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GAMES OF INNOVATION: A NEW THEORETICAL PERSPECTIVE

ROGER MILLER

Department of Mathematics and Industrial Engineering
Ecole Polytechnique, Montréal, Canada
roger.miller@polymtl.ca

SERGHEI FLORICEL

Department of Management and Technology
Université du Québec à Montréal, Montréal, Canada
floricel.serghei@uqam.ca

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Games of innovation are sets of rules that structure meso-level innovation systems composed of organisational actors that compete and collaborate to create value. All game rules are coherent, with one dominant value-creation logic, and refer to all the aspects of managing innovation, from competitive strategies and policies for investment in innovation capabilities to practices for identifying opportunities and managing projects. The dominant logic that guides them stems from prevailing conditions for innovation, which open certain avenues by which participants produce and capture value, but which close others. The rules stabilise and ensure the reproduction of innovation systems for long periods of time.

Keywords: Value creation; dominant logic; value capture; innovation systems; innovation strategy.

Introduction

The "games of innovation" concept is based on the insight that a new unit of analysis enables, first, a synthesis of various theoretical streams of research in the management of innovation, and second, a view of the strategic context of innovation that is more likely to lead to practical recommendations. This way, general concepts, such as resources, lifecycles, competencies, and networks, can be combined to explain the rich and varied dynamics of innovation. Furthermore, "best practices" promoted in the practitioner-oriented literature can be better understood and differentially applied in light of distinct innovation contexts. Our approach originated in grounded multi-sector research (Miller and Floricel, 2004), which suggests that innovative performance can be explained not by single factors seen in isolation, but by multidimensional configurations of factors, which connect and balance various levels of reality. Moreover, our research shows that some domains have commonalities in their ways of innovating; hence the diversity of processes can be distilled into a reasonable number of typical configurations, which can be used to produce broadly applicable yet workable recommendations. The development of these insights into a theory of games of innovation required us to incorporate evolutionary thinking to account for the dynamics of innovation in a way that combines structure and emergence.

A game of innovation is a dual meso-level configuration consisting of a stable and coherent set of "action rules" that interacts with a concrete value-creation subsystem, involving actors that participate in interrelated activities, to generate a typical and sustained innovation dynamics. There are multiple games, and each game has a different dynamic. Together, the rules form a system of meaning and a practical theory that defines, among other things, a dominant logic of value creation, important complementary roles, sources of competitive advantage, effective competitive and collaborative strategies, and the most effective organisational structures and practices. The rules influence the dynamic of the value-creation system by framing the strategic decisions and actions of firms and the everyday activities of innovation workers in a way that accounts for the specific exogenous conditions that affect value creation in the subsystem. In turn, the outcome of managers' actions is to reconfirm the rules, hence bringing an element of stability in change. Figure 1 depicts the mutual influence between the two sides of a game.

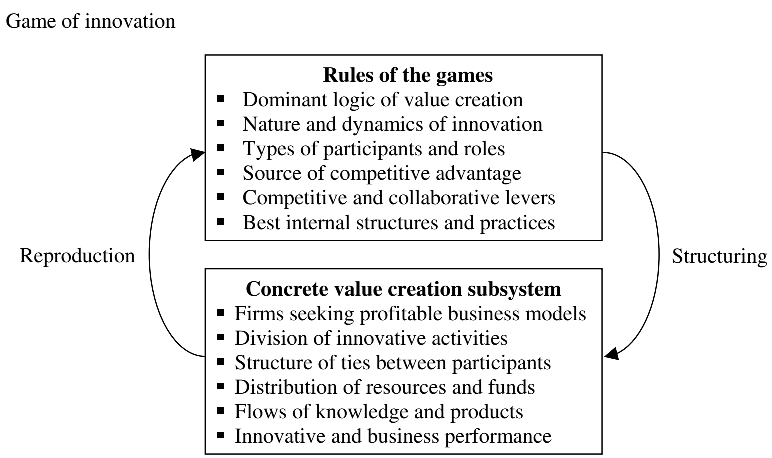

Fig. 1. The "games of innovation" concept and its dual nature.

This paper discusses the conceptual roots, theoretical framework, and implications of the games of innovation concept. Below, we review three theoretical pillars that inform our theory. We then develop the conceptual framework and present examples of different games of innovation, including contextual variables for each of them. We follow with our typology of "games of innovation", based on the assumption that only certain configurations of factors enable a viable value-creation and -capture subsystem and that very similar sets of rules can be applied in different concrete subsystems. We next outline the theoretical connections between contextual elements, the value-creation focus, and the dominant rules with respect to strategy, network ties, and organisational forms and practices. A discussion and conclusion section positions the contribution of this theory within the broader context of evolutionary views on innovation and suggests ways in which it can provide practical contributions.

Literature Review

The concept of "games of innovation" builds on three theoretical pillars that synthesise the key contributions of innovation studies: research on innovation systems; theories about the role of shared cognitive frameworks in structuring social systems; and research on the sources of heterogeneity in innovation processes. The first pillar inspired us in defining the composition, processes, and variables of the "concrete subsystem" dimension of the game. It also helped us distance our concept of "game" from game theory, which uses the same term. The kinds of problems usually addressed in game theory are only a limited portion of the strategic issues involved in only certain innovation domains. The second pillar suggests that each subsystem is structured by a coherent set of "rules" that inform action in a way that balances concreteness and generic applicability. In this sense, our view is closer to Wittgenstein's (1953) "language games", which he defined as a system of concepts that draw meaning from each other in a coherent way. However, we explicitly emphasise action and action rules, and not just concepts and grammars. The third pillar helped us find units of analysis that balance the conditions that create heterogeneity with those that create unity and, hence, lead to persistent differentiation between games. This distinguishes our concept from yet another use of the term "game" as it emerged in political science (Dutton, 1992), which emphasises competition and cooperation for power structured by a set of rules and assumptions, but neglects most processes, such as knowledge production and value creation and diffusion, that characterise innovation. Below, we briefly review these theoretical currents, and at the end of the section we justify the choices made in the development of our theory by combining the insights gained from these reviews.

Concrete innovation systems

Innovation systems research goes beyond micro-perspectives focused on isolated individuals, projects, or firms to understand how processes at other aggregation levels shape innovation. This stream of research enriches our understanding of participants, roles, and influences in innovation processes. For instance, it highlights the role in innovation of universities or regulators. It also reveals the influence of external conditions (such as regulatory frameworks) and endogenous processes (such as knowledge spill-overs) in fostering innovation and competitiveness. Further, it stresses the importance of inter-organisational collaborations and networks, including the "interstitial" links between persons or teams. Based on this research, we are led to the conclusion that in order to include most activities and flows that add to innovation, the unit of analysis cannot be limited to the firm or even to exchanges around supplier–customer interfaces. Instead, a set of diverse organisations, involving a richer set of interactions than simple market transactions, must be taken into consideration.

Different innovation system views emphasise distinct aggregation levels, boundary definition criteria, and dominant processes. Table 1 reviews the many schools of thought concerning concrete innovation systems and presents the key concepts and conclusions. To understand the locus where differentiated innovative dynamics are produced, we organised the contributions into three categories: macro-level (global

Table 1. Review of the literature on innovation systems.

Levels	Schools and typical references	Main concepts or conclusions
Macro	*Global economy* Amable and Boyer, 1995; Vernon, 1966	National factors create a global division of labour and consumption regarding innovation.
	National systems of innovation Freeman, 1988; Lundvall, 1992; Nelson, 1993; Porter, 1990	National institutions and technological infrastructure influence differentially their innovativeness and competitiveness.
Meso	*Industrial organisation* Bain, 1956; Porter, 1980	Exogenous conditions influence industry concentration, the strategic behaviour of firms (innovation for differentiation or cost reduction), and firms' performance.
	Product/market/industry lifecycle Abernathy and Utterback, 1978; Adner and Levinthal, 2001; Clark, 1985; Christensen, 1997; Klepper, 1996	Conditions and endogenous processes interact to produce predictable product diffusion, shifts in the type of innovation activities, and industry concentration; punctuated by discontinuities.

