misleading. If it was only a matter of pollution reduction, then electric cars or ZEV in general would be the way to solve it. If it was a matter of land consumption, than small size cars, underground parking and similar would solve it. But in fact the issue is probably on a different plane.

In the actions promoted by EU one could read several battlefronts in which the car is a losing competitors against other form of urban mobility. Among the reasons to let the cars out of mobility plans, the «traditional» disadvantages (high operating costs, pollution, social costs, overall efficiency, and so on) create urban contexts in which the car does not represent a worthwhile investment. But a different conception of urban lifestyle could make the car not even desirable with respect to other means or mobility solutions, existing or not. The question has its importance for the automotive industry, considering that over 70% of the European population lives in urban areas.

If this was true, at least crucial elements should be brought to attention in the automotive industry studies:

1. The impressive knowledge and skills that carmakers put on the ground in the analysis of customers' preferences and behaviour when developing a new car model might emerge as useless in an expanding context of no-car choice.
2. Urban planners, policy makers and mobility managers should be considered crucial carmakers interlocutors in pursuing an effective product development process.
3. The role of innovation, as usual, becomes crucial since the means of individual mobility coherent with the urban sustainable mobility concept should be radically different from the present characterization of car and capable of fitting the new system of emerging values.

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3

The impact of electric motorizations on cars' architecture and supply chain relationships within the automotive industry

Anna Cabigiosu

ABSTRACT *This contribute reviews the existing literature on electric vehicles' architectural changes and discusses their supply chain management implications. The study identifies the main architectural and technological changes induced by cars' electrification and it suggests that electric vehicles are likely to become more modular than the traditional internal combustion engines vehicles. Then, the study evaluates the potential impact that such changes will have on supply chain management practices focusing on the contingent and moderating role of variables such as the rate of technological change and the car makers' strategies. The study concludes identifying some conditions that may foster the development of electric vehicles modular supply chains.*

1 Introduction

This chapter addresses the issue of electric vehicles (EVs) architectural changes and then, building on the modularity literature, debates the implications of their supply chain management. In fact, there is still no study that a) reviews the existing contributes about EVs' architectural changes and helps appreciating whether EVs are moving, and to what extent, toward higher levels of modularity, and that b) relying on the modularity literature discusses their managerial implications.

J.P. Morgan estimated that by 2020 about 11 millions of EVs will be sold worldwide («Automotive News» 2009). According to J.P. Morgan, this will mean that EVs will equal nearly the 13% of the global passenger market at that point in time.

Interestingly, following both the managerial and engineering literature, electric motorizations will affect car design and architecture and, in turn, the way in which carmakers manage design activities and the corresponding supply relationships. Particularly, some scholars have argued that EVs will migrate towards more modular architectures that may lower the need of hand-in-glove relationships between carmakers and suppliers (MacDuffie 2012; Christensen 2011).

The modularity literature suggests that, beside EVs, many products are becoming more modular over time, and that this development is often associated with a change in industry structure driven by the quest for the benefits provided by higher degrees of specialization and disintegration, as the PC industry illustrates (van Bree et al. 2010; Baldwin, Clark 2000; Fine 1998; Fixson, Park 2008; Langlois 2003). In the specific case of the car industry the growing interest in the modularization of design is also determined by the strategic focus on the product architecture (Batchelor 2006). It is reasonable to assume that such interest will be intensified in view of the expected renewal of the dominant car design.

Within this area of research, studies have investigated the relationship between the degree of product modularity and the nature of vertical inter-firm relationships, namely the across firm «mirroring» hypothesis (i.e. if and to what extent products and organizations share similar architectural properties and, more specifically, if and to what extent the degree of modularity of sourced components is inversely related to the «thickness» of buyer-supplier relationships) (Cabigiosu, Camuffo 2012). While the «mirroring» hypothesis finds support in the 70% of the studies (Colfer, Baldwin 2010), the automotive industry appears to be a special case in that a) cars today are still overall integral products (MacDuffie 2012) and b) there is no conclusive answer to key questions concerning the role of modularity in shaping the vertical contracting structure and inter-firm coordination of the car industry (Cabigiosu, Camuffo, Zirpoli 2013; Zirpoli, Becker 2011).

While modularity in production and platforms design are already widespread practices in this industry, till now modularity in design has been confined to subsystems such as the A/C system and the automotive console (Fixson 2003; Sturgeon, Lester 2003). Carmakers mainly leverage on product platforms that include components shared among a variety of car models, but only a few of them are modular.

In this scenario, scholars suggest that also EVs are designed and produced relying on platforms but even that new electric technologies are increasing the cars' modularity level (Christensen 2011).

As MacDuffie (2012) suggests, product architecture of new electric vehicles needs to accommodate heavy battery packs, a high-capacity electrical system, complex software, and small electric motors potentially located in the wheels. Indeed, mapping from function to component is likely to move closer to the one-to-one correspondence that is found in electronic and information technology products. Moreover, today a large number of components used in the various electric drivetrain solutions are shared. Hybrid drivetrain, the fuel cell drivetrain and the battery electric drivetrain all share components and systems such as batteries, electric motors, inverters, generators and brake energy regeneration systems (Christensen 2011). All in all, components commonality across different electric and hybrid motorizations may facilitate modularity-in-design and shift the industry's definition of module away from modularity-in-production. Particularly, modularity-in-design may support «the rise of new suppliers providing specialized expertise for module design and production, and change the prevailing division of labour between OEMs and suppliers» (MacDuffie 2012, p. 49).

The chapter is structured as follows. The first section clarifies the concept of modularity in products and in organizations, while the second synthesizes the main findings about modularity and platforms in the automotive industry. The third paragraph describes the main car architectural changes identified/forecasted due to the introduction of new electric motorizations. The fourth section reviews the modularity literature and identifies those key car attributes (e.g. the car complexity), industry specificities (e.g. the rate of technological change), and carmaker strategies (e.g. the level of vertical integration and knowledge endowment) that all may help in predicting whether and to what extent EVs higher modularity level will reshape supply relationships. The conclusion section draws the research and managerial implications and points out some future research directions.

2 Modularity in product design and in organizations

The scheme by which the functions of a product are allocated to its components is called its «architecture» (Ulrich 1995). Modularity refers to the way in which the design of a product is decomposed into different parts or modules that are characterized by independence across and interdependence within their defined boundaries (Campagnolo, Camuffo 2010; Ulrich 1995). This independence is achievable through the adoption of standard interfaces that decouple the development and the inner working principles of a product's components (Baldwin, Clark 2000). Despite the differences in approaches, scholars converge in identifying three main features of modules: they are separable from the rest of the product; they are isolable as self-contained, semiautonomous chunks; and they are re-combinable with other components. Separability, isolability, and re-combinability are properties deriving from the way functions are mapped onto the components and from how components interact, i.e. from their interfaces.

Ideally, a perfectly modular product is made of components that perform entirely one or few functions (1:1 component/function mapping), with well-known, defined and codified interfaces among them (Ulrich 1995). If these interfaces – i.e. the communication protocols among components – are widely diffused within a given industry, these components have open standard interfaces. However, if the protocols are designed specifically to suit a certain firm's requirements, i.e. they are firm specific, these protocols are closed and non-standard, unless we consider closed interfaces as proprietary standards used by a single firm or a specific network of firms (Fine et al. 2005). Interestingly, modular products are characterized by standard interfaces among components, but the other product's features and attributes – including technologies – may change. Thus, a modular component is not necessarily standard.

Research on the degrees of coupling between product and organizational architectures has flourished during the last two decades. Within this body of research, some studies recently investigated the relationship between the degree of product modularity and the nature of vertical interorganizational relationships (Baldwin, Clark 1997, 2000; Fixson, Park 2008; Colfer, Baldwin 2010).

In the extreme case of full product modularity, all the components exclusively perform one or few functions and the interfaces among them are completely open standard. In this case, all the suppliers that design and produce a given component use the same interfaces or a closed set of interfaces. Thus, they do not need to discuss with the buyer how components should be designed in order to fit the product design. Since components' design and development can be isolated and conducted separately by suppliers within a «frozen» product architecture, co-development practices are unnecessary and the advantages of relational quasi-rents negligible. Buyers and suppliers need not to engage in «thick» relationships through which continuously improve products and processes, control opportunism, and share risk.

In 1996, Sanchez and Mahoney formulated the «mirroring» hypothesis suggesting that loosely coupled standardized interfaces in a modular product architecture provide a form of coordination that reduces the need for overt exercise of managerial authority to achieve coordination of development processes. In such cases, the concurrent and autonomous development of components by loosely coupled organization structures is possible. Modularity in product design reduces the need for «hand-in-glove» supply relationships, because knowledge encapsulation within modules lowers inter-firm interdependence and, hence, coordination and control needs (Sanchez, Mahoney 1996; Langlois 2003). The suppliers that design and produce modular components know ex ante the interfaces of the component; this, in turn, reduces the information exchanges needed to design a component that fits the overall product design. Since component design and development can thus be isolated and carried out separately by suppliers within a «frozen» product architecture, the need for intense coordination is lowered. Also, modularity in design can improve the management and the outputs of the new product development activities by allowing firms to easily decouple both the design and the manufacturing of the components that constitute a product as well as ensuring an easy and well performing integration of the externally supplied components into the final product architecture.

Overall, modularity in design should lead to modular supply chains in which members have few close organizational ties and, thus, may be more easily mixed and matched, highly dispersed and geographically and culturally distant (Fine 1998; Doran 2007). According to Sturgeon (2002), a modular industry is fragmented owing to various specialized capabilities associated with the manufacturing of various components. A modular industry is characterized by loose coupling of component designs, and a loosely coupled knowledge, a high rate of innovation, designers flexibility in developing and testing products, and a high number of compatible suppliers.

In the modular networks, the overall industry structure remains vertically disintegrated. While some OEMs retain internal manufacturing capacity for specific reasons (fear of intellectual property loss, tight integration between processes and product innovation, retention of process expertise to qualify outsourcing partners, etc.), globally operating contract manufacturers facilitate the build-up of external economies of scale and scope. Sturgeon (2002) calls this model modular production network «because distinct breaks in the value chain tend to form at points where information regarding product specifications can be highly formalized». Between these nodes, linkages are achieved by the transfer of codified information. The author underlines how such a network is allowed by standards consolidation inside an industry that works as communication protocols. Components with standardized and industry-wide accepted interface specifications decouple firms from one another, leading to increased specialization and technological improvement of components independently from innovations of other firms (Mikkola 2003). Moreover, inside modular networks the trust, one of the features of the local networks, is substituted by international standards, which permit to compare different suppliers on a common base. Firms, by outsourcing a large share of their manufacturing, become more organizationally and geographically flexible. Being the suppliers' production relatively flexible in terms of volumes and products characteristics, their transactions with brand-name companies remain general. Instead of «thickly relational» interactions between firms, as in the relational networks, modular supply chain are characterised by «thinly relational» interactions because the supplier specifies its own processes, purchases its own inputs, and retains an autonomous financial stance vis-à-vis its customer (Sturgeon 2002). Indeed, modular networks are characterised by the limited interdependence among actors. Thus autonomy is based on several preconditions as the use of IT, «base processes», and widely accepted standards. All in all, modular supply chains are more flexible and eventually global.

Interestingly, in reviewing the literature Colfer and Baldwin (2010) found that the mirroring is supported in the 70% of the cases and it is positively correlated with the firm's performance. Nevertheless, while the modularity literature emphasizes the existence of the mirroring as well as its performance implications, most recent contributes identified the necessity to build a contingent view of this theory.

Particularly, Cabigiosu and Camuffo (2012) identified some conditions under which the mirroring holds, such as (a) the stability of product architecture; (b) the presence of industry standards; (c) firms' strategies, organizations, and capabilities not aimed at increasing the integration with suppliers. Moreover, Furlan, Cabigiosu and Camuffo (2010) highlighted that, even for highly modular products with a stable product architecture, we are less likely to observe the «mirroring» in technologically dynamic industries, characterised by incremental and modular innovations, where buyer-supplier integration is needed no matter the level of component modularity. Zirpoli and Becker (2011) show that component modularity does not substitute for high powered inter-organizational mechanisms, in the sense that it does not solve the problem of integrating component's technical performance within the vehicle. Defining standardized physical interfaces does not standardize the performance contribution of a component and does not reduce the reciprocal interdependencies between component and vehicle performances. The authors show that this is particularly true for complex and technologically dynamic components (such as electronics or car occupant safety systems). Brusoni et al. (2001) show that, when the architecture of fast changing components stabilizes, manufacturers outsource both design and production but keep in house component-specific knowledge for rapidly changing components whose dynamism generates the possibility for technological unbalances.

In this study, we will rely on the above literature to discuss if, how and to what extent EVs' architectural changes may affect supply relationships management practices.

3 Modularity in design in the automotive industry

The past decades have shown an increase in vehicle development and manufacturing outsourcing with a consequent shift in tasks and knowledge from carmakers to first-tier suppliers. Nowadays the key processes own by the carmakers have a narrow focus: vehicle design and engineering, manufacturing of chassis, body, engine and powertrain, final assembly. All other components (interiors, cockpit, braking system, electrical system, traction control system, fuelling system, exhaust system, coolant system) are usually designed, engineered and manufactured by suppliers (Takeishi 2001; Fixson et al. 2005).

In this context, modularity has attracted the interest of scholars in that early studies showed that product modularity reduces the need for a tight coordination between buyer and supplier during the product development stage (Doran 2004; Fixson et al. 2005; Ro et al. 2007): the specifications of standardized component interfaces and a clear one-to-one component-function mapping were credited to create an information structure that allows coordinating the activities as loosely coupled. Moreover, component modularity should increase and ease the rate of introduction of modular and incremental innovations while the concurrent and autonomous development of components speeds the throughput time of NPD activities thus reducing the NPD costs (McDuffie 2012).

Despite the expected benefits of modularity in design, recent empirical evidence shows that only few car components at the first level of the product hierarchy are truly modular and cars are overall integral products: the modularization efforts of some US and European carmakers have not been implemented successfully, with rare exceptions (Ro et al. 2007; Sako 2003). In this respect, Fixson (2003) reviewed existing literature about product modularity in the car industry and offered a list of vehicle sub-systems that the literature has classified as modular. These systems are located at the first level of the vehicle product architecture hierarchy and are: the A/C system, the automotive console, the underbody, the instrument panel, the brake system, and the climate control.

Overall, only few car subsystems are highly modular. Recent studies suggest that while modularity may enhance carmakers' performance, modular strategies are not *the most* performing in this industry and that further modularization processes in the A/C system would not necessarily lead to inter-organizational loosely coupled relationships between OEMs and suppliers (Cabigiosu, Camuffo, Zirpoli 2013; Zirpoli, Becker 2011). Cabigiosu et al. (2013) show that the complexity in the car architecture reduces the chances of modularity to be effective as a functional equivalent of high-powered inter-firm coordination mechanisms (Cabigiosu, Camuffo 2012; MacDuffie 2012; Zirpoli, Becker 2011). High-powered inter-organizational coordination mechanisms remain necessary to ensure effective and efficient product development. Moreover, they show that, in order to increase the modularization of vehicle components, carmakers need to heavily invest in component-specific knowledge (i.e. increase their level of vertical integration) and that the knowledge they held, more than component modularity, enhances the coordination with suppliers. One exception is identified by MacDuffie (2012) that describes the case of Chinese carmakers. These OEMs design modular cars because they almost completely rely on external suppliers to design the car systems. Once the suppliers have designed the car systems, the Chinese OEMs preserve these architectures that, otherwise, they would not be able to fully manage.

Overall, modularity has still a limited traction in the automotive industry and the evidence about its impact on supply chain management is not decisive. In the automotive industry we mainly observed that modularity in production is defined as the outsourcing of a product's components: independent companies (e.g. suppliers) may develop, produce and deliver subsystems that are consistent with the scope and depth of their core competences (Campagnolo, Camuffo 2010). Modular designs are supposed to ease modular productions. While modularity in organization relates to how supply chain relationships are managed, modularity in production attains to the disaggregation of the production activities along the supply chain. Today, the automotive industry shows a high level of modularity in production and a low level of modularity in product design and organization, i.e. cars are overall integral products while subsystems are externally sourced maintaining a high level of integration with suppliers.

By reviewing the existent literature, this paper aims at evaluating the expected level of modularity of EVs and, by building on the modularity theory, at discussing how EVs' architecture may affect the management of supply chain relationships.

4 Electric vehicles main architectural changes

This study focuses on EV's main architectural innovations and their organizational implications with a focus on supply chain management strategies. Particularly, in this section we will review the existing literature on EVs to understand if and to what extent EVs are, and are likely to become, more modular in their design.

EVs powertrain system mainly consists of an electric engine that moves the wheels, a battery for energy storage, and an electronic control system. Initially, most car manufacturers, such as Renault and Peugeot, favoured electrifying existing models pursuing a low-cost strategy. These EVs were unsuccessful, mainly due to a limited range, and a higher price relative to comparable IC vehicles. After 1997 a few car makers, such as Toyota and Honda, launched hybrid vehicles that had similar range as IC vehicles. By 2008, the US market shares of these models grew till 4% (Dijk, Yarmine 2010),

The first generation of EVs is derived from the adaptation of existing product platforms. Presently, with very few exceptions, electric vehicles are obtained through the adaptation of chassis (or floor pan), bodies and powertrain engineered for traditional internal combustion engines (IC). Also hybrids and fuel cell solutions can often be integrated into existing vehicles with minor changes to the car design.

Consequently, EVs, hybrids and fuel cell cars all suffer from under-optimized energy efficiency and car architectures. The perspective of very low sales volumes and the dramatic uncertainty about the future of EVs technological trajectories has so far refrained carmakers from heavily investing into dedicated EVs' architectures for the mass market. Moreover, battery and fuel cell technology are likely to be niche markets because batteries are still comparatively expensive components. Broad diffusion for EVs is expected only around 2020 (Brown et al. 2010). Consequently, today EVs are often built on IC-based platforms and only the second generation of EVs may go over this technological lock-in (Cowan, Hultén 1996; Midler, Beaume 2010). Marletto (2011) talks about a «car regime» environment in which the lock-in is so much rooted that shift towards ecological motorization could be achieved only through policies of institutional change. Van den Hoed (2007), studying patents in alternative drivetrain technologies, showed that manufacturers invested in both battery electric drivetrains and hybrids and fuel cell solutions but gave priority to the latter because they can more easily lead the drivetrain electrification in mass-produced cars.

Table 1 shows that today the main components that are *not* in common between IC cars and EVs are those belonging to the engine group and the transmissions (Cuenca et al. 1999). Indeed, we will now focus on how the architecture of these components is changed and to what extent they may affect the overall car architecture and its modularity level.

According to Christensen (2011), a large number of the components, such as batteries, electric motors, inverters, generators and brake energy regeneration systems, are shared across EV, hybrid and fuel cell drivetrain solutions. The similarities of alternative drivetrain technologies suggest that their development activities can be partially shared and that the drivetrain can become more modular. Christensen (2011) provided some examples of how alternative drivetrain technologies are affecting car architecture. General Motors developed the GM Hy-wire model following a platform approach in which a skateboard-like lower body, containing a full fuel cell system with drive-by-wire technology, can be applied to various upper body vehicle applications. The Chevy Volt, produced by General Motors, has an electric drivetrain developed on a platform that facilitates the flexible choice between three different propulsion options: a pure battery electric option, a combined electric/combustion engine option and a combined electric/fuel cell option. In such a case, the three propulsion options constitute three modules. Finally, Mitsubishi has developed a design strategy where «the modularization of related components for electric drivetrains enables the company to develop components for three interchangeable drive systems simultaneously. Mitsubishi has designed an in-wheel assembled electric engine that can be applied to a battery electric vehicle, a hybrid electric vehicle or a fuel cell electric vehicle» (p. 217). The lithium-ion battery and the in-wheel electric motor are both produced by external suppliers.

These cases suggest that both the engine and transmission can be designed as car modules and have an inner modular architecture in which components can be shared across platforms. Moreover, following Christens (2011), EV concepts will improve the feasibility and implementation of the drive-by-wire (DBW) technologies that eliminate the mechanical connection between the steering wheel and the steering gear box thus freeing up space in the engine compartment. A small motor aids the driver to turn the steering wheel in a smooth easy motion. Instead of operating the steering and brakes directly, the controls would send commands to a central computer, which would instruct the car on what to do. The great advantage being put forward this way is that it would possible to improve the roadholding and the overall energy efficiency through the electronic control of the joint work of steering, suspensions and brakes in response to driver's actions and road conditions (Varghesee et al. 2008).

DBW would provide a triple source of benefits:

1. gear lever, steering columns and pedals could be abandoned with benefits in terms of lower complexity, weight and space thus increasing the degree of freedom in the interiors design;
2. making the chassis and the body independent with a DBW solution would give the possibility to design and engineer these two macro-components separately, theoretically as two separated modules. Indeed, the elimination of mechanical elements for driving control is a

Table 1: components in common between IC vehicles and EV.

Vehicle group and subgroup	Fully common	Somewhat common	Not common
Body group			
Body-in-white	×		
Paint and coatings	×		
Glass	×		
Interior body trim	×		
Exterior body trim	×		
Seats	×		
Instruments panel		×	
Restraint system	×		
Body electrical components	×		
Heating, ventilating, and air-conditioning (HVAC)		×	
Engine group			
Base engine			×
Emission control			×
Engine accessories			×
Engine electrical components			×
Cooling system			×
Transmission group			
Transaxle			×
Clutch and actuator			×
Transmission control			×
Chassis group			
Frame	×		
Suspension	×		
Steering		×	
Brakes		×	
Exhaust system			×
Fuel storage			×
Final drive	×		
Wheels and tires	×		
Bumpers, fenders, and shields	×		
Chassis electrical components		×	
Accessories and tools	×		
Fluids		×	

Source: Cuenca et al. 1999, p. 10.

premise for a radical detach of the chassis (which would include all elements needed to assure the motion: engines, transmission, batteries, brakes and so on in a sort of «surfboard») from the body and the passengers' cabin (presently the chassis and the body are welded together). The potential advantage is to have a lower number of interfaces, a much higher freedom of design of the body and the interiors coupled with a higher degree of standardization of the surfboard. As Cabigiosu et al. (2013) suggested, highly modular cars are characterized by a wide reliance on open-standard interfaces that can constrain the car's style viable options. The overall reduction of EV complexity is key to avoid that too many frozen interfaces limit OEM's design choices;

3. finally, the substitution of mechanical interfaces with electrical ones and the opportunities offered by the integrated electronic control of the whole powertrain should ease the development of open standard interfaces.

EVs have no emission (therefore no exhaust system is needed) and can exploit the advantages of direct transmission. Theoretically, no clutch or conventional gearbox are needed, since the electric engine provides a very high torque since the minimum regimes. Differential can be eliminated connecting electric motors to the wheel axle. Since all transmissions elements are a major source of lost in efficiency, designer will likely tend to focus on solutions that eliminate them (Larminie, Lowry 2003; Kulkarni et al. 2011). The «extreme» solution is to have the motors coupled to the wheel-shaft; such a solution provide a significant improvement in performances (speed and acceleration) and a very significant saving in space and weight.

Also, EVs allow partially substituting mechanical interfaces with electronic interfaces. In traditional cars a huge share of electronic systems is devoted to the control of IC functioning (injection, fault diagnostic, cooling, etc.). Such systems will disappear while driving and traction controls electronics will probably became even more relevant and, as suggested by the history of the PC industry, they are likely to become open standard interfaces (Baldwin, Clark 2000). As far as this last point is concerned, there already exist industry standards for computers, batteries and battery components. Nevertheless, there is still a need to develop international standards for larger-scale battery packs that can be used by the EV as well as advanced and future battery technologies. «Basic standards and frameworks exist, but much work to bring the needed regulations and standards to light is still required. A number of the most pressing areas have been identified, particularly new battery technologies, the emergence of V2G (vehicle to greed) technologies and possible impacts on the quality of electricity on power networks, and in terms of the full lifecycle environmental impacts associated with the EVs» (Brown et al. 2010, p. 3806).

Overall, EVs allow reducing the number of the components in a car, the interfaces among them and partially substituting mechanical interfaces with electrical interfaces that are easier to standardize. Today, these architectural changes mainly regard the engine group and the transmissions that are still «plugged in» a traditional IC based vehicle thus reducing the potential EV efficiency.

To achieve EV «product integrity», as defined by Clark and Fujimoto (1990), OEMs may need to deeply revise the next generations of EVs' product architectures in order to adapt to new constraints (especially the battery location). They need to rethink the performance criteria, which drive the technical design choices on nearly every component of a car. For example, energy efficiency is a key performance for EVs as it has an immediate impact on vehicle autonomy. Thus, redesigning more energy efficient lighting or heating is a key aspect of future EV projects. The whole design system has thus to be reoriented on the new electric mobility paradigm. The occurrence of a «performance gap» may be satisfied only by more technically integrated solutions (Brown et al. 2010; Sierzchula et al. 2012).

5 EVs, modularity in design and supply chain relationships

In this section we debate, by building on the modularity and the innovation management literature, what the expected effects of a EVs architecture on supply chain management relationships will be. Firstly, we will discuss the role that the interplay between modularity and technological dynamism has in shaping supply relationships. Secondly, we will include into the analysis OEMs organization, strategies and capabilities.

The literature suggests that industries often become disintegrated over time (Baldwin, Clark 2000). As Fine and Parker outline (2008), this disintegration has been explained by the increasing efficiency through the division of labour and, at the firm-level explanation, by the potential gains from specialization and gains from trade. In their work on the evolution of the computer industry, Baldwin and Clark (2000) describe the initial creation of the modular architecture as preceding the emergence of a modular industry structure. Also Glavin and Morkel (2001) and Fixson and Park (2008) emphasized the relationship between product architecture and supply chain management practices in the bicycle industry.

The above analysis suggests that OEMs' attempts to move toward higher levels of modularity may be eased by electrification (Christensen 2011). The observed higher modularity levels may support the idea that these architectural changes may enhance more loosely coupled supply relationships, increasing the suppliers substitutability, easing the integration of external sources of innovation till eventually leading to modular supply chains (MacDuffie 2012; Sturgeon 2002).

The analysed EVs architectural characteristics, such as the EVs lower number of interfaces and components, suggest that EVs are, other things equal, more modular than IC vehicles and that EVs may potentially reduce the complexity of the design activities and of the corresponding supply relationships.

Moreover, the need to simultaneously plug-in EV, hybrid and fuel cell drivetrain solutions into IC car platforms may foster the development of shared standard interfaces, ease the integration of externally sourced components and reduce the need of hand-in-glove relationships with suppliers.

Besides, the above paragraphs also describe how today EVs do not only display architectural changes but also embody innovative technologies, such as the DBW technology. Moreover, both EVs architecture and technologies are likely to face further modifications in the next years. Indeed, the potential managerial implications of EVs higher modularity level should be discussed contingently on the level of technological change of the first generation of EVs as well as on the future technological trajectories that may regard EVs technologies and dedicated platforms.

Cabigiosu and Camuffo (2012) suggest that modularity in products and organizations may be related only if product architecture is stable. Component modularity works as a functional equivalent of high-powered inter-organizational coordination mechanisms only if the product architecture is ex-ante defined and frozen thus embodying those open and widely diffused standard interfaces that ease the coordination between a buyer and a supplier.

Nevertheless, even if the product architecture is stable, we may not observe a relationship between modularity in products and in organizations. When the product architecture is stable we may still observe intense and frequent modular and incremental innovations. In industries characterized by high levels of incremental and modular innovations, buyers may remain interested in getting access to supplier's knowledge base, in monitoring suppliers' cost structures and performance via collaborative and «thick» supply relationships (Furlan et al. 2010). As Wolter and Veloso (2008) suggest, when component technological change is frequent, buyers will engage suppliers in an intense information and knowledge sharing and will rely on complex integration and control mechanisms, no matter what the degree of modularity of the sourced components is. In general, technological variation in components continuously generates inter-organizational interdependencies throughout the product development process, despite efforts to limit them through modularity.

Thus, till EVs will be characterized by architectural changes and/or by frequent and intense modular and incremental innovations, even if the car architecture is modular, we cannot expect that their supply chain will become modular *à la* Sturgeon (2002).

When OEMs act as system integrators of complex and technologically dynamic components, such as car subsystems, they have to keep substantial component specific knowledge even about outsourced components. Two ways to nurture this component specific knowledge are to maintain a high level of vertical integration or to remain engaged in «thick» relationships with suppliers. Brusoni et al. (2001) show that manufacturers keep in house component specific knowledge for rapidly changing components. OEMs acquire component specific knowledge to maintain the ability to act as system integrators and develop collaborative relationships with suppliers. Cabigiosu et al. (2013) show that the ability to design a highly modular car subsystem is contingent upon an in-depth knowledge of both the subsystem architecture and its inner components. Given cars' architectural complexity, only OEMs with components specific knowledge can design more modular systems and experience the benefits of this architecture, as coordination and control mechanism. While component modularity and design outsourcing are considered as complements in modularity literature, they may be difficult to combine. Carmakers can effectively modularize a system if they maintain in-house some subsystems specific knowledge by increasing their level of vertical integration or, alternatively, if they extensively rely on supplier's competences and high-powered integration mechanisms.

On the transactions point of view, tapping into the capabilities of the supplier by continuously exchanging information about the product or the process allows the buyer to better evaluate the supplier's offers. Moreover, technological change increases the performance uncertainty of the sourced components and makes it more difficult for the buyer to develop measures of suppliers' performance. Therefore, the partners need to share information and maintain collaborative hand-in-glove supply relationships to reduce information asymmetries and to write clear and credible contracts, no matter what the level of component modularity is (Furlan et al. 2010; Wolter, Veloso 2008).

Therefore, despite the EVs' potential higher level of modularity, we do not expect that modularity may substitute high-powered integration tolls till EVs will face architectural changes and/or frequent and intense incremental/modular innovations: supply chain relationships are likely to remain collaborative, characterized by an intense information sharing and physical co-location. On the contrary, if EVs' architecture will stabilize *and* innovations will be characterized by a low frequency and intensity, modularity in design may ease the management of supply chain relationships.

Besides, even under these circumstances, organizational interdependencies may remain and the need for collaborative supply relationships will persist. Some levels of buyer-supplier integration may complement modularization ex post allowing problem solving for unforeseen design and supply chain management issues.

Furthermore, while today EVs constitute a niche market, we do not know how OEMs strategies will evolve.

If EVs will be considered key in the competitive scenario, car-makers may be wiling to increase their control over these architectures, their sub-systems and components, thus maintaining a high level of vertical integration no matter the level of EVs' modularity. In this case, OEMs would not narrow the scope of their knowledge because relying on the component specific knowledge owned by suppliers may be too risky. OEMs' knowledge necessarily have to span components boundaries (Brusoni et al. 2001; Cabigiosu, Camuffo 2012).

On the contrary, if EVs will be perceived as a marginal market, OEMs may not highly invest in components specific knowledge and be more willing to rely on the higher level of modularity that EVs may enable and to match it with loosely coupled and less-intensive supply relationships. In such cases OEMs may rely on available industry standards and external suppliers competences to develop EVs (MacDuffie 2012). For the sake of completeness, this scenario is likely to exist only if electrification *per se* will increase car's modularity level. Otherwise, specific OEMs effort and investments in components specific knowledge will be required to increase EVs modularity, thus increasing OEMs' level of vertical integration (Cabigiosu et al. 2012).

All in all, we expect that modular EVs will be coupled with modular supply chains, characterized by a high level of outsourcing and loosely coupled supply relationships, only if a) EVs technical characteristics *per se* increase the level of car's modularity; b) architecture stabilizes and presents minor modular/incremental innovations and b) OEMs do not perceive components specific knowledge and EVs as a source of competitive advantage.

Even in this scenario, modularity may complement and not fully substitute high-powered integration tools (Cabigiosu, Camuffo 2012).

6 Conclusions

Part of the modularity literature argues that modular products are produced by modular supply chains (Sturgeon 2002). This study, by reviewing the existent literature, shows that EVs architecture is likely to become more modular than IC architecture and that EVs embody new technologies. Also, while EVs developed so far are mainly built on IC platforms, the next EVs models may be more performing and innovative if developed from dedicated platforms.

With high uncertainty about changes in technology and markets, stabilization of a modular product architecture is a two-edged sword. Some standardization may be necessary to allow first-tier suppliers to focus on the complex subsystems in which they have distinctive capabilities. But too much standardization can become a barrier to systematic innovation and lock car-makers into a potentially obsolete product architecture.

This explains why firms, such as car-makers, are reluctant to commit to single product architecture and to a closed set of standard interfaces, hence constraining the development of product and organizational modularity. In these contexts, new hybrid forms of industrial organization that mix and match elements of modularity and integration are likely to emerge. These hybrid organizational responses reflect the fact that firms need to cope with highly complex technical and competitive challenges for which no ready-made organizational solutions exist.

Only at the point in which EVs will become overall mature products, characterized by a stable product architecture and a low level of technological change, OEMs will not perceive as key to maintain the control over externally supplied EVs' subsystems and modularity may play a role in fostering disintegration processes of EVs' supply chains. In this scenario, co-development practices might be less relevant and the advantages of relational and geographical quasi-rents negligible. Suppliers and buyers identity may become less important thus increasing the competition within the industry. Besides, even this may be a temporarily equilibrium that will resist till new technologies that foster the re-integration of the product architecture will be introduced (Fixson, Parker 2008).

