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“Economics meets the other sciences: interpreting new economic programs and proposing new theories for Institutional Cognitive Economics”

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Abstract

This paper provides an interpretative key of the mechanisms underlying the emergence of several new economic programs working on the borders between economic theory and other social sciences. To this aim, it applies and updates J. Davis’ distinction among inward and outward oriented research programs, through the inclusion of new economic strands and the construction of a visual model showing interactions among orthodox, mainstream economics and new research programs. Institutional Cognitive Economics appears a paradigmatic case of outward oriented field. This aspect has been explained by showing the significant exchange process among institutional economic theory and cognitive sciences characterizing this research program. After a careful examination of its main traditional analytical tools, the paper proposes a new potential program for the development of the field, suggesting new analytical tools coming from *cognitive psychology*, *neuroscience* and *social psychology*. These new tools shed light on some crucial cognitive mechanisms which regulate knowledge production process, both at individual and social level. The study considers them as a fundamental integrative tackle in order to interpret part of standardization and evolution mechanisms underlying institutional norms. Finally, both traditional and new analytical tools have been systematized in a grid showing their main contribution to the field and distinguishing them according to the individual and social dimension of knowledge production.

Keywords: cognitive path-dependence, institutional cognitive economics, Hayek, knowledge production, social cognitive theory, vicarious learning, neurogenesis, exaptation, semantic priming, social representations, cognitive psychology, social psychology, neuroscience, inward and outward oriented programs

JEL classification: A12, B40

1. Introduction

A dominant approach towards the other social sciences has generally characterized the historical development of economic theory. Because of its solipsistic and colonialist attitude, economic theory has been charged with having drawn from other social sciences moulding them in a way coherent and compatible with its assumptions and objectives. In this sense, external contributions seem to have been exploited in order to achieve results consistent with economics' theoretic predictions (Fine, 2001; Maki, 2009; Davis, 2012).

In the middle of the XX century – when several new research economic programs and approaches started to arise, originating from other social sciences such as psychology or physics - such dominant attitude became particularly evident. This new scenario - which is more and more characterizing the development of economic theory today - sees economics working, on the one side, through the same process of “appropriation - addomestication” that had already taken place in the past. On the other side, surprisingly, economics is generating a turn in tendency – a sort of “reverse imperialism” – meaning a new kind of dominance characterized – initially - by a strong impact of some sciences on economics and – later - by the takeover of the derived interaction field on the other economic programs (Davis, 2013).

In the first part (section 2), the study takes into account and tries to further develop some relevant aspects of J. Davis' contributions (Davis, 2006; 2008). He distinguishes between those new research programs whose rationale is represented by the aim of improving some aspects of orthodox economic theory – *inward oriented* strands - and those ones proposing theories and empirical works defining new paths for economic analysis – the so called *outward oriented* strands.

The work complements Davis' contributions by considering the recent developments of some of the most representative new economic fields; moreover, it provides a graphical model in order to consolidate this general framework of analysis.

Among the outward oriented programs, a recent field represents a model of interaction between economics and other sciences: it is the *institutional cognitive economics*.

In the second part of the paper, the main relevant features and objectives of this strand are briefly described (section 3).

Institutional cognitive economics (Ambrosino, 2012; Ambrosino et al., 2015) - whose recent development is still in progress - represents a particularly interesting case. It needs not only to draw upon methods from other sciences – as for complexity economics - but also to absorb some relevant theories in order to develop and strengthen its main assumption: the reciprocal link between mind processes and institutional norms. In order to show this, the study describes, on the one side, the already existing analytical tools and theories at the basis of the field (section 4); on the other side, it

suggests a potential development (section 5) based on the introduction of new theories and tools - briefly introduced - coming from cognitive psychology, neuroscience and social psychology.

Finally, the paper resumes (section 6) its main findings in the concluding remarks.

2. Understanding the complexity of economics: revisiting J. Davis' contribution

Several new economic approaches and strands started to appear in the period between the end of the XX century and the beginning of the following one: their roots are placed outside economics. Such changes in the history of economic theory are described by literature in terms of alternation between dominance and pluralism periods (Colander et al., 2004; Davis, 2006; 2008; Elsner, 2013; Fontana, 2013).