Table 1. (*Continued*)

Levels	Schools and typical references	Main concepts or conclusions
	Technology systems and trajectories Carlsson, 1995; Dosi, 1982; Garud and Karnøe, 2003; Sahal, 1981; Tushman and Anderson, 1986	Interactions between actors developing a cluster of related generic technologies create spill-overs and determine the evolution of technologies and development opportunities.
	Sector-based systems of innovation De Bandt, 1989; Malerba, 2002; Pavitt, 1984; Salais and Storper, 1992; Van de Ven and Garud, 1989	System of heterogeneous participants that perform innovation and production activities related to a set of products; path-dependent co-evolution of knowledge base and demand.
	Networks/value nets/ecosystems Burt, 1992; Granovetter, 1973; Iansiti and Levien, 2004; Parolini, 1999; Podolny *et al.*, 1996; Powell, *et al.*, 1996; Uzzi, 1997	Innovation emerges out of network interaction (both competitive and collaborative), pattern of links determines the search effectiveness and knowledge circulation, leading to differential performance of firms, products, technologies.
	Strategic groups Caves and Porter, 1997; McGee and Thomas, 1986	Subset of industry firms that have similar value-creation systems and are protected by intra-industry mobility barriers; firms achieve similar levels of performance.
	Regional systems of innovation Miller and Côté, 1987; Piore and Sabel, 1984; Saxenian, 1991	A regional cluster of firms and institutions influence the type and direction of innovation and business creation.
Micro	*Firms* Barney, 1991; Cohen and Levinthal, 1990; Eisenhardt and Martin, 2000; Jelinek and Schoonhoven, 1990; Penrose, 1959; Prahalad and Hamel, 1990; Teece *et al.*, 1997	Heterogeneity of internal resources (including knowledge) and capabilities (structures and processes) between firms, coupled with inter-firm isolating mechanisms ensure differential innovation and performance. Firm history and evolution matter.
	Projects and teams Allen, 1977; Clark and Fujimoto, 1991; Cooper, 2001; Tushman and Katz, 1980	Team composition, decision, and problem-solving processes influence innovative performance.

and national); meso-level (inter-organisational); and micro-level (firms, organisations, and teams).

From this review, it became clear that our concept should refer to meso-level systems, which are small enough to foster distinct dynamics of innovation while being large enough to include all key participants needed to sustain a value-creation network. On the one hand, macro-level systems combine many distinct dynamics. Global and national systems are too wide and heterogeneous to support the development and reproduction of just one coherent set of rules. Even most sector-based systems are too broad to be accounted for by a set of rules. As shown in Fig. 2, the pharmaceutical sector has three different value-creation networks, which we think are each playing by different sets of rules. Participants in the science-to-technology races network, represented mainly by biotech firms, create value by transforming the latest scientific knowledge into new technologies and, eventually, new products. On the other hand, firms in the safe-science network, represented by established pharmaceutical firms, use a more stable knowledge base in biology, pharmacology, and chemistry to develop drugs via a trial-and-error approach. Firms in the research tools and services network provide tools for combinatorial chemistry and rational drug design; databases of chemical compounds, genomes, and tissues; and characterisation and clinical-trial services. Their activities rely on advanced science to help firms in the other two networks, but with a very different value-creation emphasis. While pharmaceutical firms sell to average clients, the research tools that firms have to understand and match the needs of very sophisticated clients. The dynamics, network relations, and strategies in each group are different.

The micro-level systems take the dynamics as given (Eisenhardt, 1989; MacCormack *et al.*, 2001). Even as they contribute to the dynamics, firms and projects see themselves in a stream of innovation in which their leverage is limited, because they depend on others to create value. Even some broader systems, such as strategic groups, are too narrow. Strategic groups are sets of firms with similar business models and degrees of coverage for value-creation activities. Yet, to be viable, the networks of most value-creation subsystems includes several strategic

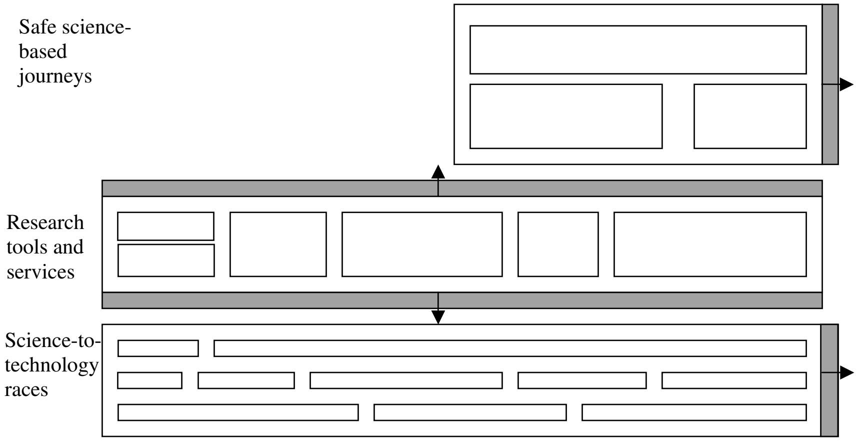

Fig. 2. An illustration of different games in the same sector.

groups. For example, in the science-to-technology races network, some firms would cover the entire drug-development process in order to sell drugs to final customers, while others would focus on a few upstream stages and sell mostly intellectual property rights, while contributing to the same value interface. These different strategic groups form types of "building blocks" within the concrete game subsystem. They know and observe each other and are in direct competition for the same value interface. The distinctions between them would be incorporated into the rules of the game.

Other authors point out the relevance of focusing at the meso level (Dopfer *et al.*, 2004). While Piore and Sabel (1984) pointed at the coexistence of distinct forms for inter-organisational innovation and production systems, De Bandt (1989) was the first to suggest that "meso-level systems", which he also calls "subsystems of the economy", are concrete arenas in which firm-level strategic interdependencies and information exchanges meet broader regulatory and knowledge-production processes, and become the locus at which distinct and autonomous innovative dynamics are generated. Since then, scholars have proposed specific meso-level systems as the locus of differential innovative dynamics: networks of innovators (Powell *et al.*, 1996), sector-based systems (Malerba, 2002), and technological systems (Carlsson *et al.*, 2002).

De Bandt (1989) suggests that meso-level systems should be defined by referring to their key interdependencies, and he contrasts this approach with standard classifications of economic sectors or industries. While each "cut" on the reality proposed so far offers interesting insights, there are few compelling arguments in favour of one or the other. Our analysis and empirical research suggest that the entity that most fruitfully captures the underlying unity and diversity of innovation is a subsystem made of organisations relying on a cluster of related technologies to perform interdependent innovation activities that share a specific value interface and value-creation focus. The value criterion sets games apart from broader but more heterogeneous innovation systems and from a reductionist focus on firms and strategic groups. This criterion makes it possible, for example, to distinguish a system of entities that develop drugs based on biotechnology, from idea generation to commercialisation, from a system of entities that develop R&D tools such as biochips; the latter emphasises different value-creation dimensions. As will be discussed below, the distinct value-creation focus infuses coherence and rhythm into the activities of the game subsystem and leads to distinct innovative dynamics, even if different subsystems may be related by exchanges and collaborations.

Sets of rules and dynamic stability

Many schools of thought consider social processes, including innovation, to be influenced by shared cognitive frameworks that take the form of definitions, rules, and scripts. These are the conceptual underpinning of decision-making processes that, together with a capability base, enable managers to develop and implement innovation strategies. Some rules, such as those included in national cultures and institutions, have a broad impact, while others result from local interactions. Most shared cognitive elements are deemed to stabilise social systems. However, recent contributions suggest that some elements, such as "organising visions" (Swanson and Ramiller, 1997), can help to accelerate innovative processes, or even induce a permanent state of high-velocity innovation and turbulent competition (Bogner and Barr, 2000). Table 2 reviews some of these currents.

