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TECHNOLOGICAL PLATFORMS AND THE GOVERNANCE OF KNOWLEDGE: EVIDENCE FROM ITALY AND THE UK

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TECHNOLOGICAL PLATFORMS AND THE GOVERNANCE OF KNOWLEDGE: EVIDENCE FROM ITALY AND THE UK

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ABSTRACT. *Innovation is a distributed process that involves the collective efforts and the interaction of heterogeneous organisations. Each of those actors is specialised in specific activities, technologies and knowledge and innovation is the result of the combination and integration of their activities. Coordination is a key determinant for the viability of distributed innovation in that it stimulates complementarities across otherwise dispersed competences. This paper argues that technological platforms are innovation infrastructures that foster the kind of cooperation that is at the core of collective innovation. Being placed strategically within innovation systems, platforms enable capacity- and capability-building for individuals, teams and organisations. Evidence on the implementation of platforms in two sectors in the United Kingdom and Italy confirms the centrality of this type of institutional responsiveness for the effective integration of individual activities towards collective innovation.*

1. Introduction

In recent years the economics of innovation has progressively enriched the analysis of the systemic conditions under which technological change and knowledge are produced and diffused. Along the lines paved by Friedrich von Hayek (1945; 1967) and Herbert Simon (1962) technological knowledge can be defined as a complex system of interconnections among a variety of organisations that own fragmented, imperfect and yet complementary kinds of knowledge. These consist in technical know-how, organisational skills and competences for the assessment and the coordination of idiosyncratic characteristics of consumers, users, suppliers and market operators; taken individually each one of them feature different combinations of tacit capabilities and scientific knowledge. In turn, the way they relate to one another is the main issue at stake to both exploit interdependencies (i.e., knowledge at the system level is not the mere addition of knowledge at the different micro levels) and make such exploitation efficient (i.e., reducing the cost of the interactions needed to increase knowledge at the system level).

Such a systemic perspective paves the way to understanding of the innovation process rooted in the principle of the division of labour, and more specifically the division of knowledge across actors and the activities they engage with. Different knowledge bases establish the boundaries of the different actors, their activity and the space of their specialisation. Co-ordination is a necessary process when knowledge is dispersed, fragmented and incomplete, i.e. different actors own different and complementary portions of knowledge. In turn co-ordination of economic activities is a means to an end to a more effective system for the generation of knowledge, and is directly linked to the transformation and distribution of existing knowledge (Loasby, 1976, 1991 and 1999; Richardson, 1960 and 1972). As with the division of labour, the co-ordination of the different actors, their functions and domains is the central issue in such a division of knowledge (Metcalfe, 1994).

Innovation systems provide clear evidence of the above phenomena in a variety of contexts. The development and the diffusion of innovation in such systems rely on the creation of dedicated infrastructures for creating and coordinating knowledge. Smith (1997) qualifies innovation infrastructures as collective processes of creation and coordination of resources. These often involve the deployment of large-scale investments and are located at the interface between the public and the private sectors. Such infrastructures are strategically placed in systems of innovation to create connections across different actors which are characterized by specialised know-how. This paper presents technological platforms as emerging governance structures in contexts where innovation is the outcome of distributed activities across organisations. Technological platforms represent a particular instantiation of innovation infrastructures, their main goal being the provision of interfaces among the capabilities of different and complementary organisations.

The paper is structured as follows. Section 2 provides the context with an introduction to the literature on innovation and technical change. Here we adopt the Localized Technological Change (LTC) approach to analyse both the characteristics of technological knowledge and the role played by technological platforms as knowledge governance structures. Section 3 presents two case studies of innovation platforms in a manufacturing sector in Italy and a service sector in the UK. This highlights similarities and differences across technologies, patterns of sectoral development and institutional regimes. In Section 4 we discuss these dynamics on the bases of the theoretical framework. Section 5 concludes and summarizes.

2. Localized and collective technological change

2.1 – Time, space and knowledge: the building blocks

Understanding the dynamics of industries is a longstanding purpose of innovation studies (David, 1992; Nelson, 1994; Metcalfe, 2001; Antonelli, 2001; Langlois, 2003). Scholars in this field share common ontological and methodological ground: first, strong emphasis is placed on the sources and the effects of technological change; second, the process is viewed through the lenses of evolutionary theorizing, whereby factual analysis complements traditionally quantitative approaches; third, great attention is paid to the dynamics generated by the interaction between business firms and the surrounding environment, therein including other firms as well as a broad array of institutions. At root of this body of research is an appraisal of the work by Allyn Young (1928) who first appraised the role of increasing returns and external economies out of specialization and roundabout methods of production. From this viewpoint economic development is the outcome of the twin emergence of variety in the actors and their coordination.

The economics of localized technological change (LTC) is an empirically-based approach that has successfully synthesized the foretold strands of innovation research. This body of work builds upon the seminal contributions of Atkinson and Stiglitz (1969) and Paul David (1975), and the articulation of a wide class of processes elaborated by Antonelli (1995, 1999, 2001, 2003, 2007). In the LTC tenet technological change is localized in historical time and in geographic space. *A fortiori* it is localized in the knowledge space and in the mutual interaction between the structural conditions of a system and the sphere of action of each component subsystem including firms, institutions and consumers. At the core of the LTC tenet is the intersection of the following:

1. The inducement mechanism whereby a mismatch between agents' plans and the actual outcomes triggers search for new solutions;

2. The accumulation of technological knowledge and the development of competences underpinning the implementation of changes;
3. Finally, the introduction of innovation which reflects both strategic decision-making well as the characteristics of the environment.

In prima facie LTC combines the microeconomic analysis of technical choices with strategic elements of business organization. LTC, however, is also a theory of multi-level economic development as the threefold path outlined above is recursive and innovation is at the same time the end of a loop and the beginning of a new one. In fact, innovation alters the relative position of each agent in the operative environment, thus fuelling structural change in an open-ended fashion. From this it follows that industries evolve as a result of the endogenous emergence of new institutions, organizational forms and technologies. In sum, the LTC framework agents are active propellers of economic development in that being exposed to the uncertainty of changing competitive conditions forces them to use their competences for building strategies and implementing changes accordingly (Antonelli, 1995; 2003).

The LTC approach accommodates the following stylized facts: (i) innovation is path-dependent, which implies that the impacts on firms and industries is a cumulative process and that this is embedded in the localized characteristics of the extant industrial and institutional environment (David, 1994); (ii) as knowledge grows and learning opportunities expand, the familiar parable of division of labour acquires a dynamic flavour whereby industries in transformation rely on progressively broader knowledge bases; (iii) in this context economic performance depends on the ability to manage the positive and negative effects typically associated with knowledge and information – asymmetries are perhaps the clearest example. It follows that the notion of efficiency no longer depends on the static allocation of existing resources but on the development of new ones, namely the twin processes of specialization and coordination (Pavitt, 1998; Chesbrough, 2003; Noteboom, 2000, 2002). Let us now take a look at the basic ingredients of LTC in a dynamic perspective.

2.2 – Collective knowledge and governance: the engine of development

The LTC approach stresses the notion that knowledge is characterized by relevant search and information costs due to the axioms of bounded rationality. Agents are myopic in a twofold sense: they cannot fully anticipate the outcomes of their decisions, and are never fully aware of what any other agent is doing, thus including rivals, suppliers and consumers. Thereby agents develop internal competences to either change internally the organization of their activity, or to exploit latent complementarities with external knowledge (Antonelli, 2006).

