GROWTH STRATEGY AND HIERARCHY THEORY: EMERGENCE OF SUPER-PLAYERS IN THE HEALTHCARE COMPUTED TOMOGRAPHY OLIGOPOLY

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ABSTRACT

This paper examines how firms discover effective strategic positions in a business technology-driven oligopoly context (limited players, no possible entrant and rapid technological change). In such settings, neither rational deduction nor local search is likely to lead a firm to a successful growth: firms escalate by launching new products faster, developing new services or acquiring new capabilities. Demonstrating the complexity of the business oligopoly, however, allows us to define the emergence of a new type of players, "super-player", able to write a new set of rules and to substantially influence the industry for a given period of time. With respect to the Hierarchy Theory, we find the attributes of context changing, filtering information and simplifying multilevel business systems for this "super-player". More surprisingly, we find a succession of "super-players" that we identify as a consequence of co-evolution for a given oligopoly-type industry, in the Healthcare Computed Tomography: the "super-player" evolves in a way that the entire industry ultimately adapts itself and co-evolves in the same way.

Key Words: complex systems, growth, strategy, hierarchy theory.

1. Introduction

This paper aims to examine how firms discover effective strategic positions in a business technology-driven oligopoly context (limited players, no possible entrant and rapid technological change) by considering business oligopolies as complex coevolving systems. We firstly develop a system theoretical framework to grasp such context by adopting hierarchy theory and then apply the framework to a real business oligopoly case to validate the framework as well as to obtain unique insights about the case.

Strategy formulation and implementation is most critical in times of rapid change and in unfamiliar environment, while firms are requested to deliver the growth rates, expected by their boards and demanded by the investors. Strategy makers must identify a viable new strategic position and innovation in a large sense is usually the key driver of market change following Schumpeter (1934). Firms have to constantly adapt to a changing environment (Prahalad and Hamel, 1990; Teece, Pisano and Shuen, 1997). To create new assets, the resource-based view (Rumelt, 1984; Wernefelt, 1984; Nelson and Winter, 1982) draws on evolutionary economics (e.g., Montgomery, 1995; Barney, 2001), where new resources and capabilities emerge, develop and demise. Executives seem to recognize new challenges in today's globally competitive environments and understand how technoloigical innovation is necessary but not sufficient for success (Teece, 2007). Sam Pisano, CEO of IBM, remarks that

'innovation is about much more than new products. It is about reinventing business processes and building entirely new markets that meet untapped customer demand'.
Specifically looking at the business oligopolies, firms as big players tend to multiply efforts to differentiate themselves versus competition, that we would call hyper-competition (D'Aveni 1994): firms escalate by launching new products faster and developing new services, very similar to the competitors' offerings, where competitive advantages (Porter, 1980) do not last. From this perspective, one firm outperforms another if it is adept at rapidly and repeatedly disrupting the current situation to create a new basis for competing. With big players like multinational firms, the concept of escalation ladders from military strategist Carl Von Clausewitz accurately describes hyper-competition in this business oligopoly situation, where rapid technological change, deregulation and globalization have intensified competition and increased turbulence that strategic makers face. The rise of global organizations and the standardized information technology have created unprecedented complexity or interdependence within organizations.
Recognizing the profound effects of complexity for these competing firms, we argue that such business technology-driven oligopolies work as complex systems. By complexity we refer to mathematical theories of complex adaptive systems in the physical and biological sciences (e.g. Prigogine, 1980; Kauffman, 1993; Gould 2002) and also in social sciences (e.g. Axelrod and Cohen, 2000). Management scholars have also attempted to introduce these theoretical ideas to administrative science (e.g. Burgelman, 1983; Thietart and Forgues, 1995; Brown and Eisenhardt, 1997). Moreover, looking at open systems (system that interacts with ist environment to maintain istelf in existence), the trans-discipline named 'General System Theory' (von Bertalanffy, 1968) argued that the sorts of behavior seen in open systems in biology could be seen demonstrated by open systems in other domains. Management scholars (Stacey, 1996, 2000; Rosenhead, 1998; Jackson, 2000) did develop some seminal frameworks to deal with this business complexity as open systems