Today, OEMs' strategic control over car subsystems, such as the powertrain, and the EVs' technological evolution are likely to limit modularity in supply chains. The need to maintain a high level of control over the powertrain technology and its performance fosters the integration and knowledge sharing with suppliers of complementary components and OEMs' reliance on collaborative supply relationships. The intensity of these relationships is also increased by the fluidity of the technology embodied into EVs' components.

Future studies should focus on the potential of EVs' market. If EVs will remain a niche market it is less likely that OEMs' strategies will focus on them, that dedicated platforms will be developed and that OEMs will heavily invest in innovative technologies. Also, scholars may analyse whether suppliers with proprietary technologies will play a dominant role thus favouring the development of open standards, as happened in the PC industry with the Wintel platform.

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4
Towards a new business model for automotive distribution

Leonardo Buzzavo

ABSTRACT *The automotive industry has been undergoing a profound reorganization in upstream activities for quite some time. Such reorganization, however, has only recently started to affect the distribution domain that has traditionally been based on a system of family-owned franchised dealerships according to a scheme of vertical quasi-integration. During recent years the market downturn in Western Europe has exacerbated an already critical situation of reduced dealer profits due to high levels of intra-brand competition, while service and intangible elements in the automotive product matter and digital technologies are creating new potential for change. This chapter focuses on the transformations in place (including margin structures and retailer concentration) and discusses how the traditional business model of franchised dealerships (intended as a set of choices on the target, the offering, the chain of activities and the profit model) is evolving.*

1 Distribution in the automotive value chain

Distribution plays an important role in the automotive industry, for two major reasons. Firstly, it represents a considerable portion of the value chain: industry observers generally estimate its cost between 25% and 30% of the vehicle list price, and the number of employees which are involved in sales and servicing activities in mature markets (such as Western Europe) is usually higher than those which are involved in manufacturing and assembly (Volpato, Zirpoli 2011). Secondly, the distribution chain is also a focal point for the effectiveness of the whole automotive system as it is a territory for value creation: the value of the whole automotive product as perceived by customers is not just determined by the vehicle itself and its intrinsic features but depends on many factors linked to the point of sale and service. Moreover, distribution is a means to match supply and demand, possibly not just shifting metal downwards but rather activating intelligent «market sensing» mechanisms that are beneficial for the whole system (Volpato 1986). As a matter of fact, franchised dealers are not just involved in selling and in physical distribution activities but have become more and more involved in tasks of marketing and brand support since manufacturers are highly interested in enhancing the purchase and ownership experience towards greater customer loyalty, possibly «for life» (Sewell 1990).

Automotive distribution features a significant degree of complexity due to the specific nature of the product and its demand. Cars are durable goods with a high economic impact on the customer budget, which calls for the deployment of an appropriate system of servicing and parts distribution throughout the market. Demand is highly segmented and that requires a broad product range with significant depth in terms of variations and specifications. In every target market there is an importer (usually owned by the OEM, i.e. a national sales company) that manages product distribution through a network of dealerships (owned by independent entrepreneurs), ensures servicing activities through a network of authorized repairers, and coordinates parts distribution.

The flows of information and finished products that move throughout the automotive supply chain involve many players after the assembly line, including market-level importers, franchised dealerships and logistics companies who often manage stocks on behalf of the manufacturers. As a consequence, the performance of the whole distribution system is not just related to the local optimization of sub-processes, but is heavily influenced by the coordinating mechanisms at the whole system level (Buzzavo 1997).

This chapter focuses on the role of automotive distribution within the whole value chain and addresses the following key questions:

1. How is distribution evolving when compared to performance improvements achieved in other parts of the value chain (i.e. upstream activities)?
2. How are franchised dealers, being the key actors in the distribution chain, performing?
3. Are there trends of retailer concentration, and to what extent?
4. How is the business model of franchised dealerships evolving in response to industry transformations?

These questions will be addressed with specific reference to the Western European market and, in most cases, by making direct reference to the Italian market, where more detailed and analytical data are available over a significantly long time frame.

Before addressing these questions, for the sake of a better understanding of our reasoning, it is worth sketching out how the current distribution system originated about one century ago.

2 The origins of the automotive distribution system

At the beginning (late 19th and early 20th century) manufacturers operated a mixed distribution structure with multiple channels (Pashigian 1961) including: a) branches (sites that were wholly owned by manufacturers and used for direct sales); b) distributors (wholesalers who managed large stocks of cars in relevant geographic areas and channelled cars to consumers through retailers – dealers –, which could be either owned by a distributor or by an independent operator, and which offered a wide range of services to the consumer, in particular repair and maintenance activities); c) agents (in charge of collecting orders from customers, but with a very simple and cost-effective organization).

With the market expansion that took place after World War One manufacturers aimed at exerting greater control over the increasing number of dealers, who were assigned an exclusive sales territory and a set of operating standards. When, after World War Two, the large growth in demand created a mass market, dealers undertook rising investments for vehicles and parts stocks and for brand-specific items (e.g. tools, signs), often representing sunk costs. The distribution contract was full of so many obligations that it determined a sort of vertical quasi-integration (Volpato 1989). In other words, dealers were independent operators but their policies were highly influenced by manufacturers.

The development of such an asymmetric situation was made possible by favourable market conditions (a seller's market), which created opportunities of high profits for car manufacturers. These profits have partly been handed over to dealer owners who in substance have given up much of their entrepreneurial independence, accepting the considerable restraints existing in the franchising contract, in exchange for high profitability levels.

As effectively pointed out by Marx (1985), the system of franchised distribution adopted by the automotive industry was not coming from a «grand plan» but rather it evolved due to changing economic conditions. In the early decades of the 20th century a relatively simple distribution systems existed that was only appropriate for a static and predictable environment: it could no longer deliver the level of coordination that was necessary to meet the increasingly diverse and sophisticated demands for products and services which were coming from consumers, with a set of sales fluctuations and the need to manage a growing need for trade-ins (that is, used cars that new car buyers had to dispose of while purchasing a new one) that made every transaction unique and requiring trading and not just retailing skills, with a new factor of risk and financial burden involved.

On the whole, the phases of market growth and rapid motorization that took place in the second half of the 20th century have heavily shaped the underlying properties of the distribution system and its operating logics. Thanks to the steady growth of sales volumes, competition among dealers representing the same make (intra-brand competition) was not an issue. Moreover, within the relationship between OEMs and the market the orientation towards customer satisfaction did polarize on the product (function, design, quality) leaving a rather marginal role to service elements (delivery times, relationship with the dealer, after-sales care, and so on). In other words, such emphasis on engineering and manufacturing dimensions left little room in OEMs and national sales companies for an approach based on a service culture and customer care.

Given their rigid cost structure, OEMs are generally inclined to saturate plants and therefore to maximize production volumes, so that even during phases of lower demand the tendency is to push sales, channelling a considerable level of product in the market. So in the traditional logics of operation the distribution network has represented a sort of pipeline in which stock pressure could be exerted rather than a tool through which a two-way communication channel could be activated so as to valorize the wealth of information that can be gathered from customers (Volpato 1986).

Starting from the 1970s, in the car market a series of changes occurred, which gradually led to a buyer's market, and started undermining the sustainability of the traditional structure. Among the most relevant factors of this transformation there are the oil crises, the entry of Japanese competition in the international car market, and the gradual disappearance of first-time buyers, switching to replacement demand in mature markets. Later on, at the turn of the century, pressures grew further with the increase of globalization and competition, the technological transformations, and the effects of the worldwide recession. Although the pressures for change in the 1970s and the evolution from a seller's to a buyer's market started increasing the degree of competitiveness and eroding margins without inducing significant changes from a structural standpoint, the set of changes unfolding in the new century have brought a more radical set of pressures for a deeper overhaul of the business model.

3 Industry transformations and the «system mismatch»

As we have seen, the specific architecture of the automotive distribution system was developed in a way that was consistent with the state of demand. When things started to change, a considerable degree of «mismatch» between upward stages of the car system and downward activities has emerged.

The market shifted from a seller's to a buyer's market, replacement demand became dominant, while customers were becoming more mature thanks to the availability of more and better information, hence they were also more demanding in terms of quality, reliability, safety, residual values, elements of customization and so on. The extreme acceleration in the growth of information and communication technologies (ICT) and the rise of social networks have altered the quantity and quality of information available among customers, and the mechanisms governing advertising and shopping. The greater level of transparency has dramatically reduced the information asymmetry between customers and dealers (e.g. with respect to the dealer margin and the presence of additional manufacturer campaigns), while electronic media stimulate aggressive comparison-shopping and can drive margins down.

While production started to chase growingly differentiated customer needs through a set of multiplying segments and niches, the higher degree of homogeneity among quality and reliability standards of vehicles triggered more attention towards intangible elements revolving around the purchase and ownership of a vehicle. This has determined the greater importance of soft elements such as: customer care, brand image, customized relationships, provision of complementary services and so on. As a result, distribution players (franchised dealers) have become more and more important as customer touch-points.

What happened upstream? Over recent decades manufacturers have embarked in massive reorganization efforts towards more efficient and flexible chains, adopting the lesson of lean manufacturing and lean component supply. This trend was vividly promoted by a research undertaken by the IMVP (International Motor Vehicle Program) that identified the set of principles lying at the basis of Toyota's superior performance – in terms of efficiency, quality and flexibility –, which acted as a world-class benchmark (Womack et al. 1990). But the most striking thing is how from the standpoint of manufacturing and component supply, many indicators show evidence of a performance improvement, whereas looking at the distribution arena the situation appears quite baffling.

Figure 1 shows the trend in the levels of stock of finished vehicles at the market level, in the four major European markets (France,

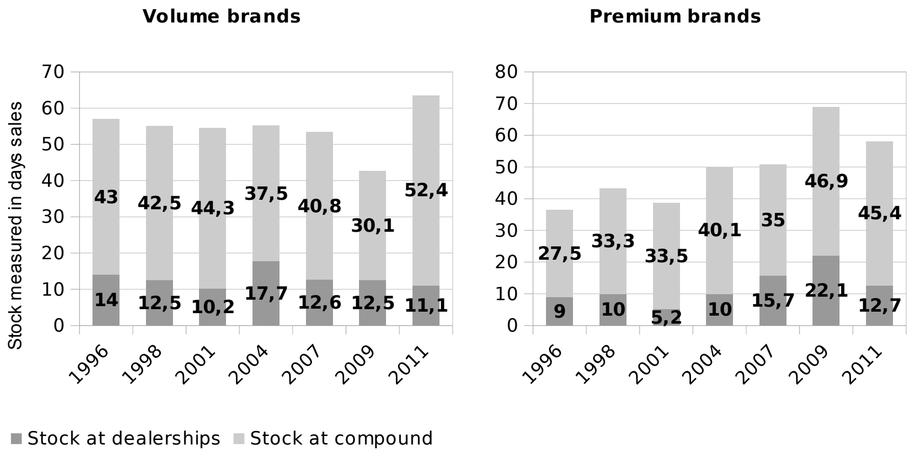

Fig. 1. Market-level stocks for volume and premium brands.
Source: ICDP – data for France, Germany, Italy and UK.

Germany, Italy and UK). Part of this stock is kept in manufacturer-controlled compounds (vehicles that have been imported to the target market), the rest is located at dealerships. For volume brands, over the last 15 years the level of stock at compounds, measured in days of sales, has reduced only marginally (from 14 days to 11.1). The stock at dealer level has remained relatively flat at around 40 days, with the exception of two swings in 2009 and 2011 due to rather favourable and unfavourable levels of demand respectively. But the situation is even more striking when one looks at the levels of stock for premium brands, with both compound and dealer stocks increasing considerably over the years.

It should be noted that a non-lean distribution can act as a serious bottleneck for the whole system and reduce its overall performance, for example by eroding advantages obtained in manufacturing in terms of product variety of lead time. For example, a lead time advantage in production, which is rather complex and costly to achieve, can be offset by inefficiencies downstream. Similarly, production leaps in terms of variety and ability to build to order and to customer specifications loose importance if high stock levels are in place, driving dealers to push sales from existing stock (Waller 2012).

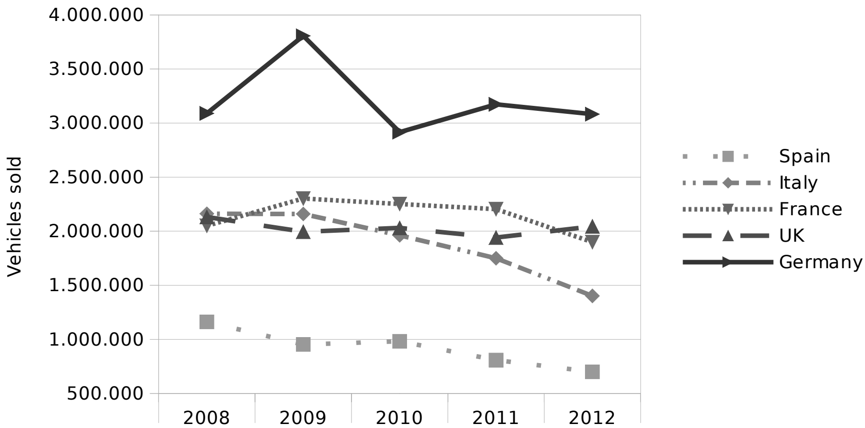

Figure 2. Sales trend in major European markets.
Source: ACEA.

We can therefore argue that the transformation of the value creation architecture of the automotive chain has just started to affect distribution that still holds considerable potential (Buzzavo 1997; Maxton, Wormald 2004; Dietl et al. 2009), and this has become a more urgent task given the dramatic fall in sales volumes in major European markets that took place more recently due to the financial crisis and recession (see figure 2).

This situation of «system mismatch» between the upward and downward portions of the automotive system is causing distribution to grow in importance within the strategic agendas of OEMs, with considerable delays to be addressed.

4 Changes at the economic level: dealer margins

The transformations in the automotive industry (saturated market and falling demand, intense competition, developments in ICT) have contributed to make the distribution business more complex. The increase in sophistication pushed dealers (with their human resources, their procedures, their services) to become more professional and supportive of customer needs, usually incurring in higher costs. Intra-brand competition has eroded margins requiring dealers to gain efficiency (i.e. reduce costs) and to boost other profit generators (such as service, parts, used cars, finance, etc.).

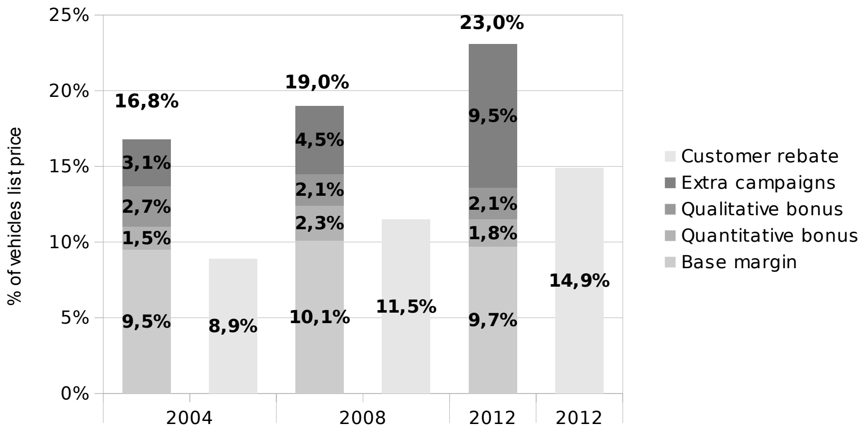

Figure 3. The structure of dealer margins.
Source: Quintegia (2013).

The intensity of the competitive confrontation has started to induce manufacturers to reduce their cost structures on all sides. Besides intensifying the focus on the reorganization of their manufacturing and component chains, they have started to reduce new car selling margins. Broadly speaking, the industry has shifted from a typical gross dealer margin of over 15% in the mid-1990s (plus some extra bonuses, mainly volume-related) to a gross dealer margin in the order of 10% in recent years, with a vast increase in variable margin elements (often representing one third or more of the total available margin). The variable margin elements are linked to the dealer's ability to fulfil certain requirements, such as, for example, customer satisfaction levels, additional brand-related investments and procedures, customer information reporting, and so on, with schemes that can become highly complex (Buzzavo, Montagner 2005). The increased competition has driven up rebates to customers, wiping out much of the gross margin, so that dealers end up covering their costs (and possibly trying to earn a profit) on the variable component, which results in a greater uncertainty. Figure 3 shows how margin structures have changed during the past decade (data refer to volume brands in the Italian market).

Over the recent decade the total gross margin available (including the base margin plus additional bonuses depending on quantitative and qualitative elements) has remained rather stable between 13% and 14%. What changed much over the last decade is the size of the rebate to customers (due to oversupply versus a depressed market, triggering strong intra- and inter-brand competition) and the size of extra sales campaigns that manufacturers must activate in order to keep dealers alive. In fact, additional incentives in the form of extra sales campaigns must grow to compensate for increased rebates to customers, so that the actual gross margin (the base margin plus bonuses plus campaigns minus the rebate to the customer) hovers around 7-8%. From a general standpoint, such gross margin is broadly sufficient to cover the structure of dealer costs, generally in the order of 7%, leaving approximately a 1% return on sales (ROS). But this line of reasoning remains theoretical, because the dramatic fall in demand has considerably reduced the average sales throughput of franchised dealers. In other words, while the gross margin has remained relatively stable (thanks to the support of extra sales campaigns), the losses in volumes have made the business unsustainable, so that many dealerships have been drowning in red ink. As a matter of fact, by looking at the portion of total sales that are retail sales (hence excluding direct sales by manufacturers for example to rental and leasing companies, large fleets, etc.) we see that the total volumes sold by dealers in Italy have reduced from circa 1.7 million vehicles in 2004 to 0.9 million vehicles in 2012 (source: Quintegia). It should be noted that while we are now focusing on data referring to the Italian market, this trend is broadly similar to other markets.

5 Changes at the structural level: retailer concentration

This kind of economic pressure has triggered a trend towards retailed concentration: more and more dealerships cannot survive in the new economic situation while bigger (and more financially solid) players look for scale economies through some acquisitions. Such concentration has been partly facilitated by manufacturers who, beginning to recognize that they had pursued strategies of territory coverage that led to too many intermediaries during stages of market growth, have started aiming at a lower number of more solid entrepreneurs with a stronger equity structure and more professional facilities and systems, capable of playing a better role as retailing partners (Buzzavo 2008).

The concentration process has accelerated further in recent years due to the enormous pressures created by massive drops in sales volumes. As shown in Figure 4, in Italy the number of sales outlets has decreased by 15% over a decade (from 6,130 units to 5,215 units). It should be noted that over the last decade some brands – particularly Asian ones – have entered the market and/or expanded their distribution networks: as a

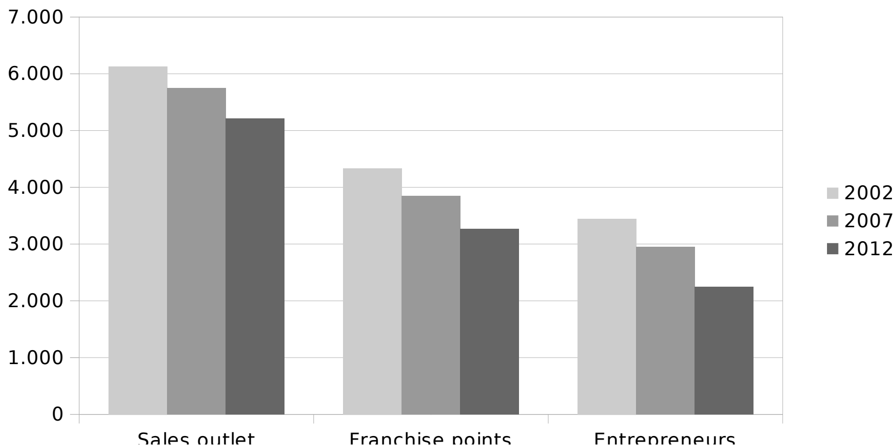

Figure 4. Trend in franchised dealerships (Italy)
Source: Quintegia (2013)

consequence the downward trend is even greater if we look just at the sales outlets of more mature networks. But the concentration process is much more visible at the level of franchise points (-25%) and at the level of the number of entrepreneurs who control them (-35%), down to 2,250 units.

As we have seen, the ongoing concentration process is quite dramatic: one Italian dealership entrepreneur out of three has exited the distribution industry over the last decade. It is also interesting to look at the degree of concentration in sales by the largest players operating in the market. Figure 5 shows the market share (in volume terms) of the top10 and top50 dealers in the Italian market. Both shares have increased by about 60% in the last decade.

It should be observed that the degree of concentration, albeit growing, is still rather low when compared to other industries. We would argue that there are a few reasons behind this (Buzzavo 2008). On the one hand the automotive distribution industry has been influenced by a quite peculiar regulatory framework («Block Exemption») that defines the scope and operation of vertical restraints (Tongue 2010) that led manufacturers to prevent too much consolidation among retailers so to keep enough control over the distribution system. On the other hand it should be said that scale economies at the dealer level are rather modest: there are no significant scale advantages in purchasing (at least for

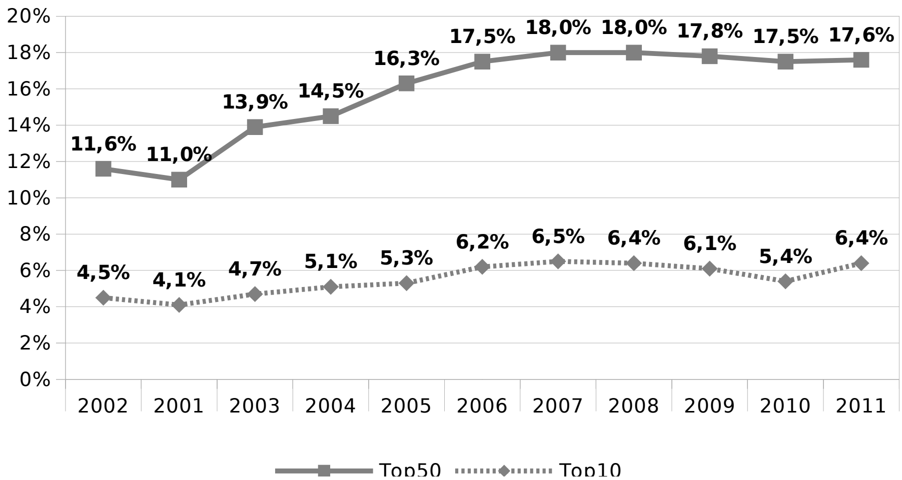

Figure 5. Market share (by volume) of top 10 and top 50 dealers in Italy
Source: ICDP, Quintegia (2013).

the time being) and it is not easy to achieve synergies across different sales outlets and different brands, at least not in the same level as for other industries. This rather low level of concentration compared to other industries is consistent with a persistent nature of family-owned businesses that still characterizes automotive distribution across many markets worldwide.

6 Manufacturer strategies and the distribution dilemma

Manufacturers, who in the past saw retailer concentration as a threat to their degree of control over the distribution system, are starting to see the benefits of retailer concentration (hence of a reduction in the number of intermediaries), although the strategic direction is not yet well established across all players. Some manufacturers (particularly French and German ones and with specific emphasis in their domestic markets) have tried to maintain a certain degree of control by using dealerships of their own (factory-owned stores). But this strategic option of direct distribution is an exception in Europe, with just 3% of dealerships being factory-owned (and none in the USA, due to very strict franchise laws that protect dealerships). The few existing cases often serve as a solution

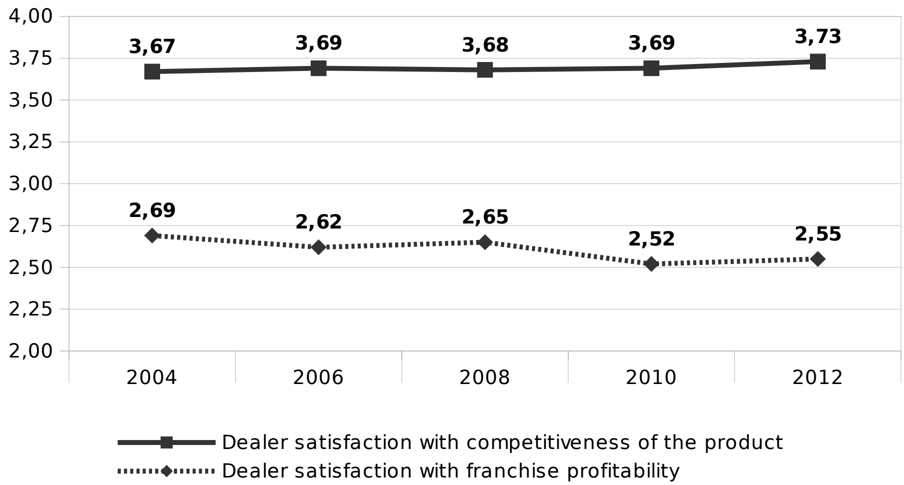

Figure 6. Dealer satisfaction in their relationship with manufacturers (Italy).
Source: DealerSTAT.

for high-cost metropolitan areas (where costs would be too high for an independent entrepreneur) and/or as marketing and retail laboratories in order to maintain a touch-point with the end market.

While factory-owned stores do not seem a viable solution, at least for a reasonable time span, manufacturers are quite interested in exploring the options to leverage Internet-based channels that could provide them with greater potential for customer access and dialogue. So far, Internet-based approaches have not yet shown a solid case on how to establish a new distribution system for manufacturers: in most cases these tools act as important complements to dealer activities rather than as substitutes of their role in the chain (Bailey 2012). Future evolution will depend not just on technological aspects but rather on a set of elements including customer attitudes and legal frameworks. On the whole, it seems that both through owned-stores and through digital channels manufacturers do not seem in a position to have a strategic alternative to the franchised distribution channel, at least for a while. Besides the financial and organizational burden associated to running a direct distribution scheme, there are important issues relating to holding the necessary competences that retailing and all the relevant activities involve.

One interesting insight into the disequilibrium that has grown inside the distribution system can be grasped by looking at dealer satisfaction data in their relationship with manufacturers. As previously highlighted, industry transformations have placed more and more emphasis on the role of the dealer as a value-creating and value-adding player in the automotive chain (Parment 2008). This has driven dealer satisfaction to become more and more important to ensure the dealer's commitment towards brand support and the pursuit of customer satisfaction (Buzzavo, Pizzi 2005; Nadin 2009). As figure 6 shows, over the past decade Italian dealers have been rather satisfied with the competitiveness of the products of the brands they represented (with a rating constantly above 3.5 on a 1 to 5 scale with 5 being the highest level of satisfaction), while the satisfaction with the profitability of their franchise has been receiving a negative rating (below 3, that represents neutrality), and, more importantly, with a downward trend.

The evolving features of the industry have led to a situation that undermines the sustainability of the franchised distribution system and calls for more substantial action. The next part looks in more detail at the business model of franchised dealers and how it is evolving.

7 The traditional business model of franchised dealerships

Business models have become a popular concept both in the strategic management literature and among practitioners over the recent decade. To a considerable extent the growing diffusion of the concept stems from its capability to represent a more operational translation of the notion of strategy and to better capture the way in which the overall architecture of the business generates a profit. Most contributions in academic literature, starting from the seminal works on the subject by Timmers (1998), Amit and Zott (2001), and Magretta (2002), revolve around the fact that a business model is broadly based on three major elements: «who are the customers», «how is the company intending to provide value to them», and finally «how is the company extracting value out of it». As many have pointed out, this approach inevitably finds its roots in the works of Drucker (1954) when defining a business.

Early introduction of the business model category took place within the domain of information management and ICT contexts. As a matter of fact, the term grew very popular during the Internet boom in the 1990s, and it became a building block of almost every company operating in the Internet environments during the fervid years of the e-business revolution. At that time, it was typical for companies to develop innovative ways of arranging production and distribution activities, and the business model category acted as a sort of interpretative (as well as normative) element to discuss the way in which the firm was going to generate value and extract it from target customers. Business models then rapidly spread outside e-business contexts and gained a key spot within the theoretical and practical frames of business strategy (Osterwalder, Pigneur 2010; Teece 2010).

The usefulness of a business model, however intended, is to draw attention towards the identification of the basic constituents of a strategy, and particularly of the way in which a firm does business at the system level: how it creates value and how it aims at capturing it from its target market. Within the scope of this work we can consider a business model as made of the following components:

1. the target: who is the target of the company;
2. the offering: what is the company providing the intended target with;
3. the chain of processes involved, both inside and outside the company, that are generating the offering in question;
4. the profit model: how a company is extracting value from the target customers in a profitable manner.

As conditions change in a given industry, firms are required to adjust their business models accordingly: this implies taking decisions that determine changes in one of the components or in more than one, determining a new combination. This leads to situations of business model innovation or «strategy innovation» (Casadesus-Masanell, Ricart 2011) where a recombination takes place in order to achieve dynamic consistency with the new context.

The automotive distribution system provides an interesting opportunity to look at how the typical traditional business model of automotive dealerships (that represent the key link between manufacturers and customers) must evolve in accordance with the changes in the competitive scenario. The business model that has characterized the rise of the dealer system is no longer sustainable in the new competitive context: this determines a drive towards business model innovation along some key dimensions.

Let’s now draw some considerations on the characteristics of the traditional dealership business model. It should be underlined that this exercise implies some necessary simplification. As a matter of fact, when considering the entrepreneurial foundations of the business, it is not surprising that when one looks in close detail at franchised dealers one finds a considerable variation in terms of size (units sold, total turno-

Element	
Target (customers)	New car customers within the sales territory
Offering (product provided)	Sale of new vehicles of the represented brand (with selective provision of after-sales support, parts sales and used cars)
Chain (value building)	Order management, finance management, delivery management
Profit model (value capture)	Predominantly the margin on new vehicle sales (considerably influenced by the manufacturer)

Figure 7. Traditional dealership business model (standard features)
Source: own elaboration.

ver), number of brands represented (size of brand portfolio), number of outlets, geographic scope, ownership and governance structure, not to mention management style, rate of adoption of new technologies, etc. This means that franchised dealers, even when operating under the umbrella of the same manufacturer brand, feature a considerable degree of variation and are far from homogeneous. Also, variations exist across different European markets (Buzzavo, Volpato 2003).

All this considered, and bearing in mind this necessary simplification, we could sketch a standard model of the building blocks of the traditional business model adopted by franchised dealers that is quite representative of the Italian situation (see Figure 7).

Automotive dealerships are assigned exclusive distribution rights for vehicles of a given brand in a territory: traditionally, sales territories have enjoyed a considerable degree of protection, so that customers in the area, unless they were prepared to travel to great distances, represented a sort of «natural» market. The dealers' offering has been typically based on the sale of vehicles, with the provision of after-sales service (warranty work, maintenance, repair) and parts generally featuring as a support activity to the sale. It must be noted that dealerships have been exploiting some additional businesses for some time. This is the case of service (that for example has traditionally been a stronger component of German dealers), parts (that has represented an important stream of revenues for some Italian dealers) and used cars (where UK dealers tended to be more actively involved). But while these streams have existed for a while and have acted as profit generators capable of supporting down-cycles, they have generally been subservient in business model design to the fixation on «moving the metal», particularly in the eyes of the manufacturers.

It should be noted that given that dealers' focus has traditionally been on new car sales, a wide network of independent players operating in vehicle servicing and repair has grown to meet the demand that has increased along with the increase in vehicle park. Similarly, the limited degree of involvement of franchised dealers in the used car business has allowed many independent players to grow in this sector.

On the whole, the profit model is centred upon the margin that is made on the difference between the selling price (that the customer pays) and the cost paid to the manufacturer: such margin, after the costs (structural and operational ones) borne by the dealer, generates a profit (it should be noted that in Italy the reliance on new car profits is considerable, while in other markets such as Germany and the UK dealers had started earlier on to support their companies through after-sales profits).

8 Elements of business model innovation

As we have said, many pressures have undermined the viability of traditional dealerships, creating pressure to transform their business model (Amit, Zott 2012). We will now explore how individual elements of the business model are evolving in order to adjust to the new context.

With respect to the *target*, the new business model requires dealers to become much more proactive, to operate a finer level of segmentation and to broaden the target.

The attitude of being more proactive, in line with the much diminished territorial protection, implies the use of more professional marketing techniques (such as geo-marketing) plus the exploitation of new approaches that move away from mass-marketing in favour of targeted initiatives, also levering the potential of new technological tools (i.e. using social media). Secondly, a finer level of segmentation depends on the need to investigate in greater detail the profile of the customers, their needs, and their willingness to pay for specific products and services. This means a major departure from a traditional way (usually reinforced by less professional salespeople) of conceiving customers as subjects merely in search of the lowest possible price. While such a view of customers induces greater discounts, at the expense of retained margins, it also inhibits the search for opportunities to extract customer's willingness to pay by providing a more tailored response to their preferences and offer them value elements other than price in the overall transaction with the dealership. Broadening the target relates to the need for dealerships to consider not just new car customers as targets, but also used car customers and service customers, in order to feed their customer portfolio and business activities that have evolved from secondary to new car sales to being fundamental.

With respect to the *offering* provided, the major building block in innovating the business model is a re-conceptualization of the dealer business, where new car sales are not the dominant portion (along with other elements such as accessories) and where the dealership is a portfolio of businesses revolving around customer mobility. This implies the need to take advantage of business possibilities that include new car sales, used car sales, finance and insurance provision, service and repair work, parts, accessories, sale of extended maintenance packages, rental services, and any other possible revenue stream associated with the above. This determines a gradual reduction in the dealership's dependency on the new car business that is on the one hand highly volatile, and on the other hand highly dependent on the manufacturer. The high volatility is associated with the swings in demand in line with key variables such as disposable income and consumer confidence. The high dependence on the manufacturer and the low degree of dealer control over the new car business is considerable because: volumes are heavily determined by the market and pushed by manufacturer objectives, buying prices are set by the manufacturer, selling prices are set by the manufacturer (and influenced by market conditions, in terms of discounts), operating costs are heavily influenced by manufacturer policies (in terms of required brand standards).