The notions of learning and localized technological knowledge are central to this tenet. Technological change is never the outcome of isolated action but rather the cumulative and idiosyncratic outcome of collective learning and interaction. It builds upon past experience but at the same time is constrained by the path of specific technical and procedural choices. Economic agents are capable to generate and exploit new knowledge only within limited domains and circumstances (Antonelli, 1999, 2001). The generation of localized technological knowledge is the outcome of collective efforts to create and sustain dynamic complementarity that exploits variety through the creation of coordination mechanisms (see Prahalad and Hamel, 1990; Coombs and Metcalfe, 2000).

Evolving industries are characterized by the expansion of the knowledge base due to the intersection of learning processes set in motion by agents. Because the latter are idiosyncratic, they generate a degree of specialization which stretches beyond the sphere of individual firms and culminates with the division of labour among firms within an industry. In the case of information-intensive industries the latter consist in cooperative agreements across a number of firms to align their heterogeneous forms of specialization on ICT applications (see Sampler and Short, 1998; Davies, 1996; Nightingale and Poll, 2000; Consoli, 2005). At the geographical level knowledge production and the introduction of innovation are collective and systemic properties emerging from horizontal indivisibilities between firms specialised in different technologies and between these and University, technology transfer centres and knowledge-intensive business services, able to dynamically change the structure of their interactions (Patrucco, 2003 and 2005).

Variety of the knowledge base, however, is not a sufficient condition for the systematic generation and exploitation of positive externalities: specialization is dynamically effective when specific governance mechanisms facilitate the coordination of variety. Antonelli (2006) provides a detailed assessment of the properties of knowledge and how they map onto the grid of governance tools available. He highlights that quasi-hierarchical command is most appropriate when knowledge is tacit and sticky; constructed interactions among learning agents work best with articulable types of knowledge; finally, coordinated transactions are used when knowledge is more codified.

The introduction of new ICTs is a prototypical case in point to illustrate the idiosyncrasy of localized technological change. ICTs are a good example of general-purpose technologies, that is, the output of significant advances in the field of computing that at the same time can be applied as inputs (Helpman, 1998; Lipsey, Carlaw and Beckar, 2005). ICTs are characterised by significant fungibility in that they can be used in a wide range of environments, both traditional and high-tech sectors, as well as in manufacturing and service activities. The introduction and use of ICT simulate the adoption of further and related innovations, improvements and incremental changes that bring about increases in productivity and profitability of investments (Bresnahan e Trajtenberg, 1995)[1].

When technologies of this kind become globally available, their adoption and development engenders learning effects towards new sector-specific competences. These are context-dependent in the sense that the new competences draw on combinations of inputs that are more intense in both the activity and the geographical location. Because this process is tied to knowledge endowment and learning conditions, productivity improvements stemming from the adoption of such technologies are spread unevenly across firms, sectors and countries (David, 2000; Antonelli, 2003). ICTs engender strong technological discountinuities that affect the activity of firms as well as the distribution of resources across sectors. This, in turn, triggers a process of structural change that favour those firms, sectors and regions characterised by a more appropriate endowment of technological, organisational as well as institutional and financial resources. Thus to be able to benefit from new communication technologies, firms must have previously introduced a critical mass of innovation and changes in terms of technological and human capital as well as organisational forms (Antonelli, 2003; Chesbrough, 1999; Helpman e Trajtenberg, 1994; Helpman, 1998). By extension, the strategic application of new generic knowledge in the form of those technologies engenders further specialization, either product or process innovations. Hence the initial claim that localized technological knowledge is a recursive and endogenous process driven by variety and coordination.

2.3 – Complexity and knowledge

The analysis of knowledge as a complex dynamic system represents the third key ingredient of the localised technological change approach. Complexity theory

[1] In this respect, Timothy Bresnahan and Manuel Trajtenberg articulate a notion of GPT as enabling technologies.

underlines the structural and dynamic properties of economic systems as an effect of the connections between heterogeneous and complementary actors, each of which possesses specific and limited cognitive resources, and command specialised modules of technology and knowledge. The network of interactions among agents is a tool for the coordination of their activities, and through which they can access and create new knowledge by exploiting latent complementarities. Changes in the organisation and architecture of such network structures induce changes in the form of coordination of complementary activities and competencies. The feedbacks between micro behaviours and the structural characteristics of the system in turn shape the evolution of the system itself (Foster, 1993 and 2005; Arthur, Durlauf and Lane, 1997).

The structural and dynamic characteristics of complex systems entail the integration of different and complementary elements and components, which in turn reflect different and complementary modules of technology and knowledge. Individual actors put in place connections in order to access and generate new knowledge, and thus to react to cognitive and structural boundaries and the changes occurred in the environment. Learning by myopic, i.e. characterised by limited and specific knowledge, but creative firms underpins the generation of new knowledge. New knowledge takes advantages from the complementarity rather than the substitutability between internal and external bodies of knowledge (Patrucco, 2008). The larger the adoption of networking as a means to access and use external knowledge modules, and the larger the complementary internal know-how required to the firm to be able to understand, command and recombine external capabilities. Increasing returns in the generation of new knowledge build upon the exploitation of complementarities between internal and external knowledge and the implementation of a collective pool of knowledge and competencies through interactions. In turn, creative firms benefiting from complementary modules of knowledge are able not only to introduce new knowledge but also to change the structure of their connections and the architecture of the network in which they are embedded, eventually modifying the processes and mechanisms of coordination. Connections and interactions between actors emerge as a crucial institutional element to understand the dynamic properties of complex system and the governance of complex knowledge (Arthur, 2007; Antonelli, 2007; Cohen and Levinthal, 1989).

The notion of the coordination of the division of knowledge is central in this context, in order to understand how complex systems evolve and the dynamics of knowledge creation and change take place. Dynamic coordination is the result of connective and generative interactions between actors, and of the changes made in such structures by bounded but creative actors. In sum, dynamic coordination drives the evolution of complex systems (Lane and Maxfield, 1997; Loasby; 1999; Potts, 2000).

Complexity does not rest upon the mere physical complexity of a given artefact or technology neither in the net of interdependencies and interactions necessary to integrate the different components, sub-systems and modules, nor in the static coordination of such connections. Static coordination refers to the integration and synchronisation of complementary modules and components within established products and organisational architectures. More importantly, complexity rests upon changes in the characteristics of knowledge introduced by learning agents with limited cognitive resources but able to behave creatively, engendering changes in the way in which actors organise their economic activity through time as well as proactive, specific and costly efforts put in place for such coordination.

In this respect, a major trade-off emerges between static and dynamic coordination and the appropriate governance structures. On the one hand, vertically-integrated and hierarchical firms are efficient in terms of static coordination as they reduce transaction costs due to the integration of different components, modules and know-how. Such firms achieve more efficiently the structural dimension of complexity, by the internal production and integration of the variety of elements and capabilities that are needed in order to give place to the final product. However, in a dynamic environment, subject to continuous changes in product characteristics and production technologies[2], and thus complex in a truly way, these firms are not able to keep the pace of change because internal capabilities are likely to prove limited. In this case, the market is a more efficient institution in that actors have access to diffused pools of resources, and where firms benefit from economies of specialisation and learning advocated by Adam Smith. Historically, outsourcing and distributed coordination through market relations emerged precisely in order to make possible bureaucratic organisations reacting to improvements in product or services required on the demand side by acquiring externally the know-how necessary to innovate.

