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Dynamic capabilities: evolving organisations in evolving (technological) systems

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Abstract: This paper aims at exploring the nature and the determinants of the dynamic capabilities of the firm: a notion which, while increasingly more fashionable, remains still conceptually diffuse. Through a critical review of the massive and heterogeneous literature which refers, either explicitly or implicitly, to dynamic capabilities in explaining the dynamic performances of the firm, the paper detects a certain gap between an organizational and an environmental kind of approach to the issue. The nature of the firm and that of the firm environment are in fact focused on alternatively, thus implying a dynamic capabilities analysis which turns out to be biased. The pros and the cons of a combined approach, which tries to integrate the two, are shown and contrasted to a more satisfactory approach, which deal with the firm as a system operating within an institutional setting of techno-economic relationships, i.e. a technological system.

Keywords: dynamic capabilities; firm organization; firm environment; technological systems.

JEL Classification: D23, L22, 033

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1. Introduction

Germinated in the field of strategic management, the concept of ‘dynamic capabilities’ has progressively flourished also in other areas of investigation of the firm and organisation behaviour, as it has turned out to be very fruitful in addressing “the way organizations deal, or fail to deal, with technological challenges” (Dosi *et al.*, 2000, p. 15). Thus, dynamic capabilities seem to have become a sort of micro-foundation of the literature, mainly with an evolutionary background, which endogenises technological change by linking the advent of new technological paradigms to the evolution of the firm knowledge-base (e.g. Dosi, 1984; Freeman, 1982).

In adapting their existing capabilities over time, in acquiring or in developing new ones, organisations engage themselves in a process of learning something new. The dynamics of the firm capabilities is thus rooted in the firm knowledge base. This appears nearly tautological when we think what capabilities refer to: in brief, “knowing what to do, or how to do it” (Loasby, 1996)¹. This crucial equivalence has made the theory of organisation the ‘shelf’ where to search the tool-box for investigating the dynamic capabilities issue, and actually made its analysis an application area of the theory of organisational learning². Organisational learning thus offers tools that made the dynamic capabilities issue to become less ‘black-boxed’. Indeed, the investigation of the process of ‘organizational knowledge creation’ (Nonaka, 1994, p. 15) has cast new light on the different ways and effectiveness with which firms/organisations deal with their changing environment.

This is for sure an extremely important result. However, the aim of this paper is to argue that, although extremely important in addressing the epistemological and the ontological foundations of the firm dynamics, the theory of organisational learning has also entailed a certain focalisation-bias. By centring upon the internal organization of the firm, it has in fact somehow neglected the relational and contextual aspects affecting the creation and development of dynamic capabilities. Indeed, although concepts of interactive nature (such as, for example, ‘integration’

¹Of course, the meaning of the term ‘capabilities’ would deserve, *per se*, a deeper exploration. However, it is not this paper’s aim to engage in such an arduous exercise, while it is recognised that a sort of change of status of the concept has happened: from “a label on a black box” to “a label on a more transparent box — which can be seen to have other boxes inside it” (Dosi *et al.*, 2000, p. 4). In particular, the authors share the emerging idea that the most inner (i.e. the core) of these boxes is represented by ‘organizational routines’, while other outer boxes contain less routinised action and cognition patterns (Dosi *et al.*, 2000, p. 5).

²See, for instance, the special issue on “Organizational Learning: Papers in Honor of (and by) James G. March”, published in 1991 by the journal *Organization Science* (Volume 2, 1991).

and ‘combination’) are often called forth in the organisational account of learning and dynamic capabilities, however, their relevance is generally hidden by relegating them within a generic environment, mostly depicted as an aseptic ‘diamond’ of firms, suppliers and users, whose relationships are almost exclusively of formal nature.

The role of relations and context in shaping firms’ learning processes finds a more satisfactory account following a different perspective, focusing on the so-called ‘local systems of production’. Indeed, by drawing on various theoretical backgrounds, this stream of research stresses the relevance, in adjusting and building up firms’ capabilities, of factors such as, for example, the localisation in a Marshallian ‘industrial district’ (Marshall, 1950; Becattini, 1979, 1987), the embeddedness in an ‘innovative milieu’ (Aydalot, 1986; Camagni, 1991b), and the firm setting in a ‘regional system of innovation’ (Cooke, 1998). However, also the focus on local production systems entails a bias somehow symmetric to that implied by the focus on organisational learning. Indeed, an ‘environmental’ account inevitably takes some focus out of the firm as a knowledge creating organisation, and even more as an organisation that manages the dynamics of its capabilities (Lipparini and Lorenzoni, 1996)³. Thus, dynamic capabilities tend to degenerate into social and system-specific capabilities: firms have different individual (rather than organisational) abilities to benefit from rather than to build up.

Given that both ‘organisational’ and contextual/relational (in brief, ‘environmental’) factors play a crucial role in shaping the learning processes of the firm, and, what is more important, given that they are strictly interconnected, laying a bridge between the two correspondent theoretical perspectives becomes an essential task. Indeed, this appears crucial once one thinks that:

“dynamic capabilities [...] emphasizes two aspects. First, it refers to the shifting character of the *environment*; second, it emphasizes the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external *organizational skills, resources, and functional competencies* toward changing environment” (Teece and Pisano, 1994, p. 557; authors’ emphasis).

³According to the industrial districts approach, for example, the learning process of the firm is crucially affected by its experience of the context, rather than by other organisational and inter-organisational dynamics. From this point of view, learning is nothing but “learning by localizing” (Lipparini and Lorenzoni, 1996).

How to integrate the theoretical analysis of these two ‘aspects’ is however an extremely delicate choice. On the one hand, overlapping the two might appear the most straightforward solution. This is what has been done so far: typically the analysis has focused the attention upon the environmental aspects from an organisational perspective. On the other hand, while casting new light on some aspects (typically on how firms organise and manage strategic kinds of relations with other firms and organisations), this integrated analysis has shed further light on some other aspects of more informal nature.

On the basis of this consideration, this paper argues that a more satisfactory analysis could be carried out by developing a novel ‘system approach’ to dynamic capabilities. Indeed, when firms are considered as open, dynamic systems, evolving (or eventually co-evolving) in broader technological systems, the analysis of their dynamic capabilities can be addressed by retaining, simultaneously, both the manifold (i.e. organisational and contextual) nature of their learning patterns, the formal and informal characterisation of the relationships they establish, and the territorial specification of their evolution. In other words, looking at firms as evolving organisations within evolving systems, would represent a more effective way to investigate the determinants and the processes of their dynamic capabilities.

The structure of the paper basically follows the logical order of the arguments presented above. Section 2 will critically review those contributions that represent the organisational viewpoint in the analysis of dynamic capabilities, while Section 3 will provide a critical survey of the environmental one. In both cases, the focalisation-bias (or de-focalisation) they entail will be stressed. Section 4 will deal with the opportunities, but especially with the dangers, of combining the two approaches by simply trying to overlap the two viewpoints. Section 5 will put forward a system approach to dynamic capabilities and candidate it as a different, possibly more effective, kind of combinative analysis of dynamic capabilities. Finally, Section 6 will sketch some conclusions and future research lines.

2. Dynamic capabilities through the organisational lens

The concept of dynamic capabilities has been recently put forward by some scholars of heterogeneous extraction to account for the different ways and effectiveness firms face ‘turbulent’ environments: either because of a certain market shock (e.g. a change in customer tastes) or

because of the advent of a pervasive technological change⁴.

This and other related dynamic issues have attracted researchers of the firm from diverse disciplines, both in economics and in other social sciences, and have inevitably entailed a certain ‘terminological soup’ around the concept of dynamic capabilities. However, a critical review of its main definitions shows some shared ‘pillars’, as well as some peculiarities, which make what has been above termed the ‘organisational’ approach to dynamic capabilities somehow partial. Table 1 presents the features of the most notable dynamic capabilities approaches of organizational nature in a taxonomic way. The taxonomy is to a certain extent original, as it is the result of the authors’ attempt at disentangling a bundle of contributions whose inspiring approaches largely overlap: for this reason, the four approaches identified are just different rather than mutually exclusive⁵.

[table 1 about here]

2.1 The strategic management approach

The first item of such a taxonomy is occupied by the definition provided by the forerunners of the concept, (Teece and Pisano, 1994; Teece *et al.*, 1997). Given that these authors introduced this concept to build up an alternative approach to strategic management on it — i.e. an approach which implements the so called ‘resource-based view’⁶ — in the following, this position will be referred to as the ‘strategic management approach’ to dynamic capabilities. According to this approach, dynamic capabilities are conceived as a generic “firm’s ability” to manage its “internal and external competencies” in order to be able to face a “changing environment” (Teece *et al.*, 1997, p. 516).

⁴To be sure, firm differentials in dynamic performances have been also explained on the basis of the strategic considerations which underlay the choice to innovate, typically in terms of adoption timing. The literature on the so called ‘first mover advantages’ is an important example of this strategic approach (for a review of this literature see, among the others, Lieberman and Montgomery (1988) and Reinganum (1989)). However, empirical evidence seems to suggest, although non unequivocally, that inter-firm differences in capabilities add to strategic choices an important element of variance in accounting for the firm performances in dynamic environments: their analysis, possibly combined with that of strategic issues, is thus inescapable (Jones, 2001).