This study totally embraces this perspective and argues that such trend is the spontaneous consequence of the intrinsic nature of economic theory as it has been described by Fontana's contributions (Fontana, 2010; 2014). Economics - according to her opinion - is a complex knowledge system characterized by dynamic forces expanding in a Kuhnian sense and trying to absorb criticisms and anomalies in order to self-enforce and enlarge. In this sense, new economic strands and approaches - which *prima facie* could be only considered as spontaneous systems of knowledge - actually are the natural consequences of a weakening of the economics' capability to enlarge its boundaries.

Davis (2006; 2008) contributes in explaining such new fields and makes an interesting distinction between what he defines *outward oriented* and *inward oriented* research programs. The outward or inward orientation is defined with respect to the orthodox theory of economics.

Such distinction is adopted here. Particularly, the work starts from Davis' reflections and develops his contribution trying to update this last one by considering the recent developments of some of the most consolidated new research programs. Through the creation of a simple graphical model for the analysis, this study wants to consolidate a general framework in order to interpret the positioning of new economic research programs towards orthodox and neoclassical theory and, generally, in economics.

Though the contribution is not interested in assigning them a label, it is necessary to briefly define the interpretation here assumed of *orthodox*, *mainstream* and *heterodox* economic theory in order to make clearer the starting assumptions.

The study completely agrees with Fontana's contribution (2014). It shares the definition of neoclassical orthodoxy and of heterodoxy as typically intellectual categories: the former is characterized by the fundamental assumptions of Olympian rationality and general equilibrium

model; the latter is defined by a strong refusal of the same ones. Mainstream, on the other hand, reveals strong sociological aspects: its development is strictly tied to the academic and institutional role of the main representative scholars. It contains orthodox theory but it includes also some external criticisms, by reviewing part of the theoretical scaffolding (see also Elsner, 2013 and Lawson, 2013 for discussion). Generally, it “includes the Walrasian/Marshallian contributions, their development by Hicks and, more recently by P. Samuelson.” (Fontana, 2014).

Figure 1 graphically represents the revisiting - proposed by this study - of the distinction suggested by Davis between “inward” and “outward” labels and updating work.

Inward oriented group includes those strands and approaches which could be defined as “ancillary” fields to orthodox economics. They develop in order to modify and improve the fundamental pillars of orthodox theory. “They all originate outside of economics and are mostly oriented toward redirecting the core of economics. That is, their agenda is to revise the existing core principles in the disciplines” (Davis, 2008, p. 356). In this sense, they exist in so far as a theory to be improved exists (circular red arrows). In other words, these approaches and strands - though contributing significantly to economic theory - do not have the aim of building a theoretical scaffolding alternative to the orthodox and neoclassical theory.

Outward oriented group includes, on the contrary, those strands and approaches that try to develop a theoretical framework different from and alternative to standard theory. “Orientation towards the field’s periphery is a matter of placing emphasis on principles closer to other sciences beyond the field’s boundaries, principles moreover which appear at any given point in time to be clearly not part of the field’s core.” (Davis, 2006, p. 25). This study is not maintaining that such fields are *totally* independent on orthodox and mainstream theory: their criticism of some of their fundamental pillars is a relevant factor of their genesis. However, their work does not try to improve or partly modify the theory: they place outside it, trying to build a new independent research block (straight red arrow outside oriented). Such contributions, hence, are not ancillary to the existence of orthodox theory: they place next to it.