Table 2. Review of cognitive elements that shape the structure and dynamics of social systems.

Schools and typical references	Main concepts and conclusions
Regulation and convention Hollingsworth and Boyer, 1997; Thévenot, 1986	Social and economic systems maintain their stability through governance rules.
Practice and action systems Barley, 1986; Bourdieu, 1977; Giddens, 1984; Orlikowski, 1992	Social structure (rules and resource distribution) enables and constrains action, but also emerges and is reproduced through patterned action.
Neo-institutional theory DiMaggio and Powell, 1983; Meyer and Rowan, 1977; Scott, 1995; Zucker, 1977	An organisational field produces and imposes legitimate practices ("rationalised myths") or institutionalised forms leading to uniformity.
Scenarios and organising visions Bijker *et al.*, 1987; Miller and Floricel, 1998; Swanson and Ramiller, 1997	A cognitive vision of future evolution underpins the social construction of a new technological domain or the start of an innovative upsurge.
Self-referential superstructure Luhmann, 1995; Maturana and Varela, 1980	A subsystem that is able to distinguish between a system and its environment, and between the system's parts, enables system reproduction.
Archetypes and paradigms Dosi, 1982; Greenwood and Hinings, 1993; Miles and Snow, 1978; Miller, 1991	Some structural configurations resist contingent change because of internal logical coherence or consistency with one core set of ideas.
Best practices, fads, and fashions Abrahamson, 1991; Strang and Macy, 2001	Repeated cycles of rapid diffusion of practices that appear to work in excellent companies followed by demise after disappointing results.
Communities: practice, epistemic, learning Brown and Duguid, 1991; Garud and Karnøe, 2003; Metcalf, 1981	Emergent interstitial networks enable collective learning and innovation through shared stories, *ad hoc* collaboration, and gradual inclusion.
Shared cognitive frameworks Bogner and Barr, 2000; Porac *et al.*, 1989; Prahalad and Bettis, 1986; Spender, 1989	Shared frameworks (dominant logics, industry recipes) shape competitive actions; in turn these reproduce the domain structure and dynamics.

We argue that rules of the game have more than a local applicability — for example, in one firm only — yet have straightforward implications for participants. Comparable sets of rules are found in several industries that face similar contexts in terms of knowledge production, economic logics, and customer–supplier relationships. Thus, we see science-to-technology races in some energy sub-sectors (fuel cells) and in nanotechnology, in which strategic issues and typical answers are similar to those found in biotech. While many scholars look for specific industry/sector recipes or cognitive frameworks, we argue rules of the game are concrete instantiations of rules with broader applicability. This level of rule generality, a meso level of sorts, fills an important gap between "best practices", supposedly valid across the board, and very narrow "industry recipes". Best practices are often difficult to translate for a given sector, while "rules of the game" offer a clear path to implementation. More general rules also enable managers to access broader cognitive communities and ideas emerging from varied yet similar contexts, where they find common problems and language.

In some sense, our "rules of the game" are similar to the "institutionalised organisational forms" or "rational myths" of neo-institutional theory. Rules are diverse, akin to organisational "building blocks" littered across the cognitive space (Meyer and Rowan, 1977). But some of them apply better in a certain context of "dominant values" (Haveman and Rao, 1997). Likewise, among the many rules that can be used for innovation, each game selects and organises rules around a dominant logic of value creation. In addition, while some rules refer to stable concrete subsystems, others refer to and must contain within their scope the seed of turbulence and high-velocity innovation. Hence, rather than recommending concrete strategies and investments, the rules state ideal propensities to innovate and to create barriers, attack, or cooperate. Such focus on "theory", rather than concrete structures, opens up a more dynamic view of the social processes of innovation and growth.

But in another sense, the rules that compose a game of innovation are like a language game (Wittgenstein, 1953), an integrated system of meaning in which the significations of the various terms draw their meaning from neighbouring terms and only collectively they are grounded in real value processes. Continual tests of the underlying reality appear to drive the system of rules towards internal consistency, which becomes the key to producing value through innovation. This contributes to the perpetuation of the system of rules, which is akin to a formal system that applies to several sectors the way a mathematical formalism can be used to describe phenomena in heat as well as fluids. For example, essentially the same game called "asset-based optimising" can be applied to the petrochemical, tar-sand-mining, and pulp-and-paper sectors.

The focus on rules leads us to a novel perspective on dynamic persistence: not only do rules structure action but they also provide stability for the future. Our view is different from most other approaches, which see the dynamics of meso-level systems either as lifecycles leading inexorably to maturity only to be punctuated by revolutionary changes (Abernathy and Utterback, 1978), or as a continuous evolutionary transformation, which is path dependent but difficult to predict (De Bandt, 1989; Malerba, 2002). On the one hand, the relevance of the lifecycle view has been diminished by the observation that many subsystems maintain a steady pace of innovation for long periods of time (Eisenhardt, 1989; Henderson, 1995). On the other hand, evolution cannot predict specific patterns, which is a condition for producing workable theories. So, we argue that, despite continuous innovation and evolution, rules reproduce a dynamic pattern for long periods of time; the pace, nature, and processes of innovation remain stable at the level of distinct trajectories. By uncovering the mechanisms that maintain innovation on these trajectories while enabling more freedom than the processes assumed by lifecycle theories, we can understand the basic conditions of existence for innovation, which enable meso-level value-creation systems to survive, reproduce, and develop.

Many factors promote the stability of subsystems. Some are society-level forces: for instance, financial institutions, such as stock markets or pension funds, certainly encourage innovation, but they want predictability and stable earning growth; governments and communities want stable regional development and employment; and so on. Other factors are the dynamic resource-reproduction cycles that renew knowledge and funds available for innovation (Thomas, 1996). In games of innovation, a powerful stabilising force is a shared cognitive framework of rules that sketches the boundaries of the subsystem, the nature and dynamics of innovation, and the most suitable types of competitive and innovative strategies (Bogner and Barr, 2000). These self-referential "rules of the game" are rather stable; they are reproduced by the participants' actions (Giddens, 1984).

Hence, we argue that a game of innovation is also a set of generic rules on which actors rely to make sense of the innovative processes in which they participate and relate to each other in a meaningful way. These rules, explicit or tacit, can be deduced by observing the actions and eliciting the beliefs of managers involved in the game. Moreover, while socially constructed, the set of rules for each game forms a coherent totality around the value-creation focus. Feedback from reality precludes long-term incoherence and inconsistency within the sets of rules. Rules play a significant role in driving and maintaining the dynamics and the heterogeneity of innovation processes by calling managers to action. Moreover, while not all firms play the same role in a game, their performance depends on many factors; the extent to which firms understand these generic rules and use them to model competitive and innovative actions is an important explanatory factor for the differential performance of firms within a game.

Sources of heterogeneity

Though producing useful insights, few contributions on meso-level systems ventured beyond a general discussion. Our goal is therefore not only to define the boundaries and composition of such systems but also to identify the key variables, pattern regularities, and trajectories. For this purpose, we sought inspiration in previous comparative research on innovation (Pavitt,[1] 1984; Salais and Storper, 1992), which explained the heterogeneous dynamics of innovation by such factors as the nature and dynamism of relevant knowledge, the nature of products, the nature of customers, and so on. Table 3 reviews the most relevant contributions in this current. The common idea is that each innovation context is different.

These ideas can be linked to recently developed concepts, such as creation and capture of value; resources, capabilities, isolating mechanisms; innovation strategies and nonlinear dynamics; architecture, modularity, and network structure, and so on. These concepts are presented as forces with universal explanatory power but

Table 3. Review of the forces that generate heterogeneous patterns and dynamics of innovation.