⁵ The technology and the evolutionary approach, for example, draw on the same institutional account of knowledge and innovation, but their specific way to deal specifically with dynamic capabilities is different.

⁶Briefly, this is a strategic view that relates the competitive advantage of the firm, rather than to the firm position in a certain sector, as in the classical Porter analysis (1980), to the firm possession of resources which are rare and difficult to imitate and replicate. For a critical survey of this new strategic management approach see Foss (1997).

Apparently, the definition is just a functional one: dynamic capabilities are just capabilities to ‘play’ with other capabilities, but their inner nature is still that of ‘capabilities’. In this last respect Teece and his colleagues draw on some previous works in the field of strategic management, in particular on the seminal paper by Leonard-Barton (1992) on the ‘dynamic paradox’: according to which the ‘core capabilities’ of the firm can turn into ‘core rigidities’ if the firm itself is unable to renew them. Leonard-Barton, in turn, refers to the contributions by Selznick (1957) and by Prahalad and Hamel (1990) on, respectively, the ‘distinctive’ and the ‘core’ competence of the firm.

In this approach, strategic capabilities, both static and dynamic, are not always clearly distinguished from ‘individual’ resources, i.e. resources which are retained separable from the firm context and thus able to carry a market price. Indeed, dynamic capabilities take on the nature of a very special kind of resource — i.e. organizational and non-price-carrying — only when they are related to processes of organizational learning (Dierickx and Cool, 1989). The firm’s ability to manage its competencies in fact emerges as an ability of the firm organization to learn, so that organizational learning turns out to be the core element of the explanation of dynamic capabilities. Dynamic capabilities are thus directly connected to the “organizational processes” of the firm, whose “dynamic role” is precisely that of allowing the firm to learn — through “communication codes and search procedures which are rooted in specific organisational settings” (Teece *et al.*, 1997, p. 518) — and to generate an organisational kind of knowledge — which “resides in new patterns of activity, in routines, or a new logic of organization” (*ibidem*, p. 520).

In spite of this important qualification, two peculiarities of this approach should however be stressed. First of all, learning is indicated as the only truly “dynamic concept”, and as such is clearly distinguished from the “coordination/integration” of the firm competences, instead treated as a “static concept”, and from their “reconfiguration”, retained as a “transformational concept” (*ibidem*, p. 518-512). In so doing, the way in which the integration and the coordination of the firm capabilities actually help firms learn is not explored. Second, integration and coordination capabilities are mainly conceived as internal, that is relating tasks and activities within the boundaries of the firm. The role of external integration is simply sketched, and always by referring to formal kinds of relationships (*ibidem*, p. 519), drawing on a specific organisation research program on ‘inter-organisational learning’. That kind of knowledge (mainly tacit) firms acquire, often unintentionally, through less formal techno-economic relationships with other firms

and organisations, instead, is not addressed. This last peculiarity is typical of contributions in the field of strategic management which, although by placing knowledge at the basis of a good theory of the firm (e.g. Grant, 1996), still considers the “environment” in which the firms operate in a quite aseptic way, that is as a set of competitive relationships among competitors, suppliers and customers.

2.2 The technology approach

A second approach to dynamic capabilities can be identified around those contributions, mainly of empirical nature, which have focused on the different capacities that different firms have to use and implement new technologies: either because “technological discontinuities” can “destroy”, rather than “enhance” their existing competence (Tushman and Anderson, 1986), or because they might require a change in the “architectural knowledge” (implicitly) embodied in communication channels and interpretative filters (Henderson and Clark, 1990). In the light of the attention these contributions pay to the nature of the new technology which is introduced, usually in the form of a new product, or a new development project (Iansiti and Clark, 1994), the relative approach is here referred to as the ‘technology approach’ to dynamic capabilities.

Indeed, dynamic capabilities are here ‘technological capabilities’, that is capabilities which apply, depending on the specific contribution: to the technological “knowledge” the evolution of techniques (around a ‘dominant design’) requires the firm to master (Henderson and Clark, 1990); to the technological “skills and know-how” the firm uses to deal with new products and processes (Tushman and Anderson, 1986); to the recursive chain of technological “activities” through which the firm engages in technological problem-solving (Iansiti and Clark, 1994)⁷. In this last account, in particular, the ‘dynamic capability’ of the firm operates precisely on such a chain, making it the shorter, i.e. with a superior “dynamic performance”, the more “consistently” the firm responds to some form of environmental turbulence, mainly technological (*ibidem*, p. 561).

While they definitively apply to technology, the inner nature of dynamic capabilities

⁷Iansiti and Clark explicitly define a dynamic capability as “the capacity of an organization to consistently nurture, adapt, and regenerate its knowledge base, and to develop and retain the organizational capabilities that translate that knowledge base into useful action” (Iansiti and Clark, 1994, p. 563). “Knowledge base”, “organizational capability” and “actions” are thus the three consecutive rings of that recursive chain of activities through which the firm engages in technological problem-solving.

themselves is in this approach more diffuse. On the one hand, organisational learning still seems at the core of their explanation, thus making them organisational competences — Henderson and Clark place them at the core of a “switch to a new mode of learning” (*ibidem*, pag.17) — if not even organizational routines — to turn new knowledge into new action, as Iansiti and Clark put it. On the other hand, strategic arguments in shaping the firm dynamics are attributed much greater emphasis. In fact, learning is directly connected to “problem-solving strategies”, related to the decisions the firm has to take about the resources to invest in accommodating for the new technology and, above all, about the timing to reconfigure its competence and knowledge after a certain technological discontinuity (see, for example, Christensen, 1997).

This strategic influence, which reveals a certain overlapping between the present and the previous approach, crucially affects the way the firm and the firm environment are depicted. First of all, the firm is described in ‘technical’ terms, as a community of engineers and strategies designers which try to tackle the firm technological complexity. Even when the need of the firm to consider, when developing and implementing new products, its internal and external context is retained, i.e. when its “integration capacity” is addressed, as in Iansiti and Clark (*ibidem*, p. 565), this is mainly a “technology integration capacity” (*ibidem*, 571): that is an ability to ‘pick-up’ those pieces of the technical knowledge evolving around the firm, which are more suitable to be linked with the existing knowledge base of the firm, and to actually implement this linkage⁸. By definition, as it is based on the identification and implementation of knowledge linkages, such an integration directly refers to an explicit body of knowledge, or to a set of codifiable information. The same capacity does not apply, instead, to other forms of knowledge integration, of more tacit nature, which call for some kind of physical proximity between the firm and its interacting organisations, and which are as important for the development of a new concept.

A second strategic influence on the present technological approach concerns the characterisation of the firm environment. Indeed, in general, the firm environment is nothing but a typical ‘industry’, just populated by ‘established organisations’ (incumbents) and ‘new entrants’,

⁸More precisely, in Iansiti and Clark’s framework the development of a new product is crucially affected by a capacity integration which is largely “external”, as it has to do with the ability to “sample external information sources” and to “frame and evaluate [the resulting concept] options” on the basis of the existing knowledge base: i.e. an ability which depends on the external interface of the firm (*ibidem*, p. 570). Such a capacity is paralleled to an “internal” integration capacity, which is instead crucial in assisting the implementation of a new concept, and which has to do with the establishment of proper organisational structures and management practices. For a deeper analysis of the idea of “technology integration” see also Iansiti (1992; 1995).

among which the relevant relationships are mainly of competitive nature. Following a traditional structure-behaviour-performance approach, the firm environment is described in terms of competitive conditions, such as “[...] uncertainty, [...] munificence ([i.e.] the extent to which an environment can support growth), [...] entry-exit patterns, and degree of order within a product-class” (Tushman and Anderson, 1986, pp. 445-446). Non-competitive relationships among firms, and relationships with other institutions and organizations of different nature, are instead just given a marginal role in shaping organizational learning and the capabilities dynamics. Even in Iansiti and Clark (1994), who explicitly consider the external integration capacity of the firm, the relevant actors are fitted in Porterian ‘diamonds’, and connected through ‘rows’ which still conduce information bits and explicit knowledge flows. What is more, out of the manifold set of relationships the firm establishes beyond its boundaries, only those with customers are deemed relevant for the capability-building process. In other words, by sticking to a sort of ‘demand-pull’ view of innovation and change, integrating the knowledge of the market and of the customer base, i.e. a “customer integration capacity” (*ibidem*, p. 570), is seen as the only relevant integration channel for increasing the firm dynamic performance. Accordingly, an interactive kind of learning (or, as the authors call it, “mutual learning”) is envisaged only between producers and customers, thus neglecting that also other actors (suppliers and competitors at first) participate interactively to the learning process of the firm.

2.3 The organization approach

Organizational learning is made more clearly explicit as a determinant of the capabilities dynamics in a third approach which could be labelled ‘organization approach’ to dynamic capabilities⁹. To be sure, under the organization theory umbrella several issues become relevant for the sake of this paper, although their linkage with the conceptualisation of dynamic capabilities is not always so direct. This is typically the case, for example, of those patterns the firm follows in “creating” new knowledge.

In those seminal contributions which model these patterns (e.g. Nonaka, 1994; Nonaka and Takeuchi, 1997), the firm dynamics, as the dynamics of any other organization, is driven by the capability of the firm to create further knowledge, i.e. to learn. The creation of organizational

⁹‘Organization’ rather than ‘organizational’ is here used on purpose, to distinguish this specific point of view from the ‘organizational’ view which instead encompasses all the approaches that are reviewed in this section.

knowledge, in turn, depends on a “spiral” of events, through which tacit knowledge, starting at the individual level, is converted into further tacit and explicit knowledge, moving up, progressively, to the collective, organisational and, eventually, inter-organisational level. The firm capability to learn is therefore an organizational capability to transform knowledge into further knowledge, and thus applies to knowledge itself.