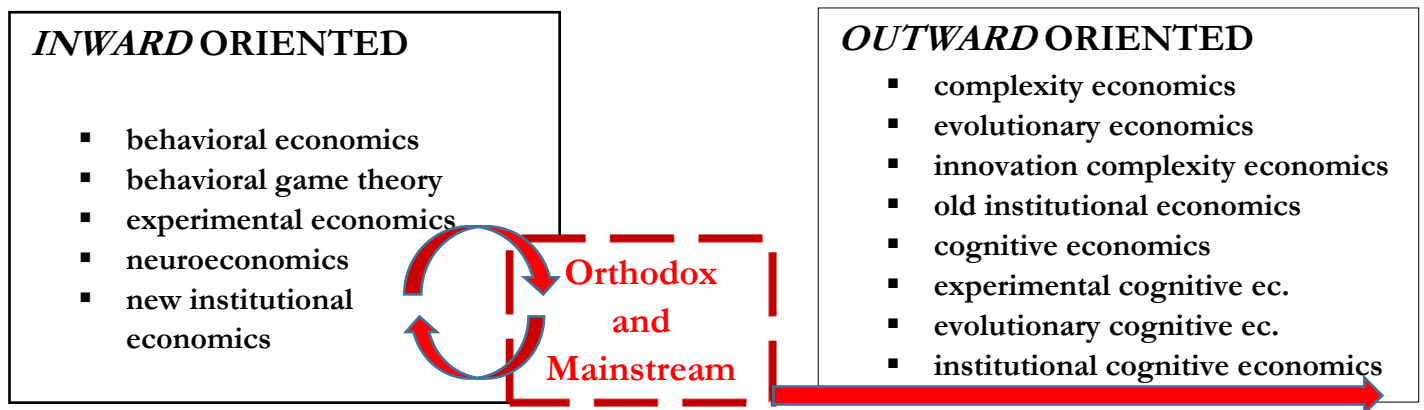


Figure 1 – Inward and outward orientation model

According to Davis' contribution, the first group includes *behavioral economics, experimental economics, neuroeconomics, behavioral game theory*. *New institutional economics* should be incorporated in this group. The main reason concerns its recent tendencies and positioning towards orthodox and mainstream theory (Ambrosino et al., 2015). Its work of enlarging and improving standard assumptions (for instance, the inclusion of institutional analysis, before missing) defines it as an inward oriented strand.

This study chooses to briefly focus on behavioral, experimental and neuro-economics, as they can be considered paradigmatic cases. Such fields enrich mainstream economics, proposing relevant incorporations concerning, particularly, assumptions on decision-making processes.

In the case of behavioral economics (Weber and Camerer, 2006; Spada, 2010; Davis, 2013; Heukelom, 2014; Ambrosino et al., 2015), the impact of psychology - starting from Kahneman and Tversky's *prospect theory* and going on with the most recent developments on mental accounting, happiness literature and nudging processes - has stressed the crucial role of heuristics, "labeled fallacies, biases and deviations" (Heukelom, 2014, p. 93) and of non-egoistic motives, showing the large divide between standard theoretic predictions (expected utility theory) and empirical evidence. Frustrations - derived, on the one side, from such way of steering research in the field and, on the other side, from the relevant distance taken from the older behavioral economics' (strand represented, particularly, by the *Adaptive Behavior and Cognition* research group and the contributions of Gigerenzer)¹ - are not missing.

"... Most behavioral economists have the goal, not of developing an alternative to economic theory and methods, but instead to incorporate new assumptions and methods into mainstream

¹ See Davis, 2013 for discussion.

economics research. Thus the goal of behavioral economists is not to develop a “behavioral economic theory” but instead to improve economic theory so that it is also “behavioral.” (Weber and Camerer, 2006, p. 187).

The recent interaction with the field of experimental economics could change the scenario. Actually, contemporary research in experimental economics (Kahneman and Smith, 2002; Harrison and List, 2004; Villeval, 2007) spans different levels. Some recent developments – particularly, the interaction with neuroeconomics, physionomics and field experiments – seem to give up under the impact of standard economic method: the development of *experimetrics* is a good instance in this sense. More expectations derive, on the contrary, from cognitive experimental economics (Novarese and Rizzello, 2004) and, particularly, from some works trying to develop new behavioral models based on the understanding of learning processes and path-dependent cognitive dynamics. Such field of analysis is very ambitious, but needs to further consolidate and enlarge.