With respect to the *chain of activities*, dealers must adapt their activities and processes to the nature of the offering that has been just described above. While the traditional business model requires dealers essentially to focus on managing the order-to-delivery pipeline, in the new context dealers must enhance their ability to manage processes revolving around customers in a proactive way (e.g. lead management, geo-marketing techniques, etc.). For example, they should improve their ability to manage customer data from prospect to sale, they should develop capabilities to manage the processes involved in the broader set of ingredients included in the automotive offering, and so on. To some extent, the new situation is pushing dealers to evolve from «hunters to farmers» (Kiff 2000). While in the traditional business model the dealer is basically required to be a sort of passive subject implementing with attention to detail the policy specified by the manufacturer, in the new situation the dealer must become an active agent defining its own set of processes, steps and indicators for the more complex set of situations involved.

Element	*Traditional*	*Innovative*
Target	New car customers within the sales territory	More proactive attitude (also outside the territory), finer segmentation (aiming at willingness to pay) and broader target (i.e. used cars, services, etc.)
Offering	Sale of new vehicles of the represented brand (with provision of some after-sales support)	Broad mix of businesses to stabilize business, increase strategic autonomy and increase share of customer wallet
Chain of activities	Order management, finance management, delivery management	Prospecting and lead management, database management, customization capabilities, follow-up procedures
Profit model (value capture)	Margin on new vehicle sales (considerably influenced by manufacturer)	Margins on all business segments (less influenced by manufacturer and more dependent on autonomous choices)

Figure 8. Features of business model innovation in automotive dealerships
Source: own elaboration.

This leads to some considerations on the *profit model* at the dealership: with the development of other business streams, dealers reduce their dependency on manufacturers and can exploit varying ways of capturing revenues (and profit margins) with greater control, where the shape of the business portfolio to pursue becomes an integral part of the dealer's own strategy depending on its capabilities and on the exploitation of market opportunities. While in new cars the structure and the operating standards and procedures are heavily determined by the manufacturer (whose interest is often to enhance the branded experience rather than to ensure an adequate level of dealer profit), in the other set of businesses dealers can take more autonomous decisions in their cost structures and operating processes. In other words, their structural choices and processes will be shaped on the basis of the expected revenue streams, so to ensure (at least in principle) the desired profit margin. To some extent, more and more dealers aim at gaining a greater share of the customer wallet, often adopting a logic of business provision «from cradle to grave» by aiming at all the revenues (and profit streams) related to all the spending revolving around the automotive purchase and ownership experience throughout their lifetime (Bloemer, Lemmink 1992; Huber, Hermann 2001).

Some of the most relevant dynamic capabilities (Teece et al. 1997) for automotive dealers seem to reside on the ability to continuously adjust the business offering to the appropriate customer segments. The fact that the business contains a highly local dimension makes it difficult for manufacturers (or large retail chains) to appropriate the value that lies in the transaction (unless they manage to achieve considerable volume discounts in purchasing). Clearly, dealers must invest in the processes and information systems in place to accumulate (and use as necessary) the relevant customer information, with more effective learning capabilities (Nonaka 1991).

On the whole, effective dealers are asked to manage the set of interrelated businesses by achieving a proper cross-functional fit by taking advantage of complementarities, so that they become less and less «local vehicle shifters» on behalf of the manufacturers, and more and more «intelligent customer managers», acting as a key link in the automotive distribution chain.

9 Perspectives

We have tried to operate some simplifications by sketching out the common drivers that are affecting the transformation in the dealership business model.

There are some important issues to be addressed in perspective.

The first issue relates to how automotive distribution will evolve in different geographies. Europe is still not a single market, and more distant markets are undergoing different stages of development. In China, for example, the strong growth in demand has triggered an explosion in the number of dealers that somehow mirrors what has happened in mature markets over the last century. Different geographic situations and market life-cycles will determine different paths of evolution for automotive distribution.

The second issue relates to the pace of the transformations. There are some critical elements that characterize the auto industry as rather different from other industries (i.e. high average unit price, low frequency of purchase, high safety implications, considerable need for after-sales care, need to trade-in a used car, etc.). To a great extent, these differences have provided a sort of insulating mechanism from transformations that have affected retailing in general. How automotive retailing will be shaped by leaps induced by the digital revolution and to what extent it will mirror developments in other sectors cannot be fully grasped at the moment and remains to be seen.

The last point relates to the extent to which the degree of differentiation across business models will be driven by the type of brand represented (i.e. volume, premium, low-cost). As a matter of fact, manufacturers have varying degrees of influence to coordinate the whole system architecture depending on a set of factors including the strength of the brand (Dietl et al. 2009). As discussed throughout this chapter, automotive dealership entrepreneurs have been willing to accept a subordinate position in the past in exchange for satisfactory profit levels. Now that those profits have been eroded by the new context quite some time ago, the manufacturers' capability to retain a significant degree of control over the distribution chain rests on their ability to adjust the economic foundations of the distribution business model before it is too late.

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5

New ventures in old industries: disrupting or embedding?[1]

Vladi Finotto

ABSTRACT *The chapter builds the case for a reconsideration of the concept of entrepreneurship and of innovation by new ventures to fit the current transformations of the car and mobility industries. Through a synthesis of the debate on the social embeddedness of entrepreneurship and the reconstruction of the history of Pagani Automobili – an Italian producer of high-end sportscars – the chapter calls for the adoption of a perspective that recognizes venture creation as the mobilization of extant resources and competences rather than as a process of disruptive entry. Ultimately, the chapter proffers a view of entrepreneurial change that is embedded in, and relies on the mobilization of, the history of the industry. Such a view could guide the assessment of the potential of emerging ventures in the car and mobility industry as well as policy and industry initiatives to answer the enduring uncertainty affecting firms and clusters.*

1 Introduction

Entrepreneurs in mature industries do not enjoy the privilege of having numerous alternative routes to introduce novel business ideas and to convey them to the market. It is often the case that they must come to terms with – or are kept at bay by – existing industry hierarchies and architectures. Persistent institutional arrangements and «rules of the game» dramatically shrink the opportunity landscape. Resistances to novelty – either deliberate and due to the vested interests of incumbents, or latent and given to the lack of intelligibility of novel business ideas – often frustrate novel business ideas and concepts.

The history of the car industry seems to corroborate such a state of affairs. With remarkable development costs, long development cycles,

1. The author thanks Michele Bottoni and expresses his sincere appreciation for his collaboration in the reconstruction of the case and for his support in the process of data collection.

a strong global competition and trends towards consolidation and concentration, the industry represents the *epitome* of such a closure to innovation by new ventures. The recent failure of what appeared to be the «next big thing» among policy makers and students of the industry's transformation is Better Place. As we write, the ambitious venture proposing a complex mix of electric vehicles, innovative battery technology and infrastructure has ousted his founder, has burned an impressive amount of cash and is being dismissed by the same media and commentators that chanted its potential when it was created under the auspices of important political figures, industry experts and academics (Gunther 2013; Reed 2013).

Nonetheless, attempts by entrepreneurs to redefine the logic of mobility and to challenge the car culture increased rather than settling out of discouragement. Recent analyses on the future of mobility (see for instance Wells 2010; Calabrese 2012) point to the end of the technological monoculture of the car and of the parallel monolithic industrial structure. On the contrary they prefigure a future industry landscape characterized by technological diversity and the coexistence of heterogeneous mobility solutions.

Expectations of industry analysts are characterized by the belief in the role of outsiders – founders of new ventures coming from different industrial backgrounds and experiences – entering the industry and disrupting its logic, displacing incumbents through to radical innovation and the establishment of novel business models. Such expectations are indebted to an overall view of entrepreneurship and of the entrepreneur as agents of radical change that «make things happen» in spite of resistances and power by incumbents. In this chapter I argue that such a perspective is to be disputed for two main reasons: the first is eminently theoretical and is rooted in recent advancements in entrepreneurship studies; the second eminently practical and related to the development of policies and industry initiatives aimed at recognizing and fostering entrepreneurial ventures that promise to leverage upon extant resources and competences.

In particular, the chapter aims at downplaying the traditional «heroic» and disruptive narrative on the entrepreneur and the parallel agentic attributions that characterized the recent debate on entrepreneurship. I claim that such a perspective underlies the incessant quest for the next «maverick» and revolution to come in the automotive industry, a quest that risks to precipitously discard the potential deep-rooted within the industry itself. On the contrary I aim at proffering a more nuanced and embedded view of entrepreneurship in mature settings such as the automotive industry, to claim that analysts, industry representatives and policy-makers need not to look far from the industry to recognize – and ignite – the potential for change. In particular I maintain that entrepreneurs succeeding in endeavours that are deemed as infeasible according to prevailing industry wisdom, concretely «make it happen» by soliciting the active contribution of incumbents, by obtaining legitimation from them, and by capitalizing on their competences and commitment. I advance the perspective that entrepreneurship in these settings is often a collective endeavour, and that the substantial engagement of incumbents in the endeavour is crucial for novel ventures to establish and prosper. Such a vantage calls for a reconsideration of the role of incumbents in supporting – or directly igniting – transformations in the way the industry thinks about mobility and provides solutions to emerging needs and constraints, through novel business models and conceptions. For extant players, clusters of firms and institutions, such a scenario means that, if adequately reinterpreted and leveraged upon, competences, technologies and ultimately jobs in the auto industry could find viable development paths into the future. To support the point, I present a longitudinal analysis of the venturing process and the eventual success of a niche manufacturer of high-end sportscars located in Modena: Pagani Automobili.

2 Perspectives in entrepreneurship: what use in the car industry?

2.1 *A knowledge gap*

Scientific analyses of the automotive industry in economics and management have been largely oblivious of theories of venture creation and of entrepreneurship. Similarly, empirical analyses in the field of entrepreneurship have been rarely investigating the automotive industry, privileging on the contrary high-tech and high-growth sectors. Such a mutual lack of consideration was indeed justified by the characteristics of the industry in question. Automotive is characterized by a number of factors of inertia and resistance to change, such as sunk costs in every segment of the value chain, the lack of incentives for the development of novel infrastructures for new mobility solutions, a substantial stickiness of the worldwide market with the traditional idea of individual mobility, political considerations related to the sector's relevance in terms of employment and many others.

Despite such a discouraging scenario, the industry currently witnesses the proliferation of a host of experimentations and entrepreneurial attempts carried out by new entrants. Some of these ventures are developing business conceptions that focus on alternative propulsion systems – electric vehicles – and related infrastructures such as in the case of Tesla Motors, a venture founded and financed by important players in the IT and software industry partnering with Lotus; similarly, Detroit Electric is heading to the market with a novel concept of a compact electric sportscar developed on a Lotus platform. Other interesting experimentations, such as Local Motors, aim at making custom car-making possible by matching designers and local producers of small batches of vehicles. Those who believe in a future scenario in which mobility will not be dominated by the car monoculture (Kemp et al. 2011) are placing their expectations on entrepreneurial initiatives leveraging on access to mobility services and mileage rather than to privately owned cars – as in the case of car sharing services offered by the like of Zipcar and other local ventures.

Whether the future of mobility will be populated by these or different firms or business models is currently disputed. What interests the most, though, is whether the evolution of the industry will be characterized by the displacement of extant players and by the marginalization of extant competences and technologies or not. To put it simply: will the future of mobility benefit a host of novel players such as Tesla, Zipcar, Google with its project on electric driverless cars, or does it have in store a role for firms and workers currently involved in car production?

The rhetoric of entrepreneurship as an agent of radical change would have analysts and commentators opt for the displacement scenario. As it has developed in the last 20 years, entrepreneurship theory, indebted to assumptions taken from economics (Shane, Venkataraman 2000; Kirzner 1973), would lead us to see the current crisis of the automotive industry as a misallocation of resources and technologies in the market for mobility. In turn we would be brought to consider entrepreneurial entry as a disrupting force that will re-equilibrate the market. Such a view, nonetheless, has been disputed recently by researchers in entrepreneurship: far from being a linear and entirely disruptive process setting off extant players, entrepreneurship has been theorized, described and interpreted as a more nuanced and incremental process largely drawing from, and capitalizing on, extant competences, resources and social networks. In order to make my case, I will briefly synthesize the evolution of theoretical frameworks in the field of entrepreneurship.

2.2 Disputing the «linear» and agentic view of entrepreneurship

The vitality of entrepreneurship as an area of research and as a reservoir of theoretical frameworks for policies aimed at generating economic growth and job creation is due to the recent establishment of a clear research agenda for the field. It largely draws from the seminal work of Shane and Venkataraman (2000) that provided a definition of entrepreneurship that has come to dominate the literature in the last decade (Baker, Pollock 2007; Baker, Nelson 2005; Steyaert 2007). According to these authors, entrepreneurship is the set of processes that take place at the intersection between (objective) profit opportunities and enterprising individuals. In particular, entrepreneurship is a process entailing the discovery, evaluation and exploitation of opportunities carried out by individuals that «notice [opportunities] in a wave of alertness» (Steyaert 2007, p. 460). Once the opportunity is discovered and evaluated, agents design consistent means-ends chains to exploit it, securing access to valuable resources that allow the attainment of clear and pre-determined goals.

The assumptions underlying such a perspective have been largely criticized by a host of contributions sharing an explicit rebuttal of the rationalist framework underlying Shane's and Venkataraman's proposal (Foss, Klein 2011; Klein 2008). Emerging process-theories of entrepreneurship such as the perspective of effectuation (Dew et al. 2008; Sarasvathy 2001) and that of entrepreneurial bricolage (Baker, Nelson 2005) provide with a more iterative and complex view on entrepreneurship and are currently central in the theoretical and empirical development of the field (Fisher 2012; Steyaert 2007; Johannisson 2009). While an exhaustive review of these emerging approaches goes beyond the scope of this chapter and is alien to the aims of the volume, a summary of their tenets and of their assumptions is beneficial for the argument I want to develop.

Emerging approaches to entrepreneurship differ from the «dominant» view based on opportunity discovery for its critique to the fundamental assumptions of the latter, namely:

1. The assumption that opportunities are exogenous, objective and waiting to be discovered is untenable, given that individuals are bounded in their ability to gather and process information and that information is unevenly distributed in society (Hayek 1949). Moreover, the trigger for technological, political and social shocks often lies inside the boundaries of the economy rather than outside them (Alvarez, Barney 2007). Proponents of alternative views and conceptualizations of entrepreneurship turn to the idea that opportunities are created by actors who enact selected portions of the environment and act upon them to gradually and incrementally obtain information and generate actionable knowledge (Baker, Nelson 2005; Sarasvathy 2004; Weick 1979);

2. The logical and chronological segregation between design and execution assumed in linear accounts on entrepreneurship – design precedes action – is discarded in favour of a recursive dynamic involving action and environmental feedbacks conducive to the refinement of both ends and needs in the process (Baker, Nelson 2005; Sarasvathy 2001). In other words, entrepreneurial action, especially in the preformation phase of a venture, is often non teleological and triggered by general aspirations (Dyer et al. 2008; Rindova et al. 2009) and by the incessant feedback loop ignited by exploratory actions by the entrepreneur in order to make sense of the environment;
3. As a partial consequence of the previous points, entrepreneurship is often the result of the mobilization of extant resources in order to generate options for future action rather than well-focused research of valuable resources aimed at attaining a precise goal. As a bricoleur (Baker, Nelson 2005; Lévi Strauss 1962; Stinchfield et al. 2012), the entrepreneur leverages upon the means at hand – her competences, acquaintances, material resources that are easily accessible – and devises potential future states that can be obtained through them rather than the other way around;
4. The overemphasis on individual agency risks to be detrimental to the understanding of entrepreneurial processes: «real-world» entrepreneurship is often a collective endeavour resulting from the mobilization of a number of stakeholders since the inception phases of a business idea (Hjorth 2004; Jack, Anderson 2002; Wiklund et al. 2011). Thus exhaustive analyses of entrepreneurship and effective practices need to take into account the role of extant social resources to figure out how to create value out of social resources.

2.3 Entrepreneurship as a collective and socially embedded phenomenon

Empirical and theoretical work in the field of entrepreneurship is increasingly focused on uncovering the dynamics and processes entailed in the «collective nature» of the venturing process. Thorough analyses of the role of social networks are not exotic to the field. On the contrary an array of investigations have tackled the role of social relations in conveying valuable resources to aspiring entrepreneurs. Emergent approaches, though, differ for the specific angle they take on the role of social contexts in the entrepreneurship process (Harryson 2008; Jennings et al. 2012). The distinction is subtle but nonetheless crucial: networking does not consist of instrumentally bringing valuable resources detained by stakeholders at the service of an (ex-ante) envisioned venture. On the contrary the venture itself emerges in the social spaces within which stakeholders self-select into the making of an entrepreneur and enlarge the possibility landscape of that making (Sarasvathy 2001; Garud, Karnøe 2001).

As Jack and Anderson (2002) put it, embedding is an important mechanism in entrepreneurial processes – one that should be put under close analytical scrutiny – in that it allows entrepreneurs to gather value out of their anchoring within social structures (local clusters, strategic groups, value chains and the like). Moreover, it is through social embedding that entrepreneurs come to create opportunities, thanks to the contributions coming from stakeholders that share the values, aspirations and identities of an individual that is perceived as legitimate. Garud and Karnøe (2001) argue that while in hindsight entrepreneurship can be interpreted as the result of the radical deviation of entrepreneurs from logics and practices of specific social contexts, its outcomes are rather the result of entrepreneurs becoming embedded in social contexts and mobilizing a variety of actors. Indeed, such a mobilization occurs before the entrepreneur even starts to think about a venture; the venture itself emerges out of stakeholder involvement deriving from embedding.

An embedded view of entrepreneurship maintains that venturing – and in particular innovative venturing – is the result of processes of *mindful deviation* (Garud, Karnøe 2001) in which entrepreneurs exercise judgement in stretching the legitimacy they gained through embedding to coalesce collective efforts towards novelty. Out of theoretical jargon, the perspective encourages analysts to open up their definition of entrepreneurship in order to recognize that it can be endogenous to specific fields rather than solely disruptive and resulting from entry by outsiders.

If the collective and «embedded» view on entrepreneurship is to be taken seriously also by practitioners and policy-makers in the car industry, it conduces to reconsider the apparent distance between the scholarly discourse on entrepreneurship, emphasizing innovation and radical deviations from «business as usual», and a strict path-dependent view of the evolution of the car industry. We could reconsider the evolution of the industry if we framed entrepreneurship as an emergent process participated and enabled by extant players coalesced around novel business conceptions advanced by embedded entrepreneurs. Venture creation and novelty development, from this perspective, do not displace extant competencies and investments made by players in automotive supply networks. On the contrary I aim at proposing an idea of innovation by new ventures that leverages upon, and recombine, the repertoire of skills, competences and technologies that already exists and that is currently locked-in in the prevailing car monoculture. To provide a concrete example of how embedded entrepreneurship benefits from resources of extant social networks and how it is conducive to the creation of value for incumbents and traditional players, I sketch the history of Pagani Automobili, a producer of high-end sportscars located in Modena.

3 The car that should not be

3.1 Embedding and mobilization in the history of Pagani Automobili

What follows is a synthetic account of the unfolding of a peculiar and highly successful venture in the market for high-end luxury sportscars. The account given in this chapter is a selection of an array of empirical evidence gathered for an in-depth case study of the firm that is currently under development. The narrative offered in the section is based on the empirical evidence gathered from repeated interviews with the entrepreneur, his collaborators and one of the firm's strategic suppliers, and from the analysis of archival material (compiled in Morelli, Racca 2010; Bottoni 2012) and over 700 articles in industry publications.

Born officially in 1993 and publicly presenting its first car in 1999 – the Zonda – Pagani has gained the attention of experts, enthusiasts and clients both for the quality of the product and for the rare economic sustainability of its business. The carmaker iconic status – disproportionate if compared to the actual market share it controls – is effectively synthesized in a review appearing on the *Independent* right after the first presentation of the Zonda in 1999:

> [At the Geneva Motor Show in April] this year, one machine was attracting more attention than any other. It was a brand-new, pounds 190,000 sports car that outdid even the Lamborghini Diablo for sheer outrageousness. Its bodyshell was made entirely of advanced carbon-fiber composites, like a Formula One car, it was capable of 210 mph, and the quality of its detail engineering, according to those present, was as good as any car in the world. It was the *belle* of the show. […] What marks Pagani out as different is […] that he seems to realise making cars successfully is primarily about business, not glory. This is a serious operation [Sanai 1999].

Although a small producer of exotic sportscars (it delivers an average of 20 cars per year), Pagani has succeeded in becoming the most sought-after and evocative marque in such a niche, counting on thousands of enthusiasts worldwide and enjoying a recurrent coverage by major publications and experts in the automotive industry. Such a visibility and extraordinary brand recognition are due to the peculiar mix of technology, luxury, performance and exclusivity of the cars it manufactures. What follows is a non-exhaustive synthesis of the fundamental characteristics of the Zonda – the first model produced by Pagani since 1999 – and later of the Huayra – the recent model launched in 2012:

1. The Zonda was the first commercial car to be built entirely with carbon fibre and composite materials. The use of these materials for the chassis and for the monocoque – hitherto used only in prototypes and Formula 1 cars – allowed the firm to develop a vehicle which was lighter than those of the competitors (1,250 kilos) and faster than many of the sportscars on the same segment. These materials conferred to the car also unmatched performances in terms of resistance and shock absorption.
2. The Zonda stood out also for its particular design. While sportscars like Ferraris and Lamborghinis privileged performance over comfort and elegance, the Zonda – and later the Huayra – was conceived as a comfortable car to be driven without compromising on speed. The car was larger and longer than the average sportscar to provide the driver and the passenger with plenty of room to drive comfortably. Its interiors are designed and realized on the clients' specifications and the firm sources high-quality leather and materials eminently from Italian suppliers. The car can be fully customized according to the client's requests and the process of design and development requires more than 9 months in order to be completed.
3. The technological content of the car – the sole central cell is built on 13 patents developed by the firm – made it one of the most advanced in terms of safety and performance in the segment.
4. The marque is one of the few – the other notable case being Swedish Køenigsegg – that succeeded in making the production of high-end hypercars (as these cars are often called) a profitable business despite low production volumes and the absence of financial backing from a larger automotive group. Although not directly comparable, producers of high-end sportscars are controlled by larger automotive groups, such as Fiat for Ferrari, and Volkswagen for Lamborghini and Bugatti. An array of other firms have tried to produce bespoke sportscars with mixed results at best for the lack of financial viability of the business, such as Bugatti (before being acquired by Volkswagen), Spyker and McLaren.

Two elements make the history of the marque remarkable. The first is that such an achievement was attained by a self-taught Italo-Argentinian car designer who worked his way from a small repair laboratory in his

Argentinian hometown to the design and styling of major Lamborghini models and ultimately to the design and production of the Zonda and the Huayra. The second is related to the timing of entry and to the fact that he succeeded despite the widely held scepticism of incumbents on the viability of such a business and of the entire underlying concept. The years in which the entrepreneur started his firm were in fact signed by a severe financial crisis – the early 90s, the years of the first Gulf War and of the compression of demand for cars due to the financial crisis of 1987 –; proponents of similar business ideas fell one after the other (Montezemolo 2003). As the entrepreneur puts it, the market was not

> properly promising. While I was developing the project [in 1990-1993] Cizeta failed, the same happened to Bugatti, McLaren developed the S1 and then closed its production. Consider Bugatti: they closed with a huge debt, the equivalent of more that 50 million euro and closed their operations after they received advanced payments from clients all over the world. In that situation nobody really believed we were going to create and sell our cars without any serious financial backing [Personal interview to Horacio Pagani].

Adopting a design entirely based on carbon fibre and composite materials was seen as an unsustainable choice: in front of enduring market uncertainties, the investment in specialized technologies seemed unjustifiable. While experimenting with these technologies in the late 1980s as a designer in Lamborghini, Pagani's projects to develop a novel car based on carbon fibre and composite materials was frustrated by the scepticism of managers: if Ferrari, the benchmark at the time, was still doing the tubular structures of the monocoque in aluminium and was still producing car bodies by «beating» metal sheets rather than using an autoclave for composite materials, there was no reason to engage in such a risky adventure (Morelli, Racca 2010).

The success of Pagani in delivering his car notwithstanding the resistances and scepticism of extant players would lend itself to be interpreted through a narrative of the volitive entrepreneur making it happen against all odds and despite the general lack of trust by incumbents. An in-depth analysis of the history of both the entrepreneur and the marque suggests that that was not the case and that, on the contrary, the industry played a crucial role in the establishment of Pagani Automobili. I will briefly sketch, through some vignettes, the process of embedding that allowed Pagani to ultimately design and sell his car. The narrative articulates along three major phases in the development of both the concept and the venture: the early years in which the young Pagani gained a prominent position in the Argentinian automotive industry (the 1970s); the phase in which he worked – first as an employee and later as a consultant – with the new product development division of Lamborghini in Italy (the 1980s and the early 1990s); the establishment of Pagani Automobili and the presentation of the Zonda at the Geneva Motor Show in 1999 (1993 onwards).

3.2 Industry apprenticeship: from the periphery to the core of the Argentinian car industry

The young Pagani, fascinated by the then growing automotive industry in Argentina and willing to work on car design, established a workshop in his hometown, Casilda, where he mainly worked on the modifications of vans for the local agricultural industry and on the production of one-shot prototypes of minimotos, buggies and caravans. Being a drop-off from college and lacking a formal education in design, he undertook an apprenticeship that passed eminently through the acquaintance and the collaboration with local mechanics and repairers. Many of his original creations (minimotos, buggies, rudimentary cars) were attained through the refurbishment of spare parts provided by local mechanics and the use of their tools and machinery. Tinkering with these materials and technologies, and the support of local practitioners, allowed him to apply the competences and knowledge he had been acquiring through industry publications regarding the latest news in car design coming from Italy and from the work of car designers such as Pininfarina and Bertone. The quality of some of his realizations gained him the recognition of local exponents of the automotive industry – mainly working on tuning and on car modifications. Their interest in the experimentations undertaken by the young passionate designer made them contribute with their labour and machines to his creations. In turn, the presentation of his creations in local fairs and industry events gained him an increasing demand for modifications and original projects.

As the workshop gained prominence in the area of Casilda, Pagani and a host of collaborators and friends embarked in the development of a fully functional Formula 2 car out of second-hand materials and refurbished components. Built during idle time and as a side project, employing refurbished components and pieces of other vehicles, the car was ultimately finished. The young entrepreneur, lacking an engine, presented the finished cars to the Argentinian subsidiary of Renault. Managers of the French company appreciated the quality of the finished artefact and decided to provide the young designer with an engine to allow him to take part into the Argentinian Formula 2 circuit with an official team. The quality of the car, its design and some original and innovative solutions that were deployed by the designer gained him the recognition of Oreste Berta, the most important figure in the Formula 2 circuit at the time. It was Berta that saw the potential and the strong drive of Pagani and that presented him to Manuel Fangio, former Formula 1 champion and then manager of Mercedes Argentina (Morelli, Racca 2010; personal interview to Horacio Pagani). Once Fangio understood the motivation of Pagani, he recommended the designer to Lamborghini in Italy, who ultimately offered him a job in the early 1980s.

3.3 The years in Lamborghini and the experimentation with composite materials

Landed in Italy, the designer rapidly gained a crucial position in the Lamborghini team dedicated to novel concepts and new materials. The young employee had the chance to work on a special Lamborghini project aimed at exploring the properties and qualities of composite materials. A side project financed by public funds, the development of the car was not considered crucial by the management of Lamborghini. The outcomes of such an experiment, though, surprised engineers and product managers. The car developed by the unit guided by Pagani was fully functional, aerodynamically innovative, lighter than any other sportscar on the market. During the tests, the car set a speed record, 330 km per hour, seen as impossible at the time (1985). After the crash test, though, the company decided not to produce the car, since it was seen as economically infeasible and, most of all, «outside of the logics of the industry» (Vittorio Balboni, Lamborghini engineer, interviewed in Morelli, Racca 2010).

The refusal by Lamborghini to continue to experiment with novel materials made Pagani opt for an exit from the firm: he continued working with the company as a consultant for the redesign of the Diablo and the Countach but at the same time he started advising other firms and working with composite materials and carbon fibre. Although Lamborghini did not believe in the potential of novel materials, Pagani's proposals for the realization of cars' particulars and components in composite materials were ultimately accepted by the Italian brand. Often the tenders and calls for components launched by Lamborghini were answered by Pagani who provided the firm with the designs as well as with full-fledged prototypes materially presented to Lamborghini's managers. In the meantime his consultancy gained visibility both in the automotive industry – where he worked for Ferrari, Renault, Berman, Dallara – and for firms from different industries – e.g. sporting equipment: Rossingol, Lange – interested in these novel materials. Being a supplier and a consultant for a number of firms in the Emilia Romagna Motor Valley gave him the access to the infrastructure and technologies of firms such as Dallara – their wind gallery, for instance – and to the informal contributions and encouragement of many industry representatives. Even though many of them were dubious about the viability of the novel materials he was experimenting with and ultimately with his idea of producing yet another niche sportscar, they were engaged in the process to different degrees thanks to the appreciation of the results the designer was obtaining. As Dallara puts it,

> My impression is that the events developed beyond any of his expectations and initial ambitions. [...] At the beginning he was in the wrong place at the wrong time. Nonetheless he adventured in this wonderful project that is probably the last one in romantic automobilism. [...] In Pagani one can see the dream of the last Don Quixote, but he did not fight against windmills: he faced his objectives and eventually succeeded [G.P. Dallara, founder of Dallara, interviewed in Morelli, Racca 2010].

3.4 Towards the Zonda: mobilization and legitimation

During the second phase of his professional history, Pagani went back to his initial ambition of designing and producing his own sportscar. The refusal from Lamborghini to actually realize his project brought him to produce designs and initial projects without a clear goal in mind. These designs and preliminary elaborations were presented to Manuel Fangio, who had become a friend and a confident of Pagani. The detailed designs of the car gained Pagani the collaboration of Fangio and of other figures of his entourage in the development of gradual refinements of the original project. Fangio actually believed in the potential of the car and had enough evidence of both the competence of the designer and of his resolution. Beyond providing him with valuable insights and technical assistance in refining his project, Fangio interceded on behalf of Pagani with the then head of AMG, a division of Mercedes that produces high-end engines for the German automaker. In 1992 an AMG engineer – Dieter Zietsche, currently Chairman of Daimler AG – and his team analysed both the designs Pagani has been producing and the various models (1:5 and 1:1) of the car he had been realizing and testing in wind galleries.

The overall quality of the project and the advanced state of its development, witnessed by the realization of full dimension models, convinced AMG to supply Pagani with an AMG engine. Pagani was, and still is, the only non-Mercedes marque sporting AMG engines. While the original engine for the Zonda was chosen among those that AMG was producing at the time (specifically a Mercedes-Benz M 120 E 60, 12 V 60° cylinders, 5,987 cc), the Huayra saw the development of a dedicated engine by AMG. The involvement of Fangio, his collaborators and AMG in the project, in turn, determined the increase of legitimation the entrepreneur had among producers of components and technologies, and gained him the collaboration of an array of specialized module producers (Brembo, Xtrac and others) as well as the coalescing of small local suppliers of materials willing to follow the firm in the production of bespoke cars. The entire development of the car took from 1992 to 1999, the year in which the first exemplar of Zonda was presented – after another one was destroyed in the crash tests – at the Geneva Motor Show. The presentation of the fully-homologated car gained Pagani the attention of industry representatives and the specialized press. More importantly, it set Pagani as the must-have for sportscar collectors worldwide. As it was effectively stated by *The Independent*'s article, Zonda «was the *belle* of the show».

After having produced more than 200 Zondas, the firm presented the Huayra at the end of 2011, and received 90 orders in advance, for which it is planning to double its production facilities.

4 Lessons from the case of Pagani Automobili

The previous section compiled a selection of the number of occasions in which Horacio Pagani succeeded in obtaining the support and active contribution of a variety of embedded actors – such as Mercedes AMG, Lamborghini, Dallara, the Argentinian mechanics, Fangio, and many others – to produce a supercar. Although a thorough narrative of the unfolding of the project goes beyond the scope of this chapter, the vignettes and the synthetic description of the phases of Pagani's history should have provided the reader with an idea of «how he succeeded» despite resistances and scepticism. In particular he succeeded despite the initial scepticism of many of the actors located in Modena, who considered the project infeasible and untenable since its costs – let alone its exploratory solutions – were not justified by the situation of the market, the enduring crisis and the industry-wide tension towards standardization and increase in the number of vehicles manufactured and sold. Despite their scepticism, they all contributed, to different extents, to the realization of the car, in what appears to be a successful example of mobilization of distributed agency.

The recurring trait of the story is the embedding of Pagani into different layers of the global automotive industry: first in Argentina, where he gained the trust and collaboration of local mechanics and repairers thanks to his creations, and later from the core of the car industry of the country and of its more representative figures (Berta and Fangio); secondly in the Italian cluster of sportscars manufacturers, where he was offered to experiment with novel concepts and materials and where he was supported by local firms and practitioners despite the «official» scepticism around his idea and the concept of a novel sportscar; finally through the establishment of a company that leveraged upon the legitimation and the credibility he gained among a variety of relevant actors in the industry that concretely contributed to the ultimate finalization of the design and its production.