Once compared with the previous two approaches, the organization one shows a higher attention to interactive kinds of aspects among firm/organization members and to organization-wide conditions and management models¹⁰. This attention for relational and contextual aspects emerges also from a related investigation area on ‘knowledge management’, which focuses on the way new knowledge can be acquired also and above all in order to improve organizational capabilities¹¹. Furthermore, such a relational dimension also spans beyond the boundaries of the firm, and makes external interactions extremely relevant in driving organisational learning: such items as ‘benchmarking’ and ‘best practices’ transfer among firms in fact implement this relational idea in several management fields such as, for example, in managing firm quality (Cole, 1999).

On the other hand, both in the models spurred by Nonaka studies and in other related contributions, these relational considerations are only partially encapsulated. First of all, although both formal and informal external communication channels are considered¹², the latter are simply treated as an extension of the standard intra-organisational case, rather than a constituent part of it, and, accordingly, are not given any special attention. Furthermore, following a typical strategic management approach, the ‘environment’ within which firms operate is often reduced to an aseptic triad (customers-suppliers-competitors), which affects individual rather than organisational learning. Finally, the inner organization of the firm and that of its context appear, a

¹⁰Indeed, in Nonaka model, interaction among organisation members is retained crucial both in constructing a “field” in which individual perspectives converge (i.e. in the “socialization” of tacit knowledge), and in conceptualising new organisational perspectives from shared tacit knowledge (i.e. in its “externalization”). Organization and management styles, instead, exert an enabling effect on the “crystallization” of new organisational perspectives into new products and systems (i.e. on the “internalisation” of explicit knowledge), and on their integration into the existing organisational knowledge base (i.e. on its “combination”) (Nonaka, 1994, p. 19).

¹¹ For a reconstruction and an evaluation of the state of the art of this reserach perspective see the special issue of the journal *California Management Review* (v.40, Spring 1998).

¹²In dealing with the construction of a field of convergence for individual perspectives, for example, Nonaka observes that “sharing tacit knowledge with suppliers or customers through coexperience and creative dialogue play a critical role in creating relevant knowledge” as “the mental outlook of an organization is shaped by a complex pattern of factors within and outside the organization” (*ibidem*, p. 23).

fortiori, even more stylised in those recent contributions in which organizational learning has been formally modelled: either by referring to the technological capabilities of particular industries (such as in the so-called ‘history-friendly’ models (Malerba *et al.*, 1999), or by considering more generic, emergent organizational capabilities (such as in the models based on ‘complexity’ and ‘artificial sciences’ (Marengo *et al.*, 1999).

2.4 The evolutionary approach

Dynamic capabilities have also attracted the attention of evolutionary economists, which have seen in them the dynamic equivalent of the firm diversity entailed by the variation-selection-retention mechanism (Dosi *et al.*, 2000).

In the ‘evolutionary approach’, dynamic capabilities are inevitably related to the minimum ontological element of the evolutionary firm, i.e. to its organizational routines, and in two ways. On the one hand, dynamic capabilities directly apply to “operational routines”, rather than to generic competencies or capabilities, allowing the firm to generate and modify them whenever it is necessary (Zollo and Winter, 1999, p. 10). On the other hand, and this is even more relevant, dynamic capabilities are distinguished from the routines to which they apply on the basis of their intentional and deliberated character. In other words, while operational routines are conceived as automatic or quasi-automatic responses to environmental changes, capabilities and dynamic capabilities are instead related to those “constant dispositions and strategic heuristics that shape the approach of a firm to the non-routine problems it faces” (Nelson and Winter, 1982, p. 15).

This twofold account emerges from the recent reformulation of the concept proposed by Zollo and Winter (1999), in which a dynamic capability is nothing but “a pattern of collective activity” — i.e. a close relative of a routine — the firm learns as the result of three interrelated learning mechanisms: i.e. from the “co-evolution of [1] tacit experience accumulation processes with [2] explicit knowledge articulation and [3] codification activities” (Zollo and Winter, 1999, p. 17). In particular, the latter two are pointed out as ‘cognitive’ forms of learning, through which the firm actually develop a dynamic capability. Indeed by engaging in those activities through which implicit knowledge is made more meaningful (articulation)¹³, and by translating it into codified tools, such as blueprints and files (codification), firms “produce an improved

¹³For example, collective discussions, but also simple confrontations of individual opinions and beliefs, through which the pros and the cons of new bits of knowledge are identified.

understanding of the new and changing action-performance links and therefore result in adaptive adjustments to the existing sets of routines or in recognition of the need for more fundamental change” (*ibidem*, p. 14).

For sure, Zollo and Winter’s argument increases the understanding of the factors which drive organisational learning and the creation of dynamic capabilities. In fact, it adds an important evolutionary qualification to the relevance of organizational learning for dynamic capabilities: while it is involved in the ‘selection’ of a new set of ideas, mainly through articulation and codification processes, the firm gets also engaged in the ‘generative variation’ of further knowledge. Accordingly, the ‘exploration’ of new knowledge does not necessarily prime its ‘exploitation’, as it is instead suggested by some accounts of the previous, organisation approach (e.g. March, 1991): cognitive and behavioural learning rather co-evolve simultaneously.

On the other hand, in Zollo and Winter’s, such a ‘mixed’ learning process is set at work in a framework (a typical ‘knowledge-cycle’) which occurs entirely within the boundaries of the firm, and with respect to which the firm environment does not play a direct dynamic role. Environmental factors are just “viewed [...] as inputs to the dynamic capability building process, rather than part of the process itself” (*ibidem*, p. 11)¹⁴. However, once fitted in an evolutionary framework, this view appears a contingent simplification rather than a general hypothesis. Given the importance that evolutionary economics has traditionally attributed to the institutions which make up the surrounding environment of the firm (Hodgson, 1988), their role in shaping the dynamic capabilities of the firm is another evolutionary qualification of the issue. The introduction and the subsequent development of innovation system kinds of concepts (Lundvall, 1992; Nelson, 1993), on which this paper will focus in the next sections, actually implements the idea that institutional and policy contexts, with their spatial and territorial characterisations, crucially shape the dynamic capabilities of the firm, thus introducing important policy implications (Metcalf, 1995).

This consideration is among the starting points of a ‘new’ approach to dynamic capabilities that is put forward in this paper. Such an alternative view will incorporate, in addition to those emerged in this section, some other insights which originate from a different way of

¹⁴In more concrete terms, Zollo and Winter observes that “[f]or example, a sound understanding of what competitors do and customers desire represent a crucial element of any firm’s competitive strategy, but, in and of itself, does not make it more capable of creating and modifying its own set of operational routines” (*ibidem*, p. 11).

looking at dynamic capabilities, that is through an ‘environmental’ rather than organizational lens. To the view emerging through this latter lens the next section is dedicated.

3. Dynamic capabilities through the ‘environmental’ lens

In order to consider the relational and contextual factors affecting the dynamic capabilities of the firm, it seems natural to draw on the literature on the so called ‘local production systems’. Under this generic heading it is in fact possible to place all those approaches that, in spite of their specific features and ‘unit of analysis’, share an important common view: the firm is not an isolated entity, but is instead ‘somehow’ related to its territory by relations and networks it establishes with other firms, institutions and organisations placed in the same geographical area. Of course, this is not the unique characterisation one can find in economics for the ‘firm environment’. However, it is for sure that in which the nature of the external relationships of the firm and the role of its socio-economic context are most deeply analysed¹⁵, in particular in dealing with the firm dynamics. Accordingly, the lens provided by the analysis of local production systems is the ‘environmental’ lens to dynamic capabilities considered in this paper.

In this section it will be shown that also this latter ‘environmental’ lens suffers, as the organisational one, of an important drawback, somehow symmetric to that one: in fact, in order to concentrate on the outside-the-firm space (i.e. its environment), this lens ends out with diverting the attention away from the inside-the-firm space. Consequently, the result is a certain focalisation-bias on the relational and contextual features that affect the dynamic capabilities of the firm. On the other hand, such a focalisation-bias takes place to a different extent in the different approaches which focus on local systems of production. A schematic taxonomy of the most significant approaches, rather than an exhaustive review of the correspondent contributions, might be useful in illustrating this point (Table 2).

[table 2 about here]

¹⁵A certain idea of firm environment is also present, for example, in standard industrial economics, where the firm relationships are however simply strategic, and the firm context often treated as an exogenous bundle of ‘rules of the game’.

3.1 The milieu innovateur approach (MI)

A first connection between the firm dynamics (and, implicitly, the related capabilities) and the firm environment can be found in the approach of the so called ‘milieu innovateur’ (MI), developed by the GREMI group with the objective of investigating the relationship between technology and space¹⁶ (Aydalot, 1986).