According to the prospective costs of changing their knowledge base actors may opt for the coordination of their activities, in turn dynamically shifting from vertical integration within the firm to market coordination, or vice versa. Hybrid coordination forms, such

[2] Think for instance of changes in product characteristics engendered by changes in the articulation of users' and consumers' needs.

as networks, between the market and the firm may eventually emerge as the result of the changing conditions and interactions between costs constrains and the creative behaviour of the firm (Langlois, 1992).

Dynamic coordination refers in this respect to search and exploring new organisational networks able to cope with changes in product and technologies. Dynamic coordination in turn implies the capabilities and knowledge necessary to cope with changes in production, technologies and the structure of the network of suppliers, components and modules of knowledge. This bears important implications for the analysis of technological platforms as coordinating solutions for the division of complex knowledge.

To advance this analytical perspective we need to uncover the processes through which economic activities are instituted and co-ordinated among the organisations that participate to distributed innovation. This part of the paper contributes to such an endeavour with an overview of the dynamics of innovation platforms, one of such models of collective specialization and coordination, in the context of health-care and automobile production.

2.4 – Coordination of complex knowledge: technological platforms

As outlined before the dual process of knowledge accumulation and exchange is a salient characteristic of industries that flourish out of technological specialization and the effective coordination of distributed innovation activities. While many associate this phenomenon to the dualism between hierarchical versus decentralized modes of production, empirical works in the context of innovation studies have contributed to a somewhat richer picture. Changing competitive conditions and the uncertainty that these entail urge organizations to explore new routes for survival. Such an adaptive process presents two salient characteristics. First, as Paul David (1994) makes clear, the path of evolution of organizations and the associated institutional settings is shaped by strong historical feedbacks. Second, organizational changes mirror reconfigurations in the knowledge structure, therein including knowledge possessed by individuals as well as the relational structure on which their activities rely (Loasby, 1991; Metcalfe and Ramlogan, 2005).

The Economics of Localized Technological Change approach provides an important contribution in this direction by emphasising the complex nature of technological knowledge, and its dual role as both input and output of the process of competence building and creation of qualified forms of interaction (Antonelli, 2005, 2006). In this paper we draw attention to technological platforms, one of such coordination mechanism, which have recently gained attention among scholars as well as policy-makers (Gerstein, 1992; Ciborra, 1996; European Commission, 2004).

Technological platforms are systemic infrastructures for the organisation and coordination of distributed innovation processes characterised by high degree of complexity, division of labour and specialisation of activities and competencies. In this regards, platforms operate at both the technological and organisational levels. Furthermore technological platforms perform both static and dynamic coordination of distributed knowledge. From a static viewpoint platforms connect and integrate the activities and capabilities of specialised actors within a given industry, thus supporting such a specialisation and favouring the accumulation of specific knowledge in the network. From a dynamic viewpoint, platforms support changes in both the structure of the network and the technological knowledge generated in the system. This is so because platforms are open architectures that favours the entry and integration of new actors, and therefore of new competencies, in the network itself. The original distinction introduced by James March (1991) between 'knowledge exploitation' and 'knowledge exploration' finds in platforms a new context for application. Performing static coordination, platforms support the exploitation of existing knowledge within the network of firms, reinforcing the effect of specialisation and the division of labour in terms of higher efficiency and productivity gains. On the other hand, platforms favour dynamic coordination as well, that is the search and exploration of new knowledge by means of the integration of new actors.

The development of technological platforms is the outcome, from a technology viewpoint, of convergence between and integration of a variety of localized innovations, generated in a wide range of industries and firms. Technological convergence is driven by the introduction of a number of innovations such as Internet services, enhanced broadband fibre optics, Asynchronous Digital Subscriber Lines, and Universal Mobile Telecommunications System opening up the possibility of integrating a variety of content, services, technologies and applications (Fransman, 2002). As a result platforms are both composite and fungible.

Technological platforms are tools for the governance of knowledge that are commonly observed in activities characterized by (i) Large Scale; (ii) Variety of the forms of knowledge involved; (iii) Distributed forms of production and supply; (iv)

Complementarity between manufacturing and service activities. In organizational science the analysis of platforms is focused on how both the constituent elements as well as the nature of their interactions change over time. In the policy context a technological platform is the model of reference for the creation of mixed (i.e. public and private) coalitions. Both realms share the idea that the outcome of a platform-type of organization is a sequence of activities aimed at long/medium-term objectives rather than finite products. The rationale of platforms is to provide a knowledge infrastructure the intentional coordination of various forms of technological specialization both within and across sectors and industries. A platform-type of organization underpins systems of production and supply whereby many users share a common set of devices and standardization rules.

Such organizations are characterized by flexibility whereby structure and rules of operation can be configured in different ways for different uses, just like computer platforms. The organizational nature of platform activities reflects at the same time the characteristics of inputs (i.e. the forms of knowledge) and outputs (i.e. products and services). As argued by Antonelli (2006) platforms are especially appropriate tools when technological knowledge exhibits levels of compositeness and cumulability that imply too high coordination costs for a single firm. In turn, technology (as opposed to technological) platforms (such as software applications) are made of interchangeable components to facilitate shared access to a variety of users with different incentives and different capabilities.

Recent contributions by William Baumol (2002) and Eric Von Hippel (2005) show that firms operating within platforms are stimulated to implement processes of knowledge sharing, making their know-how, capabilities and technologies accessible to other firms and economic actors more generally, through explicit cooperation and communication strategies. The efficiency of knowledge creation due to both internal investments and external learning is higher than processes that rely exclusively on internal creation (for instance by means of vertical integration of R&D) or on external acquisition (for instance, by means of outsourcing of R&D and design activities, or by means of buying licenses and patents). Private gains of those firms that cooperate in a collective innovation process are higher than the gains of those firms that innovate ‘in isolation’ or on the base of pure market transactions[3].

[3] Losses that firms experience in terms of lower levels of appropriability of the results of their private investments are more than compensated by the benefits that firms can reach as a consequence of the

The kind of knowledge circulating within platforms can be defined as collective in that a variety of actors contribute to its creation. It is also complex because it relies on the dynamic interactions and learning among actors. Finally, it is open because sharing competencies and technologies is crucial for the creation of new knowledge as opposed to exclusive protection and appropriation of R&D activities (Chesbrough; 2003; Chesbrough, Vanhaverbeke and West, 2006).

In this regard, the development of processes and channel of communication emerges as the key strategy to favour the generation of knowledge as well as the introduction of new actors, with new competencies, within the network. Since actors are heterogeneous due to their specific and idiosyncratic know-how, and because the environments in which such actors play are different as well on the base of their sectoral, geographical, institutional and historical characteristics, such communication strategies cannot be but specific. In other words, the structure and development of technological platforms cannot be but specific. Different organisational solutions are more or less appropriate to the coordination of knowledge production according to the characteristics of firms, sectors, their knowledge and the environment in which they play.

More precisely, the identification of the appropriate platform, at the organisational and technological level, cannot be but a local solution taking into account the characteristics of the system in terms of 1) the architecture of connections and interactions; 2) the modules of technology, product elements and knowledge involved in the system; 3) the actors playing in such system; 4) the changes occurring in such architecture, technology, knowledge and actors.

To the extent that local and hybrid solutions are able to combine some of the benefits of hierarchical design with the advantages of a distributed structure, organisational and technological platforms are valuable and appropriate means for the coordination of knowledge in complex dynamic systems productive systems such as the health and the car sectors.