Prefiguring the potential trajectories of the industry is impossible, especially on the basis of a single case, whose objective has been that of identifying processes of embedding and mobilization. Nonetheless the case and the lessons previously distilled from it allow to speculate ultimately on the meta-conditions conducive to transformations by entrepreneurs mobilizing incumbents and their repertoire of competences. These factors are presented as a conclusion to the chapter and as signposts both for future scholarly investigations on the issue and for policy-makers and practitioners in developing their way out of the current situation of the car market.

A first element that stands out is the importance of experimentation – often a blind one – as a means to create a variety of possible future outcomes. Seen from the angle of small and medium-sized enterprises in the automotive supply base, this means multiplying the opportunities and the efforts to engage in activities intended to increase their knowledge base and to test the solidity of institutional constraints and «ways of doing things». From a policy-making perspective the importance of experimentation as a means to create networks of entrepreneurs and incumbents requires to complement extant policies aimed at «sustaining» the industry along the traditional logics with measures and initiatives aimed at stimulating deviant research and development activities.

A second element that needs to be stressed is the importance of territories and of consolidated social networks as the conduits of mobilization and networking around emergent projects. Mounting evidence points to the need for a revision of the means to stimulate innovation and economic growth – and industrial renovation – through the promotion of entrepreneurship. In particular a host of analyses point to the ineffectiveness of traditional models of incubators and science parks. As the story of Pagani shows, mobilization occurs not through the creation of artificial *loci* for entrepreneurs to develop their innovations, but through daily and situated collaboration and interaction. From this point of view, policy schemes aimed at institutionalizing the territory as an incubator and at promoting a number of distributed networking initiatives could reserve promising avenues of development. While incubators and technology parks are not to be discarded as engines of innovation, much more attention needs to be devoted to the promotion of a variety of occasions and means to develop social networking in wider areas characterized by the resilience of given industrial cultures.

A third element that emerges from the case and that needs to be taken into careful consideration is the role of practice as a device to mobilize incumbents around emerging endeavours. Mobilization of actors such as Fangio, AMG, Lamborghini and Dallara did not happen because of the quality in the designs and business plans of the nascent entrepreneur. On the contrary it occurred because of the recurrent convergence of the entrepreneur and of his perspective partners around material solutions and working prototypes he presented. In a variety of instances, scepticism by incumbents was won, and their support obtained, thanks to the presentation of working artefacts that invalidated the preclusions and prejudices associated with a lock-in in institutional logics. As a general lesson for practitioners and policy-makers this means that a renewed attention needs to be attributed to education and training processes that provide workers and entrepreneurs with skills relating to the concrete realization of prototypes and artefacts as a way of bridging among different languages and cultures and as blueprints for the development of seemingly promising solutions.

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Part 2

Perspectives on industrial policy and local development

6

The evolving features of the automotive industry

Francesco Garibaldo

ABSTRACT *Tectonic movements are jeopardising the traditional picture of the players in the automotive industry as well as the role of the automotive products in assuring people mobility. Where do these movements come from? This chapter deals with the critical issue of change, trying to highlight the key driver of the recent evolution of automotive industry.*

1 The main features of the new global car industry

Tectonic movements are jeopardizing the traditional picture of the players in the automotive industry as well as the role of the automotive products in assuring people mobility.

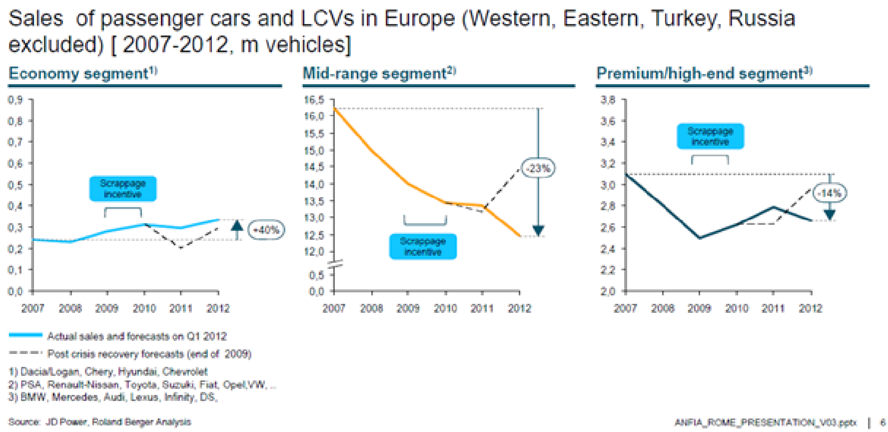
Summing up an updated understanding of the actual situation of the global car industry these are the key points:

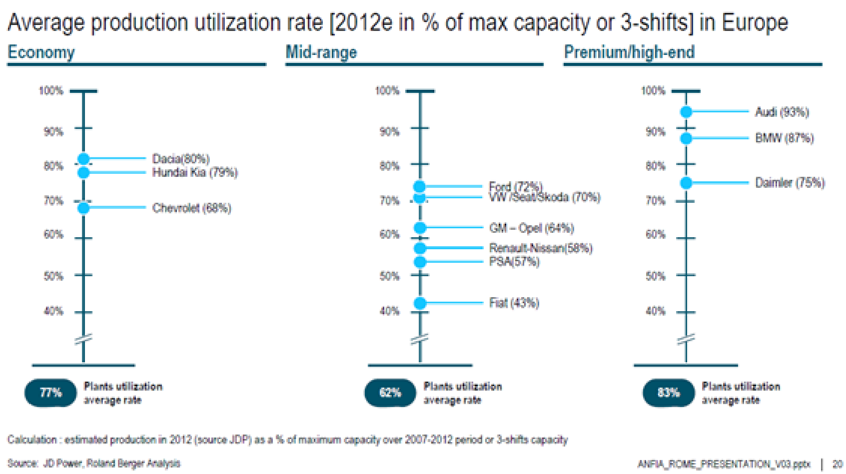
- The car industry is now fully and evenly globalized, which means that the processes of structuring and restructuring capacity are intertwined and distributed on a global scale.
- The whole industry is in a process of strategic change and repositioning whose main driver is the innovation – sometimes a breakthrough one – of products, services, processes and work organization;
- The structure of this industry is more and more a mix of a traditional volume industry[1] and a network-like industry, in the meaning of the network economic, in general related to consumers utility and to the transaction costs of the supply architecture, specifically in the alternative engines segment. The weight of the two components is

1. With huge capital investments and since the 1980s a broad product segmentation. It leads to a different mix of economies of scale and of scope and to new production technologies supporting the modularization of the design of the cars.

very different depending on the product segment in which each OEM is operating. It means that two countervailing processes are affecting the industry as a whole. On the one hand the strategic attitude of firms to internalize the factor of externalities, i.e. to reduce their potential for uncertainty, increasing their command of the structural interdependence, which is at the origin of externalities (Antonelli 1992, p. 15); on the other hand, the irreplaceable benefits coming out of the externalities, of the complementary assets and technologies, of the collaborative manufacturing, etc., to produce and distribute the required innovation. This is a never-ending dynamic because for each step in one direction a new level of externalities, of non-appropriability of the knowledge resources will be created.

- The consumption externalities are growing, and this is making interesting the idea of utilizing the paradigm of open innovation with customers (Piller, Ihl 2009).
- The footprint of the industry, in this sense, is broader and broader, including a large part of all R&D outcomes in many different fields, as well as the technological advances and the know-how coming from traditionally very different industries. It means that the traditional boundaries between industrial sectors are blurring and/or deeply changing.
- The supply chain is in a very similar deep process of change. In this process the market powers of the different actors is rapidly polarizing between two poles: the ones able to gain and maintain a strong profitability position in the value chain and the others more and more pushed in a process of full commodification and of their manufacturing / services contributions, that is a perfect interchangeability of each of them with the others.
- The winners in the supply chain are system integrators and/or complex subsystem producers and/or designers with a dynamic capability of developing the product/process/service they control both incrementally and, sometimes, also through innovation.
- These processes contribute to the selection of new players on the edge of the innovative trends, such as the new engines makers or the new mobility services providers. These new actors can challenge the incumbents in some niche markets.





2 The limits of the car-driven model of mobility and the rise of a new culture

The global financial and economic crisis dramatically compounded the situation, particularly in Europe because of the choice in favour of austerity measures affecting the volume markets, that is the A, B and partly C segments – as a matter of fact 2012 was the fifth consecutive year of sales decline. If the unit of analysis is the single firm, in Europe there are divergent trends among the main OEMs: for instance Volkswagen, also in the C segment, and BMW are growing, unlike the French ones, Fiat and Ford.

Enrietti (2013) quotes the data reported in the figures.

According to the *Financial Times*, also the operating profits show the existence of divergent trends: from a continuous growth in the period 2007-2012, as in the case of VW (more than ten billions euro) and BMW (quite eight billions euro), to a stable situation of revenues (Daimler, roughly five billions), to a reduction for Fiat and losses for PSA Peugeot Citroën and Renault.

Therefore it is no accident that Fiat and PSA, for instance, are in a so dire situation.

3 A strategic manufacturing sector

In spite of this situation, the EU has definitely stated, in the second final report by the «Cars 21 High Level Group»,[2] released in June 2012, that the automotive sector «remains of strategic importance and a cornerstone for the EU industry and economy, providing quality employment to millions of workers in the EU». It means, more in details, that the sector, maintaining a positive trade balance due to a strong export portfolio of high-quality and high-technology vehicles to third markets, should have a «strong manufacturing base in the EU», should lead in technology, namely in «the propulsion technologies» and «in alternative powertrain concepts», should rely on «a strong industrial network characterised by a flexible and integrated supply and distribution chain» and eventually on «a workforce in both manufacturing, R&D and servicing that is trained and prepared to work with a multitude of technologies». The report stresses also the key role of the car industry in transferring to and receiving from other industries: technologies, know-how, and skills. These objectives are the basis for the *CARS 2020 Action Plan for a Competitive and Sustainable Automotive Industry in Europe*,[3] the plan set up by the Commission on November 2012.

4 EU 2020 and the challenges for the car sector

The plan should also be consistent with the general European objectives of smart sustainable and inclusive growth, known as EU 2020, whose main target is to cope with the climate agenda. Traffic congestion

2. http://ec.europa.eu/enterprise/sectors/automotive/files/cars-21-final-report-2012_en.pdf (2013/02/20).

3. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0636:FIN:EN:PDF (2013/02/20).

and pollution are already leading, in the EU countries, to more and more restrictive standards on the limit of CO_2 emissions. The contribution of the transport sector to the EU's CO_2 emissions is now up to 29%, with an increase of nine points since 1990. According to the European Environment Agency, «cars are responsible for 14% of the CO_2 emissions, that is the largest source of transport emissions, representing around half of the total»;[4] reducing this level of emission is therefore a key objective of the EU 2020 plan. According to the seventh T&E report, on December 2012, in 2011: «The EU imported approximately € 300bn worth of oil every year, or € 800m every day [...] Transport is responsible for about two thirds of oil use. Cars are the single biggest consumer of oil in the EU, responsible for using around half of transport sector demand and hence a third of all oil, hence about € 100bn worth of imports per year» (T&E 2012).

In the search for new technologies the Europe's energy dependence is therefore also at stake. These standards are pushing the OEMs and the specialized suppliers to invest in innovation on the powertrain, and on new materials in order to reduce vehicle weight; as a matter of fact, «every per cent vehicles are made lighter typically results in 0,7% lower fuel consumption and CO_2 emissions».

The targets to be reached by 2020 are therefore depending on the weight of the vehicles the entire industry will produce «in 2015 compared with the average weight of the vehicles the entire industry will produce over the 2011-2013 period». According to the T&E report, almost all the EU manufacturers, but Daimler, are in the top 9 on the track to achieve the 95g/km of CO_2 emission, but only two, Fiat and PSA, are among the three front runners; Toyota is the only non-EU producer to be in the group of the nine and among the three front runners, Hyundai is tenth in the ranking but is supposed to reach the target.

5 The search for alternative powertrains solutions

The strategic decisions on the technology to adopt on powertrains are already well-defined and distributed along some parallel trajectories such as: a) more efficient traditional engines, b) alternative engines utilizing non-renewable sources, such as methane and liquid gas; or c) renewable sources, such as hydrogen as fuel, or to produce electricity, in a fuel cell (FCEV) as Hyundai, Toyota and the new UK's government

4. http://www.transportenvironment.org/what-we-do/cars-and-co2/background.

planned (Tighe 2013); and methane, as a renewable source, such as the case of the Audi e-gas project; d) mixed solutions such as Hybrid Electric Vehicle (HEV), Plug in Hybrid Electric Vehicle (PHEV); e) pure battery electric engines (BEV). The new vehicles with alternative electric engines should also be designed according to new geometries, namely in the case of the electric engines, especially concerning the battery power packs and new safety rules. This will lead to important consequences on the work content of the new vehicles and therefore on the employment levels and the skills required.

The OEMs are, to some extent, in an uncertain situation on what power train technology to adopt because of the mix of high investments, uncertain regulations and consumers' difficulties to afford the higher prices required by adopting the new technologies.

The recent case of the decisions taken by the London authority to change the rules for the exemption of cars, with low emissions, from the city's congestion charge is a clear example of the uncertainty, even for consumers, in taking a well informed investment decision.

Uncertainty is the rule. Each of these scenarios implies huge investments, not only in designing the new products, but also on new plants, new skills, and even total redesigning of the supply chain. To afford this uncertainty the main OEMs are choosing a product portfolio strategy, trying to accommodate these different perspectives. This strategy is very expensive and based on a strong and structural segmentation of the market. To be affordable it should reach the maximum geographical expansion to make each niche profitable.

6 Difficulties and opportunities

The drive for innovation is primarily a social and cultural one: the search for a smart and clean solution for people's mobility, especially in urban environments. Notwithstanding this strong social and cultural push there are economic and technical difficulties to overcome, in particular for the cases c), d), e), and, at the same time, opportunities for new business models and for new ways of storing and distributing electricity from renewable sources. Firstly there is an issue about the adoption by the consumers of vehicles that are still more expensive to buy, even though the total cost of ownership (TCO) is lower. Secondly there is an issue about the lower autonomy due to the different energy density for the case e). Thirdly there is an issue about the storage inside the vehicles, for the case c), and about a brand new distribution chain to be built for the cases c) and e); for instance the cost for building a hydrogen infrastructure was estimated in 5 billions euro.[5] Fourthly there is an issue about extra weight for all the cases c), d), e). All these economic and technical problems are taken into considerations by the various OEMs and each one has different solutions in the pipeline.

A strategic objection to the choice of affording so important costs and difficulties is related to the concept of the fuel life-cycle analysis, normally shortened in «Well-to-Wheels» (WTW) analysis (Edwards, Larivé, Beziat 2011); the WTW can be divide into two parts: «Well to Tank» and «Tank to Wheels». There is a general consensus on the fact that the solutions c) and e) produce zero emissions in the Tank-to-Wheels part, but the hydrogen and/or the electricity should be produced, transported and distributed in the Well-to-Tank part of the pathway: 1) producing and transporting the primary fuel, 2) producing and distributing the road fuel, 3) fuelling the vehicle.

For this reason the actual comparison between traditional internal combustion engines (IE) and electric engines (PHEV and EV), based both on batteries (BEV) and fuel cell (FCEV), should take the WTW analysis into consideration. In Europe the most comprehensive, and widely used as a benchmark study, is the one conducted by the European Consortium JEC, built by the European Commission Joint Research Centre (JRC), CONCAWE (oil industry consortium), and ACEA (auto industry consortium), already at its fourth version.

A research utilizing this database, and other international sources, outlines the likely scenarios. A study commissioned by Transport & Environment, Friends of the Earth Europe, Greenpeace European Unit and WWF Germany in 2010 concluded that:

> The well-to-wheel environmental impact of EVs and PHEVs is largely determined by the type of electricity production used to charge the batteries. If electricity is produced from lignite or coal, well-to-wheel CO_2 emissions are typically higher than or equal to the emissions of a comparable ICE car. When the electricity comes from gas-fired power plants, emissions are significantly lower. Electricity from renewable sources, such as wind, solar or hydro energy, would result in zero CO_2 emissions per kilometre [Kampman et al. 2010].

A more recent research presented by GM (2012) and based on the JEC data states that

5. *A Portfolio of Power-Trains for Europe: A Fact-Based Analysis*, available at http://www.fch-ju.eu/sites/default/files/documents/Power_trains_for_Europe.pdf, last visited 27/06/2013.

Fuel lifecycle GHG (greenhouse-gas emissions) for conventional diesel and CNG were within the range of conventional gasoline and gasoline strong hybrids. Biofuels and biomethane blends could further reduce lifecycle GHG for these internal-combustion engine options. The BEV, plugged into electricity with the GHG footprint of the average mix of the EU grid, provided GHG about half that of conventional gasoline and 30% below that of a strong gasoline hybrid. If the BEV were powered with wind electricity, fuel lifecycle GHG would be zero. WTW GHG of the Extended Range EV, like the BEV, depends on electricity GHG footprint, but also depends on charging and driving behaviour.

Summing it up, this research confirms that the problem of the WTW analysis is fully on the WTT part and that some opportunities are already available, without including solutions more ahead of the available technology.

But what is very important for the thesis of this paper, based on these recent research, are, on the one hand, a set of field collected data, and, on the other hand, an opportunity for innovation.

The field data show that the Chevrolet Volt extended-range electric vehicle «Reveals that two-thirds of all Volt miles driven were performed with electric energy in 'EV' mode» allowing «significant replacement of petroleum-based fuel (60% to 80%) by electricity». Besides:

Data of Opel Ampera test vehicles used by engineers over several months show that, in this sample, 45 km per day can be driven in EV mode. This is more than the average gasoline ICE vehicle in Germany, 31 km per day. The Ampera test vehicles were driven 72 km per day, which exceeds the average driving distance of diesel passenger cars in Germany of 15 km per day.

It seems that the problem of the autonomy should be reconsidered in the framework of the product segmentation concept, that will be analysed in the next section of the paper.

The opportunity for innovation comes from the problem of the storage of the electricity produced from renewable sources, such as wind power, whose main feature is a strong fluctuation from a maximum to zero. The problem is how to build «buffers», for the excess energy, in order to provide energy back to the grid. There are many different technologies available and according to the already quoted GM study the most promising is the hydrogen storage. It is also possible to use batteries as storage devices (Grid-to-Vehicle, G2V); this is the more intriguing innovation possibility. Unfortunately

This requires significant improvements to battery costs and lifetime – the latter is typically expressed in number of charging cycles. Using them for this type of concept thus reduces the number of kilometres that can be driven with them. This option may therefore be costly and potentially unattractive for car owners, but concerns may be overcome in the longer term if battery development is successful, and the benefits outweigh the cost.

The options described above need a lot of innovation. They depend crucially on smart grids and the possibilities for smart metering – the infrastructure, metering systems and standards need to be developed.

In both cases new relations between different economic sectors are coming to the fore with a growing need for coordination, through public policies, and for innovative business models. It is therefore possible to outline different business models: a) utilities driven, with a new role of the power utilities that are engaged in designing and building smart grids, b) OEMs-driven, dominated by the actual incumbents; c) energy supply arbitrage, such as the Better Place attempt, whose performance was totally unsuccessful.

7 Product segmentation

From the point of view of the product segmentation the situation looks like a patchwork of different combinations of product segment, firm's specialization, national markets, incomes distribution and dynamic, and eventually cultural shift between different generations of consumers, namely the new trends among the youngsters. However some main global trends can be observed.

Firstly, a significant trend is the affluent style of consumption of the new global middle class emerging in the new developing countries such as, for instance, China. But if the global production is divided in two subsystems – the so-called BRIC countries vs. US, Japan and Germany – the shift is very impressive because the BRIC countries are up to 27-28 millions vehicles, of which China alone 18 millions, and the others together up to 22-23 millions. It leads to new trade flows from Europe to these countries; those flows can be intercepted only by the OEMs that are specialized in producing cars in the E, F, S and also J segments, which are the ones with the highest level of economic returns. The overall effect of this shift and of the divergent trends, vis-à-vis the economic crisis, is to forecast a decline of the European world market share of vehicle sales, from 29% in 2004 to 20% in 2020. This situation created, on the other hand, new opportunities, in those third markets, that can only be seized by offshoring there the production process as a whole, mostly through joint ventures with local producers. It implied a deep and extended process of structuring and restructuring the global car value chain; in Europe this means, also, that the supply chain is more and more internationally integrated, therefore components and subsystems are increasingly sourced from other parts of the world.

Secondly, there is a global accelerated process of urbanization. The majority of people is living now in an urban environment. This leads to a fundamental split of the car market in two different spheres, one primarily looking for all-purposes vehicles and the other primarily looking for single-purpose vehicles. It implies both product innovations and business model innovation.

In general terms the car industry needs a continuous process of innovation regarding products and business models, as well as productive and organizational models, but in this new situation it needs a strategic rethinking also because of some social and cultural new trends.

8 Megatrends

In a more general perspective there are some non-industrial trends that are very critical for the future of the car industry.

The negative demographic trends, particularly in most EU countries, largely compounded by a cultural shift among the youngsters on the usage of cars and the desire for physical mobility. In the US «Driving, as measured by vehicle miles travelled, began to plateau in 2004, and in 2007 fell for the first time since 1980» and young Americans «are, increasingly, not bothering to get driver's licences. From 2000 to 2010, the percentage of 14 to 34-year-olds without licences rose from 21 per cent to 26 per cent, according to the Federal Highway Administration». These trends are occurring «in other developed economies including the UK, Germany, Canada, Japan, South Korea and Sweden (although not in Finland, Israel, the Netherlands, Switzerland or Spain)» (Skapinker 2012). This entails the search for new business models and new products.

A crisis of the traditional model of a personal ownership of the car: Zipcar, recently acquired by AVIS, and other car-sharing services have been more successful than traditional car rental companies at reacting to the trend towards the declining car ownership in many industrialized countries. «We believe this is a major step forward to reaching our goal of fundamentally revolutionising personal mobility», said Scott Griffith, chairman and chief executive of Zipcar (Gelles 2013). This entails the search for new business models.

A crisis of efficiency and efficacy of the mobility based on cars in metropolitan areas because of congestion and of the social costs of pollution.

It is impossible to work congestion out, in a structural way, without an integrated approach of urban planning, of the introduction of smart shared vehicles and their integration in a hybrid mobility platform, based on ICT-based technologies, made up of public systems and car-sharing schemes. This entails the search for the integration of different kind of knowledge, of different professions, of different economic activities with the overall task of improving the mobility of people.

9 The search for a new paradigm

A cultural shift is needed from car to mobility as the actual product. What people are more and more looking at is the utility value of the car, that is its capability to deliver mobility in an efficient and effective way, as a collective as well as a personal right. Cars were at some point in the history of mobility more effective and efficient for mobility than other goods (D'Eramo 1995, p. 96). At a certain point an insoluble conflict arose between the specific modality for realizing the mobility in a given period and its actual utilization either collectively or individually. In short, there has been a split between the utility value and the goods exchange value. At this point the conditions are determined that allow for a transformation and, when it takes place, the drive is so powerful that the process doesn't stop, even before the destruction of the non-amortized fixed capital – a case in point is the destruction of the tramways or the urban sprawl created to make way for the car – or before the vested interests however powerful they may be.

In other words, if cars are a by-product of the real product, that is mobility, and if mobility today is for the majority of mankind an urban mobility, then the focus is on designing together the city and the infrastructure for mobility; cars are just part of a broader system. Besides, each new design implies the search for new products to support mobility and of new industrial processes to build them.

This entails the necessity of a vertical integration between the classical car sector and a newly emerging urban design and management sector.

10 A transition

The car industry still represents the best instance of industrial rationality, the industry with the highest manufacturing employment rate both for the developed and for the developing countries; in short, it is a strategic industry. The amount of direct and indirect investment by the State, households and private capital in the car industry is enormous. What is increasingly crisis-ridden is the car seen as the prime and most rational means for assuring mobility both inside and towards the cities. The way to cope with this strategic crisis is to develop a transition to a new equilibrium of the means assuring personal mobility and the role of cars. This entails a new industrial perspective:

- The search for a new business model in the car industry.
- The development of the hybrid manufacturing model (Bryson 2010), also in the car industry.
- A closer integration between the strategic goals pursued in the different social and economic activities affecting the mobility system and the nature of the mobility system (Chiao 2011). For instance the decision to stop the urban sprawling implies the choice of «vertical shaped» cities; to cope with clean energy production and utilization leads to a portfolio of solutions for people mobility and goods delivery, based on clean smart vehicles and new infrastructures such as elevators, escalators, cable-ways, but also to recover old means as bicycles (Brillembourg 2011).
- The development of an urban mobility platform utilizing ICT technologies and communicating with smart vehicles (Sassen 2011).
- Publicly available clean smart vehicles, based on a web-shaped network.

The required change is very complex and cannot only rely upon market dynamics; public planning and public investments are required both on urban planning and renewal, on basic infrastructure, for instance a publicly available system of recharging for electric cars and an ICT-based urban mobility platform, on industrial policies, for instance how to accommodate the industrial transition, and on environmental policies, and eventually on R&D policies on new technologies (Kleinert 2013).

11 *Forma Urbis* and Infrastructures (Garibaldo 2012)

The specific feature of the infrastructures depends on many different issues, for instance:

- The degree of physical embeddedness of the inherited *Forma Urbis*, for instance: middle age or modern cities. In Perugia escalators are very effective as well as in Ferrara bicycles are; etc.

- The size of the city: in Italian middle towns downtown is an area smaller than the passenger area of the Frankfurt airport. It means that escalators, and/or moving sidewalks can be effective solutions.
- The interaction of GPS, electronic mapping and smart vehicles allow the setting up of an integrated platform to manage traffic.

This means that on the user side there is the possibility of a portfolio of mobility modalities within as well as outside the urban environment.[6]

This leads to a portfolio of solutions that need a new infrastructure of services, new vehicles based on new powertrains that should be clean, that is zero emission designed. It implies a deep restructuring of the car industry and of its business models, as well as of a new set of employees skills and competencies.

12 Industrial policies

A set of European industrial policies should be a coordinated effort ecologically-oriented in different fields, such as energy, urban planning, industrial renewal and technologies, in order to guarantee an efficient and effective mobility of people and goods. These policies should rely on and enrich the industrial inheritance of the car industry both as industrial and technological knowledge as well as of people skills and competencies. This is possible utilizing part of this inheritance for the renewal of other industrial sectors, for instance the energy production. It means to manage a long industrial and social transition.

The idea that the future will be without cars is totally unrealistic; utilizing cars will remain an effective and efficient solution in non-urban areas and in a specific proportion and with new business models, for instance the possibility to buy hours of utilization instead of a car, even in urban areas. The main big change will be the on-going new segmentation that will overcome the idea of all-purposes cars in favour of specific-purposes cars, that is cars designed for a specific environment, such as cities. This is the other side of the concept of a portfolio of solutions.

To accomplish a social responsible industrial transition means also to reach a different proportion between export and internal market in

6. See: the Japanese experience of smart communities as described by the paper presented at the 21st Gerpisa colloquium, June 2013, by Bruno Faivre D'Arcier and Yveline Lecler. Dijk 2012; Begley, Berkeley 2012.

Europe. If Europe will bet on a complete renewal of the mobility system in its many big urban conurbations there will be a new operative space for the car industry. This means to deploy new products.

13 Integrated systems and the role of R&D

Urban integrated systems are made of public (buses, underground trains, cable cars, etc.) and publicly available systems (escalators, moving sidewalks) as well as private systems (the traditional private ownership, but also the new leasing systems) of mobility. They can be integrated on the side of centralized governance systems such as mobility platforms, as well as on the side of the individuals through the possibility to buy a mobility carnet, made of a portfolio of means such as the possibility to use a car when needed or a bicycle or a motorbike, perhaps even electric.

This perspective requires huge public investments in education, to support the process of industrial restructuring and renewal, and in R&D in the fields of batteries, fuel cells, nuclear fusion as well as new urban infrastructures.

14 A new role for the suppliers

The typical supply chain in the car sector is structured in thousands of second-tier suppliers, hundreds of first-tier suppliers, and dozens of system integrators and/or specialized suppliers, therefore dealing with sub-systems and modules. In this configuration the typical OEM manufacturing footprint is: assembly, powertrain and stamping. The key suppliers, system integrators and specialized industrial and services suppliers, normally are not bound to single OEMs, but they supply many of them. This leads to the rise of a web of suppliers that develop an in-house specialized know-how and/or knowledge and product/services innovation. It means that part of the dynamic of the innovation in the sector is no more within the control and the ownership of each OEMs, as a competitive margin against the others, but distributed in this new industrial structure. An industrial structure whose main features are very consistent with network economics, namely as a situation in between market and hierarchies, which is a network of firms (Antonelli 1992). As Piller and Ihl analysing the open innovation paradigms potentialities, state (2009, p. 11):

> Today the common understanding of the innovation process builds on the observation that firms rarely innovate alone and that the innovation process can be seen as an interactive relationship among producers, users and many other different institutions […]. As a result, the early Schumpeterian model of the lone entrepreneur bringing innovations to markets […] has been superseded by a richer picture of different actors in networks and communities […]. Innovative performance today is seen to a large extent as the ability of an innovative organization to establish networks with external entities [Piller, Ihl 2009, p. 11].

In the same direction goes the concept of complementary assets and technologies by Teece (2006) and the case study by Dedrick, Kraemer and Linden (2008).

The car industry is characterized by high complexity and high volume at the same time; there are 20,000 detailed parts with about 1,000 key components to be managed, which means that the possible end-items configurations are, theoretically, up to millions, and actually several thousands.

So complex is the task to be achieved that there was a shift of relevance, within manufacturing, in favour of the supply chain. This is the reason why it is the supply chain that makes the difference in the ability to successfully control final markets and market share; this is also the message from a special report of the *Financial Times* (2011/26/01).

It should be elaborated more in depth on this point. On the one hand there is the integration of functions and processes to make a car, involving only some suppliers, and the management of the material flow of parts, involving the supply chain as a whole; on the other hand, there is the process of managing the overall supply chain as an integrated value chain, which is up to the OEMs and involve all the actors, at all the levels, of the supply chain. These two sides, the material side, that is the flow of parts, subsystems and modules, and the value side, that is the cash-to-cash cycle, should be each other coherent and synchronized, taking into account also the global span of the supply chain.

This is also the reason why, in the attempt to manage demand variability, downstream to the dealers and the final market, and global supply chain, upstream to the assembly lines, on the one hand the OEMs need collaborative schemes, through the supply chain, with the consequence of letting fade traditional organizational boundaries, in favour of closer integration upstream and downstream. On the other hand, according to a JDA report (Kelly 2012) the basis of competition has moved away from operational efficiency in a given functional area to the operational efficiency of the overall value chain. A rough measure of operational efficiency associated with manufacturing and the supply chain is shown in the equation below. This «return on supply chain» subtracts R&D and depreciation costs from COGS and then uses the result to calculate a margin against revenue.[7]

The same report states that the major remaining costs contained in the above equation are materials and operational/transformational costs. This is only a relative measure since costs will still contain some level of non-supply chain costs such as warranty and financial services. It does, however, give some sense of the operational and purchasing efficiency of carmakers.

These two requirements, the financial one and the non-financial one, can be jointly optimized only if there is a synchronization of the sales and marketing requirements and forecasts with parts flowing in from suppliers. This leads to a strong pressing on the suppliers in terms of flexibility.

Going back to the overall picture of the relationship between OEMs and suppliers it can therefore be stated that there are two opposite macro-requirements to balance. On the one hand, a strong push for reducing the operational autonomy and to squeeze the revenues of the suppliers to improve the performance of the overall supply chain, as an integrated value and productive chain. On the other hand, the OEMs need a collaborative relationship with their suppliers to manage complexity (Liker, Choi 2004). What the OEMs are trying to do is to enjoy the collaborative part, and the connected offloading of the investments to the suppliers, in order to retain as much control as possible over the innovation dynamic and improve the performance of the overall supply chain, that is to retain a strong control over the operative costs and over the collaborative and coordination costs.[8]

15 Conclusions

In this new paradigm what happens to the industrial structure of the car industry? To be more specific, what kind of role for the suppliers can be devised?

To give an answer to these questions a step backward should be taken to the section on the main features of the new global car industry. The

7. *Return on Supply Chain = (Revenue - COGS - R&D - Depreciation) ÷ Revenue* (COGS is for the cost of goods sold: supply chain costs including material costs, R&D, Depreciation).

8. A good example, related to Apple and HP, can be find at http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&ved=0CD8QFjAD&url=http%3A%2F%2Fweb.mit.edu%2Fis08%2Fpdf%2FDedrick_Kraemer_Linden.pdf&ei=908bUbWoFsXotQblnoDgBQ&usg=AFQjCNG9RwzSnZl3-M6NKxbaS90EZX2tJg&bvm=bv.42261806,d.Yms/ (2013/02/20).

growing weight of the role of networks as a structural feature of this industry, together with the growing need of market and product segmentation and the diffusion of decentralized loci of innovation imply that the process of change of the car industry cannot be moulded only by the OEMs and by the existing leading OEMs. There are many alternatives scenarios available to the existing players, both industrial and law-making ones – as the USA and French cases show. So complex is the network of reciprocal interactions that the actual reshaping of this industry will be a collective endeavour. It can be the outcome of a wild market selection or of a social regulated process of adaptation and transformation.