As in the organizational technology approach referred to above, innovation is still retained the crucial engine of the firm dynamics. However, out of the three approaches one can follow in analysing the relationship between technology and space – focusing, respectively, on the firm, on the technology, or on the local environment – the GREMI chose neither the first nor the second, but rather the third, retained able to encompass them both. Since the very beginning, the attention of GREMI was in fact mainly focused outside the firm. The original intention was actually that of understanding why some places are more innovative than others and, in doing so, it was implicitly assumed that these conditions were to be found outside the firm’s boundaries. The main research objective was in fact “[t]o question which external-to-the-firm conditions are needed for the birth of firm and the adoption of innovation” (Aydalot 1986, p. 10, authors’ translation).

The MI approach is evidently systemic and this crucially affects the way firms are retained in it. The MI are actually considered “incubators” of innovations and innovative firms (Aydalot, 1986, p.10), in which the firm is indeed a player, but just one of the many involved in the innovative process undertaken by the MI as a whole¹⁷. In such an approach, the organisational bias of the firm as an isolated and space-less economic agent is therefore overcome, as firms are rooted in their territory and constrained by both their local industrial atmosphere and their social, institutional and political conditions. On the other hand, however, the firm appears nearly undistinguishable from such an environment, thus introducing another bias, this time towards the MI. Indeed, only the MI seems able to innovate, while the firm and its organisation does not play any crucial role in the innovation process. In other words, the milieu determines the innovative behaviour of firms to the point that “[i]t is not the firm who innovates, it is the territory” (Gay and Picard 2001, p. 692, authors’ translation).

In the MI approach therefore, the dynamic capabilities of the firm or, better to say, their

¹⁶This is actually the research agenda for which the GREMI (*Groupe de Recherche Européen sur les Milieux Innovateurs*) was set-up in 1984.

¹⁷The firm is not an agent unexpectedly fell from heaven, who will freely choose an environment; it is secreted by its

technological capabilities, degenerate into ‘collective capabilities’: it is the MI who defines the new technological paradigms and trajectories, since it is the depository of local know-how, skills, competence and experience, specific to that particular territory. Indeed, rather than on individual learning the focus is on the ‘collective learning’ the firms realise by interacting. Interactions, in turn, are given much more emphasis than in the organizational approaches, to the point that they are considered more important than the availability of local factors and resources, again a sign of a ‘reverse bias’: non-market interactions, as well as inter-personal relations, create a local synergy that turns out to be a more powerful explanation of innovation and, consequently, of local growth within the MI (Maillat 1995, p. 159).

The idea of territory which emerges from the MI approach is evidently quite different from that of standard industrial economics - where industries come first and create the territory – or of economic geography – where it is instead space that comes first. In the MI approach industry and space are instead ontological equal, as the territory has a twofold inter-related nature: on the one side, it is the result of the innovation processes; on the other side, it performs different collective tasks in order to foster innovation¹⁸. Following this approach, the MI has come to be considered “a collective operator reducing the degree of static and dynamic uncertainty for the firms by tacitly and explicitly organising the functional and informational interdependence of local actors” (Camagni 1991b, p. 132). In order to function correctly, it has been claimed, the MI needs to encapsulate a crucial dimension, i.e. a coordination mechanism, which harmonizes all its tasks (Crevoisier, 2001). However, this concept of the MI as a ‘living thing’ gives rise to some questionings, because it seems to introduce a deterministic relationship between the firm and the MI. This approach gives the impression that, as far as a firm is located within a MI, it will become an innovative firm with no effort and with no costs. The firm does not seem to participate to the innovation processes, which is played all outside its boundaries. No connections seem to exist between the MI and the space inside the firm (i.e. its organisation).

3.2 The Industrial District approach (ID)

Out of the several approaches to the local systems of production, that of the industrial districts

environment: those who undertake and innovate are the milieux’ (Aydalot 1986, p.10, authors’ translation).

¹⁸This is what Maillat means when he writes that “The territory should not be considered as something given a priori but rather the consequence of a construction process (termed ‘constructed territory’), a result of the organizational strategies of the players and of the collective learning phenomena” (Maillat 1995, p. 159).

(ID) is for sure the most notable, as notable are its insights for the dynamic capabilities issue.

The theoretical ‘pedigree’ of the notion is quite well-known, as it goes back to Alfred Marshall observation of the tendency of small specialised firms to concentrate in a limited geographical area (Marshall, 1950). As is as well-known, this phenomenon was explained by the possibility for the firms to reap ‘external economies of scale’¹⁹, Marshall identified in: the advantages of the high specialisation of the geographically concentrated firms, the pool of subsidiary industries, the existence of a specific market labour, the easier flow of information and knowledge and the existence of a particular industrial atmosphere.

In its original characterisation, therefore, the ID represents a quite standard ‘industrial’ environment for the firm – i.e. a set of inter-industrial relationships - while it is the mechanism through which it affects the growth of the firms (and their capability to grow) which receives a novel interpretation²⁰. The same holds true for the earlier Becattini’s revisitation (1979, 1987) of Marshall’s tradition, through which the ID approach gained a new impulse. In explaining why the unit of analysis cannot be the industry, but needs to be the district, due to the presence of external economies of scale, Becattini (1979) in fact provides the first definition of an ID, whose core is still formed by inter-industrial relationships²¹.

According to this first definition, therefore, the focus is, rather than on the individual firms, on the way they interact among each other. Yet, some years later, Becattini speaks about the ID as “a socio-territorial entity which is characterised by the active presence of both a community of people and a population of firms in one naturally and historically bounded area” (Becattini, 1990, p. 38). In so doing, Becattini marks a certain shift of the idea of ID, from the consideration of purely economic factors to the inclusion of non-economic, social factors too: the ‘population of firms’ must exist within a ‘community of people’. On the one hand, this shift extends the meaning of the firm environment which drives the firm behaviour. On the other hand, however, it also entails a certain retrieval, at least with respect to the previous MI approach, of the

¹⁹Or, in Marshall’s words, economies “dependent on the general development of the industry ... [and] ... secured by the concentration of many small business of a similar character in particular localities: or, as is commonly said, by the localization of industry” (Marshall 1950, p. 266).

²⁰To be sure, also the original Marshallian district already includes some novel sociological features, which are useful in describing those system of small and specialised firms. As Marshall put it, for example, “if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas” (*ibidem*, p. 271).

²¹The definition is in fact that of “a [l]ocalised thickening (...) of inter-industrial relationships, which presents a

role of the firms themselves, as both firms and people are considered constituent players of the ID.

Although the firm does not ‘melt’ in the ID, as it instead occurs in the MI, the collectivity of the firms still captures more attention than their individuality, especially as far as learning is concerned. Indeed, by setting the ‘community of people’ at work in creating and maintaining a homogeneous system of values²², and by describing the ‘population of firms’ as specialising in one or few phases of the production processes (typical of the district), the ID gets characterised as a typical ‘flexible production system’ (Piore and Sabel, 1984). Within it, the development and transmission of new knowledge relays mainly on the embedded collective knowledge, and also technological change is a social process (Becattini, 1990, p. 47) because the ‘community of people’ embodies the relevant collective knowledge. Conversely, as in the MI approach, it seems that there is no influence of this collective knowledge within the firm’s boundaries. On the contrary, it looks as if knowledge flows among firms and individuals without interfering with the internal organisation of the firm. Again, as in the previous approach, all the attention is concentrated outside the firm’s boundaries and there is a lack of analysis of the feedback that firms gain by being located within a ID.

While the standard ID approach suffers from a certain focalisation-bias - again a bias for the system-environment, although less accentuated than in the MI approach - the assessment somehow changes if the attention is turned to the most recent contributions on the ID approach. Indeed, the change in the international economic conditions occurred in the ‘90s has opened a new discussion among those who place the firm at the centre of the analysis and those who instead focus on the system of firms (Whitford, 2001). Ferrucci and Varaldo (1993), for example, supported the firm-centred position, arguing that the ‘district-firm’ is different from a ‘normal-firm’, due to its strong root in the local socio-cultural context. Their position, along with that of other scholars who have also suggested to shift the level of the analysis away from the district-system, actually inaugurated a new way of looking at the firm dynamics, which somehow overlaps the organisational lens and the environmental one. Although this new combined

reasonable stability over time” (Becattini, 1979, p.20, authors’ translation).

²² This system of values “constitutes one of the preliminary requirements for the development of a district, and one of the essential conditions of its reproduction” (Becattini 1990, p. 39). Information and knowledge flow among people who can trust each other in fact reduce transaction costs and opportunistic behaviour and enhance the creation of new knowledge.

approach seems quite promising, it also entails some problems that will be addressed in the next section.

A further different evaluation applies to those recent contributions which have started conceiving the district-system in cognitive terms (Belussi and Gottardi, 2000), thus depicting it as “a set of information processing units and mechanisms which can learn and adapt to a changing environment” (Lombardi, 2000, p. 78). Given that, as a cognitive system, the ID has the primary task to process, diffuse and recompose information in a coherent set of knowledge, this emerging approach has in fact recovered in the analysis of the firm dynamics the importance of its strategic flexibility and strategic rationality, especially of those firms operating in integrated business groups (*ibidem*, p. 84). Indeed, the exploration and the refinement of this kind of system approach appear quite helpful in overcoming the focalisation-biases of both organisational and environmental nature that have been previously detected: an argument that will be put forward in the section 5 of this paper.