Neuroeconomics (Camerer et al., 2005; Ross, 2008; Davis, 2010), finally, seems to be divided today in two main strands: a most known version consolidated mostly around the name of Colin Camerer and the stream of *neurocellular economics* tied to Ross’ work. Both seem to be strictly inward oriented: while the first can be considered “...an extension and development of behavioral economics which aims to secure additional new evidence from neuroscientific research..” (Davis, 2010, p. 575), the second - though more autonomous from behavioral economics’ field - keeps optimization and equilibrium analysis as the main criteria at the basis of the techniques and of the mathematics used to describe brain functioning.

The outward oriented group includes, in Davis’ analysis, *evolutionary economics* and *complexity economics*.

This study, additionally, argues that also *innovation complexity economics*, *cognitive economics*, *original institutional economics* and the more recent *institutional cognitive economics* should be included. They share the same research effort to go further standard economic theory, offering a more complex perspective which - as it revolutionizes the traditional theoretical framework - places as an interesting alternative. Some new interactions among them – such as *evolutionary cognitive economics* and *experimental cognitive economics* - follow the same direction.

The positioning of evolutionary economics (Friedman, 1998; Witt, 2008; Dolfsma and Leydesdorff, 2010; Dollimore and Hodgson, 2014) seems the most controversial one. Its recent

developments show a significant fragmentation in several subdivisions², but “...relatively little progress has been made in developing further an over-arching theoretical framework... necessary to organize empirical research around driving questions and research hypotheses.” (Dollimore and Hodgson, 2013, p. 2). Evolutionary economics seems, for instance, to be far from recent developments of psychology and of other social sciences dealing with decision–making processes. This study chooses to place it in the outward oriented group as - though the contemporary limits of the research - its work tries to originally contribute to economic theory and pushes research towards its boundaries.

Institutional cognitive economics deserves a more detailed discussion. It represents an interesting case of a boundary work among economics and other sciences which becomes the basis of a new research, autonomous from orthodox and neoclassical theory.

The next paragraph will focus on institutional cognitive economics. It will pinpoint the main aspects of its (recent) development and describe the genesis process as an exchange dynamics of methods and theories between economics and other sciences.

3. Institutional Cognitive Economics: exchange of methods and theories

Institutional cognitive approach is a recent research field based on an evolutionary concept of economic change deeply connected to individual knowledge production, social interaction processes and cultural dimension.

Both origins and main features of the field have been deeply investigated (Ambrosino et al., 2015; see also table 1).

Its fundamental theoretical underpinnings derive both from old institutional economics - particularly, some Veblen’s contributions - and Hayek’s theory of knowledge.³ Their work highlight the link between mind processes and institutional genesis and evolution dynamics. Hayek, particularly, maintains that formal and informal institutional norms are the result of individual knowledge production processes, moulded by social interaction and cultural dimension. Such processes produce patterns of behavior which – if adopted by the social group – become formal and informal institutional norms.

² Industrial and technological innovation, firm dynamics and organization, management processes, economic growth, etc.

³ This study is aware of that part of literature stressing differences and incompatibilities between old institutionalism and Austrian School both on institutions and on epistemological and methodological aspects of economic investigation (Rutherford, 1996; Nelson, 2005). The continuity stressed in this study between Veblen and Hayek only focuses on a particular aspect: the link - they recognize and explain – between mind processes and institutional processes of genesis and evolution and the role played on these processes by social interaction and cultural dimension.

Recovering the same fundamental assumptions of cognitive economics' general framework – to which it is strictly connected – institutional cognitive economics describes individuals and institutions as strictly interrelated: mental models shape institutions, as well as institutions affect and modify individual thinking and behavior. In this sense, a strong continuity with Veblen and Hayek is found in North's contributions to new institutional economics: they stress the role of mental models in human behavior and economic process (Ambrosino, 2012).

Heterogeneity of individuals, interdependence and evolution – this last one conceived in terms of changing in time and totally free from any progress inference - become fundamental features of the context.

The holistic approach derived from old institutionalism grasps the evolutionary dynamics of economic process and human behavior - considered in a social dimension - but it is integrated with an individual level of analysis able to explain mind processes and knowledge production mechanisms intervening in institutional genesis and evolution mechanisms.