3. Two case studies

Complex dynamic systems are based on structural change and the creation of new sectors, firms, employment and new organisational forms. This process of structural

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accessibility to each other's knowledge. In this respect, private incentives to knowledge production and collective incentives to knowledge diffusion are concurring in a dynamic that shows the feature of a positive sum game.

change co-evolves with those of modernisation and economic development and it is interdependent with technological change. Localised introduction and adoption of new technologies modify the relative use and intensity of capital and knowledge within sectors, changing their productivity and the way in which they organise their activities. Sectors previously characterised by poor adoption and use of machinery, physical capital and by relatively low levels of technological knowledge, as a consequence of technological change improve their efficiency through a better coordination of their activities, while sectors in which the introduction of new technologies is less significant are characterised by decreasing performances and by a relative decline.

From an historical viewpoint, such dynamics transformed, for instance, the structure and the coordination of economic activities during the industrial revolution, the golden age of American economic growth in the '50 and '60 of the last century, and are nowadays characterising the transition of industrialised countries towards the knowledge economy, with the strong influence of new information and communication technologies and of the new service economy (Crafts, 2004; Landau, Taylor and Wright, 1996; Helpman, 1998; Mokyr, 2002). Technological change and structural change co-evolve and reinforce each other along a process that can be depicted as a Schumpeterian creative destruction (Schumpeter, 1942), where new actors, new forces and new coordination forms emerge.

In particular, nowadays, such transformation is clear when looking at the development of the service sector in general and at the affirmation of the knowledge intensive service sector (Andersen, Howells and Hull, 2001). New services characterised by intensive use of specialised and qualified technological knowledge reach out across sectoral and geographical boundaries, and are an instantiation of the transition to the knowledge economy. In this context, ICTs push such dual evolution, on the one hand towards the new service economy, and on the other towards the knowledge economy, in that they are at the core of the new wave of knowledge-intensive services such as financial services, heath services, education and training services, consultancy and business services, and logistics as well.

In this context, the growth and development of advanced countries are not only characterised by the mere increase in the share of, for instance, employment and GDP accounted for by the service sector, but, more importantly, by increasing convergence between manufacturing and service sectors. Three different and yet interdependent dimensions of such a convergence can be specified. First, knowledge-intensive services increasingly adopt development strategies and organisational forms previously characterising complex manufacturing activities, such as decentralisation, outsourcing, specialisation and the coordination of the division of labour through distributed networks. Second, a larger and larger share of the added value of manufacturing goods is accounted for by service activities complementary to production, such as design, R&D, IPRs management, logistics and distribution. In many cases, manufacturing firms specialise in these activities, outsourcing the production of components and even their integration into the final product to a wide network of specialised suppliers. Finally, the increasing role played by services in advanced economies is also the result of such an increasing decentralisation and outsourcing adopted by manufacturing firms, which now require a new set of activities and intermediaries, including technological platforms, in order to coordinate the wide net of upstream and downstream suppliers.

In sum, service and manufacturing are convergent and integrating systems, and are more and more similar, especially when considering the way in which they coordinate the complexity of their activities (Consoli, 2007). Moreover, the convergence between the increasing role of knowledge-intensive services and technological change introduces strong elements of discontinuities in both the structure and the dynamic of economic systems, which are characterised by technological and organisational change, and more importantly by new forms of the coordination of the division of labour. Both static and dynamic coordination of distributed knowledge emerge in turn as major issues in the analysis of the changes involved in both the manufacturing and the service sectors, and of the way in which technological platforms can play a role in such changes.

3.1. The innovation platform in the health-care system of the UK

After having operated within traditional boundaries for decades, managers and practitioners of health-care have begun to explore new routes in search of a model that stimulates and facilitates the emergence of innovation. It has been repeatedly pointed out that progress in the medical and clinical realms is associated to cross-boundary activities like the translation of laboratory research into the clinical realm, the integration of patient care experience into the design of training programmes and the management of relationships between health trusts and other relevant actors, such as universities and firms. This is further confirmed by evidence that indicates how opportunities opened up by recent advances in basic scientific research (such as biochemistry and genetics) are likely to encounter bottlenecks when tried in the diagnostic or therapeutic context.

Phenomena of this kind are not unknown to innovation scholars who have long drawn attention to the fact that the introduction of new technologies entails new relational structures among the individuals who engage in productive activities. Such changes extend beyond the sphere of any individual business firm and hinge upon the connective tissue of institutions. As the literature on systems of innovation has it, institutions provide the infrastructure upon which business organizations operate (Metcalfe, 1995). Institutions are thus agents that facilitate the creation, exploitation and the transfer knowledge, skills and artefacts that are embodied in technologies. One practical implementation of this notion in the context of formal government policies is the creation of clusters, incubators and centres for cooperation.

Recent studies have advanced knowledge on the localized processes that drive the dynamics of institutions. These show that, first, as economic activities become more knowledge-intensive the number and the variety of institutions increase together with their degree of specialization; and, second, that the determinants of success or failure of highly heterogeneous systems of innovation is ever more dependent on their effectiveness to coordinate and utilise knowledge from a variety of sources (Antonelli, 2006). Nelson and Sampat (2001) contribute this debate by emphasizing the role of procedural changes that facilitate the coordination of different forms of specialization. These 'social technologies' – "the effective ways to get things done when human cooperation is needed"– represent the missing link between institutional and evolutionary economics (Nelson, 2002: 22).

This notion is most relevant in the case of the medical sector where effective knowledge coordination has become an imperative. Advances in medical knowledge have been traditionally understood as a by-product of basic science, but recent research demonstrates convincingly that effective improvements in the provision of health-care are often attained through the development of practical procedures in patient care (Metcalfe et al, 2005; Nelson, 2005; Consoli and Ramlogan, 2007). The organization of modern health-care is no longer limited to individual disciplines, and does not feature homogeneous supply of medical devices and clinical services. Instead, it thrives on the juxtaposition of scientific knowledge and practical skills from a variety of contexts.

Patient care presents particular challenges for such coordination processes due to the highly fragmented nature of delivery. As a consequence, clinical information about patients is highly complex, not easily codified and prone to be transmitted through informal channels (Gittel and Weiss, 2004). Also administrative information tends to become complex due to the proliferation of systems for automated management that are designed towards unit-specific requirements. Furthermore, as Wicks (1998) points out, functional boundaries in healthcare are shaped by professional identities and status which undermine the effectiveness of relationships and of communication. At the same time, however, the emerging culture underscores the need to extend coordination and spread successful but episodic improvements beyond individual health-care units.

One corollary of this ethos is the growing effort to valorise front-line activities in hospital wards through the assessment of emergent innovative practices. The objective is to eventually push outwards the most effective ones. This does not deny the importance of basic research but, rather, redresses a balance between the investments – and the levels of expectation – that are placed on scientific research as opposed to improvement of existing procedural knowledge. The associated policy design seeks to strike a balance between top-down forces and bottom-up processes. The institutional infrastructures resulting from this bottom-up approach engage with exploratory activities, the evaluation of existing solutions and the orientation of the business plan. The economic incentives to invest in such infrastructures are twofold. First, to benefit from the efficiency gains due to lower operating costs; second, to encourage the opening up of new niches in the health-care market and address the associated intellectual property (IP) issues.

The National Health System (NHS) of the United Kingdom (UK) has made a clear step in this direction with a radical programme for the promotion of innovation that seeks to tackle two types of imbalance, also highlighted by recent policy discourses. First, the amount of basic research carried out in the UK exceeds the benefits actually observed in the clinical realm (Cooksey, 2006; UK Evaluation Forum, 2006). Second, it is widely recognized that improvements that come about during the delivery or management of routine patient care rarely spreads beyond the source context (Department of Health, 2003). Lack of communication channels and of standard procedures across health-care units impede the diffusion of new diagnostic tools or – more often – new practices such as use of data, training and treatment protocols.