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7

Industrial policies for sustainable mobility in the leading european automotive countries

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ABSTRACT *The role of the automotive industry is currently being renegotiated in a society that requires to return to the question of politics, states and the importance of regulation and taxation as these issues are likely to play a major role in determining outcomes for automotive companies and territories. European Union approach followed the usual path, with the institution of regulatory requirements that increasingly restrict the sale of new vehicles, the setting of specific limits on emissions, and the provision of direct support for basic research. Current industrial national policies of European countries have been for the most part non-interventionist and concentrated on improving the business environment. Nevertheless, some countries were able to covertly support their respective national automotive sectors in contradiction to community directives. This chapter presents three European country studies, each of them with its own particularity: Germany, France and Great Britain.*

1 Introduction

Finding new methods of propulsion for cars is currently a subject of intense debate, driven by the issue of global warming and more generally by the demand for sustainable development in the automotive industry.[1]

The evolution of powertrains is undoubtedly influenced by the path dependency of countries and carmakers' trajectories in terms of flexibility and inertia. Three lock-in factors of path dependency can be detected, i.e. business models, consumer attitudes and policy regulations:

1. In this chapter, alternative vehicles (AVs) include alternative fuels, compressed natural gas (CNG) liquefied petroleum gas (LPG) and biofuels, as well as alternative engines powered by electric batteries either exclusively, i.e. electric vehicles (EVs), or partially: hybrid vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and range-extender hybrid electric vehicles (REHEVs).

The carmakers' business models are generally characterized by risk aversion and by return optimization through continuous improvement and cost cutting. The current automotive business model is characterized by a lack of profitability (Nieuwenhuis, Wells 2003), given that profit comes mainly from the sale of vehicles and not from their use (Ceschin, Vezzoli 2010).

The internal combustion engine (ICE) satisfies most consumers in terms of performance and predictable costs. Those who prefer clean and fuel-efficient engines and are willing to pay slightly higher purchase prices represent only a niche market (Dijk, Kemp 2010). Consumers care a great deal about fuel consumption but very little about vehicle emissions.

As for the European Union (EU), measures to develop AVs have followed the usual path, with the institution of regulatory requirements increasingly restricting the sale of new vehicles, the setting of specific limits on emissions, and the provision of direct support to basic research. The focus has been on new vehicles, while the reduction in pollutants from vehicles currently in use has barely been considered.[2] Step by step, the Euro 1 to 6 regulations have mainly favoured incremental innovation of the ICE rather than radical innovations (Oltra, Saint Jean 2009). In the course of time, R&D financing has moved from fuel cell vehicles (FCVs) to other types of AVs, because the time-line for introducing FCVs is still largely undefined and their success is still very uncertain in relation to costs, infrastructures, hydrogen generation and storage. Albeit with greater determination, the recent CARS 2020 action plan also follows this line. The Commission proposes a massive innovative push by streamlining research and innovation under the European Green Vehicle Initiative.

The major challenge for policy units and policy-makers across Europe is the promotion of technologies which should be driven by environmental concerns rather than business and consumer considerations. New patterns of travel and vehicle ownership also contribute to fragment the market and add further complexity to the picture.

The aim of this chapter is to present a detailed description of the industrial policies of the main European countries involved in sustainable mobility (Germany, France and Great Britain) in relation to the emerging industrial scenario. Some key questions are: Which are the main schemes adopted by these countries? Do some distinctive features emerge? Is it possible to provide some evaluations *in itinere*? In particu-

2. In the EU, 34% of vehicles in use are more than ten years old.

lar, this chapter focuses on a scarcely implemented, even though transitional, measure to reduce local pollution, that is CNG and LPG vehicles.[3]

The chapter is structured in six sections in addition to this Introduction. The next section illustrates different public policy options for sustainable mobility in the automotive sector, at the national and local level. Sections three, four and five briefly present the existing policies in the three main European countries: Germany, France and Great Britain. Section six highlights the absence of significant policies for CNG and LPG vehicles in the three countries. These measures might represent an immediately viable option to reduce pollutant emissions. Finally, section seven introduces some conclusions and evaluations.

2 Different public policy options for sustainable mobility in the automotive sector

At the European Union level, three major policy areas impact on sustainable development in the automotive industry: common standard regulations on exhaust and CO_2 emissions,[4] safety,[5] and recycling.[6] This barrage of increasingly stiff regulations is driving a substantial change and presents a challenge for the global car industry, although regulatory regimes for cars remain differentiated around the world. Some markets have specific safety tests and others have specific cycles for testing emissions (Ryan, Turton 2007; Sperling, Cannon 2007). The

3. In this context, some observations on Italy will be presented.

4. The legal framework consists of a series of directives (each being an amendment to the 1970 Directive 70/220/EEC) which are mandatory in all member States. Since the Euro 2 stage, EU regulations have introduced different emission limits for diesel and petrol vehicles. Diesel vehicles have more stringent CO standards but are allowed higher NO_x emissions. Petrol-powered vehicles are exempt from particulate matter (PM) standards through to the Euro 4 stage, but vehicles with direct injection engines are subject to a limit of 0.005 g/km for Euro 5 and Euro 6. A particulate number standard (P) or (PN) is part of Euro 5 and 6. Carmakers will have to reduce CO_2 emissions from new cars to 130 grams per kilometer by 2012/2015, with an additional 10 gram reduction coming from «complementary measures» including a greater use of biofuels. A new objective of just 95 grams per kilometer has been set for 2020. This will be conditional on an impact assessment. Penalties will be imposed on a sliding scale. Manufacturers that exceed their target by more than 3 grams will pay 95 euro per excess gram. Lesser transgressions will be charged between 5 and 25 euros. From 2019, penalties will always be 95 euro.

5. EURO NCAP tests which originated in the UK but are now backed by the European Commission, seven European governments, as well as motoring and consumer organizations in every EU country.

6. The End-of-Life Vehicle Directive came into force at the beginning of 2007.

differences in fiscal regimes are even more pronounced. The European Union sees the proposal of the CARS 2020 action plan as an attempt to overcome the clear lack of political leadership in the automotive sector. The case of the 2003 biofuel directive is a typical example. Indeed, only Sweden has adopted the directive to replace fossil fuels with biofuels and support flexi-fuel vehicles. Another example are bottom-up requests from Germany, France, Spain and Portugal which have urged the EU to support transnational development projects on electric mobility and to define standards for the charging system. As a matter of fact, much of the automotive-specific effort has been directed through programmes to fund collaboration among companies and research organizations in order to reduce life-cycle emissions (MacNeill, Bailey 2010).

In this contest, most of the industrial policies of European countries have been non-interventionist and concentrated on improving the business environment (Bailey, Driffield 2007). In the manufacturing arena, national policies have shifted away from sector-specific support towards general support to all manufacturing sectors and from vertical towards horizontal industrial policy measures.

Nevertheless, some countries have been able to covertly support their respective national automotive sectors in contradiction to community directives. It is worth pointing out that, at the end of the 20th century, France and Italy were the only countries involved in the AV sectors. In the last few years, however, other countries have concentrated their efforts based on their own specific carmakers and energy structures, as in the case of EVs. Countries such as Denmark, France and Israel, which are now establishing attractive schemes for EVs through R&D incentives, could potentially generate a huge competitive edge for their domestic automotive and power industries.

Yet, unless other governments act promptly in order to provide adequate incentives for consumers to purchase these cars, and for investors to provide the necessary infrastructure at affordable prices, AVs may get off to a false start. The isolated and top-down experience of California is particularly significant. California introduced a legislation that made it compulsory for carmakers to sell at least 2% Zero Emission Vehicles by 1997, rising to 15% in 2003, but the mandate was gradually reduced and it disappeared in 1998.

Each of the three European countries studied in this chapter displays its own peculiarities:

- In Germany, public support to alternative powertrains and fuels focuses on R&D and related demonstration projects. While in the German automotive industry the shift towards alternative powertrains and fuels struggles to gain momentum, in spite of numerous programmes, energy and resource efficiency seems to have rather different effects.

- In France, one of the strengths of the 2009 plan, and of the subsequent initiatives launched in 2010, was the creation of collective expectations that EVs might characterize a scenario of significant change. The problems, hesitations, corrections along the way and delays that have been accumulating since 2011 are progressively eroding this capital of confidence and enthusiasm.
- The British government's policies intend to be non-discriminatory among international businesses which might invest in Britain. Concrete policy measures in low carbon vehicle infrastructure and innovation aim at being even-handed. At the national level, policy is «technology neutral» as regards which ultra-low or low carbon vehicle technologies should receive public funding and support.

One of the most popular schemes pursued by industrial policies is to launch fleet renewal programmes, including market incentives and car scrapping schemes. Scholars and practitioners have different opinions on the matter. However, above all in Europe, these incentives are seen as a measure intended to modify customer requirements and distort the market, leading only to limited, short-term benefits, because people are not actually encouraged to buy more cars but just to purchase new vehicles earlier than they would normally do.

Nevertheless, according to IHS Global Insight (2010), scrapping schemes have been remarkably successful and they have also been the main measure that 13 European Union member States, which together represent 85% of total vehicle sales, have enacted to tackle the financial crisis. In ten countries, the primary objective has been to provide general economic stimulus, whereas the secondary objectives have been the renewal of the European car fleet and benefits for road safety. However, political intervention greatly depends on the types of alternative vehicles taken into account, since the gap between their purchase price and that of conventional vehicles varies considerably and, in the case of EVs, it is particularly wide. For example, the Mitsubishi i-MiEV, one of the best EVs available, costs more than 36,000 euro, whereas a comparable conventional car costs less than 10,000 euro. This shows why government subsidies have not significantly boosted EV sales in Europe. Such discrepancies highlight the apparently weak influence of incentives on purchasing decisions even when the incentives are significant.[7]

7. Main incentives for buying an EV: Denmark 20,588 €; Norway 17,524; Belgium 10,907; Portugal 9,442; Spain 6,500; UK 6,400; Italy 5,000.

In the comparison between ICEs and EVs, another aspect that must be considered is usage cost. The price of the energy used hints at a situation of competitiveness between electricity and petrol,[8] but this aspect does not yet seem to be appealing enough.[9] Moreover, the prices of electricity and petrol include different levels of excise duties to which the coffers of the various States are highly sensitive.[10]

Finally, and more generally, policy response to sustainable development should aim at the implementation of measures capable of (Ceschin, Vezzoli 2010)

- encouraging companies to shift their business models by adopting use-oriented (for example, leasing, sharing, pooling) and result-oriented (for example, pay per service unit schemes, integrated mobility schemes) services;
- changing agents' behaviours (for example, public procurements, consumer awareness);
- supporting demonstrative pilot projects (for example, promising business models without direct market pressure);
- involving universities and research centres in supporting knowledge transfer and the dissemination of information.

3 Germany: essentially R&D support and local demonstrations

German sustainable mobility and transport policies are usually planned and structured as industrial and technology policies. Several government actors shape the sustainable mobility policy: the Ministries for Transport, Environment, Economics, Education and Research, as well as the agencies for Environment, Hydrogen and Fuel Cell Technology, Electric Mobility, and Energy (Heymann et al. 2011).

8. It is obvious that, if oil prices are low, consumers will tend to buy ICE vehicles; however, when other conditions are met (battery prices decrease, public utility companies provide suitable infrastructures, and the EU sticks to its 95g/km CO_2 emissions target for 2020), the future of AVs will be much brighter. In this context, the proposal to add extra excise taxes on oil prices to reach a permanent and fixed level seems sensible.

9. For example, in the case of the Smart model, the EV version consumes 12.2 KWh/100 km and the unleaded petrol version consumes 4.4 liters/100 km. Using the average prices quoted in Europe's Energy Portal (www.energy.eu), the usage cost of the Smart EV is 24.3% that of the ICE version in France, 27.5% in the UK, 35.5% in Italy, 43.2% in Spain, and 47.9% in Germany.

10. If governments imposed on electricity the same level of taxes collected from petrol, the percentages would be: France 66.5, UK 61.8, Italy 66.4, Spain 57.1, and Germany 79.6.

In Germany, the measures and targets for sustainable mobility concern mainly the implementation of a regulatory framework and R&D support. The National Platform for Electric Mobility (NPE) stands out among these actions.

Policies for sustainable mobility are strongly shaped by the political multi-level system, in which the main policy instruments are different taxes, such as energy and electricity taxes, quotas for biofuels, temporary rebates, low emission zones, incentives schemes to improve the economy, such as the scrapping bonus scheme, and indirect support to EVs. Especially the scrapping scheme, as well as reduced working hours and temporary work, mitigated the effects of the crisis on the German automotive industry. In contrast to the scrapping scheme incentives available during the crisis years of 2009 and 2010, no purchase bonus was introduced for buying EVs.

As for demand incentives, Germany is less active than other European countries. The only form of direct support to EV owners consists in a few hundred euro in tax reductions (JATO Dynamics, 2011).

The government supports R&D for sustainable mobility through a range of federal programmes, such as the third transport research programme «Mobility and transport technologies» and, above all, the «National innovation programme for hydrogen and fuel cell research» (NIP).

The NIP was launched by the four above-mentioned Ministries, by means of a public-private partnership planned for 10 years from 2007 to 2016 (NIP 2011). The Government and companies will invest 1.4 billion euro in total. The NOW GmbH agency was founded to coordinate the programme, which includes two parts: phase 1 (until 2010) mainly focuses on hybrid technology, energy storage, system and grid integration and alternative fuels, whereas phase 2 (until 2015) places greater emphasis on fuel and hydrogen technology. As part of this programme, the Clean Energy Partnership (CEP) was established in December 2002 as a political-industrial collaborative initiative (energy firms, carmakers and public transport companies). The CEP is the largest demonstration project on hydrogen mobility in Europe, and its core is a series of working groups in which firms representatives work on precise tasks. Results are regularly reviewed by a steering committee (NIP 2011). Two times a year, a plenary meeting votes on overall strategic questions.[11]

From 2009 to 2013, the National Platform for Electric Mobility (NPE) will provide one billion euro in support of R&D measures to make Germany a leading country in electric mobility. The NPE aims at one million

11. At the time of writing, 137 vehicles of 12 different models have been tested.

registered battery EVs and 500,000 FCVs by 2020. The NPE benefits from industrial, labour and environmental policies, and brings together representatives from industry, science, politics, trade unions, and society (Bundesregierung 2011).

The programme comprises three phases: phase 1 until 2014, market preparation (R&D and lighthouse projects); phase 2 until 2017, market uptake for EVs and infrastructures; phase 3 until 2020, mass marketing with business models and renewable energy integration. Its two pillars are:

- Lighthouses: limited thematic clusters, such as battery, powertrain, ICT & infrastructure, recycling.
- Showcases: technologies and partial solutions will be integrated into comprehensive concepts and visions, pooling resources and increasing investment security.

Within the NPE framework, 4 billion euro will be invested to reach the aforementioned project objectives in the market preparation phase. A package of coordinated measures to strengthen research and development and support the market start-up phase and the application of innovative technologies in so-called «showcase» projects is required to achieve the shared goals.

The NPE has been complemented by some government programmes for electric mobility, such as projects focusing on ICT (the development of intelligent vehicles with an ICT-based system architecture; the intelligent integration of EVs into energy supply systems; an intelligent transport infrastructure to raise efficiency, autonomy, and safety) or car sharing (like the Car2go mobility concept launched in Ulm or Car2gether in the wider Ulm area and in the Aachen city region).

Finally, the Ministry of Transport selected eight «model regions» via a call for projects,[12] in order to support a public policy programme on EV fleet testing with 130 million euro total funding (NOW 2010). The project was structured along overarching research lines and platforms in which actors from science, industry, and local authorities collaborated to speed up the development of infrastructures and to increase the number of available EVs. In addition, these demonstration projects were meant to raise public awareness of the advantages of electric mobility. Not only research and development for passenger cars were supported, but also the whole spectrum of different modes of transport.

12. Hamburg; Bremen/Oldenburg; Rhein-Ruhr with Aachen and Münster; Rhein-Main; Saxony with Schwerpunkten, Dresden and Leipzig; Stuttgart; Munich; Berlin-Potsdam.

In total, the deployment of more than 2,800 vehicle units was planned before the end of the programme in December 2011. Vehicle deployment was accompanied by the installation of 2,500 charging points. The program aimed at establishing local conditions for electric mobility: interconnected mobility systems which are adapted to different local needs. The idea to support model regions was based on the principles of systematic regional development and of electric mobility being created and practised in local processes. To achieve this goal, a cluster approach was adopted as the most appropriate method to support not only carmakers but also local SMEs and transport enterprises.

German actors consider the model regions programme to have been successful (BMBVS 2012). In terms of EV market development scenarios, the testing projects have shown that commercial transport will be the most promising field for EV integration, with EVs being adopted for commercial fleets. As for private use, EVs are expected to penetrate the car market only in the medium term and their first area of use will be urban and commuter traffic. In rural areas EVs have been received surprisingly well and changes in mobility culture are likely to develop also across different generations.

There is still uncertainty about the efficiency of public and private charging points, and through testing, semi-public charging infrastructures have proven to be the most effective in meeting demands. The model regions programme has caused a trickle-down effect, triggering a project multiplication and providing additional research funding at the regional and local level.

With its new call for projects on «electric mobility showcases» in November 2011, the government aimed at continuing comprehensive testing of electric mobility requirements in four German regions[13] characterized by different conditions. The government supports cooperation projects to which both the federal States and firms contribute with 180 million euro. It is probably no coincidence that the three largest German carmakers have their headquarters in these areas.

4 France: focus on electric vehicles

The ongoing crisis has had a major impact in France, with immediate consequences on unemployment and trade balance. This has provided the conditions for ambitious industrial policy actions to promote the development, commercialization and use of AVs.

13. Berlin-Brandenburg; Bayern-Saxony; Niedersachsen and Baden-Württemberg/Stuttgart.

The aims have been firstly to strengthen the competitive advantage of French carmakers in comparison to other European carmakers manufacturing much more polluting vehicles, and secondly to keep the production in France, since the innovative nature of EVs ensures higher value added also in the lower car segments (Hildermeier, Villareal 2011).

The decision-making process has been influenced by other factors:

- Renault (15% of whose capital is held by the French State) is the first and for the moment the only carmaker to have developed a full range of EVs;
- France has a strong environmental movement, currently in opposition, and a determined Minister for the Environment, Jean-Louis Borloo;
- CO_2 emissions deriving from the production of electricity are low, since 78% of electricity comes from nuclear power and 12% from renewables;
- France is characterized by the presence of other important actors in the automotive and battery industries, as well as in the service and infrastructure sectors.[14]

In addition to demand-incentive instruments, such as bonus/malus and the «prime à la caisse» scrapping scheme, especially since 2009 electric mobility has been promoted through 14 measures, which include support to R&D on batteries, the development of the charging infrastructure in public and private car parks, and the development of alternative solutions for individual mobility. The national target set for 2020 is to achieve the conversion of 5% of vehicles in use to EVs, equivalent to about 2 million cars (Ministère de l'Écologie, du Développement Durable et de l'Énergie 2009).

EV R&D is mainly financed by the Agence de l'Environnement et de la Maîtrise de l'Énergie (ADEME), managed by the Ministries of Economy and Research. ADEME has received 400 million euro to support new eco-efficient technologies in the form of «demonstration projects» and through poles of competitiveness,[15] and has funded 11 projects, includ-

14. EVs (Renault, PSA: Ligier, Venturi, Heuliez, Eco&Mobilité, Bolloré, FAM Automobiles, Lumeneo, Renault trucks, Gruau), batteries (NEC, Batscap, Saft, Dow Kokam, PVI, Valeo); services (Norauto, Freshmile, Veolia, VULog, Veolia, SNCF, Suez, Keolis); infrastructures (EDF, Total, Vinci).

15. A pole of competitiveness operates in a specific region and is an association of businesses, research centres and training institutions engaged in a cooperative action around innovative projects. The two most important poles for the development of sustainable mobility are Move'o and the Pôle Vehicule du Futur. Although a key role should be played by the regions, in truth Move'o is conditioned by Renault and the Pôle Vehicule du Futur

ing five on EVs, but also researches on HEVs, electric buses and urban microcars.

Moreover, in 2010 with the «grand emprunt» law ADEME received 750 million euro to support the development of new green technologies, and 250 million euro were allocated to research on batteries, with the explicit aim of developing a French battery industry. One of the most important projects was the setting up of a battery manufacturing plant in Flins (Renault-Nissan alliance), with an initial capacity planned for 2012 of 100,000 batteries a year. However, the project has encountered several difficulties which have led some players to withdraw from it.

In 2010 a plan for the implementation of the electric charging infrastructure was defined. It includes three phases: 18,000 charging points in the first two years; 900,000 private charging points and 75,000 public ones (of which 15,000 fast-charging) by 2015; and 4 million private charging points and 400,000 public ones (of which 75,000 fast-charging) by 2020. Moreover, the plan envisaged that about 60,000 EVs or HEVs would be put on the market in 2011-2012, which represents a crucial amount to promote economies of scale in the supply of the electric charging infrastructure (Ministère de l'Écologie, du Développement Durable et de l'Énergie 2011).

Finally, the policies which support the development of sustainable mobility are partly delegated to the local and regional levels. They mostly consist in electric mobility demonstration projects, based on the Parisian model of AutoLib, aimed at providing a basic infrastructure of charging stations in urban areas and at making available to the public a fleet of electric vehicles at discounted usage prices. More rarely, the objective of these projects is delivering goods by EV to an urban area (La Rochelle, Lyon, Paris) and restricting the access of non-electric commercial vehicles to cities (Calabrese, Vervaeke 2012).

At the time of writing, the evaluation of these policies is inconsistent (Jullien, Pardi 2013). On the one hand, the national coordination of the 2009 plan by the Ministries for Industry and Ecology has made it possible to clearly define the synergy between environmental objectives (sustainable mobility - reduction in pollutants) and industrial objectives (technological innovation - keeping/developing the production in France). The focus on the development of EVs and of a national battery industry in line with Renault's strategy has gained widespread support thanks to its great consistency in environmental and industrial targets, in spite of the European technological neutrality approach.

by PSA. Indeed, this is a strategy to bypass the European directives about directly financing an industry.

On the other hand, results are slow to appear. In all three areas, the plan has accumulated significant delays, and it is already clear that the targets for 2015 and 2020 in terms of market, supply and infrastructure will not be met. The main problems concern the supply of EVs and especially of batteries. The Renault factory in Flins has experienced major and inexplicable delays. Should Renault prove unable to ensure in-house production of the batteries, the entire business model on which the electricity supply of the French carmaker is based would have to be reshaped.

Of course, if this involution continues, it will represent a great shock for the national plan to develop AVs. It is no coincidence that, although a large consortium of companies for the acquisition of EVs has been set up, at the moment the assessment is not positive and the vehicles are not yet fully available, not least because the infrastructure is developing extremely slowly. This is the classic paradox of the chicken and the egg: without an extensive charging infrastructure a mass market for EVs cannot develop, but without a substantial fleet the cost of developing the infrastructure is not sustainable.

5 Great Britain: a technology neutral position

The main feature of the British car industry is its international character. Extensive foreign ownership combines with the absence of a small group of dominant players around which government policy can easily centre. There is no major national manufacturer for the British government to support, and the distribution of production and sales is comparatively diluted across a range of competing carmakers, compared to other major car-producing economies in Western Europe. For these reasons, national policies towards the car industry are heavily weighted in favour of measures to attract inward foreign direct investment and to be non-discriminatory among international businesses which might invest in Britain (Coffey 2006).

Similarly, concrete policy initiatives to support alternative vehicles and promote sustainable mobility at the national strategic level tend to focus even-handedly on measures to develop a supporting infrastructure, and to provide financial inducements to promote the uptake of alternative vehicles. This will facilitate all carmakers and related businesses in implementing low carbon technologies (MacNeill, Bailey 2010).

Likewise, regional level policies within Britain aim to allow carmakers who are active in different areas to develop their own priorities. No attempt is made to provide central directives to steer decisions on which non-conventional engine technologies – pure electric, hybrid, hydrogen – constitute the best way forward. In this respect, policy is avowedly and explicitly «technology neutral» (Coffey, Thornley 2013).

The main government departments responsible for the industry are the Department for Business, Innovation and Skills and the Department for Transport, which has established an Office for Low Emission Vehicles. Of particular note is the Technology Strategy Board, a «business-led» innovation agency which oversees competitive fund awarding for commercial projects. A key role is also played by deliberative bodies and national forums, the most important of which is the Automotive Council, established in 2009 and tasked with identifying strategic investment priorities, amongst other things.

Temporary policy measures aside, the economic downturn has given considerable impetus to Britain's emerging strategic orientation towards alternative vehicle technologies and sustainable mobility (HM Government 2009).

A range of policies on taxation – vehicle excise duties, company car taxes, and capital allowances –, combined with grants to private[16] or public[17] fleet buyers of ultra-low or low carbon cars and light commercial vehicles, are being used as key elements in British policy towards alternative vehicle technologies and sustainable mobility, with fairly direct carry-over to bus services. The national policy also focuses on «business-led» innovation; a wide set of individual and collaborative projects have gradually been funded to support development in ultra-low or low carbon vehicle technologies.[18] Moreover, even though not specifically targeting investment in R&D involving alternative vehicle technolo-

16. To reduce upfront costs to consumers, grants have been allocated to a range of «ultra-low» carbon vehicles, with discounts from the manufacturers' listed price of maximum £ 5,000 for new cars and £ 8,000 for vans.

17. The Low Carbon Vehicle Public Procurement Programme offers financial support to public sector organizations for the procurement of low carbon vehicles for public sector fleets. In the first stage of the initiative, funding was provided to support public fleet trials of over 200 electric and low CO_2 emission vans. At the moment, a £ 3,400 grant per van is provided for the first 500 units purchased for each fleet.

18. The Low Carbon Vehicle Innovation Platform, launched in 2007, provides match funding from the government to private sector projects, awarded on a competitive basis for tenders submitted to pre-publicised rounds. For example, in September 2010 matched funds for £ 24 million were awarded to 6 collaborative projects; while in June 2011 a total of £ 500K was awarded to fund a set of feasibility studies on the recycling and reuse of batteries for low and ultra-low carbon vehicles. The projects cover the whole range of vehicle technologies and practical technology applications. Some examples include an electric taxi produced by LTI and Smith Electric Vehicles and a collaboratively developed range-extender unit currently used by Jaguar.

gies or sustainable mobility, the general tax environment is intended to encourage research and development initiatives with positive spill-over effects on firms other than those directly engaged in these sectors.

However, there are concerns as to whether tax changes, partially driven by austerity, might undermine the progress made so far in developing EVs and HEVs.

At the same time, although still in its early stages, the development of the electric infrastructure is now well underway and it is being combined with large scale driver-focused research.[19]

Hydrogen and fuel-cell applications, which have hindered the commercial availability of EVs and PHEVs to private and business users, have also become an active focus of attention. However, the national policy stance remains avowedly «neutral» as to which branches of technology ought to be preferred.

The sector of heavy-duty vehicles is a difficult area for politics to negotiate, owing to its heterogeneity and to issues concerning cost-effective transport vis-à-vis weight and distance. This remains true despite the relative prominence of dual and bi-fuel conversions.

At the regional level the policy framework is consistent with the overall character of the British automotive industry, where a large number of OEMs are pursuing their own particular strategies on products and technology, with facilities based in different sub-regions of the national economy.

With respect to the low carbon economic sector as a whole, the vision that informs regional policy within Britain is one of devolved decision making in areas where identifiable comparative advantages exist at the regional or local level. These regional or local activities are to be nested in turn within an evolving national policy framework which encourages low carbon business and green innovation. The different areas, regions and localities of Britain should identify their own particular challenges and exploit their own specific capabilities (Harper, Wells 2012).

To better achieve this goal, in 2009 a major policy initiative was launched to identify and develop the so-called Low Carbon Economic Areas, to accelerate low carbon economic activities in areas where the

19. The Plugged-In Places programme offers matched funding opportunities to public-private partnerships supporting the installation of charging points around Britain. It started with three major pilot schemes for London, Milton Keynes and the North East of England, and eight regional (and greater city) schemes are now operating (covering the East of England, Greater Manchester, the Midlands, Northern Ireland, and Scotland). The projects include efforts to improve night-time off-peak home recharging as well as practicable workplace recharging schemes combined with targeted on-street infrastructures near supermarkets, retail centres, car parks, etc.

existing geographic and industrial assets provide major strengths. These were initially envisaged as partnerships of regional and sub-regional bodies, to be led by Britain's Regional Development Agencies, which were established in 1998, abolished in 2010, and partially replaced by the Local Enterprise Partnerships.

Not all of the designated Low Carbon Economic Areas have a remit for automotive development, but three of the areas are of particular interest (Berkeley et al. 2012):

- The North East of England, which is the designated region for ultra-low carbon vehicles. Previously, the local Regional Development Agency achieved considerable success in: using its own financing capability to boost the region's electric charging infrastructure; contributing to bids for matching funds for projects submitted to the Technology Strategy Board; helping establish a Low Carbon Vehicle Research and Development Centre by involving the region's five local universities in a collaborative endeavour. The local dominance of Nissan means that EV technologies are the leading technological paradigm currently at play. The region is host to a growing cluster of EV specialists, including Smith Electric Vehicles, Britain's oldest electric vehicle manufacturer and producer of a range of commercial vehicles, and more recently to emerging businesses like Liberty Electric Vehicles. A number of smaller entrant players are also developing electric vehicle technology platforms.
- The Midlands, which is the designated region for advanced automotive engineering. Despite initial suggestions that hydrogen technologies would be a key remit, the general thrust has instead been broader, reflecting the local businesses' great commercial interest in EVs and HEVs. This approach is also ascribable to the presence of a strong university research base, including Warwick and Birmingham universities.
- Wales, which is the designated region for hydrogen and low carbon fuel technologies. Unlike the English regions, Wales is a country within Great Britain with its own national assembly and, as such, unaffected by the abolition of regional agencies. The decision to make Wales a Low Carbon Economic Area centring on hydrogen and low carbon fuel technologies is a broader remit, in the sense that it is less specifically focussed on vehicle technologies and sustainable mobility, although these are included.

6 A shelved transition opportunity: CNG and LPG vehicles

The main target of the policies described in the previous sections is essentially industrial and only secondarily environmental. As a matter of fact, in order to immediately reduce local pollution, CNG and LPG vehicles should receive more consideration, although this measure should not be considered a permanent solution. The price and performance of CNG and LPG vehicles are comparable to those of petrol vehicles, but they greatly reduce local pollution (20-30% fewer greenhouse gasses) and are characterized by much technical expertise (Volpato, Stocchetti 2010). Moreover, due to a dramatic drop in the price of natural gas, which is likely to remain lower than that of conventional fuels for decades to come, as long as governments keep excises down, consumers and above all fleet operators[20] will have access to an alternative fuel that can slash operating costs.

More specifically, the most promising AVs able to reduce local pollution seem to be those of the CNG type, in particular when old vehicles are equipped with CNG devices. Policy-makers should intervene by implementing regulations (exploiting environmental and safety benefits as opposed to supporting traditional vehicles); through technology (by improving energy performance, and incorporating CNG into HEVs); and by supporting demand (not adjusting excise duties and promoting the conversion of cars already in use). The fundamental issue is the expansion of the distribution network, which is limited in Italy and almost non-existent in other European countries, except Germany. Recently, Italy has allowed CNG filling through the home network. This could break the vicious circle created between CNG distributors, who do not want to expand the network because of low demand, and consumers, who are not willing to buy CNG cars because of the lack of filling stations.

The German government's strategy of 2004 envisaged a potential 0.5-1% natural gas use in 2010, and 2 to 4% by 2020, corresponding to about 1.4 million natural gas vehicles in 2020. But this potential is far from being fully exploited: in 2012 the share of natural gas vehicles was below 0.3%. In Germany, natural or biogas refills are compensated for under the current tax law until 2018. About 30% of total costs can be reduced in this way, which means saving about 50% compared to diesel and 60% compared to gasoline. There are now 880 public stations, expected to rise to 1,300, which would represent about 10% of the 14,500 German filling stations. In its Energy Concept of 2010, the government decided

20. While there are not yet enough CNG and LPG filling stations on the roads, fleet operators can install an indoor filling station through the methane network.

to further support CNG vehicles. It will examine how biomethane can be used more efficiently in the fuel mix. To this end, in 2010 a large number of firms along the value chain came together in an «initiative on natural gas mobility» in order to present policymakers with a number of initiatives and requirements.

In France, on the other hand, State actions have focused on EVs, thus excluding other technological solutions for sustainable mobility, also because their market share is very marginal. In 2012, the percentage of sales was: 0.5% LPG, 0.3% ethanol, and 0.05% CNG. However, the case of LPG is interesting, because, despite the number of filling stations being limited (1,750), the inclusion of LPG in the 2009 ecological bonus system produced a significant growth in sales (3.4% of the market), confirming the potential of this technological solution. Its subsequent exclusion from State aids is due to the strategies of French carmakers, which focus on EVs (Renault) or on all HEVs (PSA).

In Great Britain, initiatives in support of gas fuels are still limited at this stage, although a role for larger vehicles has been clearly identified. In fact, while relatively few new vehicles are sold in Britain, the number of dual fuel and bi-fuel vehicle conversions is more substantial, particularly amongst larger vehicles, including heavy goods vehicles. Efforts have been made to build the infrastructure for the fuel needs of CNG and LPG vehicles. However, these technologies are not receiving the same amount of State support that EVs have seen. Early grant-assisted projects, supported by the Department for Transport, entailed awards for pilot projects intended to develop natural gas/biogas stations and infrastructures and to assist with the delivery of gas blends. Grants were awarded to a small number of projects and involved relatively modest sums. Examples included a temporary CNG filling station demonstration project, in collaboration with Mercedes Benz, and other more permanent initiatives for the construction of compressed and liquid gas filling stations. As a matter of fact, the comparatively greater importance which is being given to EVs and PHEVs with respect to public infrastructure support suggests that CNG and LPG vehicle technologies are identified as immediately relevant to larger vehicles, rather than cars or lighter vehicles.