Method is still in progress: it has been stressed the necessity to adopt an interdisciplinary method able to find the right tools in order to develop and strengthen the field. Particularly, it has been explained the necessity to go further the mere integration among Hayek', Veblen' and North's contributions and to search for new tools of analysis in those fields – such as cognitive and social psychology - which deeply study individual and social mental processes at the basis of human behavior.

Such processes have to be investigated both at individual level, taking into account the relevant heterogeneity of individuals, and at social level, considering the interdependent and dynamic character of context and the role of social interaction and cultural factors in decision-making processes.

Not only an exchange of methods among such fields, hence, is necessary. Institutional cognitive economics needs to absorb those theories which can contribute to enlarge and deepen its field of analysis.

Table 1 explains the most important focuses of analysis of institutional cognitive economics: economic problem; individual; context; institutions; approach; method.

Table 1 – Institutional cognitive economics’ focuses of analysis

FOCUS OF ANALYSIS / AREA	INSTITUTIONAL COGNITIVE ECONOMICS
ECONOMIC PROBLEM	Dynamic and evolutionary process dependent on individual knowledge production process regulating decisional mechanisms and on social interaction; it is mediated by cultural dimension;
INDIVIDUAL	“institutionalized individual” whose preferences and choices strictly depend on the social and historical evolutionary process; reciprocal link with institutions at cognitive level; individuals are heterogeneous;
CONTEXT	dynamic, interdependent and uncertain context; historical time;
INSTITUTIONS	institutions as “habits of thought” and not mere devices: reciprocal causation bond with individuals; cultural and historical evolution;
APPROACH	the holistic approach is not abandoned but it is integrated by individual analysis investigating mind processes and knowledge production mechanisms intervening in institutional genesis and evolution mechanisms;
METHOD	comparative–inductive method; ethnographic record construction; multidisciplinary method; cognitive sciences analytical and experimental tools (in progress)

The next paragraphs will describe the analytical tools and theories already used and a possible extension of the field by proposing the adoption of some theories and tools coming from cognitive psychology, neuroscience and social psychology.

4. Institutional cognitive economics: theories and analytical tools

The theoretical scaffolding of institutional cognitive economics is represented by the integration of some crucial contributions to the understanding of the link between mind and institutions. They derive, partly, from economics; partly, from psychology. Economics' contribution is represented by Hayek's analysis of institutional processes of genesis and evolution; psychology's contribution is defined by the *social cognitive theory* of the Canadian psychologist Albert Bandura⁴. Here, are described the most relevant aspects of the theory considered as the starting point for a future development of the approach, proposed in the last part of the paper.

4.1 An extended social cognitive theory

Institutional cognitive economics fully adopts the integration between Hayek's investigation on institutional norms and Bandura's work on the social dimension of cognition and exploits the main implications for institutional analysis proposed by cognitive economics (Rizzello and Turvani, 2002; Ambrosino, 2005, 2012).

Such "extended" social cognitive theory defines knowledge production as the result of individual cognitive processes and the interaction with external environment.

Hayek clarifies, particularly, the dynamics underlying individual knowledge production process. He builds up a model of the mind (Hayek, 1945; 1952; 1998a; 1998b) whose working mechanisms are explained through the classification process, the sensory order that makes it possible to perceive and interpret external objects and events. Stimuli are translated in a series of impulses transmitted through networks of connections to classes of responses (the interpretation criteria), by means of an association mechanism. Stimuli are classified through a process adjusting them to the existing classes of responses, created from past experience. Such classes modify every time the expectations deriving from a certain classification are disappointed by new experiences.

Connections and classifications processes - producing knowledge and leading to the emergence of an individual behavioral schemas - take place according to meta-conscious inner rules – this is the focal aspect of the analysis - which also guide the transmission and the selection mechanisms of behavioral schemas.