As the skills required for proper IP management go beyond the capacity and the scope of NHS Trusts, the Department of Health has recently established the Institute for Innovation and Improvement. Its central purpose is to accelerate the diffusion of innovative ideas and new practices as well as to facilitate the uptake of proven improvements in health-care delivery models and processes. Being placed strategically at the interface among relevant stakeholders, the Institute enables capacity- and capability-building for individuals, teams and organisations. It is structured in teams that pursue and contribute to specific trajectories of development by i) identifying areas of improvement; ii) searching and assessing existing solutions within the system; iii) looking for best practices in external environments (i.e. other countries, companies); iv) creating a commercial package that works with a private company or third party that will sell your idea in the marketplace; v) ensuring equitable rewards for all parties.

A key component of the Institute is the National Innovation Centre (NIC), which operates as a platform that connects inventors and relevant stakeholders. It provides a single point of contact to either NHS staff (clinical or administrative) or independent providers who want to draw attention towards new procedures or diagnostic and therapeutic devices. NIC determines both ex-ante and ex-post standards for the process. In relation to the former, it provides guidelines and stimulates the response of NHS trusts to specific problems emerging in the course of normal practice; for what concerns the latter, it develops specific formats to facilitate the widespread adoption of new practices throughout the national health system.

NIC is structured in nine regional Innovation Hubs distributed geographically throughout the areas covered by the English Regional Development Agencies.[4] Innovation hubs are the gatekeepers of local knowledge infrastructures that connect NHS Trusts and Primary Care Trusts with the health authorities and industry players. They provide a range of services to support the development and the diffusion of innovations within the NHS, mainly through the management of intellectual property. Most of the hubs offer two broad typologies of services, either aimed at NHS staff – like training, technology audits, IP management – or at local business – like market research, access to medical staff for exploring innovative ideas, licensing arrangements.

The governance of knowledge generated by the provision of a public service raises the need to uncover the relational structure between health-care practitioners and their environment. A significant aspect of the exploitation of health-care innovations out of patient care is the existence of a technological infrastructure that provides coherence to the network of contributing parties. Figure 1 illustrates the multi-layered institutional

[4] North (Sunderland); Yorkshire and Humber (Leeds); North West (Manchester); West Midlands (Birmingham); East Midlands (Nottingham); East (Cambridge); London; South East (Egham); South West (Salisbury).

infrastructure of the health-care system in the UK, and the role of regional innovation hubs within it.

FIGURE 1 ABOUT HERE

Here we note that the integration of health-care provision and innovation relies on a model of collective activities which is intended to have a life cycle beyond the incidental solution. Such a model is maintained by platforms (i.e. the hubs) that interface multiple and diverse users and, most importantly, are the result of specific policy action and funding, as opposed to the spontaneous forms of organization which is featured in the economics of networks.

Though their scope is defined by the framework of NIC the hubs enjoy a certain degree of independence. The conduit of their activity is marked by localization on the space of competences and region-specific activities, other than on geographical location. A useful indication of the kinds of specialization that characterizes the hubs can be inferred by looking at the landscape of Table 1, which maps the innovations (columns) which have been developed during the last two years with the contribution of the hubs (rows).

TABLE 1 ABOUT HERE

The innovations are divided in two macro-categories (manufactured products or services) which are further classified in: medical devices; tools for support of clinical activities; services for patients and NHS staff services. The cross-hubs innovative performance features a great degree of variety with respect to several dimensions. First, the sheer number of entries in the table shows higher activities in Yorkshire, Manchester, London and Cambridge; second, there is an observed bias towards novel clinical and medical product, as opposed to patient services, in all the hubs with the exception of Manchester; third there is variety across the models for new products and services development whereby some were carried out in-house within the trusts and some entailed the involvement of third parties either through partnerships or spin-outs.

3.2. External knowledge governance and technological platforms in the case of the automotive sector in Piedmont

The integration between the analysis of localised technological change and the role of technological platforms as coordinating systems is of special interest for the case of the automotive industry in general, and for the Piedmontese one more precisely, for different classes of intertwining factors: 1) the increasing complexity in the knowledge and technological base of the automotive industry; 2) the strong specialisation and division of labour in car production; 3) the importance of coordination costs and coordination mechanisms; 4) the crisis of FIAT and the undergoing structural and organisational change in the Piedmontese automotive system.

The technological and knowledge base required in car production has been characterised by a complex technological and knowledge base from its very beginning. This complexity is however recently increasing from both the static and dynamic viewpoint. Car production requires the full understanding of the complementarities within a wide range of different technologies and materials, and therefore the command of a very complex set of knowledge modules in engineering, electronics, chemistry, plastics technology, robotics, informatics and telecommunications. Each of these modules however cannot be fully commanded internally by the firm. Knowledge is complex because it requires the integration and recombination of external and internal knowledge via the supply and demand of products, components and process technologies.

Historically, the integration, recombination and in turn the coordination of such a growing number of components, technologies and modules of knowledge has been achieved through an increasing division of labour, specialisation and outsourcing. These are the results of the intertwining effects of market saturation, product differentiation, demand uncertainty and financial pressure that bring about increasing needs of operational efficiency and therefore organisational and technological change. From the organizational viewpoint car production is therefore clearly characterised by strong specialisation, strong division of labour and therefore important coordination costs.

Such increasing specialisation and fragmentation cause a range of ways and paths along which Original Equipment Manufacturers (OEMs, i.e. car-makers) decide to outsource production processes and activities. Know how and capabilities are distributed quite differently across both OEMs and suppliers. Product architecture in the car industry can differ substantially from model to model and the notion of interchangeable modules, components and activities across models, OEMs and suppliers is limited due to significant variations in know how and competencies. Different suppliers are characterised by different capabilities: providing even the same activity or component to different clients implies for the same supplier, different competencies. Selection among suppliers and the emergence of preferential relationships are important in this context. Suppliers' activities and capabilities are not fully interchangeable and modular, nor fully reversible. Knowledge modules are not completely interchangeable because of the specific, idiosyncratic and ineliminable part of know-how. This bears in turn bear important costs for OEMs. Important switching costs are associated to shifting from one supplier to another, and related high costs are due to changes in the technology modules and in the design of the system and the architecture of coordination. Preferential interactions between OEMs and suppliers emerge in turn as an effect of such costs (Sako, 2003).

Interaction between actors is crucial for such coordination, and successful product innovation (i.e., the introduction of a new car) implies the ability to coordinate in the more appropriate way the wide networks of specialised suppliers and partners. In other words product innovation is directly related to the ability to introduce and manage changes in both the organisation and production processes.

In this regard, the Piedmontese automotive sector underwent and is currently undergoing a phase of strong structural, organisational and institutional change due to the crisis of the main actor, namely FIAT. As the mingled result of increasing complexity in the knowledge base and the crisis of FIAT, car production in the Piedmontese system has been and is still characterised by progressive vertical disintegration and strong externalisation of more and more complex and specialised components and processes. This results into the stronger and stronger need of coordination of the division of labour and communication between specialised producers and users. Such a need for coordination mechanisms is paralleled by the loosing role of FIAT as traditional "hub" of the network of small and large suppliers and R&D institutions. The eventual lack of coordination is one of the main problems due to the crisis of FIAT, which is instead by no way a crisis of the Piedmontese automotive system as a whole. This is in fact today a sophisticated multi-firm productive system characterised by a complex network of highly specialised suppliers for the international market, design firms (such as Pininfarina and Giugiaro), machine tool firms, research and training organizations (CRF and ISVOR), and university programs (Enrietti and Bianchi, 2003).