7 Conclusions

Technological change is not a deterministic process; its use is conditioned by social and economic factors (Dicken 2011). The use of a new or emerging technology is typically dependent on business enterprises electing to maximize profit, market share or investment opportunities by developing technological advantages. However, in the case of AVs, the process of change is being driven primarily by policies at the regional, national and supranational levels. Initiatives such as the Kyoto Protocol and EU carbon emission regulations have established the policy framework for automotive producers, forcing them to provide a range of different vehicles to meet targets set by environmental regulations. At the regional and national levels, policy-makers are interpreting these regulatory structures and creating the environment in which carmakers must operate. This has included national initiatives to promote the use of AVs, for example vehicle subsidies and the widespread roll-out of charging posts for EVs. At the regional level, the policy-makers' decision to introduce the use of congestion charges and the creation of Low Emission Zones has also benn useful to generate pressure from below on producers.

However, in a broader perspective, public policies should take into account the industrial scenario in the making.

The current short-term scenario seems to be one of diversity (Freyssenet 2011). Italy is mainly focused on LPG and CNG vehicles and the same is true for Russia, which counts on its large amount of natural gas reserves, while Sweden concentrates on biomethane (NGVA 2012). Outside of Europe, Brazil is the traditional leader in biofuel in terms of all car sales. The large amount of nuclear power installed has led France to focus on electric vehicles, whereas Germany promotes electric and hydrogen vehicles.

Nevertheless, other scenarios can be hypothesized: one of progressiveness, involving a smooth transition from the ICE to FCVs, or one of rupture, with the immediate adoption of HEVs or, even more radically, EVs.

The three national cases presented above seem to show a trend towards a progressive scenario in the cases of Germany and the UK, and towards one of rupture in the case of France, which is influenced by the strategies of its national carmakers. Renault is more prone to a rapid transition to EVs, PSA and virtually all other carmakers in the world prefer a gradual evolution through HEVs. The latest hints by the French government show that the prospect of a rapid transition towards EVs, clearly advocated in the 2009 national plan, is today much more uncertain. Both in Germany[21] and in Great Britain[22] the expected targets are far from being met, due to a dwindling consumer interest. Above-mentioned targets

21. One million electric cars on German roads by the end of the decade, but only 3,000 electric cars were sold in Germany last year compared to a total market which exceeded 3 million.

22. The numbers of AVs in circulation is just over 1.1% of new registrations.

have been pursued in different ways: in Germany through R&D support, and in the UK through purchase subsidization of new HEVs or EVs.

The nature of these public policies is essentially industrial and only secondarily environmental. In fact, according to the author, in the perspective of a progressive scenario, CNG and LPG vehicles should receive more consideration.

Another measure analysed in this chapter concerns the roll-out of charging points and other infrastructures to promote the use of AVs amongst consumer in the three countries. Alongside consumer promotions, substantial investments have been made in demonstration projects and in actively encouraging automotive producers to engage with AVs in terms of R&D, marketing and advertising.

These projects are financed primarily through the resources provided by national governments (or the federal government in the case of Germany), and are mainly public-private collaborations for the dissemination of EVs. Policy-makers consider these policies successful but their impact is quantitatively limited. The current number of EVs or electricity charging stations available to the public is negligible in comparison to the fleet of cars circulating and with respect to the infrastructure needed for the development of an EV mass market.

The main focus of the demonstration projects is to support initiatives by the State and by the major industrial players. It is a way to gather information on the behaviour and needs of potential EV consumers. The impact on the media of these projects can pave the way for a more widespread use but, in any case, it is important not to confuse the interest aroused by these projects and their practical impact on sustainable mobility.

It would actually be an illusion to think that the transition to the electric mobility can emerge spontaneously from decentralized initiatives of this nature. Only a massive, long-term and central industrial policy at the European level may allow this kind of transition to support the development of battery technology, the charging infrastructure and the market acceptance.

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8
Crisis in the automotive industry and territorial development: Fiat and its suppliers in Southern Italy

Francesco Pirone

ABSTRACT *The chapter deals with local production systems in which there are automotive assembly plants. It focuses on the effects that the strategic choices of location and allocation of production among assembly plants have on local development. The effects on the supply chain – the part of suppliers located in the regional economy – are analysed. The disciplinary approach used is the one of economic sociology, in particular the approach of comparative political economy. The analytical categories used are taken from studies of local production systems and governance of local economies. The paper presents the results of a case study related to the Fiat assembly plants and manufacturing suppliers in Southern Italy. The empirical study has analysed the strategic choices of Fiat and the effects they have had on the local supply chain and territorial development. The analysis focuses in particular on the transformation of the supply chain of Fiat in Southern Italy (qualitative and quantitative dimension) as a result of the economic crisis and Fiat's strategy in the period 2010-2012. The analytical dimensions that are considered are: aspects of production, employment and labour relations, innovation, institutions and local governance.*

1 Introduction

This paper examines the relation between the territorial configuration of the automotive industry and the development of regional economies; it focuses on the analysis of the configurations of local production systems in relation to the existence of an automotive assembly plant and the proximity to few manufacturing suppliers as well. The research aims at understanding the connections between the business strategies of the sectorial big players and the development of regional economies. This work is based on a case study about Fiat assembly plants and manufacturing suppliers in Southern Italy. The first part of the paper outlines the theoretical and conceptual framework of this research through the employ of the economic sociology approach – with a special focus on the New Political Economy (Crouch et al. 2001) – and the categories of analysis related to the studies about local production systems and governance of local economies. The second part presents an analysis of the economic and institutional characteristics of the automotive industry in Southern Italy. This analysis has a specific focus on two crucial features: the first one is on the effects of the automotive industry's development on the modalities of social embeddedness; the second one is on the consequences of the strategic decisions taken by the automotive big players at a local level. Given this framework, the research examines the results of a specific study about the effects of the strategies adopted by Fiat to contrast the economic crisis and their consequences over the development of the automotive supply chain in Campania region. The third part of the work shows the main results of an empirical research about the reconfiguration of the supply chain in Campania after Fiat's decision to assign a different product mission to the Pomigliano d'Arco assembly plant, and its effects over the development of the regional economy. These transformations affect the products, the production processes, the configuration of the supply chain and the whole local production system directly. The last part focuses on the elements explaining the connection between the restructuring processes of the automotive industry at a global level, as well as their effects on the reconfiguration of local production systems at a local level.

2 The automotive industry and the territorial development: a theoretical and conceptual framework

Before the crisis, the strategies of the carmakers were set up around the continuous reorganisation of the outsourcing processes and the regulation of the relations with the suppliers (Bonazzi, Negrelli 2003). Original equipment manufacturers (OEMs) focus their activities on the development of some key technologies, while the subsystems are designed in collaboration with a small group of first-tier suppliers – which in turn are related to second- and third-tier suppliers for the development of simpler products and parts. A long-term relation occurs between OEMs and their suppliers for the development of strategic parts: the aim is to take advantage of the relationship as a source of mutual learning; for this reason, this specific relationship stands outside the dynamics of market. It is regulated by principles which aim at fostering the innovation and the inter-organizational learning, which is achieved through the sharing of savings, risks and benefits deriving from the innovations.

The permanent cost reduction and the achievement of higher quality standards are the targets of such dynamics.

The hierarchisation of the structure of the supply chain goes through the adoption of specific strategies which vary widely from one producer to another. Thus, the supplying relations experience different paths of institutionalisation according to the specific socio-institutional configurations, which can be explained through the «national regimes of regulation» (Kochan et al. 1997; Freyssenet et al. 1998; Boyer, Frayssenet 2005). The analysis at the local level revealed that the global players can organise their external operating environment: they can decide the horizontal configuration of the labour division between firms. Such decisions are taken according to the local institutional environment.

Yet before the crisis – again – the automotive supply chain underwent a process of constant rationalisation, which affected the whole industry at different paces; indeed, it is the most important shift towards an inter-company and territorial production reorganisation. These trends have been summarised in six points by Volpato (2006):

1. the demand for cost reduction of the supplied parts, which includes the incentive to delocalise the production to the low-wages areas;
2. the power of the first-tier suppliers to organise the underlying supply pyramid, in order to simplify the commercial relations of the OEMs and to concentrate the responsibility for the quality control of the manufactured parts to the first-tier suppliers;
3. the specialisation of the OEMs on the activities related to the design of the vehicles general architecture; the global players delegate or share the production of innovations and the coordination of the supply chain to the suppliers which produce integrated systems;
4. the attempt to generalise the just-in-time supply system as a transition to a BTO (build-to-order) organisation – in line with the «pull-type» supply chain management;
5. the development of a modular design architecture, in order to reduce the investments in the assembly plants and to decrease the overall assembly time;
6. the shift towards a new time-based competition – the increase in the rate of innovation through the participation of the suppliers to the involved processes; the ability to decrease the time-to-market; the reduction of the product life-cycle.

The notion of «enterprise network» represents a point of overlap between the analysis of the transformations of the post-Fordist firm, and the theories about the local models of production organisation. In particular, the «New Political Economy» theory (Crouch et al. 2001) reveals how the development of the «production networks» made the companies more dependent from the local production system in which they operate. The importance of the institutional frameworks is linked to the production networks capability to offer external economies – both tangible and intangible – to the companies.[1] These resources have been defined by Les Galès and Voelzkow (2004, p. 11) as «local collective competition goods». The external economies make it possible to explain the companies' economic performances and their different territorial development; they increase the productivity rate and the innovation capability, and affect the overall businesses' competitiveness.

The «networked firms» is the only model – among all the patterns of local business system identified by Crouch and Trigilia (2004) – to encompass the analysis of the organisational features and the governance of the local production systems in the automotive industry. Indeed, this model «includes medium and large-sized enterprises which maintain a relatively stable relationship with a thick network of small sub-suppliers that are placed in the same local business system. The 'networked firms' […] bases their flexibility and innovation capability on this specific kind of sub-supply relationship» (Crouch, Trigilia 2004, p. 309). In these production systems large enterprises produce directly the collective competition goods in the production system itself, or within a first-tier supply network – and they create the so-called «club goods». However, there is an indirect need for collective goods since the competitiveness of large automotive firms relies on a highly specialised and qualified network of sub-suppliers. Their presence is only possible within institutionalised contexts in which local collective competition goods are available. The focus of this research is about local development; thus it is necessary to analyse the interdependent relation between large enterprises and local institutional context. As Pichierri wrote:

> on the one hand, large enterprises are seen as «strategic decision-makers», which aims at becoming more independent from local specificities and policies. […] On the other hand, the re-emergence of «regional economies» and the «regionalisation of production» argues that localisation of production cannot abstract from the local presence of skills, human and organisational resources which allow a «flexible and specialised» production – because of this specific economic phase characterised by the final crisis of mass production [2002, p. 24].

1. Intangible external economies are related to cognitive and normative resources – like the implicit knowledge, the specialised languages, the social conventions and trust; on the other hand, tangible external economies include infrastructures and services.

To better assess the different paths of organisation adopted by local production systems in the automotive industry, it is useful to recall the analytical scheme of the «models of production» (Boyer, Freyssenet 2005) – a scheme which belongs to the Regulation School and that is dedicated to the automotive industry. The analysis of the evolution of the «models of production» rejects the existence of a single, national trajectory even within the same accumulation regime («growth model»). Indeed, the production models vary within a single path of national development: they are the result of the interaction between the strategies of profits adopted by firms and the regulatory framework. This perspective underlines the variability of the production models, which are the result of specific profit strategies of firms – this is the case, for example, of different producers doing their business in the same area –; but it tells nothing about the presence of different organisations of production within the same firm and at the local level – this is the case of Fiat and its Italian plants.

Under this light, it is useful to adopt the point of view suggested by Bardi and Calabrese (2006) and to focus on the impact of the automotive industry over the models of regional development. The two authors perceive the presence of several territorial, socio-productive configurations in Italy, and they classify them under three ideal type (pp. 214-220): (a) the supply base, (b) the industrial district, and (c) the production chain. Bardi and Calabrese show that a firm can develop several models of production, that are variously linked to the territories and depend on the institutional features of the local context. Their analysis reveals that Fiat developed several territorial configurations in Italy; such configurations can be linked to their own typology: SATA Fiat plant (which is located in Basilicata region, Southern Italy) is an example of supply base – indeed, the plant has been specifically designed to achieve this configuration (Bubbico, Pirone 2006); the production chain located in Piedmont region (northern Italy) evolved towards the industrial district configuration (Bianchi et al. 2001; Enrietti, Whitford 2006); while the Emilia-Romagna region developed the automotive production chain (northern Italy) – this chain is specialised in the manufacture of some mechanical parts, and has strong inter-sectoral relations (IPL Emilia-Romagna 2005). However, it is not correct to ascribe the nature of the three paths of development only to the territorial model of the organisation of production; hence, they all must be connected to the different places that the three local configurations occupy in the local labour division.

The social regulation of local production systems cannot explain by itself the existence of various dynamics of territorial development: it is necessary to take into account the place that such dynamics occupy within the global value chain. Thus, the regional differentials of development are linked to the spatial organisation of the value chain: in particular, they are connected to the strategies of localisation adopted by the global players (both carmakers and mega suppliers), and to the territorial reorganisation of the supply chain (Whitford, Potter 2007). According to the latest research conducted by Dunford and Greco (2007) – which investigates regional development and the local division of labour through a case study of Fiat production network in Basilicata and Piedmont – the regional differentials of development can be related to the different places that both territories occupy within the value chain; so, the differentials are the result of the centralisation of the highest value-added activities commanded by Fiat and its first-tier suppliers.

Therefore, it is necessary to analyse the transformations in the automotive value chain in order to better assess the effects that the different strategies of localisation produce at local level (Gereffi et al. 2008). The fragmentation of the value chain is mainly caused by the transformation of the role of the OEMs. According to Jürgens (2006), today more than half the total value of the production is located within the activities performed by firms specialised in the manufacture of technological and specific parts – whereas, by the end of the 1990s, OEMs were at the top of the production process and retained only the largest share of the entire value produced. From the point of view of the territorial development, the transformation of the value chain implies an upgrading of the geographic areas in which those activities are located.

3 The economic and institutional characteristics of the automotive industry in Southern Italy

The analysis of the articulation of the national automotive industry reveals a long-term trend of concentration of the assembly activities in Southern Italy (*Mezzogiorno*). This trend emerged with the downsizing processes in the early years of the 1970s, and then it gained new strength from the restructuring cycles and the new investments performed by Fiat at the beginning of the 1990s.[2] But its consequences on

2. Fiat acquired Alfa Romeo in 1987 and then restructured its plants in Pomigliano d'Arco and Pratola Serra; the investments have been performed in order to build two factories located in Melfi (SATA – *Società Automobilistica Tecnologie Avanzate*) and Pratola Serra (FMA – *Fabbrica Motori Automobilistici*), in the middle of the 1990s. This trend has been confirmed by the latest restructuring of Pomigliano d'Arco (2011) and Melfi (2013) plants.

economic and production development reveal some ambiguous features. On the one hand, the trend had positive effects over regional economies involved in the downsizing processes, in terms of economic and employment growth; on the other hand, the expansion and qualification of local production and entrepreneurship networks suffered the presence of such a large firm. Despite the will of the policy makers, the downsizing processes had small results in terms of innovations, economic relations, capital accumulation and entrepreneurial capabilities.

Although the presence of Fiat plants had significant economic and employment implications, it did not promote the growth of the entrepreneurship of the local automotive sub-supply chain – as Bubbico (2007) outlines in his research about *Mezzogiorno*. There are two main reasons behind this process: generally, local firms placed at the lowest levels of the supply chain did not increase in number; moreover, production and technological needs of many local manufacturing firms were subjected to specific strategies of production which were designed by companies headquartered in the manufacturing regions of northern Italy or even abroad – most of which were subsidiaries of multinational companies – and that did not take into account the particular needs of the local contexts.

Fiat assembly plants are all located in Central and Southern Italy – except for its historical Mirafiori plant in Turin – while the 75% of all the 2,692 firms manufacturing parts (Osservatorio della Filiera Autoveicolare Italiana CCIAA di Torino 2011) have their registered offices in traditional manufacturing regions of Central and Northern Italy (Piedmont 37%, Lombardy 19%, Emilia-Romagna 10%, Veneto 8%). This specific territorial configuration exposes the southern chain of the automotive industry to a double risk:

- a decrease in value produced by regions where an assembly plant is located, but where a high quality sub-supply chain is absent;
- an increase in the traditional heteronomy of southern automotive industry.

Nowadays, it seems that these risks are becoming more and more important for the outcome of Fiat latest strategies: indeed, the Italian carmaker remains the major player in the national automotive industry; and a large share of firms located in Southern Italy – which produce components and subsystems – rely heavily on Fiat.

The current conjunction exposes the southern automotive chain to a high risk of pauperisation. The analysis of the transformation of the automotive value chain (MacDuffie 2001; Sturgeon et al. 2008) shows that the share of value produced by the assembly activities decreased much to the advantage of the upstream production of components. Such process is due to the reconfiguration of the division of labour among the firms located along the value chain, as a consequence of the adoption of new models of production organisation. Over the last decade, the southern automotive industry has been vulnerable and subordinated to the power of companies located at the top of the value chain; the causes are rooted in the weakness of the local institutional context and entrepreneurship, in the adoption of inefficient industrial policies along with the implementation of specific business strategies – which were designed by the big national player and did not meet the southern sub-supply chain need for enforcement and qualification. The economic crisis worsened the structural weakness of the *Mezzogiorno* automotive: Fiat did not meet the production targets set in April 2010,[3] when *Fabbrica Italia* was presented (Fiat 2010; Volpato 2011), and the volumes of vehicles assembled in Italy decreased;[4] moreover, the decision to delocalise Fiat-Chrysler investments outside Italy[5] is having negative effects over such negative trend. These business strategies reveal the existence of a dynamic of restructuring which could lead to a downsizing process, due to the extent of the production overcapacity.[6]

3. In particular, Fiat did not double the number of vehicles produced in Italy by 2014.

4. According to the Organisation Internationale des Constructeurs d'Automobiles (OICA), 671,768 vehicles have been produced in Italy by 2012 (59% passenger vehicles, 41% light commercial vehicles): it represents a decrease by 15% compared with 2011, and a decrease of 48% compared with 2007 (1,284,312 vehicles produced: 81% passenger vehicles, 19% light commercial vehicles).

5. During the last two years, the most important production investments made by Fiat in Europe – except for the investment made to save Chrysler group – are: Tychy plant in Poland (to produce the new Lancia Y); Kragujevac plant in Serbia, ex Zastava (to produce the minivan Fiat 500L available with 5 and 7 seats, which was the former «L0» project assigned to Mirafiori plant); Pomigliano d'Arco plant in Italy (to produce the new Fiat Panda). Moreover, Fiat closed Termini Imerese plant and the product mission for Mirafiori plant is yet to be defined.

6. Some data about the crisis in the European car industry: according to European Automobile Manufacturers' Association (ACEA) 12.5 million vehicles have been sold in 2012 (-7.83% compared with 2011), while 1.4 million vehicles have been sold in Italy (-19.82% compared with 2011).

4 The economic crisis, Fiat strategy and the restructuring of the automotive supply chain: the case of Campania

The automotive industry in Campania presents some distinctive features compared with the other regions in Southern Italy: it had historically a larger dimension and a complex organisation, due to the interaction with a stronger and locally developed manufacturing structure. During the decade of Fordism, the effects of the automotive industry over regional economy and local employment development have been important, even though they exposed to the typical «pendulum effect» – that is, the alternation between phases of economic expansions and contractions, which is a typical feature of the automotive industry due to the specific product life-cycle.

The case of Campania is part of the debate about the relation between the local automotive industry and regional development, and it can be explained through the traditional model of analysis of the *indotto* (that is, the activities and industries linked to the local automotive sector). Here, the evolution of sub-suppliers[7] showed a restricted development – in terms of market, functions and features – and then the traditional pattern of captive suppliers prevailed. A captive supplier depends on a monopsonist firm or other small buyers; it is very close to its sales market; it is admitted into the value chain as much as it is able to contain production costs. In Campania, the majority of first-tier suppliers did not perform as production knots between the buyer and the local sub-supply network or chain; on the contrary, they are turned to the thick production chains and districts located in Central and Northern Italy, or they prefer to import from low-cost countries (Izzo 2006).

Through the analysis of the impact of the sectoral employment on the regional industrial employment, and the evaluation of some basic economic indicators related to the local automotive industry – such as the sectoral impact on regional exports, the productivity and value added levels – the importance of the local automotive industry stands out for the economy of Campania. Starting from 2007, the automotive industry in Campania underwent a deep restructuring process for two reasons: the decision to assign a different product mission to the Pomigliano d'Arco plant made by Fiat; the ongoing economic crisis, which broke out in 2008.

7. The evolution of sub-suppliers is based on five steps: a) the increase of the inner efficiency; b) the strengthen of the network relationship with other firms; c) the improvement of business functions; d) the introduction of new products or the enlargement of the portfolio; e) the market internationalisation (Giunta, Scalera 2010).

Traditionally, employment in the automotive industry had a relevant weight on regional industrial employment – which maintained a high growth rate in spite of a sectoral contraction;[8] but in the last triennium the incidence of the automotive production on exports, as well as the total amount of value added, has reduced, especially for sub-suppliers.

In 2010, Fiat assigned the production of the Nuova Panda (an A-segment vehicle) to the Pomigliano plant; in order to adapt the pre-existent assembly line – which was designed to produce C and D-segment passenger car vehicles – to the production of this new model, a restructuring process took place and lasted for 18 months (Fiat wanted to start the production by January 2012). Therefore, the Pomigliano plant underwent a downgrading process: today, it has only one assembly line to produce one model – while it had two assembly lines to produce three different models before the restructuring – with a total production capacity of 250,000 cars per year in 2014.

The Nuova Panda has been marketed in 2011. «Fiat Panda» sales in Europe reached about 185,000 units in 2012, but the data includes the «Panda Classic» sales – which is the previous model produced in Tychy plant in Poland. Production data gathered about Pomigliano plant allow to estimate that the total production does not exceed 140,000 units – a result which is far from the 2012 sales target of 230,000 units.[9] This outcome is influenced by the delayed market entry of the Nuova Panda range of products – in particular the GPL, methane and bi-fuel engines which are Fiat customers most favourite motor vehicles – and the «cannibalisation effect» generated by the «Panda Classic» high performance sales (whose production ended in December 2012), and the discounts offered on the Punto model sales.

The analysis carried out so far on the companies which operate within the Pomigliano plant reveals the existence of a broader downsizing process, as well as a rationalisation of the outsourcing activities; indeed, the number of third-companies working on the inside of the plant (*intra-moenia*) is decreasing, and only those firms specialised in industrial services seem to survive for two main reasons: 1) manufacturing activities have been insourced, then rationalised and integrated in the latest

8. There were about 14,063 employees employed on permanent contract in the automotive industry by the beginning of 2012, with an incidence of 6.5% on industrial employment and a large number of employees on redundancy payment (CIGS – *Cassa Integrazione Guadagni Straordinaria*) (Pirone 2012).

9. Statistical data from the European Automobile Manufacturers' Association (ACEA) database show that Fiat sold 28,326 Nuova Panda vehicles in Europe in the first two months of 2013.

organisational model – which provides a higher level of automation; 2) Fiat headquarters in Turin holds all the non-industrial activities. On the other hand, there is a significant decrease in the number of workers, as well as an insufficient use of the workers still working on-site – as the large use of the lay-offs (CIG) show. The production of the Nuova Panda allowed only a small part of the workers on redundancy payment to come back to work; indeed, the plant shows a higher level of automation as the consequence of the latest technical and organisational innovations. This scenario lets us suppose that the production process will probably require a little number of workers to run once it will reach its full speed – unlike the large number of workers needed to manufacture the previous Alfa Romeo vehicles.

The dynamic of change of the regional activities linked to the automotive industry has been directly influenced by the business strategies adopted by Fiat. The first difficulties appeared in 2008, when the production volumes of the local suppliers rapidly decreased due to the uncertainty generated by the lack of a product mission for the Pomigliano plant – a situation which lasted two years; then, after the assignment of the new product mission, a restructuring process involved the whole supply chain for other two years. So, a process of selection had modified the structural features of firms and their market repositioning for four years – it had reconfigured the local activities linked to the automotive industry, which have been downsized and shows different functional and technological features.

At the turn of the 21st century, the production expansion of the Pomigliano plant did not create a strong supply network which could emancipate itself from the leading firm. Only a few firms were able to benefit from this relationship, and then strengthen their technological and commercial capabilities. In fact, the share of components supplied for the production of the previous Alfa Romeo models by firms located in Campania never exceeded the 10-12% of the total (Pirone 2010). This is due to the fact that, historically, the industries linked to the Pomigliano plant had a low degree of development; indeed, the supply network – which was reshaped by the restructuring processes of the 1990s – was composed for the most part by those firms outsourced by Fiat. These firms could only perform the outsourced activities in a position of quasi-dependence by Fiat. Thus, this local supply network seems to be an «imploded network» (Izzo 2006), a folded network of firms which is unable to point to a non-captive market, despite the presence of local firms which manufacture highly competitive components.

Starting from 2008, the regional suppliers had to face a double challenge: the first one was to diversify their products and to vary the plants supplied; the second one, to start the restructuring investments required to adapt their production facilities to the platform of production of the Nuova Panda, in line with the organisational model adopted by the Fiat plant in Pomigliano.

As a consequence, regional suppliers followed two different paths. First, some firms closed their activities because they could not trail Fiat restructuring process: some of them, basically firms with more resources, were able to delocalise their activities, while the weakest firms went out of business[10] in Campania (because they were tied up to a single buyer, they had a more fragile financial structure and difficulties in access to credit, and they could not resort to the welfare safety net to guarantee workers' income). Generally, these firms were owned by national or international enterprises, which decided to substitute the local suppliers (second-tier suppliers) for the benefit of those firms located in low-wage countries (like the «production platform» in East Europe, South-East Asia and Northern Africa).

The second path has been followed by firms which were able to replace themselves on time over Fiat national and international supply chain: they were able to perform new product investments to produce the Nuova Panda model. These firms are not entangled in a «captive monopsonist relationship» with the Pomigliano plant: yet in 2008, they had supply relations with Cassino, Sevel (Atessa) and Sata (Melfi) Fiat plants. But even these firms will be bound to diversify, once the Nuova Panda production will reach its operating speed: indeed, the production of supply parts for an A-segment vehicle implies a low level of profit per unit produced – and the only way to make the investments profitable through the economies of scale is to reach the production volumes. These firms certainly can export towards the Tychy plant in Poland but – according to the logic of the economies of scale – the opposite hypothesis cannot be excluded: that is, the current supply chain linked to the Tychy plant[11] (Balcet, Enrietti 1998; Domański, Gwosdz 2009) can supply a big share of its parts to the Pomigliano plant. Indeed, according to Istat data about trade flow between Campania region and Poland, the «automotive parts and engines» («Parti ed accessori per autoveicoli e loro motori»)

10. Lower production volumes generated a domino effect which oppressed the local subsuppliers: they were highly dependent on large buyers who pushed them to constantly lower the prices, while there was an increase in raw materials and purchase costs.

11. Tychy plant in Poland is the most important factory – in terms of scheduled and realised volumes of production – for the A-segment platform of production: indeed, the Polish plant produces the Fiat 500, the new Lancia Y, the Fiat Panda «classic» and the new Ka (since the production line are shared with Ford).

commodities sector shows an import amount of 5.7 million euro and an export amount of 12.9 million euro for the year 2011; while in 2012, the first year in which the Nuova Panda was produced, the import increased tenfold (61.5 million euro) and the export slightly decreased (11.3 million euro). These trends suggest that the restructuring process of the local suppliers did not improve their competitiveness against the suppliers of Tychy plant, while the production of the Nuova Panda constituted an important business opportunity for the Polish production platform which benefited from the presence of Fiat Poland.

The study about the regional industries linked to Pomigliano plant shows that the Nuova Panda model did not generate any improvement in production and employment of local suppliers (Bubbico, Pirone 2011). On the other hand, some important signs confirm the existence of a downsizing process as well as the reduction in employment levels which affect the first-tier suppliers – which are the strongest firms from which the other sub-suppliers depend on – and the whole regional automotive industry as well.

5 Concluding remarks: the restructuring of the automotive industry and the regional development

The economic crisis boosted Fiat organisational restructuring and geographical relocation; the analysis carried out so far illustrate why it is necessary to focus on the regional scale to study the effects of Fiat strategy along these two paths (Sabel 1989; Storper 1997). This methodological choice is based on the literature about the territorial development, since the production and allocation models depend on the specific institutional features of the local societies in which such economic processes are located. As the case study shows, Fiat strategic choices have been taken according to the national regime of regulation (that is, the «model of growth» of the Italian industry), and they embody specific features on the local scale – even if the merger with Chrysler gives a new global structure to the Italian carmaker. In particular, Fiat is the only mass producer who has its own assembly plants in Italy: according to the terminology of the Regulation School, Fiat represents the only «model of production» for the Italian automotive industry – even if Fiat configuration and its response to the crisis follow specific patterns of local development. As a consequence, while the variable linked to OEMs models of production is not so relevant for the Italian case, the regional contexts of regulation acquires a crucial importance. Thus, it is essential to investigate about the different regional models of production, which originate from different local strategies of profit related to the features of the Local Production System (Crouch et al. 2001).

This case study illustrates that Fiat organisational restructuring follows a model of path dependence – as for the stages of development of the industry. The research retraced the historical evolution which allows to understand the regional automotive embeddedness (Granovetter 1985). As in a producer-driven value chain (Gereffi et al. 2005), the strategic decisions taken by Fiat influence the way in which the production network anchors to the Campania institutional context; such process generated a network of «captive suppliers» which gravitates towards Fiat plants: that is, a «chain of dependency» made up of sub-suppliers which are dependent on a much larger buyer. Given this situation, the restructuring of the local business network – caused by the economic crisis – was completely dependent on Fiat strategies.

The long course of the reconversion of the Pomigliano plant ended with the allocation of the Nuova Panda; this specific decision had two important effects over the local industry: the quantitative reduction in number of firms; the qualitative downgrading of firms within the global value chain. This process can be analysed within the global value chain theory (Humphrey, Schmitz 2002):

1. The production of the Nuova Panda required the Pomigliano plant to use new technologies of process to seek higher productivity rates: it is not possible to observe the same dynamic of innovation within the local suppliers.
2. The new production has a lower value added and is less diversified; there is a general pauperisation of the local suppliers, as well as a diffused technological and organisational simplification.
3. Due to the specific attention given to the local manufacturing activities, there is a reduction in the management of local corporate functions; indeed, a large share of services and R&D activities have been moved from the local production system towards the headquarters: these local activities are now weaker than before, as well as the related professional networks.

The regional automotive industry seems to suffer a lack of innovation capability. It is not simply a problem related to the R&D, or the presence of an ineffective network of firms, research centres, university and institutions (Etzkowitz, Leydesdorff 1997) as suggested by the Regional Innovation System models (Braczyk 1998; Bowen et al. 2009). In particular, the restructuring processes made the informal networks smaller – these networks have a crucial role as they produce and diffuse implicit and practical knowledge related to the industrial processes and their linked activities. The informal networks are an intangible asset, they are rooted in the professional skills and in the social networks which are historically anchored to the economic processes of the regional automotive industry.

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9

Local industrial policy for the automotive industry in Italy: Innovation, export support and the crisis of the Fiat Group

Davide Bubbico

ABSTRACT *In these last years local policies in support of the automotive industry in Italy have increased, in order to contrast the crisis of supply chain or, in some cases, to support the internalization, the export and the diversification of production. The aim of this work is to map a frame of these initiatives and their distribution on the national territory. Over the years, Italian automotive production has been concentrated in southern regions. In the north of Italy the largest and most qualified production of car components remained, mainly from firms who are export-oriented and less dependent from Fiat Group. Consequently, the recent crisis has had different consequences on the national territory depending on the different characteristics of the local automotive segment. In the article we analyse the consequences of these regional differences and the role of the national government in supporting the sole Italian automotive producer corporation (Fiat). We also consider some specific initiatives promoted in the three regions where the Italian production of car components is concentrated (Piedmont, Lombardy and Emilia-Romagna). In the conclusions we discuss a possible medium-term scenario in which Fiat group could decide to produce abroad high volumes models while keeping in Italy the production of premium brands, that have significantly lower production volumes.*

1 Introduction

In this article, I will consider the role of the State, Chambers of Commerce, public institutions and employers' associations in Italy in supporting the automotive sector, particularly in relation to export and R&D activity. In recent years, data on exports show that the automotive industry has maintained a positive performance for car components, whilst Fiat car production has decreased and its market share in Europe has declined. The latter has given rise to a crisis that is most severe in Southern Italy, where assembly plants and supply companies are concentrated. These are mostly subsidiaries of larger (national or foreign) companies that have specialised in meeting Fiat's requirements.