3.3 The Regional System of Innovation approach (RSI)

The role of the environment in driving the firm dynamics appears more evident in a very recent ‘local’ kind of approach, that of the regional systems of innovation (RSI). Steaming from the literature on national system of innovation (Edquist, 1997; Freeman, 1987; Lundvall, 1992; Nelson, 1993; Porter 1990), the RSI approach questions the key elements a region must possess in order to foster innovation (Cooke, 1998, p. 13). While a RSI has many features in common with a NSI²³, it would be however a mistake to consider a RSI as a ‘proto’ of a NSI, but on a smaller scale. Rather, the RSI represents another point of view of the whole system of innovation (Howells, 1999, p. 67). Indeed, from a top-down perspective, the regional governance structures are quite different from the national ones, due to the different ensemble of local institutions. From a bottom-up perspective, instead, the qualitative differences are related to the regional internal sets of interactions between firms and organisations (Howells, 1999). A regional system therefore becomes a crucial arena for localised learning and tacit know-how sharing, thanks to its institutional fabrics and informal links. The relevance of the RSI for the dynamic capabilities of

²³First of all, they are both based on an integrated system, where not only the elements but the relationships between the elements are crucial. Secondly, they both give a central role to institutions in enhancing and supporting innovative activities. Finally, they both accept an evolutionary way of thinking about innovation and technological change.

the firm is thus notable.

Given the importance that also the RSI approach attributes to innovation and learning, it might seem that the same approach does not add to the analysis of the dynamic capabilities issue much more than the MI approach²⁴. However, the RSI concept is built up on five constituent elements which make its interpretative power somehow superior: (i) the region, an administrative and political unit with some cultural and historical homogeneity and with some statutory power; (ii) innovation, meant as in the neo-Schumpeterian evolutionary approach; (iii) networks, i.e. relationships based on trust, reputation, custom, reciprocity and reliability; (iv) learning processes, especially in the sense of institutional learning; (v) interactions, driven by formal and informal links and relationships (Cooke, 2001). No matter its exact composition²⁵, drawing on this conceptual framework the RSI is able to incorporate the firms, along with the other actors involved in the innovative process, within specific regional contexts, but still keeping the former conceptually 'independent' from the latter. Furthermore, unlike the two approaches which have been previously reviewed, in the RSI the internal organisation of the firms is explicitly considered, by positively correlating their systemic innovation potential to such elements as "trustful labour relations, shop-floor co-operation and a worker welfare orientation" (Cooke 2001, p. 960). To be sure, the RSI approach quite naturally concentrates around the region, as an administrative and cultural unit of analysis. Nevertheless, "the 'culture' of the region (...) can be divided into the institutional level, the organizational level for firms and the organizational level for governance" (Cooke 2001, p. 960), so that the firm organisation emerges as relevant too.

These and other elements make the present environmental approach less de-focalised on the organisational issues of the firm than the previous two. However, a certain environmental bias still remains in it. Again, as in the previous approaches, there is a lack of analysis about how the RSI influences the firm, which, inevitably, depends on the internal structure and organisation of the firm itself. Moreover, the RSI approach, as well as the MI one, concentrates its attention on learning as a collective and socialised process. Yet, both forget to see how the new knowledge,

²⁴A certain overlapping between the two approaches is also suggested by the relevant terminology, such as when the RSI is defined as the place where "firms and other organisations are systematically engaged in interactive learning through an institutional *milieu* characterised by embeddedness" (Cooke *et al.*, 1998, p. 1581).

²⁵Typically, the main actors of a RSI are "university research, research institutes, technology-transfer agencies, consultants, skills-development organisations, public and private funding organisations and, of course, firms, large and small, plus nonfirm organisations involved in innovation" (Cooke *et al.*, 1997, p. 478).

mainly tacit, has different fallouts for different firms. Each firm would use, apply, implement, develop and change the new knowledge in different ways, according to their internal structure. Taking into account these drawbacks, also the RSI does not seem able to encapsulate all the factors that are at stake in dealing with the firms dynamics and with their dynamic capabilities.

3.4 The New Industrial Space approach (NIS)

The California School of Economic Geography developed the new industrial spaces approach around the middle of the 1980s (Scott, 1988; Storper and Scott, 1988; Storper and Walker, 1983) in order to explain the development of new locational structures of production brought about by the emerging regime of flexible accumulation (Piore and Sabel, 1982). According to this approach, the new industries, emerging after technological breaking points, have structures that are independent from older industries and can enjoy a window of location opportunities.

Here, the firm is central and seen as an organisation with the aim to internalise transaction costs (Coase, 1937). Thus, by expanding the transaction cost approach to the firm, the new industrial spaces are seen as “the organization of complexes of firms into networks of purely externalized transactional relations (...). Better yet, since there is not in reality a sharp break between internal (hierarchical) and external (market) relations, but an irregular continuum extending over a variety of intermediate forms (...), we can see production as a complex but rationally comprehensible organizational structure rooted in the polarities of the firm and the market (Scott 1988, p. 24). Therefore, production is seen as a more complicated phenomenon involving both a single enterprise and the interactive system or network of socially divided enterprises. This argument roots flexibility in the division of labour of production and links that to agglomeration via the transaction costs associated with inter-firm linkages.

This one is the only approach, among all those reviewed in this section, which gives much more importance to the firm; while the external environment is considered as a typical Porter’s diamond, based on the relational practices between customers and suppliers. Firms are seen as agents seeking to reduce transaction costs through agglomeration and urbanisation economies, and localised industrial agglomerations occurs where these external economies tend to spur continuously out of their variegated production systems and local labour markets. Yet, the external environment is also considered because “there was no assurance that markets alone, nor even various forms of contract, could successfully coordinate the nexus of transaction in an

industrial agglomeration” (Storper, 1999, p. 30). Industrial agglomerations are more likely to be successful when they manage to build an appropriate framework of institutional and collective order, such as industrial technology, labour training, business service associations, innovation networks, cooperative manufacturing structure, local government and land use control (Scott, 1992).

Unfortunately, this approach suffers from the limitation of its basic concept, the transaction cost view of the firm. The new industrial spaces are seen as a system coordinated by institutional and/or business transactions, but only formal transaction among firms are taken into consideration. The simple explanation that, when external transactions increase firms tend to geographically concentrate in order to reduce transaction costs, seems quite reductive. All informal transactions, which can be explained by neither the market nor the hierarchy, are completely neglected. Also the external environment is considered only according to its ability to reduce uncertainty and, consequently, transaction costs. This view seems to focus its attention on cost criteria, which, certainly, cannot capture the complexity of an informal organization such as a local system of production. Therefore, the territory is seen as just functional to the cost-cutting seeking and the institutional as well as the historical context of firms are not questioned.

Also this last consideration, along with those made in the previous sections, suggests that sticking to an environmental lens only, however articulated it might be, does not seem enough, as insufficient it appears to draw on the organisational lens only. Of course, this does not amount to doubting of the relevance of the LSP literature per se, but just of its exclusive use in investigating the dynamic capabilities issue. A more ‘complex’ approach appears necessary, but, as the next section will show, its identification is far from automatic.

4. Towards a combined analysis: overlapping the two lenses?

If sticking to one lens only, either ‘organisational’ (Section 2) or ‘environmental’ (Section 3), inevitably entails a partial view of the dynamic capabilities of the firm (i.e. a focalisation-bias), one might think that using both lenses simultaneously, somehow overlapping them, enables to capture the same capabilities more accurately. A similar exercise appears implicit in an interesting research program which has recently tried to extend to spatial systems of firms a relational approach of inter-organisational nature (Lipparini, 1995; Lipparini and Lorenzoni, 1996).

The starting point of this last stream of studies is the role that, in developing and

integrating firm capabilities (in a word, in their dynamics), is played by the relational set-ups the firms of a certain local system establish and through which they interact. According to this ‘relational view’, setting-up firm networks, signing-up partnership agreements with other organisations, managing the ensuing relationships, or simply involving (also informally) customers and suppliers in their business operations, would increase the learning (i.e. dynamic) capabilities of the firms involved. The dynamic capability of the firm is in fact retained nothing but a “relational capability”, in turn resulting from the interaction of other three kinds of firm capabilities, some of which have already been touched upon in the organisational review of Section 2: the capacity to access external information and knowledge, and to assimilate it in the relevant production and innovation process (“absorptive capacity”) (Cohen and Levinthal, 1991); the capacity to find alternative uses for, and linkages among, the existing capabilities and resources of the firm (“combinative capability”) (Kogut and Zander, 1992); the capacity to find a knowledge-intensive interface with other firms and organisations (“coordinative capability”) (Grant, 1996).

The relevance of a relational argument of organizational nature for firms located in local systems of production has emerged both from a theoretical and an empirical point of view. First of all, from a theoretical perspective, it has become evident that while externalities and spillover effects make firms, operating in local systems of production, relative more efficient in dealing with the trade-off between competition and cooperation, moreover, their dynamics also depend on the organisation of the firm itself. This insight has recently spurred some researchers of local systems to ‘magnify’ the firms which populate them, searching for their strategic choices, their deliberated relational actions, and the entailed organisational hierarchies and set-ups (Lipparini and Lorenzoni, 1996; Ferrucci and Varaldo, 1993; Mariotti, 1991)²⁶. Furthermore, the relevance of these theoretical suggestions appears confirmed by some recent empirical studies which have showed how groups of firms and across-firms shareholding, although with idiosyncratic features, are quite pervasive also within local systems of production (Brioschi *et al.*, forthcoming-a;

²⁶Lipparini and Lorenzoni, in particular, both in joint and individual contributions (e.g. Lipparini, 1995, 1998; Lipparini and Lorenzoni, 1996), have pointed out the role that in building up and renew the competence (also) of this kind of firms is played by what they call “inter-organisational platforms”. Roughly, an inter-organisational platform is defined as an organised “knowledge market”, in which knowledge is generated through a deliberated interaction between (at least) a “provider” — i.e. a firm which is the prime source of the relevant knowledge — and (at least) a “recipient” — i.e. a firm which uses such knowledge by participating directly to its development, and which is managed and regulated by specialised organisational figures (Normann, 1977).

