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ENGINEERING A SOCIOECONOMIC PHENOMENON: ABSORPTIVE CAPACITY IN ORGANIZATIONS

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Abstract: The absorptive capacity construct has been defined as an organizational dynamic capability to identify, assimilate, transform and apply external knowledge in a productive way fostering competitive advantage and productivity increase, in a fast changing environment, intense rivalry, market pressures, and global economic uncertainty. Investment in absorptive capacity promote the ability to anticipate innovation trends and take advantage of emerging opportunities before their competitors can recognize them. However, most of the literature focuses on description and conceptualization of absorptive capacity. Furthermore, absorptive capacity has been confined to the organization domain without taking into consideration the macroeconomic and socioeconomic context where organizations are dynamic agents. An alternative wider approach comes from modern engineering designing (not defining) the construct of absorptive capacity. This research introduces a design –both conceptual, applied and implementable- of the absorptive capacity of organizations construct to make them sustainable in highly dynamic environments, founded on organizational knowledge.
Keywords: Absorptive capacity, dynamic capability, engineering organizations, knowledge management, socioeconomic phenomena.

INTRODUCTION

Both the knowledge-based view (KBV) of firms and 'organizational learning' are based on knowledge as a critical asset to produce competitive advantage (Porter, 1991, 1998). The KBV model refers to knowledge in all its forms, whether codified or not, whether explicit or tacit (Nonaka & Takeuchi, 1995; Nonaka, Toyama, & Nagata, 2000), emerging in organizations.

The KBV model is not developed into a single structure. An elaborate proposal of a structure was introduced at the beginning of the 1990's (Huber, 1991) where four constructs/learning processes aims to knowledge management: (1) knowledge acquisition, (2) information deployment, (3) Interpretation of Information and, (4) internal organization memory. First of this, knowledge acquisition, unfolds into four sub constructs: (1a) Use of congenital learning, (1b) learning by experience, (1c) vicarious learning and, (1d) grafting knowledge considered useful.

The primary focus of KBV model is to explain how to make sustainable competitive advantage achieved by knowledge appropriability. Focuses on knowledge as an intangible resource and difficult to replicate but intra-firm and extra-firm transferable. More than a knowledge repository a more appropriate model of a firm is an instrument to transfer and develop knowledge with other related organizations. This model recognizes individual foresight and abilities as (tacit) knowledge hard to transfer, but anchors operational learning (Dhanaraj, Lyles, Steensma, & Tihanyi, 2004 p.430). This makes relevant to identify how to draw on organizational knowledge. The construct absorptive capacity seems that allows to explain how the receiving organization of knowledge makes it productive

This research aims to show that literature on absorptive capacity, regarding knowledge harnessing, focuses on rhetorical descriptions and insufficient attention had been paid to design proposals based on organizational knowledge. Because of that, this research introduces a conceptual and implementable design of the organizational absorptive capacity, making it sustainable in dynamic macroeconomic contexts.

In addition to the engineering design approach, the context is enriched considering absorptive capacity as a socioeconomic

phenomenon connecting human capital in organizations at the microeconomic level, organizations at the "*meso-economic*" level, and market pressures and global economic trends, for instance, at the macroeconomic level (Belenkova, Vanchukhina, & Leybert, 2018).

This document is structured into four sections: first, the analysis of previous studies on absorption capacity (ACAP) is presented. Second, research methodology is introduced, then main findings, ending with a conclusions section where key issues are highlighted.

ANALYSIS OF PREVIOUS CONCEPTUALIZATIONS

The construct "absorptive capacity" recently emerged (Cohen & Levinthal, 1989, 1990, 1994) referring to a dynamic capability of organizations (Helfat et al., 2009; Prahalad & Hamel, 2006; D. Teece & Pisano, 1994; D. J. Teece, Pisano, & Shuen, 1997) unfolded into three dimensions: (i) capability to identify and recognize, (ii) assimilate and, (iii) apply to harness available knowledge in the environment of the organization. Absorptive capacity was originally defined as an ability[1] (Cohen & Levinthal, 1990), based on previous knowledge, to recognize the value of new information, assimilate it and apply it to trading purposes (fig. 1). Originally, the "information" concept is related to data elements allowing to identify knowledge external to the organization that, when compared to internal knowledge, is new and could represent an opportunity to use it in commercial activities.