The paper is divided into four sections. In the first one, I reflect on the different consequences of the crisis of the automotive sector in the Centre-North and South of Italy. The former includes not only the Mirafiori and Grugliasco establishments in Turin and the pole for production of luxury cars in Emilia-Romagna, but also most of the car component sector. By contrast, the South hosts the main assembly plants of the Fiat Group. By highlighting the differences between these industrial structures, I will seek to identify promising regional automotive policies. In the second section, I discuss the role of the State in supporting Fiat, the only domestic car producer in Italy, stressing similarities and differences vis-à-vis other European producers. A key question relates to the potential role of regional policy-making, which has become increasingly important for the automotive sector, in the absence of national policies for the car industry. For this reason, in the third section I concentrate specifically on these regional interventions. Focusing on three regions (Lombardy, Emilia-Romagna and Piedmont), I show how regional public bodies and industrial associations have promoted specific interventions to support the automotive industry, with an increasing interest in component manufacture and the possibility of expanding their R&D activities in Italy and facilitating exports. Similar initiatives have been undertaken in certain southern regions, although they have largely failed (Bubbico 2013). In the final section, I will make some closing remarks on the relationship between industrial policy and regional policies for the car industry. In the light of a sharp decline in the presence of Fiat in Italy, I will ask what is likely to remain of automotive production in Italy following the present crisis.

2 Different consequences of the automotive crisis on the Italian regional economies

In the 1980s, with the acquisition of Alfa Romeo by the Fiat Auto group, Italy became the only European country where car production was in the hands of a single producer (if we exclude Lamborghini). As a result of this acquisition process, supply chains have changed, largely to the advantage of traditional northern suppliers and to the detriment of local firms in the South (including the assembly plant in Pomigliano). In the 1990s, with the construction of the new assembly plant in Melfi (Basilicata), car production became even more concentrated in the Southern Italy when compared with the previous decade (Amin 1982).

During the same period, the Alfa Romeo plant in Arese (Milan) began to be phased out, and was closed during the 1990s. The historic

Mirafiori plant in Turin also experienced a progressive reduction in production volumes, whilst other small assembly factories in Piedmont (Chivasso and Rivalta) and Lombardy (Desio, former Autobianchi) have been closed. Although the Mirafiori plant – at least until the recent crisis – retained a small share of production of various models at the end of their product life-cycle, and a modest quantity of new models, the production of cars and commercial vehicles in Italy (with the exception of the luxury car segment) has been definitively transferred to Southern Italy. This is particularly clear if one considers the output and the links between the plants in Cassino (Lazio), Pomigliano (Campania), Termini Imerese (Sicily) and Melfi (Basilicata), not to mention the Magneti Marelli factories in almost all of the Southern-Italian regions and the FMA engine plant in Pratola Serra in the Province of Avellino. In Piedmont, by contrast, car production decreased from about one million in 1990 to just over 500,000 cars in 1997, whilst production in Lombardy declined from about 300,000 to just under 30,000 cars. In the South, by contrast, it rose from 600,000 to one million (Bubbico 2002).

The progressive reduction of the production at the Mirafiori plant has had a negative impact on the regional value chain, although the assembly plants in Southern Italy have continued to receive significant supplies of components from firms located in Piedmont and Lombardy and more generally in Central and Northern Italy (Bubbico 2003). With the reduction of the overall car production by Fiat, many suppliers have been forced to start new lines of production, or to reinforce existing lines that address foreign (European) markets for components or have followed the relocation process of Fiat Auto group towards other countries.

In the 1990s, but probably starting much earlier, the car component industries of Lombardy, Emilia-Romagna and Veneto have established a stronger relationship with French and German car producers, becoming a key area of industrial subcontracting for Germany. It is no coincidence that, to date, 95% of exports of automotive components (including the production of spare parts) is localised in Central and Northern Italy, primarily in Piedmont, Lombardy, Emilia-Romagna and Veneto (Enrietti 2008).

In the South, however, car component suppliers have rarely penetrated these foreign markets. In some cases, exports from Southern Italy have become possible precisely because Fiat has explicitly commissioned production for one of its overseas factories. However, these firms have generally remained dependent on the Fiat plants that are already localised in the South, not least because the number of foreign firms in this part of Italy is limited (although some interesting exceptions have been reported recently, such as the Adler Group in Naples).

The limits and weaknesses of the automotive sector in Southern Italy reflect not only its exclusive relationship with the Fiat group, but also the weaker industrialisation of the Southern regions themselves and the absence of a connection with public and private research centres. Nevertheless Fiat took advantage of public funding in the 1980s to situate its research centres in various areas of the South (e.g. Elasis). These centres were largely successful, and the Fiat Research Centre in Bari, for example, developed the Common Rail (an industrial patent later sold to Bosch). What is more, the relationship between Universities and companies in the automotive sector has been enhanced by a range of institutional and economic actors. The experience of the Fiat Research Centre in Bari and investments by two major companies in the automotive components sector (Bosch and Getrag) in the same area of Puglia favoured the birth of the Mechatronics District. This outcome was also encouraged by the presence of small and medium-sized enterprises specialised in the same sector (including Magneti Marelli) and by the existence of links with the university.

However Bari is more an exception than the norm. In the rest of the South, where there are Fiat plants – with the exception of Naples[1] – there are no exchanges between the research community and industry. In Basilicata, Sicily, Lazio and Molise there are practically no links between Fiat factories, supply firms and research centres. Only in Abruzzo, where Fiat has a presence with its Sevel plant (commercial vehicle production), a proposal was presented at the end of the last decade to establish an Automotive Campus involving several actors (Association of Industry, Regional Government, research centres, etc.), although this project was never realised.

The aggravation of the sectoral crisis since 2008 and the absence of new investments by the Fiat Group led to the closure of assembly plants in Campania (buses) and Sicily (cars). If we consider the low production volumes of the other Italian factories (including the motor assembly plants in Avellino and Termoli), the condition of supplier firms in Southern Italy is weaker than ever. The persistence of the crisis and the low volumes of Fiat production (particularly in Pomigliano, Cassino

1. In Naples, Fiat's ex-Elasis research facility provides work to 700 engineers and 100 other employees. Similar facilities are located in Orbassano, in the province of Turin, and Surbo, in the province of Lecce. In March 2010, the activities of Elasis were transferred to seven different Fiat Group companies (Fiat Group automobiles, Fiat Powertrain technologies, Fiat Powertrain technologies industrial, Iveco, Cnh Italia, Fiat Group Purchasing and Fiat Item). Research facilities dedicated to the automotive sector in Campania include the Engine Institute of the National Research Centre in Naples and some Departments of Engineering at the University of Naples, as well as companies which were founded after the establishment of Alfa Sud in Pomigliano.

and Melfi) could also have an impact on foreign companies which supply components to these factories.

The absence of an industrial plan and the continuous relocation of production of new models to countries such as Poland, Serbia and Turkey (and elsewhere) threatens the automotive industry in Italy, considering the absence of other companies. One has only to consider that in 2012 less than 400,000 cars and about 250,000 commercial vehicles were produced in Italy. This represents a reduction of 15% compared to 2011, the worst performance recorded in Europe. In 2002, production in Italy was slightly higher at 1.1 million cars and 300,000 commercial vehicles, but already lower than in the UK (at least for cars). In fact, compared to the main countries with a strong automotive tradition (in the industrial sense), such as France and the UK, or compared to the weaker Spanish car sector, Italy recorded a marked decline in production volumes. By 2012, car production in the latter three countries had reached 1.7, 1.5 and 1.6 million vehicles respectively. The remarkable decline of Italian production was due to the decisions taken by a single producer (Fiat) to considerably increase its productive operations in other countries, such as Poland and Turkey, and more recently Hungary, Serbia and Russia.

Returning to the regional policies for the automotive sector, initiatives promoted in recent years in the Southern regions of Italy have been a substantial failure. These initiatives aimed to promote cooperation between companies, the diversification of clients and products and the development of sub-supply chains. Examples include the ICARUS project in Basilicata, the COSVIN consortium and Irpinia Automotive in Campania, Automolise in Molise, Sub4Lazio in Lazio. Even the most recent (December 2011) Network Contract[2] (*Contratto di rete*) between the automotive sector companies of Campania, Abruzzo and Basilicata, which aimed to reduce dependence on Fiat production, does not appear to have produced significant results.

3 The role of the national government in supporting the Fiat Group

If we look at the relationship between the Italian State and the Fiat Auto Group, we find that this has historically been characterised by the weaknesses of the political system and the subaltern role of the State.

2. It is a new instrument promoted by the Ministry of Economic Development in 2009 to promote the aggregation and collaboration between small and medium-sized companies geographically distant but operating in the same sector.

For example, the State assisted Fiat during recurrent crises by providing income subsidies for workers made redundant due to industrial restructuring or by using investment funds to subsidise new plants in the South of Italy. Even in the current crisis, government action has been characterised by non-interference with company strategy. Graham (2010) observes that

> In the case of Italy, the Government has restricted its role to giving money to the automotive industry. General government policy is that no plant must be shut down; only a crisis putting a company at severe risk of closure would constitute a valid reason for giving government support. In Italy, there is no collaboration between the Government and companies, and unions mainly stand aside.

The only case in which the government directly intervened was in the case of acquisition of the Alfa Romeo corporation in the 1960s and the creation of a State-owned company in the automotive sector. Following the privatization of State-owned companies in the mid-1980s, Alfa Romeo was sold to Fiat. As a result, a monopoly of automotive production was created and foreign manufacturers who were interested in purchasing Alfa Romeo (such as Ford) were effectively deterred.

The last and most important investment by Fiat Auto in Italy occurred when the company used public funding provided under law n. 64/1986 (*Integrated rules for extraordinary interventions in the Mezzogiorno*) to build assembly plants in Melfi (cars) and Pratola Serra (motors) in the mid-1990s. As a consequence, production was boosted in Southern regions at the expense of Turin (Mirafiori). This law also financed first-tier supply firms situated close to the Fiat factories, based on the organisational model of just-in-time production (Bubbico 2002).

Within the same «Programme Contract» (*Contratto di programma*), Fiat made other investments in Italy, involving component producers owned by Fiat such as Magneti Marelli. During this phase, Fiat was seriously considering the possibility of investing in other countries (such as Spain), and would have moved in this direction if unions had not accepted a new employment contract for the two new factories as well as accepting a series of other concessions.

State support to the Fiat Group should not be viewed as a policy of supporting a *national champion*, as in the French case, because the Italian State has never developed a strategic plan for the automotive industry.[3] In fact, government intervention has only occurred to support

3. Drawing on Bianchi (1995), Germano (2009, p. 60) notes that «while the French fusions were favoured with the intention of guiding companies to European markets (due

Specific support	Extraordinary support
Economic incentives for investments in Southern Italy	Transfer of loss-making firms to the State (e.g. Teksid)
Incentives for R&D and employment training	Acquisition of State enterprises on favourable conditions (e.g. Alfa Romeo)
Incentives for restructuring/innovating production and products	*Ad hoc* measures
Income support schemes	
Tax breaks	
Higher taxes for cars exceeding 2,000cc	

Table 1. Classification of State support for Fiat in Italy.
Source: Germano 2009.

industrialisation in Southern Italy. In this way, Fiat has had the possibility of obtaining financing to reduce labour costs and conflicts in the historical factories of Turin (Mirafiori) and Milan (Alfa Arese). More in general, as Germano (2009, p. 139) observed in relation to direct State support in the 1970s,

> in the 1980-1990 period, frequently the State intervened in favour of the company with various instruments (protectionism, monetary or fiscal aids, various kinds of incentives). Instead, in the 1991-2006 period, State support for Fiat declined as a result of the Europeanisation process that reduced the possibility of national government intervention because of the emergence of *supranational politics* for the European automotive industry.

The various forms of national support provided to Fiat are reported in Table 1.

In this context, the role of regional governments has grown, as many areas of public responsibility for industry have been assigned to the regions. Only incentives for new productive investments and income support schemes during periods of crisis remain the responsibility of national government.

to the saturation of domestic markets in which they had operated until then, the National Champions), the Italian fusions were almost always aimed at strengthening the firms in the internal market rather than international market».

If we leave aside State incentives to consumers who purchase new cars or those with reduced emissions (in 1996, 2002 and 2006), public funding to the Fiat group has directly involved the regions in recent years through the system of Programme Contracts. Once the period of extraordinary State intervention came to an end, big corporations generally benefited from public funding under law no. 488/1992 (*technological innovation*). This law replaced the extraordinary State intervention measures for the South of Italy. New productive investments with State contributions have taken place thanks to Programme Contracts, although their level has gradually decreased. The last wave of significant State funding to Fiat (in the early 1990s) involved the aforementioned assembly plants in Melfi and Pratola Serra.

Over the years, other public subsidies for specific investments were provided by the Ministry of Industry and by the Regions. For example, 15 million euro of European funding for underdeveloped areas were allocated by Basilicata to Fiat in order to establish a Manufacturing Campus, a regional research centre focused on productive process innovation. However, over the years, most of these initiatives have been reduced to veiled attempts to favour the permanence of these companies within the region, supporting industrial restructuring in order to reduce the risk of factory closures.

4 Regional support measures for automotive firms in Piedmont, Lombardy and Emilia-Romagna

4.1 Piedmont

In this section, we will analyse some of the supporting actions taken by three key Regions in favour of automotive component production in Italy, starting from Piemonte (Piedmont). In most cases, these initiatives have been undertaken by Regions, Chambers of Commerce or associations of industry. Information on these measures was obtained from the websites of the relevant Regions, Chambers of Commerce and trade associations.

In 2011, the Piedmont Region used Regional Law no. 34/2004[4] (*Ac-*

4. The accompanying documentation to the regional Law no. 34/2004 indicates that this measure introduces methods and tools for planning the implementation of regional industrial policies in order to better cope with the new responsibilities assigned to the Regions as a result of a constitutional change. Innovations introduced by this regional law consist in the adoption of a comprehensive policy document which: a) defines objectives, priorities and methods of the industrial policy, and b) defines goals over the medium term for the Region as well as potential beneficiaries.

tions for the Development of Productive Activities) to put in place a second «Action Programme for Productive Activities, 2011-2015». This programme was developed in line with guidelines by the European Union, the National Government and the regional programme for scientific research, environmental protection and energy, as well as involving representatives of trade associations. The programme defined several specific objectives, including: a) investments in the knowledge economy and innovation; b) internationalisation of the industrial system; c) growth of firm size and better access to credit for high-tech firms; d) a strong industrial specificity of the regional economy, even if the goal is to promote a green energy sector; e) firm aggregation and support for traditional productive sectors exposed to the crisis in a broader project for conversion, innovation and competitiveness of the industrial sector.[5]

Specifically, Axis 1 of the Programme (Firm competitiveness, 204 million euro) seeks to promote a «smart & clean automotive» platform for the car sector. This platform includes automotive technologies for hybrid motors, integration of information and communication technologies for future projects, the development of biofuels and the construction of infrastructures for a smart mobility. It also provides a means of cooperation between institutions, universities and research centres, big business and associations representing small and medium-sized companies.

Another programme related to the automotive sector is the so-called *contratto di insediamento*. This is addressed to foreign investments and regional companies which invest overseas (Axis 3: Internationalisation of enterprises, 55 million euro). The platform for a «smart & clean automotive sector» refers to the regional call for technological projects for the automotive sector in February 2012 (30 million euro under POR-FESR 2007-2013). Regional funding, in agreement with the Ministry of Education and Research (MIUR), is targeted at companies (small firms are preferred), research centres and trade associations. Scientific and technological intervention areas include engines with lower environmental impact, new materials, as well as reduction of energy consumption. Similarly, another funding programme termed «Electromobility+» supports companies and research centres involved in transnational projects for industrial research and the development of a pilot project on sustainable electromobility (one million euro).

Already during the sectoral crisis of 2002-2003, Piedmont developed a project to provide a series of actions to facilitate credit for small firms and to support the working capital of the companies that were forced to

5. It is important to note that the law binds firms to maintain any manufacturing plants that obtained subsidies in the Region for at least seven years.

reorganise production due to the reduction of Fiat orders. Other support initiatives for the short term (economic incentives) and medium term (strengthening small and medium-sized companies with a specialised production) were put in place (Enrietti, Lanzetti 2003). Taking as an example some positive experiences at European level, it was proposed to establish an Agency for the promotion and development of auto components companies in Piedmont (Enrietti et al. 2003). As Enrietti and Lanzetti observe (2003, p. 256), the big question faced by suppliers in this Region is whether it is appropriate «to leave the evolution and dynamics of this complex situation to market logics and firm strategies, in order to compensate for the lack of strategic planning by Fiat».

One of the most interesting proposals in Piedmont was the project «From Concept to Car», which was sponsored by the Turin Chamber of Commerce in 2003. This project aimed at reducing the dependence of local companies on Fiat, focusing on emerging markets. It provided support to help firms meet demands from the main international buyers.[6] Meanwhile, the Turin Industrial Union intensified its promotional activities targeted at companies in the major automotive foreign markets (Brazil, Canada, China, Russia, the United States).

4.2 Lombardy

Although now devoid of automotive plants, Lombardia (Lombardy) maintains a strong specialisation in the automotive components sector. In 2008, there were at least 700 firms employing 50,000 workers in this Region. Of these, 300 companies supplied processes, technologies and systems, 32 supplied modules and 379 supplied components (Magni 2010). As in other Regions, firms in Lombardy have a strong presence in foreign markets, especially in Europe and in the fast-growing markets of Asia and Latin America. At the end of 2010, only 110 out of 2,421 industrial firms had overseas automotive factories (1.4% of firms and 4.3% of employees). However, these firms grew rapidly between 2005 and 2010 (around 14%). By the latter date, there were just 23 foreign-owned automotive companies in Lombardy, accounting for just 0.6% of all industrial firms (Confindustria Lombardia 2011).

These data reflect the uneven process of internationalisation of regional firms and the relative lack of interest amongst foreign companies to build factories in Lombardy. The absence of final assembly plants might also explain this phenomenon. Supporting the presence of re-

6. For further information, see `www.fromconcepttocar.com`.

gional companies in foreign markets is one of the main axes of regional interventions, particularly in new markets where the automotive industry is developing.

These interventions include an Industrial Automotive Pole called POLI-AUTO, and in 2009 the Lombardy Region evaluated this project as one of the seven most innovative regional productive systems.[7] The purpose of this project – coordinated by the Department of Mechanical Engineering at the Milan Polytechnic, CSMT (Multi-sector Technology Service Centre) of Brescia, AIB (Industrial Association of Brescia), KilometroRosso in Bergamo and ComuniImprese in Arese – is to coordinate the broad regional automotive cluster (second in Italy, seventh in Europe) that involves the Provinces of Milan, Bergamo, Brescia, Cremona, Mantova and Lecco.

At the end of 2012, the Regional Government presented a project to support firm internationalisation (with funding of 290,000 euro) with the collaboration of a special agency of the Chamber of Commerce of Brescia and participation by 20 small and medium-sized companies. This project includes ISO TS certification courses and VDA 6.3 for the quality of automotive supplies; logistics and organisation of internationalisation courses; three technology days to meet major firms in the automotive components sector and business trips abroad. Analogous initiatives have been promoted by special agencies of other Lombard Chambers of Commerce, including Varese, which focused particularly on the automotive and aeronautics sectors. These kinds of initiatives are common in Lombardy because, unlike in Piedmont, the Lombard automotive sector is less spatially concentrated. For example, in April 2011, the special agency of the Chamber of Commerce of Milan, in collaboration with Confartigianato and CNA of Lombardy, coordinated a project denominated «Subcontracting», to promote small, specialised companies in foreign markets, including Germany and Sweden for subcontracting the production of machine tools, machinery, automotive goods, aeronautics and energy.

The most recent initiative for the automotive sector is contained in a Programme Agreement with the Ministry of Education and Research (MIUR).[8] In December 2010, Lombardy and MIUR signed a three-year agreement to promote a series of industrial research projects (agribusiness, aerospace, sustainable building, automotive, energy metallurgy,

7. For further information, see `www.poli-auto.org`.

8. There are also protocols between large companies and the Lombardy Region, for example for employment training. In December 2012, the regional administration and Bosch signed an agreement to create an internal training programme involving placements, traineeships and apprenticeships.

fashion industry, etc.).[9] A total of 120 million euro was made available for the project, 59 by MIUR under the «Fund for Research Grants» (*Fondo per le agevolazioni alla ricerca*) and 61 by the Lombardy regional administration. The regional administration procured additional European funding (€25.5 million) from the POR FESR 2007-2013. Specifically, in the section that aims at strengthening production, €23 million out of €458 million (5%) were targeted at the automotive sector through the financing of industrial research and pilot projects. In general, the funding provided under this programme aimed at promoting the development of new products, productive processes and highly-innovative services. This programme also seeks to facilitate cooperation between industries and universities on specific scientific and technological projects, via different forms of collaboration such as supply contracts, network aggregation or the creation of meta-districts.

4.3 Emilia-Romagna

As far as the automotive sector is concerned, the case of Emilia-Romagna is one of the most interesting. In this Region, there are not only important automotive component producers, but also assembly plants for luxury cars (Ferrari, Maserati and Lamborghini) and the most important Italian motorcycle factories (Aprilia and Ducati). In recent years, the diversification of regional production helped firms to weather the crisis, avoiding exclusive dependence on the automotive sector (Bardi 2005). As in the other cases discussed above (Piedmont and Lombardy), an important part of regional production is export-oriented. The value of exports of car components (Istat code DM343) grew by 160% between 1992-1994 and 2002-2004 (taking the average value for each three-year period), consolidating its share of the regional total at roughly 5%. As a share of national exports, the regional share in this sector remained above 16%, and regional specialisation in terms of exports remained unchanged at 1.4% (Aronica 2005, p. 161).

The analysis of regional trends in exports to BRICS countries reveals that exports are higher for Russia and South Africa and lower for China, India and Brazil. For this reason, recent initiatives of the Chambers of Commerce of the Emilia-Romagna Region and the ICE (Institute for Foreign Trade) have targeted the latter countries. For example, in Octo-

9. The focus on sustainable mobility among regional firms is demonstrated by several initiatives. In the Province of Brescia, for example, traditional producers of aluminium for the building sector are considering the possibility of producing aluminium also for the automotive sector (Meneghello 2010).

ber 2011 the Emilia-Romagna Region financed twenty-four cooperative company projects (210 firms in all) to support exports to BRICS countries and Turkey with €3 million. Most projects concerned the Mechanical Engineering sector and sub-sectors (45.2%), followed by furniture for home and construction (25.8%), clothing (12.9%), food (9.7%), energy (3.2%) and information technology (3.2%). For the automotive sector, for example, the financed project is named «Automotive in Brazil, Euroclean 2011» and this is one of the Regional Programmes under BRICST 2011-2013.

In this programme, the Emilia-Romagna regional administration, the Chambers of Commerce of Reggio Emilia and Modena, the Emilia Romagna Empowering Italy Agency and the regional Chamber of Commerce promoted a diversified project to support the creation of trade relations and productive partnerships between firms in Emilia-Romagna and Russian companies in the Mechanical Engineering sector. This project is open to all companies active in the automotive industry at regional level (technology, materials, equipment, components, aftermarket, etc.) and in Agricultural Engineering (machinery, equipment, technologies, etc.).

Once again in 2012, the regional administration promoted the BRICST programme 2013-2015 (with €30 million of regional funding) that includes another eleven countries, such as Vietnam, Indonesia and Mexico. New actors are involved in this programme, such as universities, trade associations and banks – and the key sectors indicated involve mechanical engineering and the automotive industry.

In December 2012, the Region approved funding for 48 projects involving industrial research (€31.6 million, out of a total investment of €80 million). A significant share was allocated to biomedical firms located in the earthquake area of 2012. As in previous cases, the mechanical engineering and automotive sectors play a key strategic role. At the end of February 2013, the Autonet-Transnational Network of Automotive Regions was agreed and approved and co-financed by the European Regional Development Fund, of which the Reggio Emilia Province is a partner. This project seeks to promote process innovation in the automotive sector and to encourage closer ties between universities and firms. The international partners are the Slovak Republic (project leader with the automotive cluster in West Slovakia), regional development agencies such as ComunImprese for the Emilia-Romagna region, the Polish Chamber of Commerce of South Carpathia and other clusters from Slovenia, Hungary, the Czech Republic and Germany.

The initiatives described above show that the Emilia-Romagna regional administration, together with other institutions and trade associations, has constantly pursued a policy of promoting access to foreign markets, establishing collaborative links between the world of research and private firms. This was possible because of the presence of research centres in Modena, Parma, Bologna and Reggio-Emilia which are specialised in the automotive sector.

The impressive nature of the initiatives that have been undertaken in Emilia-Romagna and in the other two Regions (see Table 2) show that, in collaboration with Chambers of Commerce and industrial associations, these actors have the potential to promote the internationalisation of enterprises and a closer relationship with the world of research. This is particularly important for small and medium-sized firms which often lack the resources necessary for sustaining R&D.

In conclusion, all (or almost all) of the industrial policies described above were emanated in order to support car component production in light of the absence of an assembly plant at regional level. Moreover, access to special forms of unemployment protection for surplus labour at the Mirafiori factory (initially justified by reorganisation and then by the effects of the crisis) do not appear to be justified by increased car production at this plant in the future. The production target of 50,000 Maseratis by 2015 at the Grugliasco factory also appears ambitious, due to the high cost of the cars in question and the presence of many competitors in the luxury car market. These regional policies are thus coherent with a local context characterised by small and medium-sized firms; regional supports for R&D and export promotion are strongly focused on a production that is already «export-oriented production», due to the decline in national car production.

5 Can suppliers exist without large assembly plants? Some final remarks on the Italian context

The Fiat group crisis is having extremely negative consequences for the car components sector in Italy, especially in the South. On the contrary, the greater autonomy of car component firms in the North from Fiat orders appears to be more effective in overcoming the effects of sectoral crisis. In Northen Italy, the initiatives undertaken by regional administrations, Chambers of Commerce and scientific research systems support both investment in innovation and internationalisation.

In other words, the absence of significant new investments by Fiat in Italy, with the exception of Grugliasco (Maserati) and Melfi (production of Chrysler-branded cars), Italy could be the first European case of a country with a strong tradition in the automotive sector which has a

Region	Organism	Action	Period	Description of the action
Piedmont	Piedmont Region	Programme for productive activities for the period 2011-2015	2012	Technological projects and initiatives for the automotive sector (30 million euro)
Piedmont	Piedmont Region	Project Electromobility+	2011	Industrial research on sustainable mobility (one million euro)
Piedmont	Chambre of Commerce of Turin	From concept to car	2003	Internationalisation of SMEs in the automotive sector and investment attraction
Lombardy	University Politecnico of Milan and others	POLI-AUTO	2009	Support the internationalisation of SMEs in the automotive sector
Lombardy	Lombardy Region and Ministry of Education	Programme Agreement	2010	Industrial research, pre-competitive development, advanced training
Emilia-Romagna	Emilia-Romagna Region	Automotive in Brasil, Euroclean 2011 (Regional Programme BRICST)	2011	Internationalisation of SMEs in the automotive sector
Emilia-Romagna	Emilia-Romagna Region	Public funding programme	2012	Industrial research
Emilia-Romagna	Province of Reggio Emilia	AUTONET project for a Transnational Network of Automotive Regions (Europe Programme)	2013	Innovation

Table 2. Framework of recent initiatives to support the automotive industry in Piedmont, Lombardy and Emilia-Romagna.

solid car components industry, with good export capacity, even without growth in car manufacturing.

In Europe today, productive capacity is currently much higher than the market can absorb, and this is the main reason for the crisis that has hit producers of generalist cars. This is illustrated by the crisis in European markets in 2012 (except for Kia and Hyundai), within which Fiat represents an extreme.[10] Undoubtedly, the decision by Fiat to delay production of new models has created uncertainty in almost all of the factories that form part of the group. With the exception of Pomigliano and Melfi, it is unlikely that more than four Fiat plants can be maintained with production levels below their Polish equivalents. The tendency is thus to produce for export and to scale down Italian production for segment B. In fact, if we limit our attention to the Panda model and the likely transfer of production of the substitute for the Punto, the risk of a drastic reduction in national automotive production is a serious one, as car production coincides with Fiat production in Italy.

Moreover, the decision by Fiat to transfer production of B-segment vehicles (e.g. the Fiat Punto) is another critical factor in the supply chain. In fact, the new models that will be produced in Melfi, Mirafiori and Grugliasco will have inferior volumes compared to the city car segment. In the coming years, the real risk is that the city-car market is increasingly filled by non-Italian manufacturers, especially those from Korea and Japan. For example, the Chinese government recently declared the objective of concentrating 90% of car production amongst domestic manufacturers in order to increase export capacity in the international market.

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10. The situation in France also shows signs of crisis, but with a different behaviour by firms and a more active presence of the national government. Although Renault has had good market performance with the Dacia (in 2012, for the first time, the French group sold more than half of its production outside Europe), the company announced a reduction of 7,500 employees in France over the next four years. At the same time, it announced a large investment in electric cars. Peugeut announced a cut of 10,000 employees with the closure of its historic factory in Aulnay, although this decision is strongly opposed by the national government.

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10

The crisis and the survival of the Italian automotive suppliers

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ABSTRACT *During the crisis started in 2008 several plants and businesses have closed down in the Italian supply chain. Such events have been reported by the press, but this does not provide a historical and comprehensive overview of the phenomenon. In fact, closures and bankruptcies are significant occurrences which have so far been overlooked: in the period under our investigation (2007-2011), almost 16% of the companies included in our sample went out of business. The aim of this preliminary paper is to analyse the transition from activity to inactivity of these firms. To sum up, the reorganisation of the Italian automotive supply chain seems to be characterised by a twofold trend: the micro enterprises are most heavily affected by the crisis and often expelled from the market, whereas the medium to large enterprises not only survive but also become financially stronger through the creation or expansion of industrial or financial groups. Furthermore, in terms of regional location, the effects have been stronger in the South of Italy.*

1 Introduction

The Italian automotive industry has some peculiar characteristics when compared to other European countries. On the one hand, in Italy there is only one manufacturer of cars and industrial vehicles, the Fiat Group; on the other hand, Italy's component manufacturing sector is among the most important in Europe, but it mainly comprises small and medium-sized companies and is quite heavily dependent on Fiat.

The last ten years marked important changes in this historical condition, especially by the appointment of Sergio Marchionne as Fiat's CEO: he represented a chance for a radical change in Fiat (Volpato 2011; Berta 2006) after the death of Giovanni and Umberto Agnelli, the two leading figures of the Agnelli family. The most important one is the new start of internationalisation process after the failure, in 2005, of the agreement with GM signed in 2000; in fact, the matter became once again crucial when the financial downturn of 2008 started to affect the automotive sector, since Fiat was considered too small in comparison to its competitors (Volpato 2011). So, in 2008 the Group moved to pursue scale and scope economies through international mergers and acquisitions with the production target of 5-6 million units globally (Ciferri 2008). The strategy has been successful, also thanks to gaining control of Chrysler in 2009 (Balcet, Comisso, Calabrese 2013), but the production targets have not been met so far, as total production in 2012 was 4.2 million passenger cars and light commercial vehicles. Further steps towards internationalisation have been taken in Europe, with investments in Serbia, where the Fiat 500L is produced, and in Russia.

The other main change is the crisis of the Italian car industry starting from 2008, with a decrease of car production from 910,860 in 2007 to 396,817 in 2012. When analysing this gloomy scenario, related to Fiat's car production in Italy as well as to the general crisis spreading across Europe as a whole, it might be appropriate to wonder how this has affected the component manufacturers, considering that they have traditionally been strongly dependent on Fiat (Enrietti, Lanzetti, Sanlorenzo 2007; Enrietti, Whitford 2005; STEP various years). Contrary to expectations, Istat data on foreign trade and a number of researches (STEP various years, Enrietti et al. 2010) show that this sector has displayed a great ability to withstand the crisis.

Nevertheless, the Istat data and researches do not shed light on a dramatic aspect which has characterized the recent years, i.e. the fact that several plants and businesses have closed down, especially due to bankruptcy.[1] Instead the press has reported such events especially by regional daily newspapers, but this does not provide a historical and comprehensive overview of the phenomenon.

In order to make up for this lack, the aim of this preliminary article is to analyse the most undesirable effects of the ongoing financial and industrial crisis by highlighting the transition from activity to inactivity of the Italian automotive suppliers due to: bankruptcy, compulsory liquidation, or voluntary closure.

Our empirical analysis should be framed into the literature on entry-

1. The 2012 Report of the *Osservatorio sulla componentistica autoveicolare italiana* mentions the matter for the first time: «Another consequence of this difficult phase in the markets is a drive towards changes and replacements in the production base. The Observatory has reviewed the enterprises included in the database, finding that 299 enterprises (out of around 2,700 enterprises in total) went out of business over a period of three years. In 2007, these enterprises still had a turnover of two billion euro» (STEP 2012, p. 44). Also, a research made by Enrietti and others in 2010 on Piedmont's SMEs in the automotive sector highlighted that the data referred to enterprises which had survived the crisis.

exit and firm survival. Agarwal and Gort (2002) pay attention on variations across firm mainly from learning-by-doing linked to the product and the firm life-cycle. Audretsch (1991) hypotheses that firms survival is related to the technological regime, especially the extent of scale economies and capital intensity. Cefis and Marsili (2005) focus not only on the inputs to the innovation process, such as R&D expenditure, but also on the impact of innovative performance on survival distinguishing between product and process innovation.

In this context, our contribution could represent an element of novelty as we address in particular firms' features in terms of Darwinian survival of the fittest – size, location, specialisation, ownership, financial rating – in a special period such as the ongoing crisis.