The evolution of the organisation and coordination of car production paralleled the loosing of technological capabilities internal to Fiat and can be articulated in three stages: 1) coordination through vertical integration, 2) coordination through a centralised network of local suppliers, 3) coordination through a distributed network (Table 2). Fiat moved from a vertically integrated production structure to the outsourcing of manufacturing activities and the production of components to local small suppliers, creating a local and closed productive network of suppliers dependent on Fiat to a very large extent, and coordinated centrally by Fiat. Subsequently, and more importantly, suppliers able to benefit from economies of specialisation and learning, accumulated competencies that make these firms emerging as first-tier suppliers. On the one hand, these first-tiers suppliers are also able to integrate themselves into international productive networks and becoming international suppliers of car makers. On the other hand, they are able to move from the mere provision and supply of simple components to the provision of product design services and the co-operation with Fiat in the design of the overall production process. Now Fiat chooses to outsource those strategic activities such as design, and to transfer to supplier not only activities, but also autonomy and key decision processes in terms of the design features. This is clearly possible only in that suppliers accumulated specialised competencies with regard to product design, and more generally innovative skills.

TABLE 2 ABOUT HERE

As a matter of fact, important changes involved not only the choice between make and buy, between internal production and external provision, but also the way in which Fiat coordinates and manages external supply. A straightforward example of such changes is the adoption by Fiat of the so-called Advanced Product Quality Planning (APQP)[5] methodology in managing the suppliers network and their activities. Prior the adoption of APQP, the definition of new cars and component characteristics and the process of their acquisition from suppliers was defined ex-ante and dominated by the design centrally specified by FIAT: given ex-ante characteristics of components, FIAT set prices and identified the appropriate suppliers. With the adoption of APQP and progressive decentralisation of activities also engendered by the accumulation of competencies by suppliers, the process reverted. Now Fiat defines the general design and characteristics of a new car model and communicates such information to the network of suppliers. Each supplier, according to its specific technological knowledge and to the price/quality requirements, elaborates a project for the production of the given component or system. The competition among suppliers makes the more appropriate projects emerging and allows Fiat to select the more appropriate suppliers.

[5] The APQP (Advanced Product Quality Planning) has been adopted by Fiat in the context of the partnership with GM, established in 2000 and failed in 2005. The APQP method is a structured system for the control of the different phases of new products development, from early conception to design and to production. The method is part of quality standard QS-9000 and ISO-TS 16949.

Only after such competition and selection processes, the negotiation between Fiat and the selected suppliers defines ex post and precisely the characteristics and the prices of the given component or system.

Such a change contributes to the emergence of a decentralised and distributed platform (Figure 2) where medium sized suppliers acquired new centrality in both the organisation of and innovation in car production in Piedmont, thanks to their ability to accumulate and create new internal technological knowledge. The performance of both Fiat and the system now is very much depending from the performance of these first-tier suppliers, especially in terms of higher efficiency in production, better quality of components and modules and innovative capabilities brought into the process.

FIGURE 2 ABOUT HERE

Paralleling the difficulties Fiat went through, a new organisational structure in the sector emerged, where medium firms are more and more key actors both in productive terms and in terms of their innovative and design capabilities, as well as actors that progressively acquired coordinating functions that were previously demanded to the large firm.

From the viewpoint of the external governance and the coordination of the network of suppliers, the process of progressive transfer of upstream strategic activities and autonomy from Fiat to suppliers (Whitford and Enrietti, 2005) put in place in the '90s involved not only first-tier suppliers but also, nowadays, second-tier suppliers and can be seen as an effective mechanism of the dynamic coordination of the division of innovative labour.

Although the decision to adopt and the implementation of the distributed platform has been decided centrally by Fiat, the new mode of coordination implies the integration of top-down resources and capabilities provided by the OEM (i.e. the general and macro template of a new car) with the bottom-up innovative activities provided by specialised suppliers (i.e. the actual implementation of modules and components with new features and performances). This integration is especially relevant in terms of the dynamic coordination of the production of new car models. A given new car model is now an emergent property of the cooperative efforts of Fiat and suppliers along the entire production chain, aiming at the development and exploitation of complementarities in different activities, technologies and spaces of competencies. The introduction of a new car model is now possible only in that the OEM and the specialised suppliers co-design the features of the variety of components and modules that need to be integrated into the new final product. The effective coordination of this innovative process, and the successful introduction of new cars, is now possible only because of the adoption of a distributed platform that supports the interaction between the different organisations.

In such a context, the introduction of advanced and systemic digital communication infrastructures may have important implications to different extents.

First, the costs of interactions and integration of different actors and element within a network increase often exponentially with the increase in the number of actors, elements, components and subsystems, i.e. with the increase in the complexity of the system. Coordination costs that quickly increase with the number of elements and modules rapidly also spoil any benefits from specialisation and the division of labour. Implications from the use of digital technologies are two-folded in this context. On the one hand, digital technologies mitigate the collective costs of increasing complexity making such interactions and the integration of individual modules of knowledge easier. On the other, digital technologies favour the exploitation of the complementarity between face-to-face and digital communication, with face-to-face interaction focused on crucial decision making processes and problem solving and computer mediated communication focused on the management of routines activity (Steinmueller, 2000).

In this regards, a distinction between information governance and knowledge governance seems useful in clarifying both the scope for technological platforms and the application of ICT in the organisation of complex knowledge. On the one hand, information, in that it is codified, can be diffused and shared by means of standardised channels and processes of communication such as ICT-based networks. Information Systems are standardised interfaces between actors within, for instance, a supplier network, that enables the transmission of information between clients and suppliers, even on long distances. On the other hand, however, knowledge is much more complex than and cannot be reduced to mere information. It entails an intrinsic amount of tacit know-how characterised by high levels of stickyness and idiosyncratic conditions of learning. Knowledge requires articulated communication processes and practices of knowledge sharing where information technologies must be integrated and enriched with vis-à-vis interactions and co-location.

Second, complex products and technologies such as car production are characterised by relatively high engineering costs because models need to be frequently modified in order to embody technological improvements. Firms have an incentive to reduce the costs of new design in order to improve their efficiency in the innovative process. In such a context, 'pure' architectural innovation (Henderson and Clark, 1990) does not seem an appropriate model for the car industry in that modules too often change in response to demand needs and the requirements of new models. Digital platforms, when standardised, permit old and new components and modules to be assembled and integrated easier in large and complex systems reducing the cost of changing product design in that they improve the interconnection and integration of different knowledge and technology modules (Steinmueller, 2003).

However, the introduction and use of digital technologies is limited by the extent to which the different car models are characterised by high levels of variation in their components, sub-systems and systems. In those segments of the automotive sector where variation in models and components is relatively limited, a common product design exists that defines the characteristics of systems and components across the different models. OEMs and suppliers can change at the margin the characteristics of components and systems introducing incremental changes into the common and standardised product design. This allows car-makers to adopt a unique technological platform shared by the different models and suppliers, eventually supported by digital technologies.

Where, on the contrary, variation across models and components is higher, competencies and the degree of specialisation of the different suppliers vary a lot as well. Here production is much more similar to a taylor-made activity where each model has its peculiar components and systems, which in turn have their own technologies, performances and quality standards. Here, the scope for technological as well as digital platforms is more limited and client-supplier relations involved bilateral and ad-hoc interactions and agreements rather than being based on wide-spread and systemic coordination of activities.