Factors and typical references	Main arguments
Nature of knowledge Cohen and Malerba, 2001; Garud, 1997; Hayek, 1945; Nelson, 1982; Nonaka, 1994; Pavitt, 1984; Vincenti, 1990	Innovation patterns vary as a function of dominant knowledge type (scientific, engineering, and tacit skills). The extent of knowledge distribution and transfer difficulty influences the division of labour and niche creation.
Knowledge-production dynamics Bettis and Hitt, 1995; Burns and Stalker, 1961; Eisenhardt, 1989; Klein, 1977; MacCormack *et al.*, 2001	Innovation patterns vary significantly as a function of whether the underlying science and technology are advancing rapidly or slowly, whether the advance is linear or turbulent, etc.
Nature of buyers and of their needs Day, 1990; Moore, 1991; Porter, 1990; Von Hippel, 1986	Various groups of customers have different problems and degrees of knowledge about technical systems, which impact on the nature and patterns of innovation.
Nature of products and production Langlois and Robertson, 1992; Miller *et al.*, 1995; Piore and Sabel, 1984; Salais and Storper, 1992; Teece, 1986	Systemic nature versus isolated nature of products, product versus process technological emphasis, mass versus small-batch production, etc. influence the extent of collaboration and appropriability as well as dynamics.

[1] Keith Pavitt was a researcher in our programme before his untimely death.

Table 3. (*Continued*)

Factors and typical references	Main arguments
Public regulation Freeman and Soete, 1987; Miller *et al.*, 1995; Porter, 1990; Teece, 1986; Van de Ven and Garud, 1989	Economic regulation impacts the allocation of funds to innovation by altering the prospects for value capture. Safety regulation forces rational justifications and procedures (e.g. science-based explanations) that increase the cost and duration that may be barriers to entry into the club. IP regulation can increase or reduce the appropriability of value created by innovation, and hence influence innovation in directions that better protect IP.
Innovation policy and infrastructure Cohen *et al.*, 2002; Freeman, 1987; Nelson, 1993; Rothwell, 1988	Direct role of government, as well as purchasing policies, corporatist arrangements, convening collective research, and university funding provide resources and inflows, and generate spill-overs.
Intrinsic structuring forces Arthur, 1989; Bain, 1956; Caves and Porter, 1977; Scherer, 1990; Schilling, 1998; Shapiro and Varian, 1999; Simondon, 1989; Ulrich, 1995	Cost factors such as diminishing marginal cost (economies of scale and scope, learning curves) and network effects lead to nonlinear relations between innovative effort and captured value affecting relative firm size and industry concentration. The extent to which the architecture can be modularised influences the need to integrate and coordinate the development of products.

IP: intelleutal property.

our approach is that in the complex reality of innovation they work together to form context-dependent configurations. Multilevel social systems research (Bunge, 1977; Kontopoulos, 1993) can also help us understand the relevant influences from the proximate levels of analysis: respectively, society and firms. By seeing meso-level processes as being conditioned by both higher-level processes and firms' strategies, we can isolate variables that are, at least in the medium term, exogenous, and understand how firms' strategies and practices combine to produce meso-level dynamics. By comparing different sectors, we propose a parsimonious conceptual framework that helps make sense of this heterogeneity and explains the differences in the value-creation focus of different games.

In sum, we argue that by focusing on a limited set of distinctions that make a real difference in the patterns of innovation, we can elaborate a parsimonious

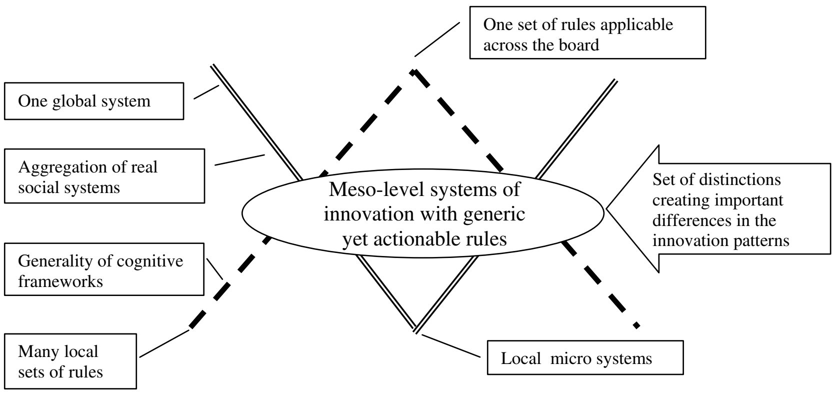

Fig. 3. The convergence of meso-level distinctions, systems, and rules.

framework and identify rules with a broad but precise area of applicability. We identified three key factors, which enabled us to distinguish 11 games of innovation, each of them relevant in different industries. This level of precision regarding the basic distinctions enables us to unify our search for real meso-level systems that are the locus for generation of distinct dynamics, with the need for generic yet actionable rules. This idea is illustrated in Fig. 3.

Theoretical Framework

Firms find themselves in dynamic contexts characterised by emerging knowledge that stimulates value-creation processes through innovation; by property, investment, and cost factors that trigger processes enabling the capture of this value; and by conditions of differentiation and insistent demands by customers. However, not all areas of this opportunity space are equally viable in terms of sustainable economic models and richness of opportunity flows; some combinations of factors offer high value-creation potential. Our key hypothesis is that games of innovation emerge and flourish around the opportunity peaks in this space, while configurations of conditions enable mutual reinforcement between value-creation opportunities, value-capture processes, and demand stimuli. The process of groping and searching to create value leads to the identification and development of rules that match the dynamics of innovation activities to contextual opportunities and constraints. The core set of rules, which come to be shared by firms in a meso-level innovation subsystem, refer to the emphasis on value creation through innovation. Based on this set, other rules are developed for strategic positioning, investment and coordination, and organisation and practices, forming a coherent frame that guides action towards the peaks of the value creation. Not all firms and managers are equal in perceiving those opportunity peaks and the rules that lead to them.

Contextual conditions

A combination of empirical research (Miller and Floricel, 2004) and theoretical analysis (Floricel and Miller, 2003a) led us to the conclusion that a limited number of prevailing contextual conditions explain the differences between the dynamics of various games. We grouped these conditions in three dimensions: *knowledge-production dynamism*, which refers to the extent that the sector faces technological opportunities for value creation; *structuring potential*, which determines the extent to which participants can capture value; and *demand specificity*, related to the opportunities for value creation provided by customer needs and degree of expertise. These dimensions correspond to three fundamental requirements for innovation: technical opportunity, value appropriability, and market opportunity (Dahmén, 1970; Metcalfe, 1981; Pavitt, 1984). Some combinations of these dimensions create peaks in the opportunity space and hence produce viable games, generating a continuous flow of opportunities for innovation. Other combinations are logical impossibilities or produce economic traps — games that produce negative value because of the competitive behaviour of players. Figure 4 relates these dimensions to the different games of innovation that we observed. Table 4 describes each game.

Dynamism of knowledge production refers to the flows of new relevant knowledge to which game participants have access. Innovation activities in a game subsystem form just one segment in a broader knowledge-renewal cycle that prevails in the cluster of technologies on which the game relies. Games face high, average, or low knowledge-production dynamics. “High” knowledge-production dynamics means a strong and constant influx of new scientific knowledge suggesting new principles that can lead to the development of new technologies. Biotechnology is a good example of such dynamism. When “average” knowledge-production dynamism prevails, a strong flow of technology development around a limited set of basic principles and a constant restructuring of technical architectures enable spectacular performance improvement, and addition of new applications and functions. The telecommunications sector is a good example of such dynamism. Finally, when “low” knowledge-production dynamism prevails, most knowledge production takes the form of learning from experience with existing product architectures, production systems, and use patterns. This enables improvements and cost reduction. The automobile industry is an example of such dynamism. A higher level of knowledge-production dynamism calls for specific network forms and innovation practices, but, while it creates innovation opportunities, it also disrupts or destroys existing production processes and firm competencies (Henderson and Clark, 1990;