At the beginning of the twentieth century, a reconceptualization of ACAP (Zahra & George, 2002) was introduced as a set of organizational routines (OR) and processes to (i) acquire, (ii) assimilate, (iii) transform and, (iv) make use of knowledge to produce an organizational dynamic capability (Helfat et al., 2009; Prahalad & Hamel, 2006; D. Teece & Pisano, 1994; D. J. Teece et al., 1997). A third reconceptualization (Todorova & Durisin, 2007) brings back the dimension (i) identify and recognize the value of knowledge, takes apart (ii) acquisition from (iii) assimilation, making this last as an alternative phase to (iv) knowledge transformation, previous to (v) application or usage of knowledge. Furthermore, maybe the most valuable element is the inclusion of a feedback loop. This makes explicit the conceptualization of knowledge dynamics difficult to be captured by analytical methods (Todorova & Durisin, 2007). In turn, this implies the possibility to choose an appropriate research methodology to gain as main result a construct design.

Twelve years after (Zahra & George, 2002), a reconceptualization of absorptive capacity as "dynamic capability" is proposed (D. Teece & Pisano, 1994; D. J. Teece et al., 1997) broadening organization capability to gain and sustain its competitive advantage (Porter, 1998) as an strategic asset to produce organizational change as well as determine the evolution path of the organization.

Regarding the original definition, this review of the construct recognizes it as (i) a dynamic capability, (ii) identifies OR as its main components and describes their roles (Bobrow & Winograd, 1977) and, (iii) identify required conditions of those OR to create value. This allows to conduct research to understand and explain differences in performance between two organizations in the same economic sector and, foresee those differences.

Every organization rely on organizational, operational and dynamic capabilities (Vasudeva & Anand, 2011; Winter, 2000). An

1. *Ability* means an actual capacity (either mental or physical capacity, innate or acquired), the possession of qualities of an individual, competences, natural attitudes, flairs, or expertise levels or the power to do something. Refers to what an individual is able to do at the present.

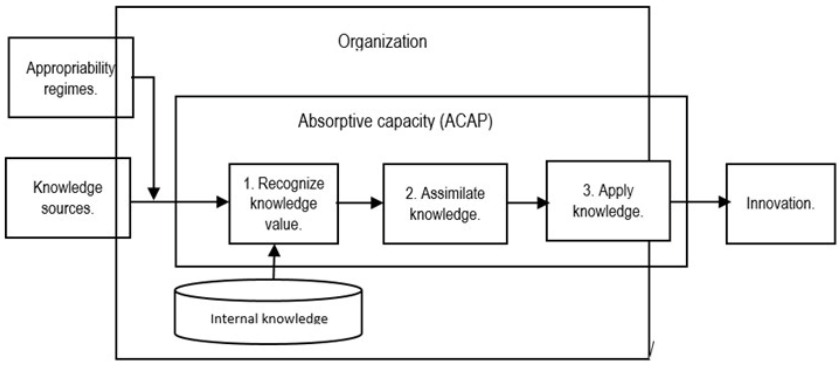

Fig. 1 Absorptive capacity –ACAP- model based on the seminal paper (Cohen & Levinthal, 1990).

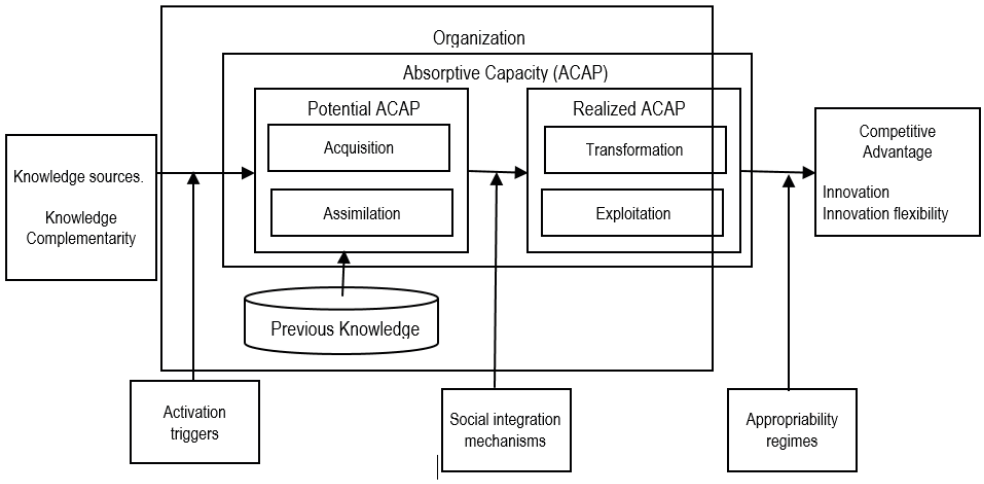

Fig. 2 Reconceptualization of the absorption capacity -ACAP (Zahra & George, 2002).