2. Business Oligopolies as Complex Evolving Systems

The previous discussion argues that at the industry level of analysis, business oligopolies may be considered as complex coevolving systems because they can change the rules of their development as they evolve over time. Simon's (1962) essay on the architecture of complexity analyses the properties of complex systems: 'one made up of a large number of parts that interact in a non simple way…in such systems…given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole' (p. 468). In complex systems, the parts can be understood in terms of their relationships with each other and with the whole. The number and variety, as well as their numerous interactions make the business oligopoly being a complex system: the rules of the system are nonlinear, order is an emergent property of disorder; they do not simply adapt to their environment but co-evolve with them. A hierarchical theory is needed because the business oligopoly as a complex system is itself hierarchically arranged. As Simon (1962) pointed out, hierarchical ordering is one of the most natural ways of organizing complexity. These hierarchies are inclusive and the hierarchical levels are nested one within the other (customer hierarchy with firm hierarchy, competitor's hierarchy with firm hierarchy…). _
For a given firm, dealing with growth in such a complex context represents a complex problem. A problem is complex when an explanation of its associated behavior

requires several disparate levels to be addressed simultaneously (Ahl and Allen 1996). Then, low-level details in complex systems exert an influence over high levels and affect the behavior of the whole system. The problem of growth strategy in such an oligopoly requires taking account both fine-grain details and aggregate behaviors from inside and outside and consequently multiple levels of organization are needed to provide us with a solution. According to the Hierarchy Theory, the complexity is a function of the model embedded in the question, not of the material system itself.

A system is defined as hierarchical if it can be described as composed stable subunits, unified by a super ordinate relation but the different levels delimitating the subunits are relative to the observer. What matters in understanding complexity comes from the relationships between levels and the relationship evaluation is observer's dependant (Ahl and Allen, 1996). We aim to describe the super-player as the player able to create instability of a given complex system and as such able to drive two possible outcomes: either the system collapses to a low level of organization; or alternatively a new set of upper-level constraints emerge and the system moves to a higher level of organization. Here are embedded as sources of instability, evolution and revolution, change in objective laws or in subjective rules, sometimes at the same time. "Laws" capture the dynamical aspects of the phenomena, structure-independent, whereas "rules" are local and structure-dependent (Patee 1973).

To a certain extent, the super-player is able to create disturbance within the complex system, either by changing the structure of the given system or by modifying the behaviors of the entire system players. We aim to describe this possibility either as a stone falling into the water and creating subsequent waves, or as a bubble emerging on the surface of the water. The super-player tends to simplify the current, embedded model by not filtering information and by enhancing nested ness within the ordering principle of the multilevel-system. The closing remark of 'bigger bigger picture' as a strategic mindset (Brandenburger and Nalebuff, 1996) tends to find a solution through this super-player's behavior. Within a hierarchical organization, information is filtered from the lower level to the upper level in three possible ways: attenuation of the signal, delaying and integration/averaging. Considering current MNE' sales structures, we can see the following organizational hierarchy:

Level 1 Customers

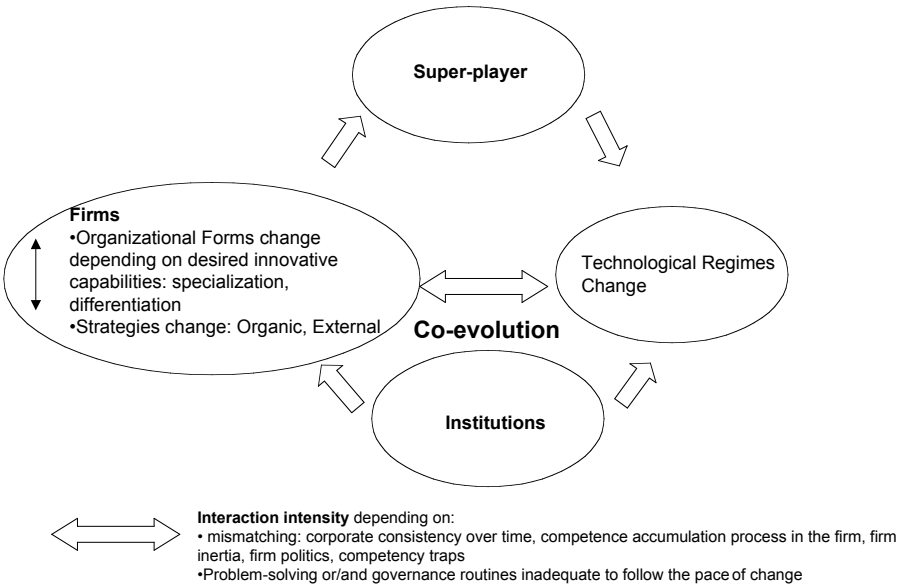
Relationship Focus	Product Focus	Service/Post-sales Focus
Level 2 Account Manager	Level 2 Bis Modality specialist	Level 2 ter Service Account Mgr
Level 3 Zone Sales manager	Level 3 bis Modality Leader	Level 3 ter Service Manager
Level 4 Country Sales Manager	Level 3 bis Modality Leader	Level 4 ter Country Service Mger
Level 5 Regional Sales Manager	Level 3 Bis Modality Leader	Level 5 ter Regional Service Mger
Level 6 Pole Sales Manager	Level 4 Bis Modality General Mger	Level 6 ter Pole Service Manager
Level 7 CEO	Level 5 CEO	Level 7 CEO