Brioschi *et al.*, forthcoming-b)²⁷. The findings of these studies add new elements of interpretation to those obtained through the traditional lens of the local production system approach. Accordingly, also the resulting image turns out quite different, showing a surprising mixture of formal and informal relationships, with interesting implications in terms of innovation and firm dynamics²⁸.

In front of these encouraging theoretical and empirical results one might wonder whether the combined perspective which is referred to here actually allows to overcome the biased-views documented in the previous sections. Unfortunately, a closer look at those aspects does not seem to confirm this suggestion. On the contrary, the retrieval of organisational aspects in the analysis of local production systems seems to occur at the expenses of those tacit and informal elements which are typical of the environmental lens, and which get therefore somehow hidden, if not even lost.

First of all, the focus on formal inter-organisational arrangements inevitably entails a peculiar view of the learning process, which drives the dynamic capabilities of a local system of production. Indeed, according to the research program referred above, such a system would evolve mainly by developing a system-wide “architectural” knowledge which, intelligently and purposely combines the “component” knowledge embodied and developed by the relevant individual firms²⁹. Evidently, such a view neglects that rarely local systems of production draw on a body of production and innovation knowledge which has an explicit and hierarchical nature. On the contrary, the properties and dynamics of their ‘collective’ knowledge are usually diffuse and emergent so that, if a certain combination of the ‘individual’ knowledge of the firms is possible, it occurs unintentionally, through repetitive trials and errors, until a satisfactory fit is achieved which could not be foreseen *ex ante* (Camagni, 1991b).

A second distortion, entailed by the combined analysis sketched above, refers to the actual specification the knowledge creation process finds, once it is set at work within local systems of production considered as systems of organisational arrangements. Indeed, such a view just retains

²⁷To be sure, these studies exclusively refer to the Italian case, with respect to which the relevance of local production systems has been widely documented.

²⁸Apparently, for example, those local systems of production where inter-organisational platforms are more diffused reveal a higher innovative intensity (Lipparini, 1995).

²⁹This argument, which finds a direct application in the idea of “inter-organisational knowledge-platform” (Lipparini, 1998), in fact extends to local systems of production the interpretation that Henderson and Clark (1990) have put

those moments of the ‘spiral knowledge model’ (Nonaka, 1994) which operate on a codified and explicit kind of knowledge — typically its ‘combination’ and its ‘externalisation’ (i.e. the transformation of tacit into explicit knowledge) — while it filters out those which are more intensive of an implicit kind of knowledge — namely its ‘internalisation’ and its ‘socialisation’³⁰. The consideration of these latter stages of the process seems therefore to call for an additional network of relationships on which the present view does not explicitly focus on³¹.

Indeed, a third relevant limitation, the present approach seems to presume that, in order to generate knowledge and thus feed-up the dynamic capabilities process, the interaction among the firms of a system must be deliberately planned and organised³². Less explicit forms of interaction, such as those which accompany the supply of intermediate inputs or/and the delivery of final goods, are not deemed very powerful in increasing the knowledge stock of the interacting agents (Lipparini, 1998). This way of looking at ‘learning-by-interacting’, however, is not entirely satisfactory. As clearly emphasised by Lundvall (1992), the same kind of learning is in fact affected, not only by an organisational kind of distance, but also, and above all, by the degree of proximity that (firm) producers and (firm) users show in economic³³ and in spatial terms. What is more, the relative importance of these different forms of distance varies depending on the content of the interaction themselves. In the phase of ‘commodification’ which typically precedes the introduction of a new product, for example, the most crucial relationships are those which occur in a common economic and geographical space, while more formal and organisationally close interactions seems to matter more in accompanying process innovations of less radical nature (Andersen, 1991). These and other ‘stylised facts’ of the innovative process thus suggest that learning-by-interacting is actually less formal and organised than what the combined lens to dynamic capabilities envisages.

In the light of the previous set of considerations, and of their critical relevance, the evaluation of the organisational analysis of local production systems, although extremely

forward with respect to individual organisations.

³⁰This is, for example, what typically occurs within inter-organisational knowledge-platforms (Lipparini, 1998).

³¹To be sure, this holds true for the business organization literature that is being considered, while a certain attention for tacit knowledge can be found in the economic literature on industrial districts.

³²Mainly focusing on Research and Development agreements, co-design practices, extensive partnerships, single-projects groups, total quality management, brainstorming, benchmarking, just to mention a few.

³³That is through the similarity of their commodities, of their production processes or through their input-output

important, cannot be retained fully satisfactory. On the contrary, it seems that the dynamic capabilities process gets examined in an even more partial way. This is not surprising! As it happens in practice, when one just imposes a lens over another, without bothering with their relative convexity, the resulting image is not necessarily more crystalline. Using a different, more appropriate lens in general yields a more accurate view. To the search of this further lens the paper turns in the next section.

5. A ‘system approach’ to dynamic capabilities

In order to coherently encapsulate both organizational and environmental factors, the approach to dynamic capabilities put forward in this paper draws on the literature on ‘complex systems’, and deals with the firm as a ‘complex adaptive system’ (CAS).

An increasing number of contributions along this research program has in fact started showing that firms (and more in general organizations) actually present the traits of a wide range of open systems in natural and physical worlds, whose ‘adaptation’ to their hosting environment resolves in a ‘complex’ process of evolution/co-evolution. By conceiving of the firm as a CAS, it is possible to interpret its ‘emergent structures’, also but not only of organizational nature (Montresor and Romagnoli, 2003), in terms of its degree of internal order (i.e. its entropy). More precisely, such an internal degree of ‘order’ can be maintained only dynamically, that is by exporting entropy towards the environment.

As is well known, in CAS this negentropic process is at the origin of a non-linear dynamics, stylised as a sequence of phases in which the so called ‘edge of chaos’ — a ‘transition phase’ from a highly ordered phase to a chaotic one — hosts the maximum degree of fitness between the system and its environment (Kauffman, 1995). As is possibly less known, similar non-linear mechanisms have been argued to be at work in the case of the firm too (see for example Fuller and Moran, 2000, 2001). Indeed, it has been suggested that the firm dynamics possibly resembles a series of punctuated equilibria, with long phases of relative stability (along a path of steady growth), punctuated by sudden jumps, forcing a qualitative change of structure, i.e. a structural kind of change. Moreover, it has been shown that, in the neighbourhoods of the discontinuity, bifurcations can well make the structural change depending on small accidents that can force one dynamic path rather than another one (see, for example, Arthur, 1989; Fuller and

technical coefficients.

Moran, 2001).

Endorsing such a metaphor in interpreting the firm dynamics is for the sake of the present paper extremely fruitful. It is in fact suggested that the inner determinants of this non-linear process can be directly related to the dynamic capabilities of the firm, and in a way which allows one to consider both organizational and environmental factors in a consistent way. The starting point of this argument is the idea that the non-linear firm dynamics can be sketched as a process triggered and fuelled by the intertwining of two factors: (1) the threshold level in the firm response mechanisms to environmental flows; (2) the relative balance between environmental ‘turbulence’ and inner ‘entropy’.

(1) The first factor is the ‘usual’ homeostatic mechanism which, in this case, applies to whatever of the firm-system ‘functional layers’ (Fuller and Moran, 2001): in particular, to the legal, the organisational, the capabilities, and the institutional one (Montresor and Romagnoli, 2003). The elements and relationships of these layers are indeed subject to structural change once the relevant environmental signals overcome a certain threshold level. In the case of the legal layer, a relevant example is provided by the change intervened in the firm governance models following the historical diffusion of sparse stockholders without any interest in the management and control of the firms. Once it had reached a certain level, this process actually determined the famous divorce between property and control (Berle and Means, 1932). With respect to the organizational layer, instead, a homeostatic mechanism can be seen at work in the changes that the organisational structures of the large companies have undergone over time as a consequence, for example, of the overcoming of a certain level of diversification: the notable transformation of U-firms into M-firms can be read in this way (Chandler, 1962). More in general, stability in organisational structures strictly depends on how the firms are pursuing different strategies in terms of their production process in a broad sense. As far as the capabilities layer is concerned, organisational routines are the structural component subject to a homeostatic kind of pressure, maybe the most known since the works of Nelson and Winter (1982) and Simon (1955). In this case, the element (the routine) delimiting the search patterns remains stable (i.e. is not subject to structural change) unless it consistently fails to deliver its pre-determined goal. Finally, homeostatic elements can be seen at work also by referring to the institutional layer of the firm, in the sense indicated, for instance, by the transformation of ‘networked firms’ into ‘networks of firms’ (Antonelli, 1987). In this last case, as the institutional context changes (and, for instance,

intermediate institutions start appearing and diffusing on the firm territory), it might become for firms more profitable to being part of the network of firms rather than being simply internally networked. Once more, it is when the ‘signal’ from the institutional set-up overcomes a certain threshold that the profitability of ‘being outside’ becomes larger than that of ‘being inside’.