		Knowledge-production dynamism that creates opportunities for value creation			
		High (strong scientific influx creating new operating principles)	Average (fertile technological advances that add to and transform the knowledge base)	Low (stable knowledge base with incremental advances based on accumulated experience)	
Structuring potential that enables value capture	High (regulations enabling strong appropriability with low contestability)	**Science to technology races** (biotech, fuel cells, nanotechnologies)	**Science-based safety journeys** (chemicals, drugs, medical equipment, aerospace)	**Asset-based problem solving** (power, gas, petrochemicals, mining, regulated telecom)	
	Average (underlying technical and economic logics that favour appropriability but maintain contestability)	**R&D tools and services** (evolving science-based design for sophisticated customers in effervescent application domains)	**Battles for architectures** (mass software, computers, internet and telecom services, networking equipment for telecom, semiconductors)	**Learning and marketing** (automobile, snowmobile, mass consumer products) **Innovating in packs** (chemicals, industrial gas, steel, materials, aluminium)	
	Low (weak appropriability and strong contestability)	**Research programmes** (public or corporate lead users who innovate for themselves, plus the odd product by a large firm such as EMI's CT scanner)	**Systems engineering and consulting** (IT systems: PLM, IRP, CRM, SCM, specialised telecom systems, enterprise solutions)	**Niche craft problem solver** (specialty food ingredients, speciality chemicals, electronic equipment)	**Short-lived news** (apparel, movies, music)

Very high demand specificity Complex customer needs and high internal expertise

High demand specificity Special customer needs accompanied by higher expertise create opportunities for value creation and capture

Low demand specificity Ordinary needs and expertise

Fig. 4. Games of innovation.

Tushman and Anderson, 1986). Hence, to produce viable games, higher levels of knowledge dynamism require compensating conditions on other dimensions.

Structuring potential refers to social, economic, or technical processes that produce value-capture asymmetries between game participants. "High" structuring potential exists in the presence of strong institutional frameworks, such as regulations and public policies, in the economic, safety, intellectual property, and procurement areas. These limit access to markets, as a result of social pressures and perceptions of risk associated with some products or activities. "Average" structuring potential is produced by economic logics such as economies of scale and

Table 4. Short descriptions of the games of innovation.

Name	Brief description
Science-to-technology races	Socially structured framework to fund research activities (beyond basic research) in promising sectors, and enable the appropriation of return in case of success. Strong inflow of small firms carrying new principles from sciences and resources create narrow technological niches, in which actors enter and exit at different stages. Failure is part of the game and rapidly advancing science frontier precludes accumulation of expertise. Industries include biotech (nanotech and fuel cells).
Safety journeys	A publicly controlled framework to ensure safety in the development of products such as drugs, genetically engineered food, airplanes; forces major projects for research, design, engineering, testing, and approval, virtually eliminating small players. An established and only moderately advancing science base further favours the accumulation of expertise inside firms.
Asset-based problem solving	Economic regulation and property rights lead to the emergence of large systems of capital assets. Scale is needed for efficient production of commoditised products. The complexity of these systems offers opportunities for optimisation by blending IT and operational research with accumulated knowledge about the functioning and operation of such systems. Innovation amounts to solving these concrete and complex problems or replacing old assets with the state-of-the-art facilities.
R&D tools and services	Design tools based on recent advances in effervescent science fields to design computer chips, bioinformatics, genetic diagnostic tool kits, and drugs. Clients are sophisticated users facing very stringent requirements. Producers are start-ups led by recognized experts capable of synthesising a new paradigm at the intersection of evolving requirements and science. Over 50% of sales allocated to innovation. Continual versioning of the product due to evolving science and user demands.
Battles of architecture	Occurs in ecosystems of players structured along the levels and modules of technical architectures. On one level, innovation consists in orchestrating the technical architectures to compete against other architectures based on the similar basic principles. On another level, it occurs in the development and improvement of modules and applications. Modularity enables autonomous innovation in modules and applications, while standards allowing interconnectivity enable many creative combinations. Markets may be expanded by integrating new modules that were traditionally closed systems, such as photography. These become open in order to interact with digital systems such as computers. In some cases, such as telecommunications, these areas become part of the core technical architecture.
Learning and marketing	The game is based on capturing value by avoiding commoditisation of products. Learning from experience in existing products and manufacturing systems enables incremental innovation that leads to performance and cost advantages. Mass markets are segmented based on the dimensions of user needs and served with different products or brands. Differentiation is based on perceptual elements such as styles, touch, and product features. Players are usually large (global) firms that dominate networks of suppliers and have worldwide marketing expertise.

Table 4. (*Continued*)

Name	Brief description
Innovating in packs	Players are generally large, well-established producers of common industrial products, such as steel, aluminium, industrial gases, and paper. Because production requires large investments, producers need to renew demand for their product by finding new application that require mass quantities of the product. Hence, they build alliances with major existing and potential customers to identify, understand, and solve their problems in the hope of developing innovative solutions that will lead to new uses for their generic technologies and common products.
Research programmes	This is an "amateur" game. It depends on excess cash and "visionary" promoters in large organisations such as governments and large corporations wanting to renew their technology. Firms invest in centrally managed research programmes, such as Xerox's PARC. Similarly, government programmes, such as NASA, or government-owned firms, such as Hydro-Québec's IREQ and Ontario Hydro's Sheridan Park, want to achieve breakthroughs for competitiveness and development. Serendipity enables companies such as EMI to develop computer tomography. But usually, success is unpredictable and benefits are captured elsewhere.
Systems engineering and consulting	The important capabilities required for playing this game are understanding the evolution of rapidly evolving infrastructure technologies, such as information and communication technologies; and user applications, such as management processes, manufacturing, retailing, and billing; and generating faddish waves of investments such as reengineering, ERP, CRM, SCM, PLM, e-commerce, and VoIP. Firms capture value by proposing to large clients, such as banks, insurers, steel companies, a vision of future change, and recommending major investment in IT and processes and help in the implementation of these projects.
Niche craft problem solver	This game relies on recurring problems that take a variety of specific forms. Solutions are obtained by combining a stable knowledge base with prior experience in solving similar problems. The competitive advantage of each producer lies in its accumulated stock of knowledge and experience. The value capture and innovation depend on ongoing relations with major buyers.
Short-lived news	Innovation relies on pure perceptual novelty in sectors with mature technologies. The game is characterised by overproduction of ideas plus a system of selection and hype creation through herding and rapid imitation around a few winners. Examples include music, movies, publishing, fashion clothing, news media, and electronic gizmos. Value capture for innovators is risky but players specialised in selection and promotion survive with a continually renewed innovation portfolio.

scope in innovation, production, and distribution, or by network and reputation effects. Appropriate action in their presence can give some firms disproportionate market share or technical dominance over competitors. "Low" structuring potential is present in all sectors that are not socially sensitive and are subject to nonlinear logics. For instance, standard construction, consulting, and clothing manufacturers face a low structuring potential. Structuring forces enable firms to capture more value from innovation by creating barriers to entry, mobility, or competition; regulations, in particular, significantly increase the cost of innovation. Economic logics give rewards that are much higher than firms' innovative expenses. This protection enables certain firms to capture enough value even in conditions of high knowledge-production dynamism.

Demand specificity refers to the extent that customers have advanced and unique needs, demand differentiated products and services, and have the willingness and the capacity to pay. "High" demand specificity usually exists in the presence of customers, usually large firms or government agencies that use products in very complex applications or as critical production system components. Customers that face this kind of complex problem usually have a high level of technical expertise with the product (Von Hippel, 1986). They do their own R&D and are able to signal new needs or problems to vendors. Because they are keenly interested in obtaining innovations, they are more likely to support the innovation activities of suppliers. For instance, leading telecom service providers will sometimes demand and often collaborate in innovation by equipment suppliers. In "low" demand specificity conditions, needs are common and products are not mission-critical. Customers can judge the quality of products but do not jolt suppliers into being innovators. Such conditions occur with individual buyers or in mass industrial markets. High demand specificity creates opportunities for innovation because customers provide ideas and knowledge and are willing to support innovation. It also creates asymmetry via bilateral supplier–customer learning and development of trust, giving suppliers an advantage relative to competitors with respect to specific customers. Thus, high demand specificity compensates for adverse conditions on the two other dimensions.