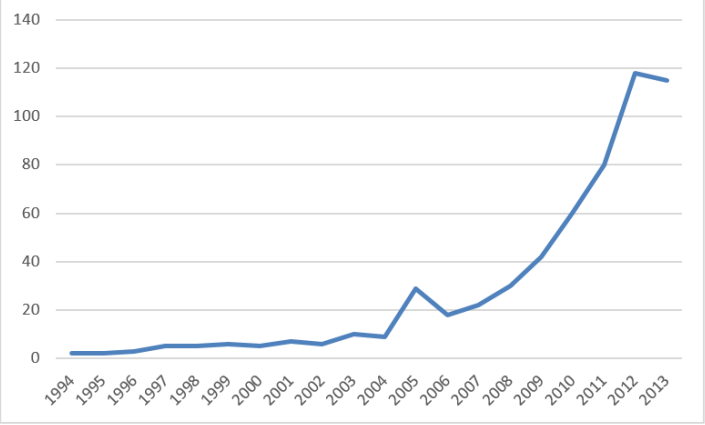

Fig. 3 Results of "Documents (Y-axis) per year (X-axis)" using "absorptive capacity" as keyword in Scopus. ("Absorptive capacity") AND (PUBYEAR>1989) AND (LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON"))

organizational capability is a high level routine that, counting with specific organizational processes and resources, confers senior managers of the organization alternative scenarios which provide them with different options to make decisions and, therefore, to produce particular significant results. Sought results usually are the achievement of strategic goals using available *know-how* as well as non-specific resources of the organization (David J. Teece, 1977; Winter, 2000). Operational capabilities are competences and abilities determining organizational effectiveness to perform daily mission activities. And last, a dynamic organizational capability is the capability to integrate, build and, reconfigure operational capabilities (D. J. Teece et al., 1997), as well as internal and external competences to deal with rapid changes in the environment (Zollo & Winter, 2002). Dynamic capabilities are intended to organizational change allowing to formulate appropriate responses to changes in the environment and implement a course of action of the organization bringing the evolutionary character of organizations.

The components of ACAP –organizational routines- (Bobrow & Winograd, 1977)- group into two classes: potential ACAP and realized ACAP (fig. 2). OR of the first class –potential- include knowledge acquisition routines and knowledge assimilation routines. Realized OR comprise knowledge transformation routines and knowledge exploitation routines.

OR of the class potential ACAP, or PACAP, (fig. 2) promotes organization receptiveness to external knowledge. This is the equivalent to the component "recognize the value of knowledge" (Cohen & Levinthal, 1990).

Realized OR of ACAP, or RACAP, (fig. 2) aims to leverage the organization on previously absorbed knowledge. The efficiency factor of ACAP (μ) is defined as the ratio PACAP – RACAP (Eq. 1).

Eq. 1 $$Eq.\ 1 \quad \mu = \frac{PACAP}{RACAP}$$

However, measuring m in practice is not practical because measuring PACAP-OR and RACAP-OR are not still conceptually and functionally defined or unified. In finding a way out of this situation, this research proposes the design of PACAP-OR and RACAP-OR as components of the ACAP construct.

Researchers at the dawn of the twenty-first century suggest that OR provide systemic, structural and, procedural mechanisms to haphazardly exploit knowledge and take advantage of it on a long-range term, spite of barriers to knowledge such as "appropriability" regimes or mechanisms: institutional dynamics (intellectual property) affecting organizations capacity to protect their rights to gain benefits from new products or (organizational) processes.

The following relationships are suggested in this model:

a) The level to exposure to knowledge sources is directly proportional to PACAP.

b) Understanding knowledge complementarity as an extension where knowledge is related to knowledge in the organizational information network, knowledge complementarity is directly proportional to PACAP.

c) Organizational experience and PACAP are directly related.

d) Activation triggers moderate PACAP.

e) Formal social integration mechanisms (coordination) or informal (social networks) has a positive effect on assimilation.

f) Knowledge "appropriability" is in inverse proportion to the propensity of organizations to invest in research and development (R&D) (Lane, Koka, & Pathak, 2006).

g) Main forms to reach competitive advantage in a dynamic market are innovation and strategic flexibility.