Social interaction makes possible those mechanisms promoting the emergence of those behaviors (which will become "regular") considered satisficing by the social group (Langlois, 1985,

⁴ A recent economic contribution using Bandura's theories is offered by Phelipe Almeida and tries to revisits the Veblenian theory of the conspicuous consumer (Almeida, 2014). Moreover, his theories characterize some relevant advances in behavioral economics (Camerer; Loewenstein; Rabin, 2004; Vuchinich and Heather, 2003).

p. 466). In this sense, sensorial order in Hayek's theory regulates the spontaneous coordination of individual choices making it possible the fulfillment of a social order – *catallaxis* (Langlois, 1985; 1986; Hayek, 1998b; Rizzello, 1999; Ambrosino, 2005).

Hayek stresses the relevance of *vicarious learning* in the social adoption of the selected behavioral patterns. In this sense, he is coherent with Bandura's theory, which represents a necessary integration.

Bandura's *social cognitive theory* (Bandura, 1986; 1989; see also: Rizzello and Turvani, 2002; Ambrosino, 2005) focuses on the social interaction mechanisms at the basis of knowledge production.

He describes *vicarious learning* as characterized by cognitive sub-processes involved in the elaboration of the pattern observed: a former mechanism of selection of the behavioral schema; a process of symbolic construction and encoding of the schema; a continuous adjustment of behavior to the constructed symbolic model.

Vicarious learning does not result in a mere imitation process. The individual capability of "reflective self-consciousness" entails a work of self-evaluating external behavioral patterns strictly dependent on individual biological characteristics, experiences, feedback from external environment and - also - fortuitous events.

Self-evaluation, therefore, makes it possible the genesis of new patterns of behavior. This process, however, is strictly conditioned by social mental constructs which limit the set of the possible interpretations.

The implications for institutional analysis have been highlighted by cognitive economics (Rizzello and Turvani, 2002; Ambrosino, 2005). Vicarious learning has been considered crucial for assuring continuity and solidity to institutions, as it contributes to the standardization of rules. "I comportamenti osservati, tanto nella teoria hayekiana quanto nel pensiero di Bandura, si trasformano in comportamenti acquisiti dopo essere stati "rivissuti" mentalmente e consapevolmente. Tanto più questi meccanismi di self-reinforcement si ripetono nel tempo, accompagnati da azioni che hanno portato a risultati soddisfacenti, tanto più un determinato comportamento si consolida in ciò che Hayek definisce *routine*.." (Ambrosino, 2005, pp. 82-3).

On the other side, self-evaluation, involving the complex genetic and experiential sphere of the individual in the elaboration of the observed behavior, makes it possible the evolution in time of institutional norms and the genesis of new ones.

4.2 The analytical tools: transposition of categories

As also emerged in the last paragraph, the most relevant analytical tools of institutional cognitive economics are the result of a transposition process. Partly, there is a transposition of external concepts into economic analysis – this is the case of *neurognosis* and *exaptation* categories; partly, there is an inverse trend: the transposition of an economic concept towards new levels of analysis – this is the case of *path-dependency*.

Neurognosis and *exaptation* derive respectively from biogenetics and evolutionary biology.

Neurognosis' concept refers to some neural structures originated in the cerebral cortex during the prenatal and perinatal age and genetically determined. They organize neural networks through which information is elaborated (Laughlin, 1996). *Exaptation* defines a kind of adaptation process whereby a characteristic born in natural selection for a certain function is coopted for another function that represents its current role (Gould and Vrba, 1982).

A recent work of Ambrosino (2012) follows the application of the two categories suggested by cognitive economics – they are proposed in order to enrich economic *self-organization* approach⁵ - and describes these categories as key-elements in the development of the institutional cognitive analysis of economics.

Neurognosis and exaptation can explain different aspects of cognitive processes, that become complementary if integrated with Hayek's model of the mind. Neurognostic structures preserve the genetic organization of neural networks and are significantly moulded by past experiences: in this sense, they represent the micro-foundation of mind's resistance to change. Such property can be easily found in the elaboration of stimuli which takes place according to a process of adjustment of the new to the already existing interpretative classes of responses.

At the same time, the quasi-rigidity of neural structures makes it possible evolutionary cognitive mechanisms. In elaborating external data not compatible with the preexisting neural structures, brain modifies these structures or originates new ones: such process represents the neurobiological foundation of evolutionary cognitive processes.