Configurations that produce peaks of value-creation opportunities. Rules emerge as choices and trials lead to the stabilisation of the value-creation dynamics in innovation subsystems. Games of innovation, as a set of rules, suggest that an appropriate "code of conduct" applied to a subsystem will raise value creation to the highest potential allowed within the combination of contextual conditions. For a combination of conditions, a workable set of rules would enable the activities in the innovation subsystem to proceed and persist over time, in a similar form, for a suitably long period (20 years or more). Concretely, they would create sufficient opportunities for value creation and reasonable prospects for value capture by participants to enable their survival, in certain proportions, and the development of their competencies. Hence, high knowledge-production dynamism creates many opportunities for innovation but often reduces value-capture perspectives because subsequent opportunities cannibalise current ones. A regulatory framework that slows and severely prunes novelties and keeps close imitations ("me too" products) at bay paradoxically helps to sustain innovation in this context. If knowledge production is slower, average structuring potential offers sufficient leverage to build temporary barriers to entry and enable participants to value capture.

However, not all combinations produce "codes of conduct" that lead to viable innovation subsystems. When knowledge production is high, a low, or even average, structuring potential is not enough. In such cases value creation and capture can continue only if close relationships with clients and bilateral dependence emerge. Figure 4 shows 18 possible combinations of conditions, but there are only 12 viable combinations.[2] For 3 combinations, with rather high dynamism but rather low structuring potential and demand specificity, the context is unfavourable and no set of rules can sustain a viable game. For 3 others, conditions are "too good" and innovation is stifled by the presence of both high structuring potential and high demand specificity.

Dominant logic of value creation and prevailing conditions

For viable games, the internal coherence among rules and the need to fit the prevailing conditions lead to a dominant logic of value creation. This dominant logic means that all game participants, irrespective of their role, emphasise a certain combination of vectors of value creation for customers. All other rules of the game align themselves with this dominant logic. The grounded empirical research reported elsewhere identified four such vectors: productising science, aligning, engineering, and matching. *Productising science* means transforming ideas and scientific theories into products through R&D activities and legitimation, for instance, through regulatory approval. Customer value is created by basing products on superior operating principles. *Aligning* means developing interfaces and architectural standards for products. This enables interoperability, increasing the uses of a product, and stabilises markets, hence reducing customer uncertainty. *Engineering* means analysing and designing technical systems to make them more efficient, reliable, and safe for customers. *Matching* means studying and characterising customer needs and use products to design products and variants that correspond very closely to their specific requirements.

The dominant logic of value creation is related to the prevailing conditions in the game. In games with high knowledge-production dynamism and high structuring potential, value creation will emphasise productising science, because participants can benefit as much as possible from the protection offered by the institutional

[2]The game of battles of architectures corresponds to two combinations that are distinguished only by the demand specificity. In other words, the game works essentially the same way irrespective of demand specificity.

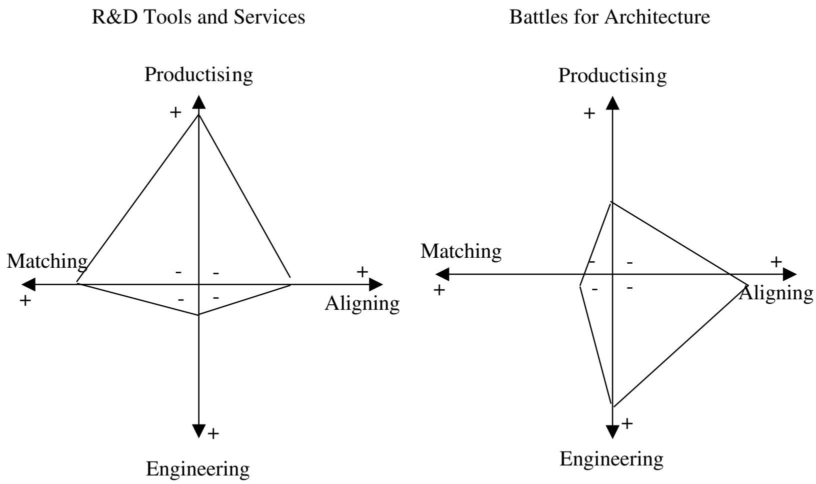

Fig. 5. Illustration of the vectors of value creation in four different games.

frameworks. By contrast, when the structuring potential is average, resulting only from factors such as scale, scope, learning, reputation, and network effects, firms will pay a great deal of attention to finding and maintaining the positions that enable them to benefit from these factors in order to capture value. Hence, in games with average knowledge-production dynamism and average structuring potential, value creation focuses on aligning by promoting architectures and developing alliances to this effect.

Figure 5 illustrates the value-creation vectors for two distinct games and shows how different the profiles for two "high-velocity" domains may be. The R&D tools and services games emphasise productising of new scientific and technical knowledge as well as matching the needs of sophisticated customers with complex or cutting-edge problems. Systems need to work; they do not have to be perfectly optimised. Many different systems may coexist in the market. By contrast, the battles of architecture game emphasises alignment around one or two standard architectures and the reliability of operating systems. Customers have generic needs that have to be satisfied with products that are based on existing knowledge.

Rules about organising for innovation

Games call for a process of fitting and adaptation of organisational forms and capabilities to the dominant logic of value-creation and contextual conditions. The process entails the search for a coherent articulation of value-creation activities and capabilities, strategies to build competitive advantage in collaboration with networks of complementors and suppliers, and organisational incentives, business processes, and innovation-management practices. Within a particular game, some configurations of choices enable a firm to climb the peaks of performance available for the given context and game subsystem, while other designs permit only a partial achievement of this potential. In the games of innovation view, coherence means that the choices regarding strategies, structures, and practices are not only adapted to the context of the game but reinforce each other in light of the dominant logic of value creation. The rules of the game referring to strategies, structures, and practices play a key role in guiding managerial choices towards achieving adaptation and coherence.

The first set of rules refers to the building and maintenance of organisational capabilities needed to innovate in a particular game. For instance, the central capabilities in the design and production of airplanes are not scientific research but the ability to accumulate engineering knowledge in the fields of aerodynamics, materials, structures, and electronics, as well as the ability to engineer integrated systems with absolute safety and reliability while meeting the cost expectations of buyers and regulatory requirements. As a senior manager at an aircraft manufacturer expressed it during an interview for the MINE project, when the focus of innovation is engineering, the last thing one wants to be known for is being science-driven. The capabilities can be grouped under four dimensions which match the value-creation vectors described above: *capability to know*, interact with, and judge the performance expectations of buyers; *capability to engineer* new products, processes, and services to meet targets in terms of reliability, safety, costs, robustness, and so on; *capability to manage* product architectures and to align with emerging standards, dominant designs, or protocols; and *capability to productise and transform scientific knowledge* into products by innovation management processes.

The second set of rules refers to the nesting of the firm into networks. Firms rarely innovate alone but develop rules as to worthwhile kinds of interactions and exchanges. External parties include customers, complementary partners, regulators, stakeholders, venture capitalists, and innovation support agencies. These provide financial resources, market access, or informational resources. In some games, stakeholders and regulators are the most important external players. In others, customers are the only significant external bodies. In sectors with high knowledge-production dynamism, the external players most likely to contribute to creating value are universities, regulators, complementary firms, or venture capitalists. By contrast, in sectors in which knowledge-production dynamism is slower, the most important external players are likely to be value chain suppliers. Rules will suggest the direction and the nature of ties that firms have to develop in each game.