(2) As far as the second factor is concerned, being less obvious, it needs some further elaboration. In fact, the process of evolution that firms undergo depends from the ‘relative’ dimension of the environment, rather than from its absolute dimension. Hence, differently from agents that relate with the environment simply undergoing a process of selection that picks up the fittest, the relative dimension of the relationships firm/environment can assume quite different specifications. Indeed, it is possible to consider the environment firms face from both a functional and a territorial point of view, and both of them allow for a active role of firms (i.e. a biunivocal causal relationship): they can actively work to co-define their environment, either by clustering spatially with others, or by ‘tuning’ their dimension with respect to the sector/technological regime they are part of, in order to try and smooth out to a certain degree the environmental turbulence.

It is fairly obvious that differences in sectoral specificity, technological regimes, and spatial clustering, provide completely different environmental set-ups, with completely different needs and possibilities for the firms to survive and prosper. If these patterns are referred to the evolution in the natural world, it becomes easy to understand the importance of this difference, and the relevance for the final result of allowing units of selection to interact with the ‘global’ environment, rather than with its neighborhood environment. Suffice to think, for instance, to the process depicted by Hughes (1989), in which large technical systems progressively inglobate chunks of the environment in order to keep their ‘balance’ between growth and governance right. However, as it will be pointed out in the following, there is an inner element in processes like these, which relates to the fact that it is not possible to expand the system indefinitely and at request, since as the environment shrinks, the possibility of exporting entropy radically decreases.

In general terms, although the resulting dynamic process cannot be merely decomposed in the two factors that have been identified above – i.e. the firm response threshold level and the relative turbulence/ entropy balance – as it rather results from their mutual interaction, each of them however plays a different kind of role. Indeed, the first factor determines the actual degree of the firm-system response to the signals coming from the environment. This allows the firm-

system structure to remain qualitatively unchanged unless the signals overcome the threshold, thus spurring a structural change which results in the emergence of a novel system structure. The second factor, instead, informs about the way the threshold level of the system itself changes subject to the dynamics of its ‘relative’ environment. Indeed, on the one side, the firm-system tends to smoothen out the degree of volatility of their relationships with a turbulent environment through the progressive incorporation of fractions of the environment itself, thus expanding the system’s boundaries. On the other side, as the balance between the system and its environment dynamically shifts, the latter decreases in size relative to the firm’s one. Thus, as the relative dimension of the environment decreases, in turn its degree of ‘overall’ stability progressively decreases to cause increasing fluctuations in the entropy exchange.

The previous dynamic process can be described more concretely by referring to the firm as a set of interrelated capabilities, whose degree of entropy is so-to-say fine tuned by a two-tiered mechanism. On the one side, inner mechanisms of organizational learning define a set of threshold levels for the firm capabilities, within which the firm performances are reputed to be satisfactory with respect to its goals. Indeed, this is actually what happens when the firm is capable to accommodate the environmental turbulence (mainly, but not only, of technological nature) by resorting to specific integration/combinatory principles, lamarckian routines, and problem-solving algorithms. On the other side, but simultaneously, a co-evolution process is set into motion in which the firm interacts with its environment, in order to reach a dynamic balance between turbulence and entropy. Again, this is what actually happens when the firm implements different kinds of integration strategies, or sets up some kinds of institutional networks (both formally and informally) with the other actors which make up its environment and provokes its turbulence.

Once the firm dynamics is figured out in this way, also its dynamic capabilities assume a two-fold nature. On the one side, they refer to the capacity of the firm to fine-tuning its capabilities set and its organisational structure in order to fit its competitive relationships with the outer environment. On the other side, dynamic capabilities also refer to the capacity of the firm to (strategically) shift its boundaries, typically but not exclusively through the integration channel, in order not to be overwhelmed when the environmental pressure becomes excessive. The two sides have a different nature, since the first represents the so-to-say static component of dynamic capabilities, while the second is instead the most inherently dynamic, referring to the firm

capacity to suitably stretch its boundaries to redistribute the pressure between several internal components, and between inner and outer environment. However, these two components of dynamic capabilities are strictly interrelated, as the firm boundaries which somehow separate them are intrinsically dynamic. Indeed, the firm boundaries are not simply a ‘red line’ between the inner and the outer firm environment, while they are defined, consistently with the system approach here embraced, on a functional basis. By adopting a functional criterion, the firm can in fact be identified as a set of ‘functions’, in turn related to its own resources and capabilities, to keep the level of entropy within ‘control’, in order not to make it dissolve within the environment (for instance, as a bundle of contracts), or to make it enlarge to the point of comprehending (for instance, as result of deep integration/conglomerisation) the whole environment. The actual organizational setting of a firm is thus defined as a sort of ‘indifference’ dynamic state, emerging more or less spontaneously at the edge between order and chaos. Similarly, the firm variety turns out to be the result of a push-and-pull process. In such a two-fold process, firms, on the one side, are constantly trying to cope with a turbulent outer environment by moving their boundaries out (e.g. by extending their functions, thus expanding the dimension of their technical system with respect to the outer environment), and, on the other side, they are facing a turbulent inner environment calling for entropy export in order to dynamically balance the degree of internal order (e.g. by outsourcing some of their functions).

The capabilities of the firm to undertake this complex process of change are in fact its dynamic capabilities. Their nature is evidently quite different from that of the approaches reviewed in the first part of the paper. Indeed, following the present approach dynamic capabilities apply to the firm as a system of capabilities, rather than to one or another of its constitutive elements (be they routines, competencies, or technology). Their core element is the firm capacity to undertake a complex adaptive process, rather than its ability to implement an organizational kind of learning. In fact, such a capacity is not purely organizational, and merely consisting of an evolution process of its organization in response to changing patterns of the selection mechanism. On the contrary, once the firm dynamics is conceived as a co-evolutionary process, environmental factors become as relevant as organizational ones in explaining dynamic capabilities, thus actually laying a bridge between the two perspectives that have been reviewed. Indeed, dynamic capabilities come to depend on: (i) the relative extension of the firm with respect to environment; (ii) the relative speed of entropy exchange; (iii) the role of the relevant

technological system, and of the correspondent institutional set-up, within which a particular firm (or a set of firms) operates.

(i) As far as the first point is concerned, the system approach here proposed suggests that dynamic capabilities do not simply depend on the absolute size of the firm, but rather on its relative extension with respect to the hosting environment, being this the sectoral or the territorial environment of the firm. A large, vertically integrated firm, operating within a narrow ‘technological regime’ (Breschi *et al.*, 2000; Malerba and Orsenigo, 1997) — for example in terms of ‘technological opportunities’ (Breschi and Malerba, 1997) — will possibly have different dynamic capabilities from a firm as large as the previous one but operating within a more pervasive techno-economic environment. Similarly, the dynamic capabilities that are necessary to a small firm will differ depending on the firm having to face the turbulence originating in a quite localised industrial district, rather than that of a more territorially diffused system of production. Looking for a correlation, possibly positive, between firm size and dynamic capabilities would therefore be misleading. On the contrary, the relative firm dimension could well be detrimental to the firm’s capability to keep its entropy within a certain balance. This occurs, for example, if the environment, being relatively ‘small’, cannot absorb relevant flows ‘coming out’ from the firm: such as for a highly innovative firm operating in a technological regime in which appropriability is extremely difficult to obtain, or for a firm of an expanding business group which is ‘forced’ within a certain territorial partition. Also in these cases, however, the degree of turbulence of the outer environment could be so low, with respect to the relative dimension of the firm, that it might never overcome the firm’s threshold level to force a qualitative leap. In the previous examples, appropriating innovations or even implementing them might be not so necessary if the relevant technological regime is not marked by diffuse opportunities. Similarly, extending control and ownership relationships over the territory might not be so crucial if the competitive process remains mainly played at local level.

(ii) As far as the second point is concerned, the relative speed of the entropy exchange is obviously another crucial element in affecting dynamic capabilities. In fact, a relatively stable environment, in which the flow of, for instance, information is easily predictable, has completely different implications on the firm dynamic capabilities with respect to an environment where overloading of information prevails. In the first case, the high (if not even total) predictability of the environment dynamics tends to make the ‘static’ side of dynamic capabilities more relevant

than its inherently dynamic one. The relative instability induced by an incremental innovation occurring in the firm sector is a typical example of this first case, to face which the firm just needs to be capable to fine-tuning its ‘ordinary’ learning mechanisms (though they still are dynamic capabilities). In the second case, instead, unpredictable changes in the firm environment force heavy re-configurations of its organisational learning procedures, thus reversing the relevance of the two dynamic capabilities components. The relevant example of this second case is the classic example of a quite dramatic technological breakthrough in the firm sector: if the firm capabilities thresholds are overcome, the firm needs to re-design its entropy balance, and possibly extend or change its organizational boundaries and its administrative procedures. Of course, in-between these two polar cases — which can well have a territorial rather than a purely sectoral specification — a continuum of environmental turbulence can be envisaged, the response to which determines different degrees of combination of the two dynamic capabilities factors. This argument naturally extends the relevance of the dynamic capabilities concept per se, as drawing on such capabilities is necessary, although to a different extent, not only in front of paradigmatic technological changes but, more in general, also in dealing with minor (incremental) changes, and not only of technological nature.