Mind's resistance to change, on the one side, and its evolution in time, on the other one, can explain some cognitive processes underlying institutional mechanisms of genesis and evolution. "La

⁵ Self-Organization approach describes non-equilibrium dissipative systems and their dynamic evolutionary processes (Foster, 1997; Witt, 1997). In economics, this approach makes it possible to study economic systems as dissipative and entropic structures. These systems are regulated by the entropy law: in order to survive, they import new energy and export entropy. In this sense, change is only possible through evolution and is time-irreversible. Considering the entropic character of economic systems, cognitive economics has tried to integrate self-organization approach with some relevant contributions coming from neuroscience and biology. In particular, the neuro-biological categories of *neurognosis* and *exaptation* give a relevant contribution to the explanation of the entropic and cybernetic functioning of brain and mental processes, in order to further clarify micro-foundations of economic behavior (Rizzello, 2003).

presenza di elementi di propensione così come di forze di resistenza al cambiamento....dell'evoluzione della mente attraverso l'interazione di strutture genetiche innate ed esperienze personali, mette in luce la centralità di questa tensione bipolare nei processi di modificazione delle regole di comportamento, sociali e giuridiche. Tale bipolarità comporta la possibilità di esiti evolutivi diversi: è possibile, infatti, che prevalgano le spinte verso il cambiamento e che, quindi, attraverso un processo di *exaptation* emergano nuove regole, così come può anche accadere che siano le forze di resistenza a prevalere mantenendo *habits e routine* inalterati.” (Ambrosino, 2012, p. 240).

As noted by Fontana (1998), *path-dependency*⁶ - typical economic category, derived from P. David' (1985) and B. Arthur's (1989) contributions - has been progressively transferred to the institutional and the cognitive levels of economic analysis.

Path-dependency in institutional economic analysis (Fontana, 1998; Rizzello, 1999; Gigante, 2016) – North's contributions (North, 1990; 1991; 1994a) represent a milestone in this sense – defines institutional change significantly conditioned by the presence of high transaction costs in imperfect markets characterized by increasing returns (Fontana, 1998). Institutional change will depend - on the one side - on the previous institutional arrangements; on the other side, on the dynamic interplay between individual choices and small events which can change the direction of the process. The most relevant aspect is that society can get “stuck” in a determined institutional system that can be inefficient, characterized by law returns and errors.

The transposition of path-dependency on the institutional cognitive level of analysis passes through its definition as a cognitive category (Fontana, 1998; Rizzello 1999; 2004; Gigante, 2016). *Cognitive path-dependency* defines learning processes as strictly determined by individual's genetic characteristics – the individual neurobiological structures as organized by genetic code; past experiences; unexpected events; finally, by the feedback relation with the environment.

North's contributions stress particularly the path-dependent character of mental models and their crucial role in perception and decision-making processes (North, 1990; 1991; 1994a; 1994b; 2003; 2005; Denzau and North, 1993; see also Mantzavinos et al., 2004). Mental models are dynamic constructs which derive from a reciprocal causation link between individual choices and external environment. The interplay between individual choices, small events and feedback from

⁶ It describes a typical non-ergodic process: initial conditions and historic events which may take place during a development process - even little and apparently insignificant - play a decisive role. Path-dependence was applied in economics for the first time through P. David' (1985) and B. Arthur's (1989) contributions. Industrial and innovation economics, as well economic geography are traditional fields of application of this concept which has led to the achieving of important results. For instance, recent applications in innovation economics showed the endogenous nature of technological change and the path-dependent character of innovation persistence (Antonelli, 1995; 1997; Antonelli, 2006; Antonelli et al., 2012; Gigante, 2016).

outside strongly conditions their genesis and evolution in time. “In case when the content of the shared learning is the same or similar over a number of periods, the mental models become relatively inflexible and shared belief systems are shaped. These are in turn the source of *cognitive path dependence*, since the more inflexible the mental models are, the more difficult their modification and revision become” (Mantzavinos et al., 2004, p. 14).

Considering the cognitive nature of institutional norms, cognitive path-dependence has become a fundamental tool in the analysis of both formal and informal institutional norms.