The third set of rules refers to the most effective competitive and collaborative strategies. Experience, analysis, and feedback can foster rules regarding the competitive strategies that lead to different types of comparative advantage and the collaborative strategies that expand markets. In some games, competitors are well aware that investment in knowledge building is the way to maintain competitive advantage. In other games, competitive advantage is maintained by focusing on assets and barriers. In some sectors, the rules indicate that the appropriate innovation effort requires R&D expenditures at around 40 percent of sales plus another 10 percent for capability building, while in other sectors 1 or 2 percent overall appears to be sufficient. In some sectors, aggressiveness, continuous disruption, and fostering entry by innovative start-ups are the norm, in order to increase dynamic resourcefulness (Thomas, 1996), while in others firms seek to calm the competitive game in order to avoid price wars that destroy value.

Finally, rules concerning internal organisation and management practices for innovation will vary from game to game. In some games, innovation will be a marginal functional activity confined to an R&D laboratory, while in other games innovation is a core activity centrally located under the supervision of top executives. Certain games will favour broad exploration of external knowledge and opportunities, while others will favour the capture and formalisation of internal experience. In some games, iterative technology and product development are the norm, while in others a linear and well-controlled sequence is preferred. Finally, even rules that determine the dimensions for performance assessment will vary by game. In games with low knowledge-production dynamism, good and consistent returns on investment, sales increases above average economic growth, and innovations that maintain the product portfolio while reducing cost will be the expected benchmarks. By contrast, in games with high knowledge-production dynamism, high sales growth and high profitability will be expected to compensate for the risks taken to innovate in products and services.

The process of adaptation to a particular game locks capabilities, strategies, and structures into one configuration and creates inertia. This creates difficulties for firms that want to diversify into subsystems in which another game is played, when they seek alliances with firms that are used to playing a different game, or when contextual changes force subsystems to adopt a new set of rules.

The performance of firms in games

Figure 6 indicates that firms and games are involved in mutual relations. Games, as collectively learned sets of rules, inform managers about the most appropriate ways to create and capture value given the particular innovation subsystems in which their firm operates. The "games of innovation" theory proposes several factors to explain why some firms perform better than others. Participating in games that lead to high value-creation and -capture peaks is more likely to lead firms to higher performance than is participating in low value-creation and -capture games. Rich

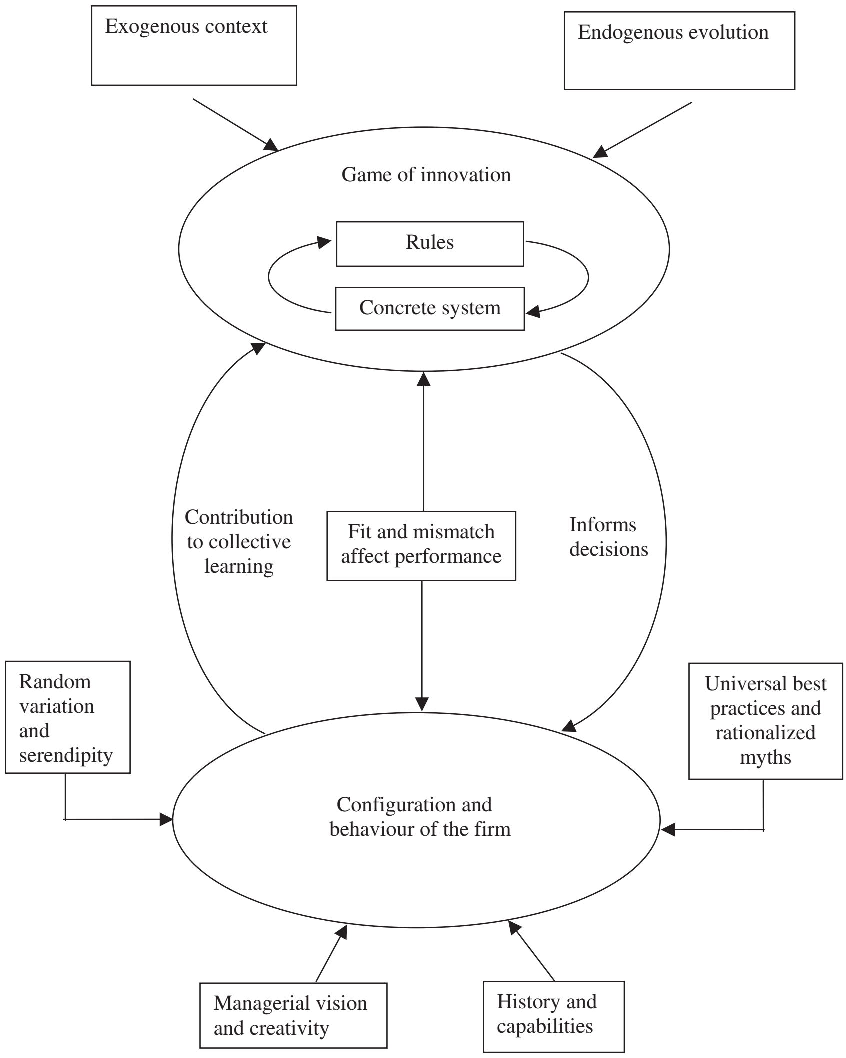

Fig. 6. Possible explanations of the behaviour and performance of firms.

opportunities and rewards tend to increase the probability of high performance. By contrast, competing in games with fewer opportunities and slower dynamics will bring the performance of firms down. Within games, the performance of individual firms will depend primarily on the degree of match between the sets of rules for value creation and capture that are appropriate for a game given its context, and the organisational configuration that managers have been able to build.

But if rules exist, why do all firms not have equal performance within games? First, not all rules are explicit and clearly defined. Some are experimental solutions or approximate guidelines. Managers cannot learn all rules through industry seminars or management training; some result from accumulated experience and remain tacit. Even if many separate rules can be taught, their coherence is more difficult to grasp. Some managers are better than others at understanding how rules, roles, and capabilities fit into a coherent configuration of innovation activities. Moreover, managers' efforts are hampered by a constant barrage of "best practices" promoted by management consultants and imposed with the help of financial institutions, analysts, and the business press. These practices are presented as universal solutions that are supposed to work well across games, and some managers may succumb to the combined pressures of performance targets and "rationalising" discourse (Meyer and Rowan, 1977; Strang and Macy, 2001).

The history of the firm also influences its ability to achieve high performance. A firm's current capabilities and structure result from a history of personalities and accumulated skills, commitments and investments, mergers and acquisitions, and so on. In come cases, this accumulation makes it possible to focus innovation activities in effective ways and preclude imitation by other firms in the game. In other cases, however, this inheritance and the associated inertia preclude firms from building coherent configurations of capabilities, strategies, organisations, and practices that fit the roles that they want to play within their games.

Moreover, not all firms are focused on a single business. Diversified firms that operate in distinct games have to balance the requirements of these games, which often precludes them from achieving the optimal configuration in any of them. They have to continuously deal with dilemmas such as those between investing in large assets and being able to renew their capabilities, or between the development of stable routines and the ability switching and reorienting activities. Not all firms understand that playing many games requires decentralised autonomous business units, internal heterogeneity, and versatile top management; their attempts to control and impose uniformity hampers their performance in at least some games.

Discussion

Games of innovation is a workable concept based on an empirically grounded comparative search for deeper structures in observed innovation processes, backed up by a constant matching and tying of findings to existing theoretical contributions. We have discussed how the concept builds on research on innovation systems, on the role of shared cognitive frames in the persistence of social systems, and on the factors that lead to differentiation of innovation activities. Because the game of innovation perspective is dynamic, it is important to discuss in this section the positioning of our theory in conceptual context of the evolutionary theories of innovation. Schumpeter (1934, 1950) presented economic evolution as changes brought about by innovations and responses to such changes; incessant innovation by entrepreneurs, as well as corporate initiatives, results in the creative destruction of capabilities and the reconfiguring of sectors and industries. Building on this thesis, Nelson and Winter (1982) developed an evolutionary perspective emphasising processes that produce and amplify the differentiation between innovation patterns in different contexts. These two strands, creative change and differentiation, are echoed in the games of innovation theory.