If we assume that the Chief Executive Officer (CEO) of a given MNC is responsible for formulating the growth strategy, then the numbers of levels between customers and the CEO represent as many filters to get the information about the unmet customer needs, source for future product or service. Moreover, by answering to these unmet needs, the CEO could decide to acquire some new capabilities or to develop them internally as we previously saw. New resources will be acquired or allocated and like a living system, the organization will grow and develop new properties. Association of new components provides customers with new collective sets with transformed information not resident in the previous components. The new information can only be read in a frame provided by often newly formed level of order. Consequently, aside from external complexity, derived from multiple technology paths, combined with geographic specificities, multinational companies in such technology-driven oligopolies add their own internal complexity. Growth adds complexity to an organization and this 'internal' complexity is sometimes difficult to manage (e.g. Penrose, 1959; Covin, Slevin and Heely, 2000).

Facing this external and internal complexity, the super-player, at a certain point, aims to simplify the different levels by "ignoring" the current hierarchical levels of the industry and its own levels. As such, the super-player' status does not imply full predictability of success in the long-run because by essence, predictability in complex systems is achievable if only many levels are taken into account, while the super-player' strategy is just the opposite by "over-simplifying" the levels within the oligopoly. By simplifying the problems they face, managers can bring problems within the bounds of their processing power and possibly come up with effective solutions (Simon, 1991). We tend to acknowledge that these business solutions belong to a more aggregate level of understanding business strategy. If we consider that the business technology-oriented oligopoly as a game with pre-defined objective laws like competitive fairness, free trade and technology bets available for everyone, then, each player of this game may sooner than later copy or implement the best practices coming from the other players. Schumpeter (1934) stressed that successful innovations/enterprises are threatened by swarms of imitators, all striving to produce 'me-too' substitutes. However, this condition –writing new set of subjective rules- is not sufficient to win: the source of the new rules really drives coming successful attributes of the new set. Players may develop tendency to internal focus (meeting profit's expectations from shareholders), rather than listening to customers, who drive some of the coming attributes. Moreover, the way to implement the new rules within the organization adds another layer of complexity, which tends to be as important as the formulation itself.

These complex independencies within organizations have been studied with respect to evolutionary and ecological perspectives (Nelson and Winter, 1982; Hannan and Freeman, 1977) which have been applied at many levels of analysis (Baum and Singh, 1994). We ground our model in the evolutionary framework of variation, selection and retention (Campbell, 1969; Nelson and Winter, 1982; Anderson and Tushman, 1990; March, 1994; Van de Ven, 1992). Burgelman (1994, 2007) has shown that this evolutionary model can serve as a general framework for strategy process research: autonomous and induced strategic initiatives operate together to create the variation that the selective system operates on. In Burgelman's model, the key role of the top management is to act as a selection filter, through resource allocation, even if top management actions are severely constraints (March and Simon, 1958). In our model,

we suggest that the experiences of the super-players, coming from a right filtering effect, create enough variation in the system to influence the entire industry, i.e. the other players: they replicate the same experiences as if it was a natural selection environment. As the super-player evolves in his strategic choices, the industry as a whole evolves and the other players adopt sooner than later this evolution. This model provides a link between emergence of super-players and succession of super-players by its focus on co-evolution of players within an oligopoly. At the start of a time period, the super-player evolves in a disruptive way, creating variation in the complex oligopoly system. This variation is selected and adopted by the other players, as a consequence of the co-evolution between super-player and other players. Then, another player may evolve in a disruptive way, becoming then the super-player, creating a succession of super-players as shown in Figure 1.



Source: created by author including partial addition and editing from Dosi, G. and Malerba, F. 1996. *Organization and Strategy in the Evolution of the Enterprise* . MacMillan Press: London.