This model (Zahra & George, 2002) shows gaps and ambiguities according to some researchers (Todorova & Durisin, 2007). The most notorious gap is the omission of the "value recognition of external knowledge" routines. At the outset of ACAP this routines were just a construct component (Cohen & Levinthal, 1990).

METHODOLOGY

To conduct this study the first step consists of a search in *Scopus* and *Web of Science* gathering data to analyze relevance and prospective of ACAP to retain and productive transform of knowledge.

Literature (L. A. Leydesdorff, 2011) proposes three historical stages in the development of ACAP: (i) First stage is the emergence of the concept of ACAP (1989-2001), (ii) conceptual foundation and setting of research domain (2002-2007) and, consolidation of research domain (since 2008).

During the first stage (1989-2001) ACAP developed in the field of management science (Cohen & Levinthal, 1989, 1990, 1994; Chang, 2010; Reséndiz Nuñez, 1987; Teasley, Almeida, & Robinson Jr, 1996).

Along the second stage (2002-2007) the construct experienced conceptual refinements (Easterby-Smith, Graca, Antonacopoulou, & Ferdinand, 2005; Lane et al., 2006; Todorova & Durisin, 2007; Zahra & George, 2002): research reached the body of knowledge of organizations theory.

Since 2007, the third stage, research in absorptive capacity focused on components of absorptive capacity (González, 2014; Hevner & Chatterjee, 2010; Marín, Laureiro, & Forero, 2007a; Nishiyama, Ikeda, & Niwa, 2000; Todorova & Durisin, 2007; Vega, Gutiérrez, & FERNÁNDEZ DE LUCIO, 2007; Vessuri, 1990) and the study of the role of the conditions of context and other external factors and the performance of innovation in organizations (Abad Arango, 1973; Carrère et al., 1974; Fabrizio, 2009; Picas Contreras, 2003) and applications (Gruber & Marquis, 1968; Jayaraman, Bhatti, & Saber, 2004; López-Paniagua, Nieto-Carlier, Rodríguez-Martín, González-Fernández, & Jiménez-Álvaro, 2011; H. W. Volberda, 1996; Henk W Volberda, Foss, & Lyles, 2009), design of measurement instruments (Goldstein, 1989; Koen, 2003; Layton, 1974; Marín, Laureiro, & Forero, 2007b), experimental researches (Filgueiras Sainz de Rozas, Castro Fernández, & Rafull Suárez, 2013) and their relation to technology transfer (Polya, 1981; Teasley et al., 1996).

There has been a progressive consolidation of absorptive capacity as a research field, as the result shows in a search of "absorptive capacity" as keyword in Scopus (Fig. 3) where related topics were knowledge management, innovation management, research and development, competitive advantage and, organizational learning (L. A. Leydesdorff, 2011). In 1990 was found one, while in 2001 the result was 142, in 2002 was 164 and, in 2014 was 1.458. The search of "absorptive capacity" in Web of Science results show the same growing trend (Fig. 4). In 2001 results in 15 documents, in 2002 were 18, in 2007 were 86 and, in 2014 resulted in 311.

Following citations of the seminal paper (Cohen & Levinthal, 1990) in *Scholar Google*, 26.505 citations were found. This number is greater than results obtained in Scopus or in Web of Science. This is explained Google algorithms perform a wider search including citations in books. However, this result includes duplicates and false positives.

These 26.505 citations include knowledge transfer and technology transfer (Blanzieri, Giorgini, Giunchiglia, & Zanoni, 2003;