The article is organised as follows: section 2 briefly describes the current crisis of Italian car industry and the structure and performance of the Italian manufacturers of automotive components; section 3 illustrates the methodology used; lastly, section 4 presents the results emerging from the analysis.

2 The crisis of the Italian car industry and the Italian automotive supply chain

The crisis started in 2008 and affecting most of Europe, but Fiat's internationalisation strategy (by focusing on Chrysler and relocating part of its manufacturing from Italy to Serbia), and delays in upgrading the Italian portfolio of Fiat models have had a negative impact on the production levels of the Italian plants. In fact, the production of vehicles in general (cars, industrial vehicles, and buses, see Table 1) decreased by 61.4% in the 2000-2012 period, dropping from 1,738,315 units in 2000 to 671,768 units in 2012,[2] even though differences can be detected within the sector.

The production of cars decreased by an astounding 72.1%, whereas the production of industrial vehicles suffered less, and the commercial vehicles returned to almost pre-crisis levels. However, by considering the crisis years only (2007-2012), the production of cars decreased by 57%, versus 26.3% for industrial vehicles.

The figure for buses, worse than that for cars, can be partly ascribed to the fact that the Iveco plant of Grottaminarda, dedicated to the production of buses, was closed in 2012.

2. If we consider only the last crisis (2007-2012), the total production decreased by 48%.

	Cars		Industrial vehicles		Buses		Total	
	No.	Index	No.	Index	No.	Index	No.	Index
2000	1,422,284	100	312,868	100	3,163	100	1,738,315	100
2001	1,271,780	89.4	305,710	97.7	2,206	69.7	1,579,696	90.9
2002	1,125,769	79.2	298,715	95.5	2,597	82.1	1,427,081	82.1
2003	1,026,454	72.2	292,327	93.4	2,850	90.1	1,321,631	76.0
2004	833,578	58.6	305,451	97.6	3,076	97.2	1,142,105	65.7
2005	725,528	51.0	309,365	98.9	3,459	109.4	1,038,352	59.7
2006	892,502	62.8	316,225	101.1	2,867	90.6	1,211,594	69.7
2007	910,860	64.0	372,003	118.9	1,449	45.8	1,284,312	73.9
2008	659,221	46.3	363,209	116.1	1,344	42.5	1,023,774	58.9
2009	661,100	46.5	181,135	57.9	1,004	31.7	843,239	48.5
2010	573,169	40.3	263,952	84.4	1,065	33.7	838,186	48.2
2011	485,606	34.1	303,919	97.1	823	26.0	790,348	45.5
2012	396,817	27.9	274,466	87.7	489	15,6	671,768	38,6

Table 1. Italian vehicle production.
Source: Anfia.

The above data, in particular those concerning cars, only partially mirror the general crisis of the European automotive industry,[3] since they mostly refer to some specific features of the Italian situation:

- the weakness of Fiat's production range in Italy, linked to the fact that models which have reached their end of life have not been replaced (among these, the Fiat Croma, the Fiat Idea, the Fiat Multipla, the Fiat Punto Classic, the Lancia Musa, and the Lancia Thesis);
- the closure of the Termini Imerese plant (Sicily), from where production was moved to Poland, while the production of the new Panda was moved from Poland back to Italy (in Pomigliano plant);
- a severe drop in car sales in the domestic market: from 2,495,115

3. The production of cars in EU-15 went from 14,216,262 units in 2007 to 11,331,076 units in 2012, with a 20% drop.

Years	Passenger cars	Index
2007	2,494,115	100
2008	2,161,359	86.7
2009	2,159,924	86.6
2010	1,962,042	78.7
2011	1,749,294	70.1
2012	1,402,986	56.3

Table 2. Passenger car sales in Italy.
Source: Anfia.

Years	Passenger cars	Index
2007	374,177	100
2008	279,670	74.7
2009	251,038	67.1
2010	231,557	61.9
2011	203,769	54.5
2012	174,514	46.6

Table 3. Passenger cars export.
Source: Anfia.

Plant	Brands	Production	Capacity utilisation
Cassino, Italy	Alfa, Fiat, Lancia	91,809	46%
Melfi, Italy	Fiat	106,857	36%
Mirafiori, Italy	Alfa, Lancia	46,809	17%
Pomigliano, Italy	Fiat	155,822	74%
Tychy, Poland	Fiat, Lancia, Ford	293,890	65%
Kragujevac, Serbia	Fiat	23,830	13%
Bursa, Turkey	Fiat, PSA	189,680	63%

Table 4. Fiat plants capacity utilization.
Source: Ciferri (2013).

vehicles sold in 2007 (the year with the highest absolute sales) to 1,402,986 in 2012, which corresponds to a 44% decrease (Table 2);
- a limited tendency towards exporting vehicles produced in Italy, so that the weakness of the Italian market has not been offset by an increase in its exportation, which has actually decreased by 54% (Table 3), a figure higher than the decrease in production in Italy, i.e. -47%;
- the fact that the Italian plants are generally underutilized and workers are temporarily laid off. On the basis of recent data (Ciferri 2013), the production capacity utilization of Fiat's European plants in 2012 was as follows (Table 4):

The only positive event was Fiat's decision to reopen the ex-Bertone plant in Grugliasco (Turin) as a site dedicated to the production of Maserati vehicles.

When analysing this gloomy scenario, related to Fiat's car production in Italy as well as to the general crisis spreading across Europe as a whole, it might be appropriate to wonder how this has affected the component manufacturers but, preliminary, we to analyse the structure of the Italian component.

According to STEP (2012), the Italian component manufacturers generated a turnover of 41.8 billion euro in 2011 (45% exported) and employed 179,000 workers for 2,500 firms. In 2012, the turnover is forecasted at 37-38 billion euro, with a decrease between 10 and 12% on 2011 and the export decreasing from 19 to 18 billion euro (-5,3%)[4].

The industry is still characterized by small size and high production fragmentation. As indicated by STEP (2012), small firms with less than 50 employees are about 75% of the total (about 67% in Piedmont, the most important Italian region for this sector). Of course, this might be a weakness, because small firms are generally less innovative than medium-large firms.

Production is concentrated in certain areas, with just under 40% of manufacturers located in Piedmont (STEP 2012).

The level of diversification towards other sectors is quite low: on the whole, 80% of the sales are made to the automotive sector (STEP 2011) and 35% to the sub-suppliers. Nevertheless, diversification changes across the various regions: it is higher in Emilia-Romagna, where firms focus not only on the automotive but also on the motorcycle and agricultural vehicle sectors, as well as other sectors (Bardi, Calabrese 2007), while it is lower among Piedmont companies, mainly manufacturing for the Fiat Group (Enrietti et al. 2010).

The automotive sector's dependence on the Fiat Group (cars and industrial vehicles) is still high, about 55%, but it is decreasing. On the contrary, the firms' export capacity is increasing:

> Within the sample of companies interviewed, exporters are now more numerous than the firms which supply the Turin automotive group, both in Piedmont (where 84% of the enterprises are exporters and 79% supply the Fiat Group directly or indirectly) and in the rest of Italy (70% are exporters and 55% supply Fiat) [STEP 2012, pp. 37-38].

4. Ferrari M., Introduction to Convegno ANFIA, *Quali prospettive per la componentistica italiana nel contesto internazionale? Limiti e opportunità*, Turin, May 7, 2013.

	%
Modules, systems	6.0
Components	30.0
Sub-suppliers	52.0
Engineering & design	12.0
Total	100

Table 5. The Italian automotive cluster.
Source: STEP 2012.

Table 5 shows the distribution of Italian automotive cluster according to its main areas of operation: manufactures of automotive modules and systems, manufactures of automotive parts (components), providers of materials and minor mechanical works (sub-suppliers) and providers of automotive design and engineering services (engineering & design).

Most of the module and system suppliers are multinationals which have purchased plants from large domestic suppliers and adapted them to the tiered production system launched by Fiat Auto during the 1990s (Enrietti, Lanzetti, Sanlorenzo 1997; Rolfo, Vitali 2001). Nowadays, their dependence on Fiat Auto has decreased and they are selling to other carmakers through their affiliated companies; consequently, many module and system suppliers seem to have downsized or closed their local R&D centres, as research is carried out at their headquarters.

The component manufacturers and sub-suppliers have a tendency to operate in a context of incremental innovation: for these firms innovation is not a structured activity, rather, it is incremental, occurring on a daily basis and involving all aspects of the company. Nevertheless, the technological sophistication of component suppliers has constantly increased in order to meet the needs of their automotive customers. In the past they only provided generic materials, whereas they now tend to produce highly specialised products.

Engineering & design firms are concentrated in Piedmont (more than 60%), but only few of them, such as Pininfarina, Giugiaro and Bertone, are known worldwide. However, Piedmont's automotive cluster includes a large number of firms, even though most of them are very small and only a dozen have more than 100 employees (Calabrese 2010).

The above overview describes the structure of the component sector in Italy, but let us now return to the main question of this article: how have automotive component manufacturers reacted to the crisis of Fiat in the first place and of the European automotive sector in general?

Istat data on foreign trade and recent researches carried out at the

	Import	Export	Balance
2007	12,053,628,806	18,810,757,764	6,757,128,958
2008	11,748,249,439	18,556,695,690	6,808,446,251
2009	9,096,752,061	13,091,537,777	3,994,785,716
2010	10,663,844,408	16,466,904,961	5,803,060,553
2011	11,799,217,583	19,104,518,929	7,305,301,346

Table 6. International trade of components (euro). Source: Anfia elaborations on Istat data.

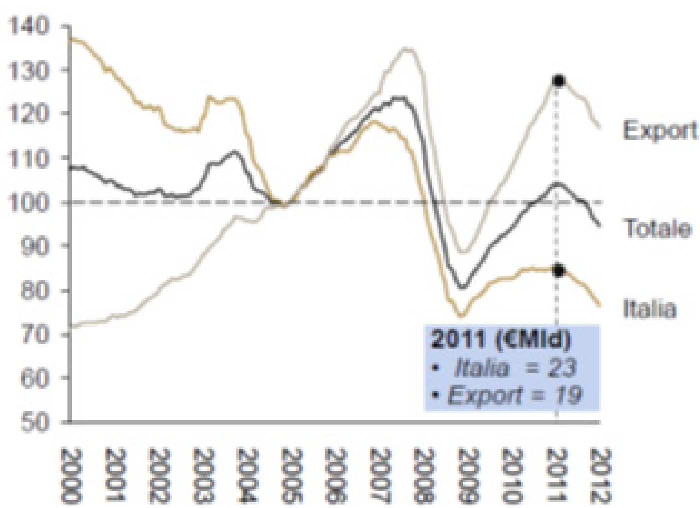

Figure 1. The turnover of the Italian component industry (2005 = 100) Source: Aversa S. (AlixPartners), presentation to Convegno ANFIA, *Quali prospettive per la componentistica italiana nel contesto internazionale? Limiti e opportunità*, Turin, May 7, 2013.

national and regional level (STEP various years; Enrietti et al. 2010) highlight the resilience of this sector and its ability to withstand the generalised crisis.

The data on foreign trade (Table 6) show that exports fell in 2009 but increased strongly in the following years, soon returning to the 2007 levels. This, combined with a drop in import, led to an increase in the balance of trade.

STEP's annual reports[5] have repeatedly underlined that the sector's ability to withstand the crisis can be ascribed for the most part to its exports that has counterbalanced the drop of the internal market (Figure 1).

5. Made in collaboration with the Chambers of Commerce of Turin and Chieti and with ANFIA.

Here are some remarks included in the 2012 report, referring to year 2011:

> While the final national production decreased overall, positive results were mostly due to our companies' ability to export. 77% of the companies included in the national sample [...] managed to export, so that the share of revenues coming from abroad over the total turnover of the supply chain was equal to 57% [...] At the same time, the companies' dependence on Fiat is decreasing: within the sample of companies interviewed, exporters are now more numerous than the firms which supply the Turin automotive group, both in Piedmont (where 84% of the enterprises are exporters and 79% supply the Fiat Group directly or indirectly) and in the rest of Italy (70% are exporters and 55% supply Fiat) [pp. 37-38].

Therefore, within the Italian automotive supply chain, weaknesses in the domestic production of cars are partially offset by increases in exports, contrary to what happened for what concerns the manufacturing of cars.

3 Methodology, sample selection and description

The aim of this chapter is to analyse the most undesirable effects of the ongoing economic-financial crisis by highlighting the transition from activity to inactivity of the Italian automotive suppliers due to: bankruptcy, compulsory liquidation, or voluntary closure.

To this end, a comprehensive picture of the Italian automotive supply chain before the beginning of the crisis (2008) was put together by merging different databases coming from previous empirical investigations made by Italian scholars (STEP, several years; Bardi, Garibaldo 2005; Morsa, Pirone, 2010; Zirpoli, Stocchetti, Scattola 2012) and by the authors of this chapter (Enrietti, Lanzetti, Sanlorenzo 2007; Enrietti et al. 2010; Calabrese 2005).

The result can be considered an accurate representation of the total population of the Italian automotive supply chain.[6] The sample includes 4,207 firms and it is more comprehensive than other surveys (STEP 2012). Differences mainly consist in how the supply chain[7] is defined and which types

6. Nevertheless, the described methodology don't allow an entry analysis because researches in this field haven't make about the Italian component industry and it wouldn't be correct to study the new firms starting from the database of the Italian Network of Chambers of Commerce, as several Istat activities are related to the component industry and not all these firms belong to the automotive supply chain.

7. The automotive supply chain can be understood as including only companies whose core business is directly connected to car products or extended to companies belonging to functional sectors too.

	First sample	Second sample
Piedmont	48.1	45.9
Lombardy	14.5	16.0
Veneto	6.5	6.8
Emilia-Romagna	8.4	8.7
Rest of Northern Italy	2.0	2.0
Central Italy	10.8	11.1
Southern Italy	9.8	9.5
Total	*100*	100

Table 7. Sample distribution by region before and after the analysis restriction (%).

of companies, as to their liability, are considered. The sample is made up of 72.6% limited-liability companies and 27.4% unlimited-liability companies.

The impossibility to cross-check the sample with the database of the Italian Network of Chambers of Commerce, in which all the companies are listed, caused the analysis to be restricted to the limited-liability companies included in the Aida[8] database of Bureau van Dijk. This limitation reduced the sample to 2,458 companies, but its spatial representativeness was preserved, since regional differences between the first and the second sample are minimal (Table 7).

Concerning the second sample, the first methodological step was to determine the legal status of the companies which were active in 2007 and became inactive in the following years: 81.1% of the companies in the sample remained active, whereas 15.9% turned out to be in bankruptcy, in liquidation, or no longer existing. Furthermore, the Aida database made it possible to identify a further 3% of the sample made up of companies bought or incorporated by other companies. Since this subgroup includes a large number of companies and displays some specific features, it was decided to separate it from the other two.

The second step was to identify some explanatory variables which might be significantly correlated to the legal status of the companies belonging to the Italian automotive supply chain.

The selected variables are: regional location; company size; sector; ownership and original country ownership; static and dynamic strategies in make or buy; and static and dynamic rating assessment.

8. The Aida database mainly contains financial data on limited companies. Companies which are no longer active are included as well.

	Total sample		Without incorporated	
	Chi-squared test	P-value	Chi-squared test	P-value
Regional location	17.8036	0.1218	15.7338	0.0153
Company size	48.7711	0.0000	36.8791	0.0000
Sector	17.6441	0.2235	8.2389	0.3120
Ownership	72.0114	0.0000	71.8167	0.0000
Original country ownership	5.1137	0.5293	0.2333	0.9720
Make or buy strategy	17.7723	0.0068	17.2941	0.0006
Sourcing strategy	27.8755	0.0000	25.9879	0.0000
Rating	328.0107	0.0000	315.5652	0.0000
Rating change	34.9022	0.0000	34.9037	0.0000

Table 8. Chi-squared test on contingency tables between legal status and some variables.

4 Empirical results

4.1 The study

As mentioned in the previous section, 15.9% of the companies in the sample became inactive within a five-year period, with 3-4% of companies closing down each year, a percentage which is slightly higher than that found by STEP (2012). Conversely, 81.1% of the companies were still active and filed their financial statements in 2011, as indicated by the Aida database. The remaining 3% of the sample underwent a process of financial concentration, thus increasing their economic and/or financial dimensions.

The sample of companies divided in the groups illustrated above was cross-referenced with the selected variables in order to generate contingency tables.[9] This made it possible to ascertain the presence (connection) or absence (independence) of relations at a given level of significance (Table 8). The chi-squared analysis shows that there is statistical significance for what concerns current legal status and size as well as, above all, geographical location, make or buy strategies, solvency risk,

9. See the section below; due to missing values, in some contingency tables the percentages of active, incorporated, and inactive companies might diverge slightly.

	Active	Incorporated	Inactive	Total
Piedmont	82.1	3.5	14.4	100
Lombardy	79.4	3.1	17.5	100
Veneto	84.4	1.8	13.8	100
Emilia-Romagna	86.5	2.8	10.7	100
Rest of Northern Italy	80.0	0.0	20.0	100
Central Italy	78.6	2.6	18.8	100
Southern Italy	74.8	2.6	22.6	100
Total sample	*81.1*	*3.0*	*15.9*	100

Table 9. Regional location of the Italian automotive supply chain.

and type of ownership. In the following sections, each chi-squared test will be specified and it will be analysed how these processes modified the scenario described in section 2.

4.2 Regional location analysis

As already highlighted in Table 7, the geographical distribution of the companies in the sample was simplified by focusing on the regions which play a major role in the Italian automotive sector, such as Piedmont (45.9%), Lombardy (16.0%), Emilia-Romagna (8.7%) and Veneto (6.8%), while the remaining regions were grouped by homogeneous geographical areas: North (2.0%), Centre (11.1%) and South (9.5%).

For what concerns the distribution of mean values, it can be observed that the location of the companies operating in this sector was modified by the economic crisis (Table 9), although in an unexpected way. Indeed, the highest frequency of closures and bankruptcies was not found in Piedmont (where inactive companies correspond to 14.4% of the subgroup), undoubtedly the region most heavily hit by Fiat's production crisis due to the presence of the Mirafiori plant. Instead, closures and bankruptcies occurred mostly in the South of Italy (22.6% of the subgroup) – due to changes in production at the Fiat plant of Pomigliano (Naples, which ceased to produce the Alfa and began to manufacture the Fiat Panda) and to the closure of the Termini Imerese plant (Sicily) – and in Central Italy (18.8% inactive companies in the subgroup), where Fiat operates at the Cassino plant (Lazio).

On the contrary, regions such as Veneto (13.8% of the subgroup) and, above all, Emilia-Romagna (10.7% of the subgroup) interestingly display the highest negative difference in comparison to the overall sample. The component sectors of these two regions have some specific features. Most companies located in Veneto do not work to supply Fiat Auto, whereas the Emilia-Romagna sector (Bardi, Calabrese 2007) is characterised by two key aspects: on the one hand, despite still being within Fiat's sphere of influence, it does not manufacture components for mass-produced vehicles (since it supplies Ferrari and Maserati) or for motor vehicles (but, instead, for tractors); on the other hand, a large portion of its production is not within the Fiat Group.[10]

Nevertheless, the chi-squared test (17.8026) does not provide evidence of a significant association between the two variables since the P-value (0.1218) is greater than the significance level of 0.05 probability. It becomes significant if incorporated companies are excluded.

As table 9 shows, the merger phenomena occurred more in Piedmont (3.5% of the subgroup) than in other regions. At this stage of the work, we can presume this is related to the characteristics of the Piedmont's automotive supply chain: the companies are more dependent on Fiat business that has been heavily declining and, therefore, they need to achieve more economies of scale by merger and acquisition.

4.3 Company size analysis

The analysis performed in this chapter is based on the EU regulations which divide companies into three groups depending on their turnover: micro enterprises (less than 2 million euro and 35% of the sample); small enterprises (from 2 to 10 million euro and 36.4% of the sample); medium enterprises (from 10 to 50 million euro and 21% of the sample). Our investigation considers two additional subgroups, i.e. medium-large enterprises (from 50 to 300 million euro and 6.4% of the sample)[11] and large enterprises (above 300 million euro and 1.1% of the sample).

As far as size is concerned, the companies display significantly different behaviours (Table 10). It clearly emerges that, at least until 2011, the companies most heavily hit by the crisis were the micro enterprises (21.1% of companies in this subgroup became inactive). In the other size classes, instead, this percentage is lower than the average and

10. According to Istat data, in 2007 Veneto and Emilia-Romagna accounted for around 23% of the Italian exports in the sector, whereas the South of Italy accounted for less than 3%.

11. The threshold of 300 million euro follows indications provided by Mediobanca.

	Active	Incorporated	Inactive	Total
Micro	77.0	1.9	21.1	100
Small	82.5	2.5	15.0	100
Medium	82.4	4.6	13.0	100
Medium-Large	89.8	5.7	4.5	100
Large	92.9	7.1	0.0	100
Total sample	*81.1*	*3.0*	*15.9*	*100*

Table 10. Company size of the Italian automotive supply chain.

decreases progressively as the company size increases, until it reaches zero when companies with more than 300 million euro turnover are considered. Furthermore, only 4.5% of medium-large companies became inactive. On the other hand, however, mergers and incorporations mostly involved the bigger companies, as confirmed by the higher percentages found in the larger size classes (7.1% of large enterprises).

The above figures indicate that a clear selection process occurred: over one fifth of the micro enterprises, which can be classed as marginal, were expelled from the market, whereas the medium to large enterprises not only survived but also became financially stronger through the creation or expansion of industrial or financial groups.

The chi-squared test confirms the association between the two variables since the P-value (0.0000) is lower than the significance level of 0.01, with or without the incorporated companies.

4.4 Sector analysis

A more detailed analysis of the automotive supply chain takes eight subgroups into account, in order to identify those companies whose core business is directly connected to automotive products – parts and components (50.2% of the sample), rubber and plastic (7.7% of the sample), and electrical and electronics components (6.9% of the sample) – and those which belong to functional sectors: metal products (i.e. cold/hot plate pressing – 22.2% of the sample); basic metal (i.e. above all metal and alloy casting – 1.9% of the sample); machinery (i.e. machine tools, instrumental mechanics, electrical machines, die manufacturers – 7% of the sample); engineering houses (i.e. design, test, prototype construction – 1.8% of the sample); other suppliers (i.e. textile, leather, glass, and logistics – 2.4% of the sample).

	Active	Incorporated	Inactive	Total
Parts and components	80.6	2.7	16.7	100
Electronic components	80.5	5.3	14.2	100
Plastic-rubber components	85.2	2.6	12.2	100
Total direct sectors	81.1	3.0	15.9	100
Metal products	83.0	1.8	15.2	100
Basic metal	76.6	8.5	14.9	100
Machinery	81.3	3.5	15.2	100
Engineering houses	80.0	6.7	13.3	100
Others	67.2	5.2	27.6	100
Total functional sectors	81.1	3.0	15.9	100
Total sample	81.1	3.0	15.9	100

Table 11. Sectors of the Italian automotive supply chain.

The chi-squared test (17.6441) indicates the independence between the two variables since the P-value (0.2235) is greater than the significance level of 0.05, with or without the incorporated companies (0.3120). In fact, in the sectors directly linked to the production of cars there are no relevant differences among the various activities (Table 11): the propensity to become inactive is slightly higher in «parts and components» (16.7% of companies in this subgroup became inactive) and moderately lower in «plastic-rubber components» (12.2% of the subgroup). For what concerns the functional sectors, only in the «other suppliers» subgroup the share of companies which became inactive is considerably higher than the total sample average (27.6% of the subgroup).

As table 11 shows, a higher occurrence of merger phenomena is found in «basic metal» (8.5% of the subgroup) and «engineering houses» (6.7% of the subgroup).

4.5 Ownership analysis

The sample was analysed (Table 12) in relation to the type of parent company – natural person or family (66.9%), industrial company (26.5%), or financial company (6.6%) – and the nationality of the parent company – Italian (94.1%), European (5.1%), American (0.6%), and Asian (0.2%).

	Active	Incorporated	Inactive	Total
Natural person or family	85.8	0.8	13.4	100
Industrial company	78.0	7.1	14.9	100
Financial company	82.6	3.2	14.2	100
Total sample	*83.5*	2.6	13.9	100
Italy	83.5	2.5	14.0	100
Europe	79.8	5.9	14.3	100
America	85.7	0.0	14.3	100
Asia	100	0.0	0.0	100
Total sample	*83.5*	*2.6*	*13.9*	*100*

Table 12. Ownership and original country ownership of the Italian automotive supply chain.

The results displayed in Table 12 are particularly interesting for what concerns mergers and incorporations, which almost exclusively involved companies not controlled by a natural person and occurred only among European companies.

The chi-squared test (17.7723) shows divergent results. There is an association between type of ownership and legal status (P-value 0.0000) but not between original country ownership and legal status (P-value 0.5293). This is due to the fact that enterprises controlled by an industrial company had a higher propensity to become inactive (14.9% of the subgroup versus 13.9% of the total sample). Data on original country ownership do not provide significant evidence, besides the fact that no Asian companies became inactive or were incorporated.

As table 12 shows, merger phenomena were more common among the firms acquired by industrial companies and located in Europe (respectively 7.2% and 5.9% of each subgroup).

4.6 Make or buy analysis

Make or buy activities are investigated from both a static and a dynamic point of view. The aim of the static analysis (Table 13) is to evaluate the performance of the firms according to their degree of outsourcing, whereas the dynamic analysis focuses on make or buy trends (Table 14).

	Active	Incorporated	Inactive	Total
Highly deverticalised	80,1	3,0	16.9	100
Deverticalised	84,2	3,0	12,8	100
Integrated	83,7	3,5	12,8	100
Highly integrated	76,5	2,6	20,9	100
Total sample	81.1	3.0	15.9	100

Table 13. Make or buy strategy of the Italian automotive supply chain.

	Active	Incorporated	Inactive	Total
Outsourcing	79.4	3.6	17.0	100
No strategy	85.3	3.1	11.6	100
Insourcing	76.2	2.1	21.7	100
Total sample	81.3	3.0	15.7	100

Table 14. Sourcing strategies of the Italian automotive supply chain.

In the static analysis, the firms are split into four quartiles calculated on the basis of the ratio between internal costs and total operating costs incurred in 2007 and classified in ascending order as follows: highly deverticalised (ratio less than 17%), deverticalised (ratio less than 24.7%), integrated (ratio less than 35.2%), and highly integrated (ratio more than 35.2%).

Although the chi-squared test (17.7723) shows the association between the two variables, since the P-value (0.0068) is less than the significance level of 0.05 with or without the incorporated companies (0.0006), verticalisation strategies do not have a direct correlation to legal status. The quartile of highly integrated companies is characterised by a higher share of inactive companies (20.9% of the subgroup); however, this is found, though to a lesser extent, also among highly deverticalised companies (16.9% of the subgroup)

In the dynamic analysis approach (Table 14), make or buy trends are calculated on the basis of the difference between the ratios of 2007 and of 2005. The threshold value used to define changes in sourcing strategies is half of the mean absolute deviation (±0.029). If the difference between the ratio of 2007 and that of 2005 is higher than +0.029, then the firm adopted insourcing strategies (30.9% of the sample); if it is lower than -0.029, then the firm adopted outsourcing strategies (38.0% of the sample).

	Active	Incorporated	Inactive	Total
AAA	87.6	6.2	6.2	100
AA	88.5	4.4	7.1	100
A	91.0	2.0	6.9	100
BBB	84.9	2.2	12.9	100
BB	77.1	1.8	21.1	100
B	62.7	4.3	33.0	100
CCC	40.8	2.0	57.1	100
Default	17.8	2.2	80.0	100
Total sample	81.1	3.0	15.9	100
Improved	81.7	3.1	15.3	100
Constant	84.4	2.8	12.7	100
Worsened	73.2	3.1	23.7	100
Total sample	81.2	3.0	15.8	100

Table 15. Rating and rating dynamics of the Italian automotive supply chain.

Once again, the data are not univocal: the companies which became inactive belong to both the group that increased its outsourcing and the group that decreased it during the period considered. However, the biggest difference from the sample average is found among companies which increased their vertical integration (i.e. which reduced their outsourcing). It can be deduced that increases in internal costs had a negative impact on the companies, as also confirmed by the higher average share of companies which became inactive found in the «highly integrated» quartile.

Again, the chi-squared test (27.8755) shows the association between the two variables since the P-value (0.0000) is less than the significance level of 0.01, with or without the incorporated companies (0.0000).

4.7 Rating analysis

The rating assessment is also based on a static and dynamic approach.

In the first case (Table 15), technical ratings were calculated using the CNR-Ceris software (Falavigna 2012). The sample was divided into

	Improved	Constant	Worsened	Total
AAA	1.4	0.5	0.0	1.9
AA	4.1	4.6	0.8	9.5
A	3.0	2.7	1.1	6.8
BBB	5.9	10.8	4.9	21.6
BB	4.9	12.2	7.8	24.9
B	1.1	8.4	10.2	19.7
CCC	0.0	1.6	5.4	7.0
Default	0.0	3.8	4.8	8.6
Total sample	20.3	44.6	35.1	100

Table 16. Comparison between 2007 rating and rating change in 2005-2007 of inactive companies.

the standard eight categories, from excellent to default (AAA 5.2% of the sample, AA 21.1%, A 15.9%, BBB 26.1%, BB 18.3%, B 9.5%, CCC 2.0%, D 1.6%). In the dynamic analysis, the rating of 2007 is compared to that of 2005: ratings improved for 21% of the companies in the sample, whereas they worsened for 23.4% of the companies.

In both the static and dynamic approach, the chi-squared test confirms the association between the two variables since the P-value is less than the significance level of 0.01, with or without the incorporated companies.

As expected, the higher the rating, the lower the percentage of inactive companies. 80% of the firms with default rating and 57.2% of those with CCC rating in 2007 went bankrupt. However, about 7% of the companies with upper-medium to high rating (at least A) went out of business, which means that their good financial situation did not prevent them from suffering the most undesirable effects of the ongoing economic-financial crisis.

A similar assessment of rating can be provided by adopting a dynamic approach. 23.7% of the companies with a worsening rating between 2005 and 2007 became inactive. Nevertheless, 15.3% of the companies which improved their rating also became inactive. As further proof of how deep the ongoing economic crisis is, 8.5% of the companies which became inactive in 2007 had actually improved their rating, achieving a high or upper-medium grade (Table 16).

As table 15 shows, merger phenomena mostly occurred in firms with AAA or AA rating (respectively 6.2% and 4.4% of each subgroup).

5 Conclusions

The results presented in this chapter concerning the impact of the economic crisis on the Italian automotive supply chain are to be seen as preliminary evidence requiring further investigation, by using a larger number of explanatory variables and more comprehensive statistical methodologies. At this stage of the research, we address in particular firms' features in terms of Darwinian survival of the fittest (Agarwal, Gort 2002): size, location, specialization, ownership, financial rating. The next step will be the analysis of technological and efficiencies variables in relation to survival of the automotive suppliers.

Nevertheless, these early results make it possible to interpret the reorganization which is currently underway in the Italian automotive sector.

Closures and bankruptcies are significant occurrences which have so far been overlooked. In the period under investigation (2007-2011), almost 16% of the companies included in the initial sample went out of business. However, considering that 2012 was the worst year of the period in terms of both macroeconomic and sector indicators, it is reasonable to assume that, following the current trend, at least another 4% of companies might have become inactive, so that the total is likely to be around 20%.

In other words, around one fifth of the companies which were active in 2007 became inactive in the following five-year period. Nevertheless, this figure is probably an underestimation of the actual extent of the phenomenon. Micro enterprises display a higher propensity to become inactive, but our sample includes only joint stock companies and not partnerships, which are by definition of very small size. Therefore, if our data are related to the actual overall situation, the percentage of closures is likely to be well above 20%.

As mentioned above, inactivity heavily affected above all the micro enterprises (which represent 46.5% of the total sample), regardless of their solvency risk. Indeed, if the inactive companies are divided according to their rating classes, the share of micro companies which became inactive is higher than the sample average, both for those with a near-default rating and for those with a rating equal to or higher than A (respectively 60.9% and 56.9% of each subgroup).

The chi-squared analysis shows that there is statistical significance for what concerns current legal status and size as well as, above all, geographical location, make or buy strategies, solvency risk, and type of ownership.

The crisis does not seem to have affected all the geographical areas

	Micro	Small	Medium	Medium-large	Total
At least A	56,9	25,0	18,1	0,0	100
At least B	40,0	40,0	17,3	2,7	100
CCC and Default	60,9	23,5	15,6	0,0	100
Total sample	46,6	34,5	17,1	1,8	100

Table 17. Comparison between 2007 rating and size of inactive companies.

uniformly. Its effects have been stronger in the South of Italy, confirming that the enterprises located in these regions have suffered from isolation and, in most cases, the network of suppliers has not been able to create an autonomous market for itself, independent of Fiat (Bubbico, Pirone 2006).

As far as make or buy strategies are concerned, the crisis has had a more limited impact on the enterprises which fall into the intermediate categories in relation to both their degree of verticalisation and changes in their sourcing strategies.

A more in-depth analysis should be performed on the companies which, during the period under investigation, were incorporated by other companies (these represent around 3% of the sample). This phenomenon concerned above all the larger companies, which were mostly taken over by industrial or financial companies.

Hence, the reorganization of the Italian automotive supply chain seems to be characterised by a twofold trend: the micro enterprises are the most heavily affected by the crisis and often expelled from the market, whereas the medium to large enterprises not only survive but also become financially stronger through the creation or expansion of industrial or financial groups.

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