FIGURE I. Co-evolutionary model of super-player's emergence

3 A Case Study: Healthcare Medical Imaging Device Industry

In this section we will give a detailed description of a case of business oligopoly, namely, Healthcare Medical Imaging Device Industry to discuss relevance of our framework shown by Figure 1 to dig out some relevant insights about the industry.

3.1 Healthcare CT Players

Looking at the official firm background of the top medical imaging manufacturers, we find a commonality in terms of mission statement and the international dimension of their operations.

- About GE Healthcare "GE Healthcare provides transformational medical technologies and services that are shaping a new age of patient care. Our expertise in medical imaging and information technologies, medical

diagnostics, patient monitoring systems, […] is helping clinicians around the world re-imagine new ways to predict, diagnose, inform and treat disease"

- About Siemens Medical Solutions: "Siemens Medical Solutions, with headquarters in Malvern, Pa., and Erlangen, Germany, is a healthcare technology innovation leader"
- About Philips Medical Systems, "[…] Today, Philips Medical Systems is a global leader in diagnostic imaging systems, healthcare information technology solutions, and patient monitoring and cardiac devices."
- About Toshiba Medical: " […] Today, Toshiba's focused offering of imaging technology continues to save lives and improve the health of people around the world with some of the most powerful and patient-friendly systems available"

At least three out of four MNEs claim being "Leader" in their market place, which tends to be unrealistic or biased. We plan to use as "grain" the behavior of Computed Tomography Manufacturers, even if these MNEs design and manufacture other devices within the Radiology Department. We aim to study the behavior of these MNEs, comparing them to each other, due to the specific concentration of players in such an industry, while the possibility of new comers and the risk of substitution do not exist. The choice of the Computed Tomography product line is linked to specific reasons from a methodology standpoint:

- Among all the product lines of the various medical devices makers, the Computed tomography is a fairly new product line, originated in 1970's and has been developed mostly internally by the main device makers,

- The CT product line of the four main players has not been impacted by any major acquisition, which helps the author to isolate the organic growth strategy effect for this specific Product line Vs other product lines (Conventional radiology, Magnetic Resonance Imaging…) and as such, the innovation path chosen by each manufacturer,

- The CT product line is considered as a mainstream medical device, distributed globally and used all over the world from the low-end CT (mono-slice CT) to the high-end medical equipment (64-row detector CT and above), which aims to provide us with relevant findings, rather than just "anecdotes".

3.2 Growth strategy within the CT Oligopoly

In such a new technology-dominated industry where group of buyers interact with limited players, to acquire the same complex type of system, several business characteristics surface:

a. Willingness of each player to gain market share, while the CT market growth tends to slow down under the local budget constraints (in terms of reducing both the reimbursement rate and the volume of procedures)
b. Incompletness of information for each of the players in a competitive environment tends to get a specific meaning in this industry, where

physicians get access to various CT systems, while working and while attending Radiology congresses (ECR, RSNA, Arab Health, Japan Radiology Congress…). In such a open information context, we aim to assume that each player knows at least the next CT generation projects from the competition.

c. Moreover, manufacturers deliver privileged information to their "opinion leader" customers in order to retain them and to ask them validating from a clinical standpoint any technology innovation. Manufacturers create local, regional or global "show sites" where the CT system operates in optimized conditions, under the leadership of opinion-leader radiologists, in well-known hospitals and clinics, creating a "word-to-mouth" marketing effect. For instance, Siemens Medical Solutions develops strong relationship with Prof. Kalendar at the Erlangen-Nueremberg University Hospital, Germany and at the Mayo Clinic, Rochester, MI,USA, while Ge Healthcare Europe actively supports the "Centre cardiologique du Nord" (CCN) in Saint-Denis, France, where operates Dr. JL Sablayrolles, pionneer of the CT cardiac imaging. Toshiba Medical Systems intensively uses the medical expertise of the Keio University Hospital in Tokyo, Japan to test their new CT systems.

d. If at the beginning of the industry, simple specifications were the key technology differentiators (number of dectector, acquisition time, reconstruction time…) of simple CT systems, the mutiple choice of new technology applications combined with the versatility of the CT system in the daily medical practice aims to complexify the possible offering and as such the staretgy formulation for CT manufacturers: what technology should they push? Where and how should they sell it?

Based on these business characteristics, growth in terms of market share/revenues for each player relies on perceived differentiation compared to the other players, while external growth by acquiring a competitor is not an option for regulatory and financial reasons (each of the four MNEs are not "on sale" and their respective market capitalization discourage any taking-over from anyone). To achieve this perceived differentiation, the CT oligopoly faces emergence of new behaviors, along the time.