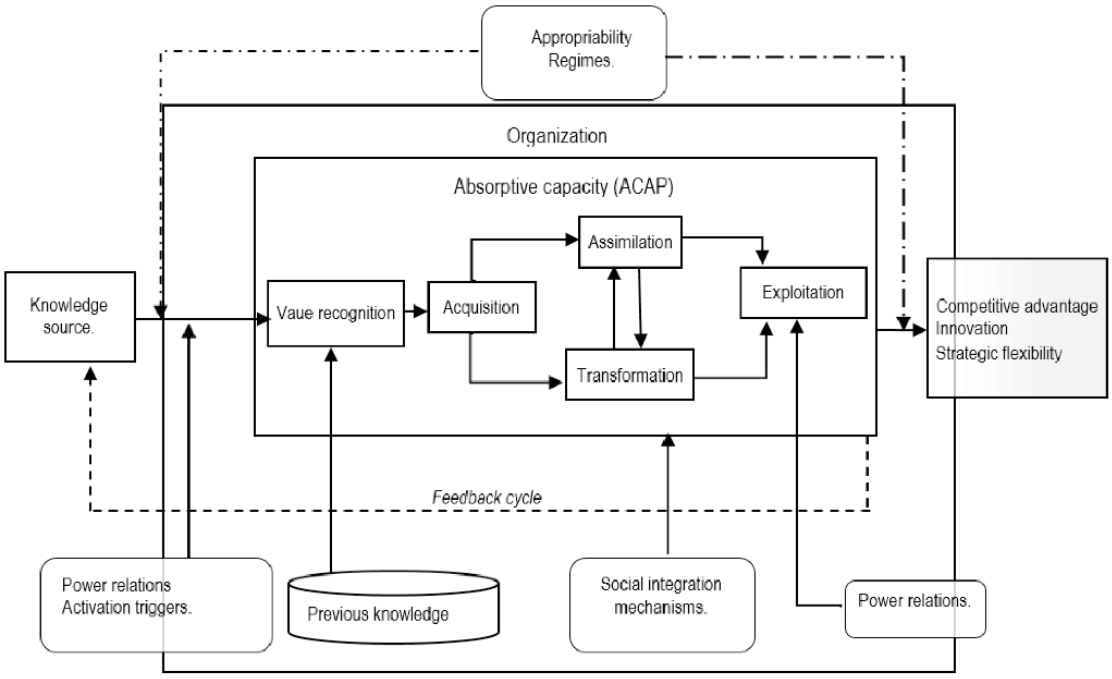

Fig. 4 Results of number of papers per year. Search of "absorptive capacity" in Web of Science. Topic: ("absorptive capacity") AND Category: (MANAGEMENT OR BUSINESS OR ECONOMICS) AND Document type: (ARTICLE OR REVIEW).

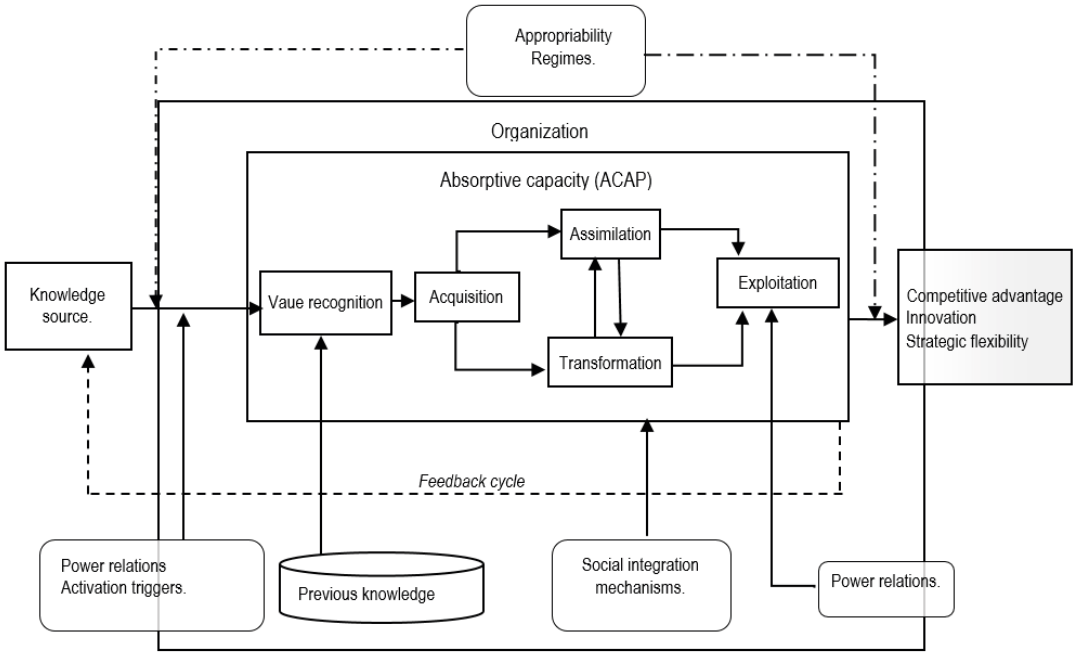

Fig. 5 Model of absorptive capacity (ACAP) with feedback dynamics (Todorova & Durisin, 2007).