Like any evolutionary model, the dynamics assumed by the games of innovation theory contain a mechanism composed of three complementary stages: variation, selection, and retention. The variation is generated by individual and corporate agents that invent, develop products and competitive strategies, invest in assets, and so on. The variation process is usually considered "random" or, to use terms preferred by social scientists, "creative" and "blind" (Campbell, 1969). This means that the structure and context do not automatically channel these actions along a unique predetermined path, and that the ultimate consequences of these actions cannot be totally foreseen, excluding the possibility of a teleological evolution. In other words, actors face significant uncertainty, and, from the viewpoint of structural reference frames, "deviate" (make "mistakes"). However, despite this indeterminacy, differentiation can emerge even at this early point in the evolutionary process, for example, from the sources that prompt entrepreneurs to innovate. Different dynamics of variation can result from the fact that in some fields, relevant scientific production is low, while in others, such as biotechnology, it relentlessly opens up opportunities.

Selection occurs through competition between ideas, technologies, and firms, taking place with contextual forces and within institutionalised structures. As discussed above, certain combinations of values of the three contextual factors create opportunities for sustainable value creation, while others do not offer such opportunities at all, or offer smaller ones. Corresponding selection mechanisms also take many forms and enable further differentiation (Metcalfe, 1981). For example, in some areas of this three-dimensional contextual "space", customers may express easy-to-meet performance criteria, while in other fields they want and are ready to pay for increasing performance much beyond the *status quo*. In certain contexts, such as industrial markets, structuring processes lead to meritocratic selection. By contrast, hyper-selection will take place when individual customers face high uncertainty and cannot assess products based in available information. Dominant players can also influence selection criteria by promoting platforms or standards (Iansiti and Levien, 2004).

Additional differentiation comes from the fact that different value-creation vectors appear to work better in different areas of the contextual "space", suggesting that the adaptive evolution of games amounts to the "exploration" of a "fitness landscape", which is a function that relates performance (fitness) to a multidimensional vector of strategic decisions (Kauffman, 1993; Levinthal, 1997; Wright, 1931). Moreover, because these decisions interact, forming certain configurations that have a definitely higher "fitness" than others, this fitness landscape is, to use a complexity theory term, quite "rugged" (Levinthal, 1997). In this sense, the differentiation of the "games of innovation" has a configurational explanation (Milgrom and Roberts, 1992; Miller, 1991; Porter, 1996).

But, contrary to the population ecology approach in sociology (Hannan and Freeman, 1977), the games of innovation theory suggests that exogenous conditions do not directly "select" organisations as carriers of certain structures or practices. Instead, selection works at two levels. It selects meso-level subsystems, which are dynamic networks of organisations that interact in producing value, and focuses on a certain value interface and value-creation vector. In other words, the proximate result of selection is an ecosystem. The role of ecosystems in selection is still not completely understood in biology (Mayr, 2000, p. 897), yet the idea has made its way into social science theories, including some dealing with innovation (Haveman and Rao, 1997; Iansiti and Levien, 2004; Murray, 2002; Podolny *et al.*, 1996).

The history of the development of electric power is a good illustration of ecosystem selection. The search involves foresight, sometimes helped by theoretical visions, as well as institutional entrepreneurship. But more often it involved incremental experience-based search (Gavetti and Levinthal, 2000). By taking risks and often failing, yet learning from mistakes as well as successes, their own as well as those of others, participants collectively developed a set of rules. The competition was often between alternative systems and the diverse coalitions of players that supported each alternative (Hughes, 1983).

The result was a set of rules that Hirsh (1989) calls "build and grow", and that combines the dynamics of "asset-based optimisation" in its power-supply segment, with "learning and marketing" for the electric appliances segment, and "innovating in packs" for the complex electrical equipment segment. For the power-supply segment, besides rules about the underlying economics of production and distribution, referring to economies of scale and scope (or of "massing the production," as Samuel Insull called it), rules also emerged with respect to the roles and interrelations between electric utilities and different types of clients, regulators, unions, city, state, and, later, federal politicians, coal suppliers, equipment manufacturers, and others (see, for instance, McDonald, 1962). While one organisational form, the investor-owned regulated monopoly, dominated others, what was selected was a subsystem that conjugated the interests of these monopolistic utilities with those of other players. Selection forced major corrections, such as the disbanding of holdings and the reinforcement of cooperative and municipal utilities, when these interests appeared to be at odds.

In addition to the selection of game subsystem forms and rules, within the game subsystem itself there is another selection process that refers to organisational forms and practices. These are selected based on their fit with the core set of rules of the game — the value-creation focus — as well as with particular roles within the game. This selection process continues the differentiation of games, favouring practices that correspond to the vector of value creation. It also involves configurational mechanisms, in the sense that the totality practices harmonise the innovative throughput inside the company and synchronise it with the dynamics of the game (Floricel and Miller, 2003b).

Retention processes are represented by accumulation and persistence of rules, some of which become institutionalised practices to manage innovation, norms, or even legal and regulatory frameworks, as well as through investments in durable assets and infrastructure, knowledge bases, and recurrent interaction and demand patterns. The games of innovation theory sees the past as always partly influencing the future, with the elements that are retained constraining action. Yet, we stress that the core of what is retained in a game is not necessarily specific technological and organisational forms, but dynamic expectations and interactional attitudes. Therefore, while there is some technological trajectory, the open space that it makes available at any moment is usually quite large. Of course, the selection mechanisms are different, and more or less past oriented, in different games. Some of these retention mechanisms may interact with some of the sources of variation and with some of the selection mechanisms, resulting in mutual reinforcement; this creates an unscripted movement towards coherence in innovation systems leading to regularities and distinct trajectories.

Across the workings of these three mechanisms (variation, selection, and retention), contextual forces have important influences but do not act in a strictly contingent determinism. Trajectories are similar to broad trends within which there are high levels of openness and indeterminacy that create opportunities for creative and strategic action. To cope with the uncertainty that the space left open creates, managers develop and learn sets of rules about the organisation of business and innovative activities. A game is the result of concurring exogenous pressures and endogenously emerging rules of action. The rules emerge as a result of the accumulation of codified or tacit knowledge about innovation patterns, but there is strategic freedom in choosing among several possible sets of rules. This freedom creates the following possible scenarios of change and persistence for incumbent firms (a detailed discussion is beyond the scope of this paper):

		Context	
		Stable	Changing
Sets of rules	Stable	Playing the game as it is	Adopting an “ostrich” attitude or Migration to a new set of rules
	Changing	Incremental adaptation or Futile institutional revolution	Transformation of both game subsystem and set of rules

Conclusion

Games are subsystems of the economy in which distinct patterns of innovative activities lead to the production and exchange of goods and services. The outputs of games in which clients are industrial firms serve to increase the effectiveness of product design or the efficiency of production. For instance, car assemblers rely on RD&E tool builders to help them by building car design systems efficiently while optimising mass production. Pharmaceutical products are researched and produced in a sector in which productising scientific knowledge in large projects is central. However, pharmaceutical firms also rely on producers of RD&E tools to build drugs according to rational and scientific principles.

Much of the discourse on management of technology stresses that R&D activities have to be aligned with corporate strategy. Such a view is certainly possible in games in which the rates of technical and commercial change are slow. However, in some games only those who participate in the turmoil of scientific and technical change can identify and exploit opportunities. In this case, R&D sets the strategy and energises the firm by absorbing the flow of innovative energy from scientific communities, venture capital, and leading customers. R&D then converts these ideas into opportunities.

The natural follow-up for the outline of our theoretical views is to identify the rules of the game by measuring and comparing managers’ cognitive representations of the value-creation network, participants and roles, strategies, and practices. In preliminary research, we used measures that are relevant across all industries and sectors and found that clusters of firms share similar representations in these terms, even through they appear to be from different industries. In future research, we will use theoretically derived categories and measures, and will attempt to show that the empirically measured expressions of these rules are those that our theory predicts, given the conditions and value-creation emphasis of each game.

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