3.3 Emergence of new behaviors of CT Players

- Emergence of new CT systems: Product innovation

Considering the high technology content of a CT system (X-ray tube, power generation, detector type, reconstruction engine…), the "classic" perceived differentiation has been the Core CT Product Innovation path: every year, at the RSNA (Radiology Congress of North-America Radiology Society), in Chicago, USA, more than 60,000 radiologists, radiographers and radiology manufacturer employees converge to the Mc Cormick Hall to see the latest innovations, show-cased through academic publications and on-the-booth demonstrations. In November 2003, while the whole radiology "community" knows that each CT manufacturer did work on the next generation of CT, so called 64-slice CT, no one before the show could bet about any annoucement for CT manufacturers because just three years ago, the entire industry

did adopt the 16-CT system as the standard device, booming the CT market: for the first-time ever, since 2000, it was possible to scan fast and with high-resolution.

However, the evening before the official RSNA opening date, Siemens Medical Solutions did remove the sticker of their 16-slice gantry on the booth, by a new "64-slice CT" sticker: it was the fastest and smoothest upgrade in the Medical Device Industry! At that time, the only existing product as a prototype in the Siemens research center became for the customers a real product, only available from this particular player, while the other players were perceived as left behind. During the days of the show, Siemens Medical Solutions did capture the attention of the whole community, creating a "buzz" in terms of new specifications and new clinical applications. Difficult then for the other players to claim, on their respective booth, the title of "Technology Innovation leader", when showing 16 slice-CT gantries and 16 slice-CT images.

In November 2004, just twelve months after the "soft" launch of the 64-CT system by Siemens, at the RSNA, all the CT manufcaturers were demonstrating their own 64-CT systems with clinical images coming from their respective show-sites, playing each of them on their relative CT-system strenghts and highlighting the limitations of competitor' system. In such a case, technical specification war and complexity of offerings emerges. For Siemens, the new "64-slice CT" announced in 2003 was in reality, specification wise, a 32-row detector CT system with a flying focal spot, creating "simili" 64-slice images. For Toshiba, the 64-CT system got the best specifications but its reconstruction engine and the clinical applications were outsourced to a third-party vendor, Vital Images, creating some limitations. Philips Medical Solutions used an inspired Marketing campaign, re-branding their product line with a "Brilliance" name, annoucing both 40-slice and 64-slice CT systems. GE Healthcare pushed a concept on "Volume CT" with their 64-slice CT, claiming a complete volume image of the heart in "a heartbeat" (less than five seconds acquisition time), showing images processed by Dr. Jean-Louis Sablayrolles.

Despite other CT manufacturers' efforts, Siemens was perceived by the CT Community, for at least 12 months (from November 2003 to November 2004) as the CT Product Innovation Leader, allowing him to "freeze" the CT market for the lower-specification CT systems and to get pre-orders from customers. But in November 2003, from a technical standpoint, each CT manufacturer was, more or less, at the same level of development (prototype) and the only difference between Siemens and the other players was the player's behavior. For instance, Siemens announcing its 64-slice CT did create an important short-cut, by-passing its internal levels and the external levels of its given industry (no prior clinical trials, no prior show site visits…) and simplifying the "launch" (no marketing collaterals, no real gantry.

- Emergence of new Clinical Applications: Value-added feature creation

Possible consequences of business strategy decision are provided by the real understanding of customer expectations, which tends to move the player focus from an internal perspective (how to grow my revenues?) to an external focus (what are the real needs of my customers?). Since 2001, French University Hospital La-Pitie Salpetriere did make the decision to install their GE 16-slice CT, not in the radiology

department but directly in the emergency department: the fast acquisition of a large set of anatomical structure appeared to secure the vital diagnosis of poly-traumatised patients, coming from the south of Paris (more than 250 poly-trauma patients are treated on an annual basis at this hospital). An unique medical expertise was consequently built between radiographers, radiologists on-duty and emergency doctors: for instance, to "save" broken vertebral spine nerves, the "golden hour" guideline has to be strictly followed between the accident and the surgery. After this 60-minute timeframe, there is unlikely no chance to get the spinal nerves working and as such, patients encounter high paralysis risk. Ecah minute counts for poly-trauma patient: vertebral spine assessment, Pulmonory embolism diagnosis, internal bleeding, pleurothorax, aorta dissection, heart failure, all life-threatening causes need to be properly diagnosed and treated in a very limited amount of time.