Etzkowitz, 2003; L. Leydesdorff & Meyer, 2003; Lopez-Cruz, 2010; López-Cruz, 2004; Rogers, 2002; Roulet, 1973; Tenière-Buchot, 1986), knowledge management (Grant, 1996; Ravn & Valqui Vidal, 1986; Van Elst, Dignum, & Abecker, 2003; Vasco Furtado & Ponte Machado, 2003), social, relational and, intellectual capital (Brynjolfsson, Malone, & Gurbaxani, 1991; Diamand; Nahapiet & Ghoshal, 1997; Pérez & Cruz, 2007; Sandroni, 1973), organizational relational view (Clancey, Sierhuis, Damer, & Brodsky, 2006), innovation diffusion (Rogers, 2003), organizational learning (Maes, 1994; Sábato & Botana, 1968; Zollo & Winter, 2002) and, the process of making decisions (Filipe, 2004).

Literature warns (Todorova & Durisin, 2007) that analytical models (Cohen & Levinthal, 1990; Zahra & George, 2002) do not describe appropriately the complexity of causal relationships of ACAP explaining its dynamics by organizational learning: exploratory, transformative and, exploitation (Lane et al., 2006).

The ACAP (Todorova & Durisin, 2007) model (i) resumes the component of value recognition of a previous model (Cohen & Levinthal, 1990) including it as one of its components, (ii) extends incidence (positive and negative) of the social integration mechanism (Zahra & George, 2002) to all organizational routines by theorizing of contingency factors, (iii) adds power relationships as contingency factors (Fig. 5) directly influencing value recognition routines and exploitation routines of knowledge, (iv) recognizes complex relationships between dimensions of assimilation and transformation, (v) redefines transformation routines and, (vi) feedback cycles are added characterizing dynamics and complexity of the phenomenon.

CONFIGURATION OF THE ABSORPTION CAPACITY (ACAP)

Models of ACAP (Cohen & Levinthal, 1990; Todorova & Durisin, 2007; Zahra & George, 2002) misses an explicit and clear interrelation to the environment, even though main discussion is about absorption of knowledge external to the organization, except for "appropriability" regimes and the obvious incidence of the deployment of knowledge produced inside the organization or the previously existent knowledge on the environment (Todorova & Durisin, 2007) which may transform knowledge sources (Fig. 5).

To manage means and media enabling organizations search for available knowledge in its environment, selecting and taking it and, after, carrying knowledge taken in this process to activities that generate competitive advantage is necessary to design absorptive capacity to exhibit these abilities and, besides, identify interactions between an organization and the environment where knowledge is taken.

In organizational contexts, knowledge differs from information in different ways. For instance, the only way knowledge can be obtained is by cognition and interpretation processes (Tecuci, 1992). Learning organizations get knowledge via adaptive learning – to assume environmental changes without significant changes in its mental models (paradigms)- and via generative learning – a creative one that produces significant changes (Graham, 1979) in mental models of the organization (Senge, 1995). Knowledge in organizations is verified in relation to structures and organizational routines since this does not arises from available information for a particular member of the organization but emerges as a property of the learning system shaped by interactions in learning processes which

constitute the organization (Dosi & Marengo, 1993; Hodgson, 1999), without disregarding relevance of workforce in contemporary production processes (Lopez-Cruz, 2006).

KNOWLEDGE ABSORPTIVE CAPACITY

Tacit knowledge is partially embodied in habits and organizational routines, making it irreducible to information (Hodgson, 1999; Tecuci, 1992) and therefore it cannot be "transmitted" in codified form. All economic agents depend on tacit knowledge (Bareiss, Porter, & Murray, 1989) and all abilities and decisions depend on tacit knowledge also (Tecuci, 1992), hence the importance of a construct that allows a more concrete and real implementation. Furthermore, ACAP is a complex construct (Morin & Pakman, 2011). It is composed by different interacting components which in addition allows interaction between organizations with their environment. (Fig. 6).

In this model ACAP is recognized as a dynamic capability between various organizations. It is characteristic the distinction between potential ACAP (PACAP) where particular actions of the individual, or micro-environment, prevail and realized ACAP (RACAP), or meso-environment, where shared (collective) knowledge overrides other forms of knowledge.