(iii) Coming to the third determinant of dynamic capabilities, following a system perspective, the ‘environment’ in which the firm operates as a system is in turn conceived as a system too. This naturally follows from the extension of the CAS view, so far applied to the firm at the micro-level, to all the firms and institutions which make up the firm environment (Monk, 1998). Once the firm environment is considered as a system, of which the system-firm is also part, drawing on the literature on innovation and technological systems in investigating its dynamics becomes unavoidable (for a review see Edquist, 1997). In particular, it becomes possible to qualify the different sub-systems of a technological system (Leoncini, 1998; Leoncini and Montresor, forthcoming) to which the dynamic capabilities of the firm apply according to the two-fold dynamical mechanism previously described. A co-evolutionary process of that kind can in fact be envisaged by looking at the firm as an organization involved, respectively: in the introduction or adaptation of new technological ideas and knowledge, and thus co-evolving within the scientific-core (sub-system) of a technological system; in the actual implementation of its innovative outcomes (or of those of others) into new products or processes, and thus co-evolving within specific technical sub-systems; in the interaction with those firms and agents

which acquire the outcome of their economic activity, and thus co-evolving within the market sub-system; in the interplay with those formal (such as patent offices or chambers of commerce) and informal (such as norms or standards) institutional arrangements which make the previous co-evolutionary processes possible, and thus the firm co-evolving within a specific institutional set-up. Evidently, in each of these four dynamical processes the firm threshold levels refer to different kinds of response mechanisms: for example, to a change in the consumer tastes (in the market sub-system), rather than to the introduction of a new scientific breakthrough (in the scientific core), or of a new law on patenting (in the institutional set-up). As well as different are the entailed entropy-turbulence balances, and the firm layers (Montresor and Romagnoli, 2003) with respect to which the firm boundaries get repositioned: for example, the legal layer (such as in the extension of the so called corporate control), rather than the organizational layer (such as in the case of a vertical integration process), or that of its capabilities (such as in the case of a de-focusing, differentiation strategy). Referring to the hosting environment of the firm as a technological system is thus extremely helpful in better qualifying the functioning of its dynamic capabilities previously addressed in generic terms, as well as in retaining the crucial role that institutions have in allowing them to turn from capabilities to run a dynamic process into an actual pattern of change. What is learnt by the firms is in fact inevitably shaped by the relations, typically of informal nature, they naturally and ‘instinctively’ develop with the social and institutional environment underpinning the system, by which their cognitive structures are also affected.

The system approach to dynamic capabilities put forward in this paper is quite novel, mainly because it proposes a conceptual framework, deeply rooted in the theory of complex adaptive systems, within which the organizational and the environmental determinants of dynamic capabilities can be jointly considered in a consistent way. Furthermore, the same system approach has a series of positive implications that will be recap among the conclusions.

6. Conclusions

That the firms’ success in managing their changing environment is not exclusively a matter of strategies appears a quite established result. Their capabilities are at least as important in accommodating and, eventually, reconfiguring their ‘structures’ in front of some kind of environmental turbulence, so that dynamic capabilities occupy a central place in the investigation

of the firm dynamics.

Less established is instead the nature of these capabilities, as several strands of literature have differently solved the delicate issue of the balance between organizational and environmental factors in explaining their origin and functioning. In particular, any attempt at giving a rigorous conceptualisation to what the empirics suggest to be a sort of pragmatic trait of the firm has inevitably entailed a certain focalisation bias, on one or another of the two kinds of explanatory factors.

In trying to overcome this further conundrum, the present paper suggests to approach dynamic capabilities from a system perspective, and to conceptualise the dynamic capabilities of the firm as the firm capacity to make its system-organization adapt and evolve within a system-environment, that is of undertaking a complex evolutionary process with it. More precisely, dynamic capabilities are meant as a two-fold kind of capabilities, that is as the capabilities of both fine-tuning its response mechanisms — the first ‘static’ folder — and redesigning its functional boundaries once the threshold levels of the former are overcome — the second ‘dynamic folder’. Furthermore, these two-fold capabilities are depicted at work in a co-evolution process between the firm and its environment which is also manifold. The firm in fact co-evolves in complex technological systems in which homeostatic mechanisms are set into motion with respect to several other institutional actors and in different fields of action.

Dealing with dynamic capabilities in such a way has some important positive implications. First of all, the firms which populate a technological system are typically treated as ‘evolutionary’ in their nature (Nelson and Winter, 1982), and this has in turn at least two crucial implications: on the one hand, their learning patterns are informed by the variety generation mechanisms which are centred on their organisational routines, thus calling for an organisational analysis of their dynamic capabilities; on the other hand, their ‘evolution’ is co-determined (along with the previous mechanism) by the selection process that the market forces operate on them, thus calling for an environmental analysis of their dynamic capabilities. In this first respect, therefore, the system approach here proposed focuses on both the constituent aspects of dynamic capabilities pointed out in the first part of the paper.

A second important implication has to do with the fact that, following a system perspective, the dynamics of the firm (and of the relative capabilities) cannot be considered in isolation from the set of actors and relationships of which a technological system is made up of.

Not only because do firms need an institutional set-up and an economic structure to carry out their business activities, but also, and above all, because they learn (and innovate) by interacting with other firms and actors of the technological system (Lundvall, 1992). This means, first of all, that what is learnt by the firms is inevitably shaped by the relations, typically of informal nature, they develop within the institutional set-up underpinning the system itself: an environmental kind of analysis is thus necessary in this last respect. Furthermore, the learning process of the firm is also influenced by those interactions, typically of formal nature, firms deliberately establish with others in building up ‘inter-organisational platforms’ for the generation and diffusion of collective learning: accordingly, an organisational (to be sure, inter-organisational) approach to dynamic capabilities turns out to be useful once again. Also in this second respect, therefore, the system approach captures both the building blocks of the dynamic capabilities analysis.

A third implication concerns the opportunity to deal with dynamic capabilities by retaining elements of territorial nature. Indeed, the relationships which innervate a system occur both through ‘immaterial’ and ‘material’ kinds of networks. While the former are conducive of codified bits of knowledge, whose diffusion does not require (to be effective) spatial proximity between knowledge (innovation) producers and users, such a kind of closeness is instead essential in the spreading of tacit bits of knowledge, whose ‘embodied’ diffusion benefits from the location in a common territory. Accordingly, while the former kind of network can be strategically planned — and thus organisationally investigated — the latter provides ‘local’ systems of innovation (and production) with a special advantage in ‘socialising’ and ‘externalising’ their organisational knowledge (Nonaka, 1994, p. 19) — thus invoking an environmental/spatial kind of analysis. Also in this last respect, therefore, a system kind of analysis allows for a twofold kind of approach to dynamic capabilities.

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Table 1 — The main approaches to dynamic capabilities

	<i>Strategic management</i>	<i>Technology</i>	<i>Organization</i>	<i>Evolutionary</i>
<i>What are dynamic capabilities?</i>	An organizational ability (a special individual resource)	Technological capabilities (organizational/strategic competences)	The capability to create organizational knowledge	A learned collective activity (intentional routines)
<i>What do they apply to?</i>	Competences to address change (other resources)	Technology (i.e. technological knowledge, skills, know-how, recursive activities)	Organizational knowledge	Operational routines (quasi-automatic routines)
<i>Which is their core element?</i>	Organizational learning from a strategic point of view	Organizational learning combined with strategic considerations	Organizational learning from an organization theory perspective	Cognitive learning from an evolutionary viewpoint
<i>How is the firm conceived?</i>	A set of resources and capabilities whose integration/combination is a static factor	A technical system of resources with respect to which technological integration is dominant	An organization in which individual and collective knowledge interact	A set of organizational routines and capabilities
<i>How is the firm environment dealt with?</i>	An aseptic (strategic like) diamond with which the firm is integrated in formal terms (competitors, suppliers and consumers)	An industry characterized by competitive relationships and with a special focus on external (formal) technology integration and consumer integration	A set of organizations interacting (mainly) on a formal basis (inter-organizational learning)	A system of institutions which operate in a socio-political context with a territorial specification

Tab. 2 Main features of the different local production system approaches

	<i>Milieu Innovateur</i>	<i>Industrial District</i>	<i>Regional System of Innovation</i>	<i>New Industrial Spaces</i>
<i>Research agenda</i>	Why do some places innovate more than others?	Why do firms tend to concentrate in some geographically bounded areas?	Why do some regions innovate more than others?	Why do new industrial spaces emerge?
<i>The core feature</i>	Innovation	“Embeddedness”	Institutions	Agglomeration and urbanisation economies
<i>The players</i>	Firms, institutions, organisations, research and training institutions, etc.	Community of people and population of firms	Firms and institutions	Firms with economies of scale and scope
<i>Core of the innovation dynamic</i>	local synergy created by the relationships between all local actors	Inter-firm and inter-personal relations	Relations between firms and institutions	Formal relationships among firms
<i>Type of territory</i>	Active: task to foster innovation Passive: result of the innovative processes	Social organisation	Administrative defined region	Porter’s diamond
<i>Main task</i>	Coordination of all forces of the territory	Maintenance of a homogeneous system of values	Supporting innovative activities of firms	Reduction of transaction costs
<i>Firms</i>	Homogeneous evolutionary firms	Homogeneous evolutionary firms	Homogeneous evolutionary firms	Transaction-cost approach to the firm