From 2001 to 2004, Dr Catherine Beigelman and her staff developped step-by-step settings of the CT system with pre-defined acquisition protocols and reconstruction views, routinely used when receiving a poly-trauma patient. GE Healthcare using this site to promote their 16-slice system rapidly acknowledged the unique value of tailored settings for specific clinical applications and decided to support further IT development on this clinical CT-based Emergency application, in close relationship with Dr Beigelman. Moreover, with the coming 64-slice CT system, scanning time could be reduced to 10 seconds from head-to-toe. Combining pre-defined protocols dedicated to Emergency and available technology, in 2004, GE Healthcare claimed having unique clinical Emergency CT-based applications and used La Pitie-Salpetriere as a show case. In 2004, the biggest Trauma center in Sweden, Karolinska Hospital in Stockholm acquired two GE 64-slice CT systems, based on this unique value; in Lausanne, Switzerland, Prof. Pierre Schnyder, radiologist and key developper of Emergency Radiology, did ask for the installation of a GE 64-slice CT system in the Emergency Department of the CHUV (University Teaching Hospital of Lausanne), based on the promising clinical results of the new protocols.

Carefully listenning to main customers drive new behaviors within a player's organization: the player completely reverses the perspective, where the customer acts as a partner and even as a co-player; in this case, the player designs the right solution, based on the co-player's requirements and not from internal filtered limited information or assumption.

- Emergence of new Services: Service Innovation

Having CT systems in Emergency departments drives as well new behaviors from customers in terms of service. The players have to cope with these new behaviors, by creating services in line with the level of expectations of customers. All the players have developped a large set of services, after the one-year standard warranty: high-technology devices like CTs require regular maintenance, from X-ray Tube failure to IT debugging and this service brings a large stream of revenues and profit to the players, as well as a good retention tool. Service contracts, even renewed every year, tend to last the lifetime of the product and due to the large variety of customers, service contracts have been tailored according to the customer needs: labor only, parts only, parts and labor, 24 hour support on 7 days a week basis…

However, the service implementation varies by player: Toshiba Medical Solutions sourcing their CT systems from Japan uses the high-quality standards to offer two years of warranty, free of charge. Such a statement carries several consequences: the total cost to serve calculated by the customer significantly decreases and the perceived differentiation is centered in Quality of product/Reliability. Service becomes a strategic weapon against the other players. When Siemens Medical Solutions operates under the same leadership team CT equipement and Service, they tend to consider some possible offensive trade-offs where they can slightly reduce the acquisition price and still make an overall profitable business in the long run. GE Healthcare organized under a clear seggregation between CT sales and CT Service, to maximize the profit at the customer level, may be perceived at the most expensive vendor by the customers.

4. Discussions

Our study contributes to validate our theoretical framweork, with respect to the resource-based growth approach, in a number of ways. First, we begin to reconcile the concept of 'growth strategy' with the classic way of considering growth as market and product expansions logics. The super-player reduces growth strategies to product/service and market logics and such a strategic choice incorporates evolution of firm's organizations. More surprisingly, this organizational evolution consequently drives the entire industry evolution. Second, our study recognizes the relationship between growth logics and resources to generate growth: the total amount of resources is not equivalent to the pool of resources a firm has at its disposal to fuel growth, a fact recognized by Penrose (1959). The super-player drives growth logics, even in a shortage of resources. Some scholars have argued that growing firms require increasing amounts of resource inputs. Other have suggested that growth brings with it increasing administrative complexity. Our results add yet a third explanation for the difficulty of a given player to grow in a business complex oligopoly in that strategic move is correlated with the creative capacity of top management to bringing new actionable solutions to complex problems. Our data suggest that this interaction is a function of selecting the kind of growth that is being pursued with retening focused dedicated resources. Third, complexity of business strategy decisions aims to located not only in the number of parameters to be taken into account at a certain time (present complexity) but much more in the possible consequences of a given business strategy decision (prospective complexity). We have in mind the previously described business cases, where an one-time event ('sticker on a gantry', 'An Emergency doctor in Paris'…) drive important business consequences, typically found in complex system theory where fine-grain details influence the system as a whole ("Butterfly effect" by Lorenz, cited by Gleick, 1987). Fourth, our study strongly supports the evolutionary dynamics of economics: evolutionary change processes operate on a firm strategy in that it may be suggested (variation), it may be changed (selection), it may exist over several time periods (retention) and a firm has to choose one strategic intent among several possible (competition). Finally, our study argues that intraindustry competitors, same players within a business technology-driven oligopoly, hold a commom pattern of beliefs or schemes, influenced by the super-player itself and co-evolving with him. The underlying economics of an industry foce industry players to accept a reality they might not have enacted on their own. Our model suggests interaction between managerial cognition and competitive factors and retains the salient aspects of bounded rationality (attention-constrained agents), managerial