Third, the adoption of digital platforms is major technological change that brings with itself organisational change and new forms of coordination of the division of labour. The car industry is characterised by high cost in the design, engineering and more generally set up cost of outsourcing and the design of the organisational architecture (Baldwin and Clark, 2000). These determine not only the industry structure but also and more importantly the organisational and institutional form adopted to manage outsourcing and the coordination of the division of labour between OEMs and suppliers (Sako, 2003). In this regard, the introduction of digital platforms may reinforce the trend towards vertical disintegration and horizontal modes of coordination of production and knowledge; namely from centralized coordination (i.e., OEMs-centred coordination), to decentralized coordination (multi-hub coordination), towards distributed coordination (highly decentralised coordination). Digital platforms co-evolve with and are major driver of the emergence of new technological and organisational platforms, and more generally of institutional forms apt to coordinate the variety of organisations, activities and competencies.

4. Discussion

Inter-organisational division of labour and coordination channelled by technological platforms address the inherent instability that characterizes systems of innovation. In these, technologies and organizations undergo frequent changes that trigger both the emergence of wider opportunities as well as the prospect of imbalances and failures. Neither of these can be ascribed to availability or lacking of technological knowledge and competences. Likewise, changes in the design of organisation of production imply also the revision of bargaining power and power relations across actors (Baldwin and Clark, 2000; Steinmueller, 2003; Volpato and Stocchetti, 2002). Infrastructures like technological platforms ensure the viability of innovation systems by putting in place rules of governance that stimulate collective participation and at the same time preserve the alignment of diffuse interests.

They play an important regulatory role (when close, proprietary and for instance managed by a central actor) or instead open new rooms for conflicts and governance questions (when open and non proprietary). The benefits of hierarchical and centrally planned platforms are clear in this perspective, in that they establish without ambiguities both the levels and nodes where crucial decisions in terms of productive strategy and the structure of organisation itself are made, as well as the actors who have the right to perform such tasks. The central node filters inclusion of new members of the network and eventually of new modules in the technology and knowledge, and commands the knowledge about the design of the organisational architecture.

As seen in the case of the health-care system, the standards for intellectual property management are designed centrally by the Innovation Institute and executed locally by the regional hubs. This ensures lower prospective costs in the management of the architecture, i.e. lower set up costs when compared to those of decentralised organisations based on outsourced and diffused networking. Likewise, organisation of car production displays an inherent degree of integration of production and centralisation of decisions in that modules cannot be swapped in a fully reversible and interchangeable way because of the model-specific characteristics of, let us say, engines, powertrains, and the electrical and steering systems. Hierarchical and centralised models provide better consistency and coherence to the integration of different components and technology modules, when these are often subject to changes in their characteristics and in the way they are combined together. Systemic integration of changing modules into changing architecture may be better provided by hierarchical platform. For instance, FIAT-centred technological platforms on the one hand may take advantage from the characteristics of close and hierarchical coordination forms, but on the other have to face the problem of the losing institutional coordination played by FIAT itself through time. On the other hand, increasing technological and product complexity made interaction crucial, such as in the case of true co-design. Still in the automobile case, cooperation between OEMs and suppliers involve the creation of suppliers' capabilities according to the needs of OEMs but at the same time providing suppliers with the know-how and the competencies necessary to serve even other users.

Both case studies show the role of co-investments between clients and suppliers for adaptations of components and subsystems as well as the structure of the network itself, according to the requirements of the customers. Here, integration of new actors, components and modules of technology and knowledge is favoured by coherent rules of engagement and can be delegated to peripheral nodes. Similarly, both cases show that the design of products in a platform often matches that of the organization. Digital platforms, for example, are open to allow enough flexibility to the adoption by small suppliers and knowledge services firms. In the context of health-care new software applications designed by peripheral units of the NHS undergo a phase of standardization through the conduits of the Innovation Institute. In so doing software acquire coherence and, thus, fungibility of use in the system. Moreover, decentralised, distributed and open solutions take advantage from division of labour, specialisation and the use of localised knowledge. Such solution, when standardised, benefits from rapid trial-and-error learning and the tapping into local pool of collective knowledge where each actor contributes with its specific module of competencies and technologies. Open and distributed platforms can benefit from the diffused pool of competencies and the network of complementarities already in place like in the case of the Piedmontese car system. They also imply the proactive and creative role of producers and users.

Producers and users can now co-design the characteristics of new products, component and service according to their common needs.

The adoption of distributed coordination is a process innovation in itself that can make the introduction of products and services (i.e. patient-care and cars) easier and more effective, through the diffusion of the variety of knowledge modules and the creation of dynamic complementarities across the distributed innovators. In other words, platforms favour the exploitation of collective pools of knowledge and competencies that are built upon the connective structure of the system. However, redundancies of connections, increasing networking costs and governance issues may limit the scope and the advantages of such solution.

5. Concluding remarks

This paper looks at the conditions under which the generation and diffusion of technological knowledge stimulates development in the context of systems of innovation. These important phenomena cannot be effectively examined without crossing levels of analysis. The main argument proposed here is twofold: first, technological change is a collective process generated by the coordination of dispersed capabilities of a variety of agents; second, the viability of this process relies on the creation of innovation infrastructures that are responsive to the dynamics of interrelationships within and across different activities, and forms of specialization embedded in these. As coordination across different organizations is increasingly important to achieve desired performance outcomes, such infrastructures are strategically placed within systems of innovation to facilitate connections across different actors.

Technological platforms are a particular instantiation of innovation infrastructures. Though on surface they present similar characteristics, technological platforms differ from networks. The former involve *ex-ante* coordination as opposed to the ‘spontaneous’ coordination commonly discussed in the context of the economics of networks. Accordingly, the creation of technological platforms entails the search for and the development of complementarities among a variety of activities, as opposed to mere agglomeration. The notion of platform subordinates the analysis of network-type of activities to the relational structures that concur to their generation, thus presenting a dynamics reading of the phenomenon.

The paper presents two empirical case studies in the United Kingdom and Italy. We describe the efforts of the UK health system to encompass coordination of dispersed innovation efforts through the creation of a national technological platform which operates locally through nine regional hubs. Similarly, the case of the car industry in Turin shows that institutional change, involving the shift from vertically integrated coordination of production to the implementation of a local distributed platform, engenders cooperation between the OEM and specialised suppliers on the technological design of new models and components. These highlight the importance of institutional responsiveness to distributed innovation through the creation of relational structures that facilitate the translation of individual efforts into collective activities.