The role of interactions between an organization and its environment are relevant because they able to connect meso-environment to the macro-environment, some of them in a feedback interaction resulting from the transformation and exploitation of that knowledge. This in turn affects "appropriability" regimes when creating patents, copyrights and royalties on knowledge internally produced. This is not necessarily the case in public organizations where prevails universal interests over particular ones. Besides, an internal feedback with a knowledge base (different than a database) which is affected by both R&D internal budget and R&D internal activities, if these are conducted by the organization.

Contribution of this conceptual model is twofold: at first, recognizes various feedback cycles, internal and external to organizations (directed dashed lines from right to left in Fig. 6), representing elements of knowledge that impinge on absorptive capacity itself (as the directed edge between adoption/adaptation and identification/recognition), or inside organizations (as the directed edge between innovation and incentives to R&D). Second it provides a starting point to design elements for computer assisted engineering of the ACAP construct. Up to my knowledge, no other model offers a closer representation of the dynamic nature and intrinsic feedback cycles to ACAP and thus facilitate the development of computer simulation models.

CONCLUSIONS

From the knowledge-based view of organization it was shown that the absorptive capacity (ACAP) construct have evolved from abstract or rhetorical descriptions, when ACAP is identified as an organizational dynamic capability unfolded in three dimensions: capacity to (i) identify or recognize, (ii) assimilate and, (iii) apply or seize available knowledge in the organizational environment (Cohen & Levinthal, 1990), up to a concrete construct that in addition to describe the array of organizational capabilities to seize knowledge aiming to create competitive advantage and increase productivity, identifies functional components of ACAP and provides explicit relationships between them.

In other words, the proposed configuration of ACAP introduced by this research, components of ACAP and dynamic interactions relating these components –

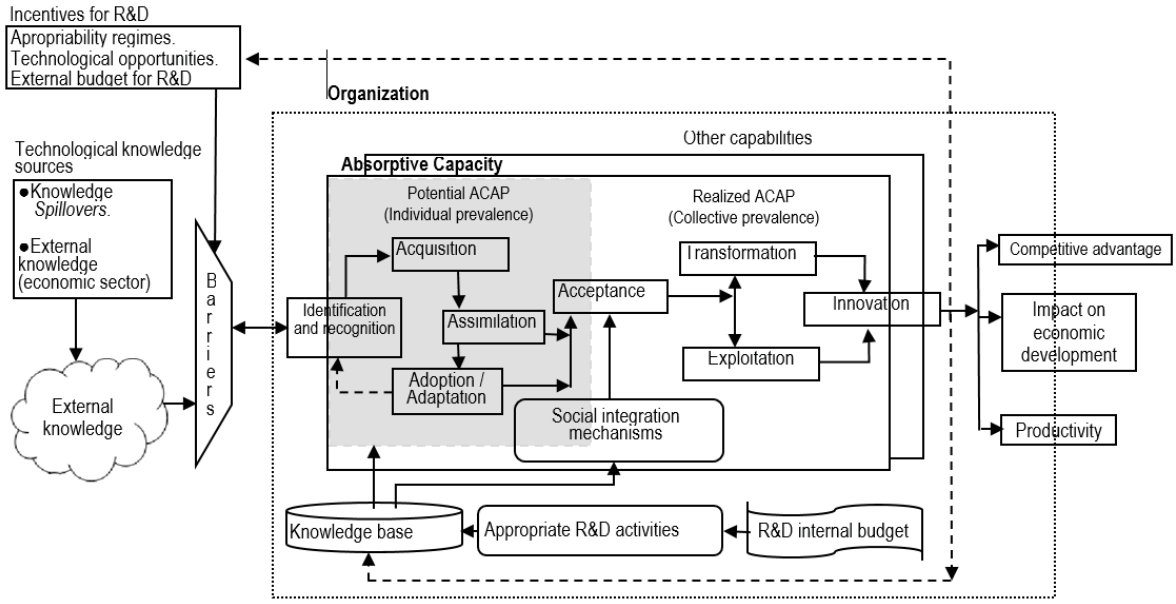

Fig. 6 Conceptual and functional model of absorptive capacity (ACAP) and its concept.

internal components as the knowledge base- with external components such as access barriers to external knowledge and the market where the organization develops, via impacts in economic development (Fig. 6).

This is a complete design model of the ACAP construct that may be implemented in real computers empirical environments via the codification of structures for ACAP components and codification of algorithms for the dynamics of the construct leading to a possible feedback cycle between the design model of the ACAP construct and its implementation model in a progressive process.

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