cognition, while including competition, strategic choice and the evolution of the industry structure. Our result demonstrate how competitive factors and bounded rationality together influence managerial beliefs, growth strategy and intraindustry variation. We find that industry-specific factors coming from the super-player and bounded rationality force other players to focus their attention on nearby competitor, the current percieved super-player. Focused attention means that firms do not consider a full range of 'available' information. This causes firms to develop biased estimates of their competitive environment. Since this interaction is reciprocal, firms' estimates correlate with the estimates of nearby firms. Thus, because they observe each other, cluster of firms in a given oligopoly have similar beliefs. Managerial beliefs tend to converge, with the exception of the super-player's behavior. Our data suggest a behavorial model of strategic choice wherein imitation drive strategic decisions of the standard players, while the super-player observes other firms and deduces appropriate disruptive choices , without considering the beliefs shared within th industry.

Applying our theoretical framework provides us with three meaningful insights about this specific industry: (i) the limits of managerial rationality and the importance of representations in complex systems; (ii) growth as a disruption factor in complex industry ; (iii) the 'entrepreneurial ambition' as the source of disruption.

First, discovering an effective competitive position in business oligopolies is a necessary but difficult task for top management of a firm. Positioning scholars emphasize the role of deductive reasoning and rational choice in the origin of positions (Porter, 1980). In contrast, evolutionary theorists highlight the bounds of individual rationality and posit that effective positiosn emerge through a mix of luck and experiental, local search , thus leaving little space for the cognition of managers (Nelson and Winter, 1982). We tend through our model of growth strategies to recognize the limits of managerial rationality and the intelligence of local search. Bounded rationality suggests that thinking is typically premised on simplified cognitive representations of the world (Simon, 1991). As boundedly rational actor, the super-player create cognitive simplifications of their decision problems and come up with solutions on the basis of such simplification. These actionable solutions, in turn, may imprint subsequent efforts at local search, playing as such a central role in the discovery if strategic positions (Gavetti and Levinthal, 2000). This perspective represents a middle ground between positioning and evolutionary arguments. The super-player behavior suggests that the roots of superior competitive positions may lie in the management cognition, in the way they represent the world. Our conceptual model of super-player finds its validation in business complex evolving oligopolies: in such settings, we conclude that a large number of underlying characteristics of the complex system drive the relationship and the interaction between firms. There are so many characteristics and their effects are so difficult to discern that the boundedly rational super-player focus its reasoning efforts on a subset of the characteristics. These subsets form representations, i.e. classifications schemes. An effective scheme puts similar objects in the same class and different objects in distinct classes. The super-player acts as an observer of a hierarchical system. Armed with an adequate representation of the world, the super-player is well prepared to draw a solution and apply it to a target sector. Our framework applied to the CT Industry shows the best performance among firms with adequate representation of the business world, at a certain point of time.

Second, in examing the role that strategy plays in firm growth, researchers generally have either relied on positionning generic business strategies (Porter, 1980) or have employed technical innovation related strategies based on specific capabilities. Penrose (1959) viewed the growth of the firm as comprising the double-sided problem of diversifying into new products and new markets within the constraints of a firm's current pool of available resources. Growth brings with it greater organizational complexity and the difficulty of managing complexity is at the heart of the Penrosian growth engine since it is assumed that such complexity taxes available resources beyong their capacity, thus slowing firm expansion. By reducing the strategic problem of growth down to its most elemental product and market dimensions, the super-player substantially reduces the organizational complexity. One way of framing such finding is to consider firm's underlying business routines. Since March and Simon (1958), scholars have viewed organizations have viewed organizations as bundles of behavioral routines that are enacted as 'programs' when triggered by internal and external stimuli. Nelson and Winter (1982) have expanded this argument to organizational growth by conceptualizing growth as a change in an organization's existing routines. In their words, 'just keeping an existing routine running smoothly can be difficult' (Nelson and Winter, 1982: 112) and managers spend a significant portion of their time struggling to keep an organization in conformance with its routines. Since, in Nelson and Winter's viewpoint, growth entails the replication, addition, or recombination of existing routine, growing a firm is an order of magnitude more complex than merely operating the firm in a steady state. The added complexity is due to the disruption of the tacit coordinating mechanisms that have evolved to bind a firm's routines within the boundaries of its existing businesses. In that respect, we argue that the super-player uses this disruption as a factor of growth, by exporting this disruption outside its firm's routines and inside the industry, consequently transforming the industry routines.