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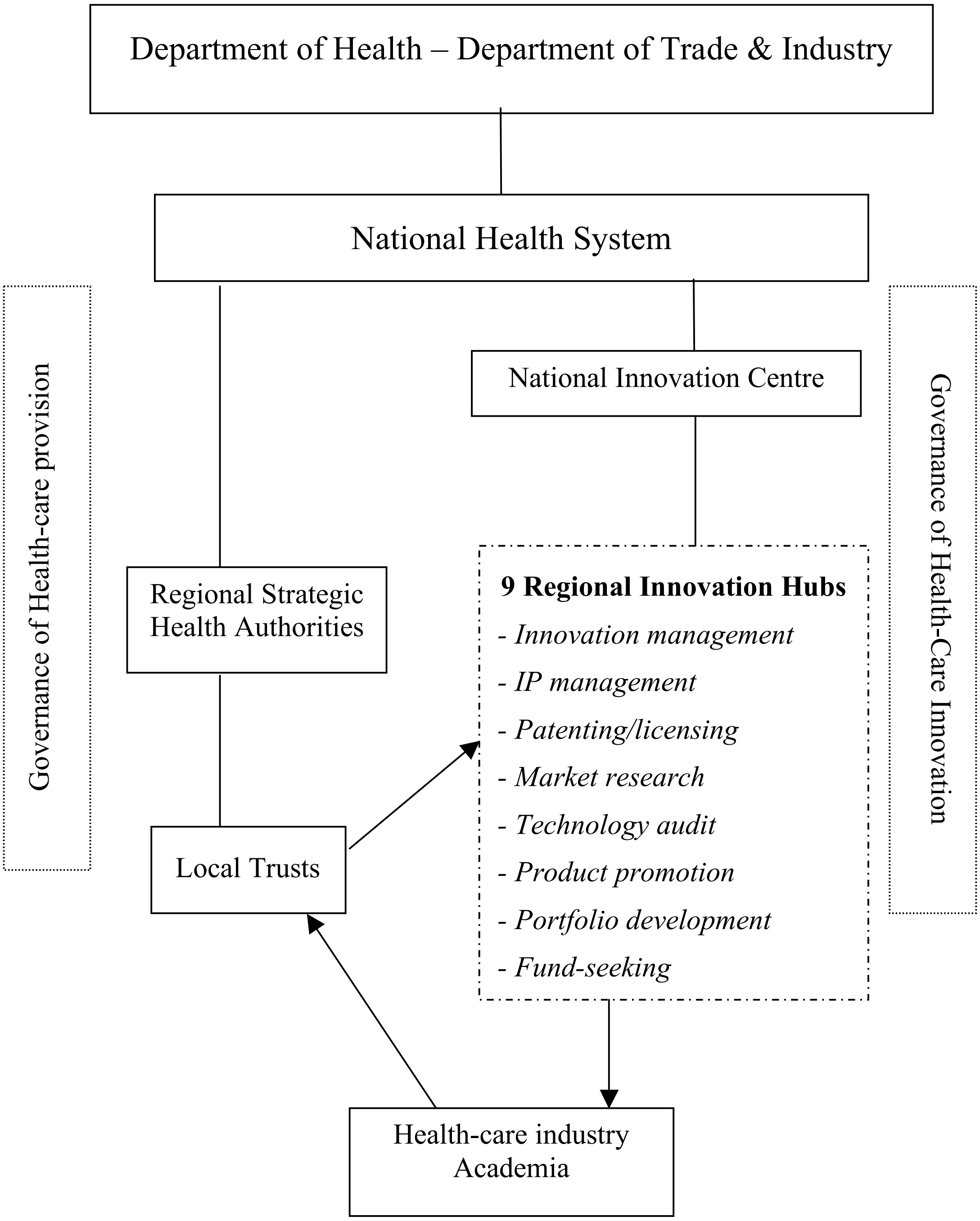
Figure 1: Institutional infrastructure for Health-Care innovation in the UK



	Manufactured products		*Services*	
	Medical devices	*Clinical support*	*Patient Services*	*Staff Services*
North (Sunderland) 6	- Pupilometer* - Blood tag reader* - Fluid flood meter - Hand -splint support*		- Drop -off repair system	- Booklet on speech for children with special needs *
Yorkshire (Leeds) 34	- Panoramic test * - Motorised lifting aid* - Sway Pen Device - Digital Video Sleep Monitoring System* - Cast Battery device* - Snore capture device* - Switch device for di sabled children - Patients Lifting Device * - Hip Stick for wheelchair users * - Motorised drip stand*	- Electronic Patient Questionnaire * - Support arm * - Personnel Management database - Software to assess motor skills * - Test for panoramic dental x -ray - Ultrasound Device for blood flow * - Fibre -optic device for tracheal intubations * - Phantom for x -ray bone densitometers * - Visual Field Analyser - Urological Digital Diary * - High-resolution dose meter * - Software for digital manipulation * - Radiological software package * - Solution for storing transplant organs - Focussed Gene Array* - Diagnostics for colorectal cancer * - Measurement of gastric acid secretion - DNA/RNA Extraction Buffer * - Markers of Preeclampsia		- Interactive Radiotherap y training - Fire safety training simulator - Training device for colorectal surgery - Patient Safety Device - Haematology training aid
West Midlands (Birmingham) 5	- Multi -grip walking stick * - Breathing support valve * - Pyjama design for in - patien ts*	- Sensory Software * - Optical Coherence Tomography probe *		
East Midlands (Nottingham) 2	- Sterilising sleeve for limb surgery *	- R&D Operating System *		
East (Cambridge) 9	- Needle Exchange Cabinet - Pelvic Cushion	- Web d atabase for haematology diseases* - Lifestyle check -up software - Health Screening Software for GPs - Falls care assessment bundle	- Diabetes Management program	- Improvements Review Toolkit * - Resource Pack to assist patients with learning disabiliti es
North West (Manchester) 20		- Patient Observation Chart	- Transcranial Magnetic Stimulation - Home Pulmonary Rehabilitation - Prevention for heart diseases - Down -syndrome	- Information Governance Booklet - Smoking Cessation Service - Protocol for patient constipation - Buildings design

North West (Manchester) 20 **North West (continued)**		- Patient Observation Chart	- Transcranial Magnetic Stimulation - Home Pulmonary Rehabilitation - Prevention for heart diseases - Down -syndrome Children support - Young Pregnant support - Breastfeeding support - Nurse intervention for Hypertension due to diabetes - Diagnostics for mental health - Assistance for nebulised medication - Screening program for Gonorrhoea - Health awareness development program - Prescription support practice - Fear of falling booklet	- Information Governance Booklet - Smoking Cessation Service - Protocol for patient constipation - Buildings design project - Secretarial services improvement program - Management of needle stick injuries
London 10	- Aid for Parkinson's patients - Falls mat	- Multi -purpose sensors - Fibre -optic oximeter - Airway inspection device - Anti -coagulant for blood collection* - Support for fractured arms - Laparoscopic tool - Collapsible bed tray - Slide comparator for histological exams		
South East (Egham) 5	- GPS tracker for patient w/ dementia *	- Dosimeter for nuclear medicine * - Electronic quality Audit for trials		Training courses: - Defibrillation; - Primary -care skills;
South West (Salisbury) 3	- Electronic muscular stimulators *			- Functional Electric stimulation courses* - Infection Control Training Package

* commercialization licensed to third party/spin-out or developed in partnership

Table 1: NHS Innovation hubs in the UK and their successes

Table 2. Institutional change in the coordination of car production in Turin

Phase	Coordination structure	Characteristics
I phase: '70s	The firm	- Vertical integration of production - Internal accumulation of R&D - Internal accumulation of capabilities in the design of cars models - Internal accumulation of capabilities in technology design - Innovation in isolation
II phase: '80s	The centralised network	- Outsourcing of components production - Ex-ante and top-down design of both cars models and components - Central coordination of suppliers' activities by the OEM - Exclusive provision from small suppliers to the OEM - Innovation undertaken internally by the OEM
III phase: '90s and ongoing	The distributed platform	- Suppliers benefit from economies of specialisation and learning - First-tier suppliers emerge as innovators at the local and international levels - Outsourcing of R&D - Outsourcing of components production - Outsourcing of design in both components and modules - Internal to the OEM product and system architecture design - Integration of top-down (OEM) and bottom-up (first-tier suppliers) innovative process - Co-design - Co-innovation

Figure 2: The platform in the car industry in Turin