Third, the motivation to transform its routines quickly onto growth and consequently to transform industry routines is rooted in what Penrose called the 'entrepreneurial ambition' of the top management team: management 's desire for growth and its appetite for taking risks to ensure growth occurs. Managers will seek to extract growth from resources immediately. Resource-based conceptions stress the importance of resource slack as a driver of growth rather than the total quantity of resources possessed by a firm (Penrose, 1958). Slack is the dynamic quantity that represents the difference between the ressources currently possessed by a firm amd the resources demands of the current business. For entrepreneurial managers, slack is 'waste' and they are willing to endure short-term deficits or negative slack in order to promote futur growth. (Siemens 'launching' new product without marketing colleterals, just a sticker in our study). Risk takers have the confidence to assume that the missing elements of the pattern will not compromise the entire strategic move. Such deficit-driven growth is obviously not sustainable in the long run. But in the short run, this risk taking decision gets some pay off by disrupting the industry established routines.

In addition to the above theoretical contributions, the study suggests several potentially fruitful directions for future research. First, additional studies are needed to explore the generality of our results over longer periods of time and in subsequent complex industries (Ultrasound, Magnetic Resonance for instance). The possible difference between short-term and long-term patterns of growth as emerging strategic

moves is a complicated issue, both conceptually and methodologically. On the one hand, it is tempting that growth strategies and their interactions with the industry can only be evaluated in the long run, as the pattern of growth unfolds over the time. On the other hand, growth is an ongoing and instantaneous phenomenon and resource deployments are made in real time according to short-term feedbacks, based on the emergence of super-players in a given industry. This suggests that patterns of long-term growth are primarily aggregations of short-term decisions and our focus on short-term strategy and actionable solutions is not only appropriate but preferred. Adjudicating between these two interpretationsof our results will be possible only with the collection of cognitive data over a longer time period with a cross-sectorial approach. Second, while our arguments assume that complexity serves to emerge super-players in a given technology-oriented oligopoly, we may expand the model of emergence of super-players to any kind of oligopolies. To explore this issue further, we may consider other oligopolies where limited players search for competitive positions and we may correlate the number of players with the level of complexity to determine the possibility of super-player's emergence. A possibility we do not model, worthy of future research is to track more thoroughly the interactions among growth logics, number of players involved and level of complexity within a given industry. Our conjecture will be to assume that the larger the number of players is, the more difficult the occurrence of finding super-player able to influence a given industry is. Third, future research might be useful to examine more deeply the interdependance between strategic choice of a firm and implemented actionable actions in complex evolving oligopolies. The choice of a particular approach for higher-order strategy typically has an influence on detailed choices. A type of interdependence that Simon (1962) has labeled near-decomposability. Finally, what emerges as well from this super-player‘s framework is the question of sustainability of the super-player, due to the co-evolutionary dimension in business technology-oriented oligopolies. Further theoretical work is needed to tighten the framework and empirical research may be critical to validate such a model in other business technology-oriented oligopolies.

5. Conclusion

This research investigates the relationship between strategic choice, managerial cognition, complexity of business oligopolies and industry evolution. Drawing upon economics, strategy and complexity science literatures, we have constructed a model that can explain the emergence of a certain type of players in a complex evolving oligopoly. This study suggests that these findings can be explained as being a result of the interaction of the cognitive processes of bounded rational strategy makers with the underlying economic structure of their industries. Bounded rationality in and of itself cannot explain why managers will develop a different set of beliefs for developing new strategic choice, within a given industry; it is only under the co-evolutionary conditions that managers will come to hold different cognition about their industry.

More broadly, cognition in complex worlds inevitably involves simplification. The precise basis of simplification is our condition of bounded rational individuals, which limits us to think in high-dimensional spaces. The relevant question, for strategic makers in business complex evolving oligopolies, is not whether we conceive of complex strategic problems in terms of few general variables but rather what those variables will be. Our hope is that rigorous analysis of managerial cognition in business complex environments will help bridge the distance between the behavioral,

evolutionary approaches on strategy with the system theory. Understanding how firms identify effective strategic positions in a complex world requires both perspectives. With the current work, we try to provide some substance of that link and a model on which we can build.

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