In this regard, Rizzello (1999) points out how path-dependence, in the genesis of informal norms is more related to individual processes of knowledge production and less to the history of the society. On the contrary, in the formalization of norms, the process seems to be more connected to the history and the traditions of society.

5. A proposal of development: new theories from cognitive sciences

Previous paragraphs have defined the fundamental analytical features of institutional cognitive economics considered in this study as one of the most representative outward oriented research program. The main aspect highlighted, in fact, is that such approach integrates theories and analytical tools derived from economics and other sciences - particularly cognitive and social psychology - proposing to build an autonomous and robust research field. It has also been stressed that such integration should be considered a first stage in the progress of this recent strand.

Here, a potential path of development in this sense is proposed. Considering the cognitive nature of institutional norms, it is necessary to deepen knowledge about the principal cognitive and neurobiological mechanisms involved in individual learning and to clarify how such mechanisms influence and are influenced by social interaction – what the study defines as the *first dimension* of knowledge. Finally, it is necessary to incorporate theories coming from social psychology and describing what the study considers the *second dimension* of learning: social knowledge systems. It refers to that kind of knowledge shared by social groups and sub-groups, originating and evolving according to their inner rules of interaction and interpretation of information.

The main potential implications of the new theories and tools for institutional genesis and evolution mechanisms will be outlined.

5.1 Theories from cognitive psychology

An interesting integration of Hayek' and Bandura's theories on individual and social learning can be represented by the contributions of the American psychologist Tory Higgins and by the analytical tool of *semantic priming* offered by cognitive psychology. Higgins extends significantly their cognitive theories, through his study on the sub-processes of knowledge production and on the role played in by social interaction. Priming paradigm seems to explain well the fundamental dynamics underlying the working of interpretative cognitive categories in the elaboration of stimuli, described by Hayek.

The main relevant aspects of such theories will be briefly outlined.

Higgins (Higgins, 1985; 1989; 1991; 2000; 2012; see also: Echterhoff et al. 2005; Cesaro et al., 2006; Eitam et al., 2010) identifies different steps of individual learning: the *availability*, *accessibility* and *applicability* states of knowledge. Availability and accessibility in knowledge activation define the states in which knowledge is potentially usable for cognitive processes regulating behavior and judgment. This study is particularly interested in those aspects concerning knowledge applicability: the distinction he makes between *knowledge activation* and *use* is fundamental, as it explains learning processes both at individual and social level.

Knowledge activation is strongly determined by recency and frequency⁷ in the use of specific classes of responses in the elaboration of stimuli. This makes knowledge accessibility higher and consequently its activation easier. In Higgins' theory, however, the activation of knowledge does not imply necessarily its use.

Knowledge use means, in fact, that knowledge is not only active, but also applied in cognitive and decision-making processes (judgments and behavior). Knowledge use is, on the one side, possible if learning process is automatic and not controlled by the individual (automaticity increases significantly when individuals are repeatedly exposed to the same or similar stimuli); on the other side, it depends on social interaction. Individual's expectations, (biological and affective) motivations (the *motivational relevance*) and actions meet expectations, motivations and actions of other individuals as well as their behavioral characteristics, stereotypes and social positions. Such social interplay automatically induces individuals to specific judgments and choices.⁸

⁷ Theories explaining the importance of recency, frequency and intensity levels of knowledge on its application in the elaboration of information start to be formulated at the beginning of the 19th century. In 1991, a coherent knowledge activation law is first formulated by Sedikides and Skowronski: a stimulus – if ambiguous enough - is elaborated by that cognitive category which is the most accessible, but also the most similar to such stimulus (Higgins, 1989; 1991; Bargh and Chartrand, 2000). These theories, however, do not consider the determinant role social interaction plays on learning processes and are limited to the individual level of analysis.

⁸ "Situated cognition" is one of the most significant approach in this sense. It rejects the idea of cognition as only abstract process and marginally influenced by social context and suggests an interpretation of the cognitive process as extremely sensitive to the social context, building itself through communication (Smith and Semin, 2007).

Particularly precious in this sense is Higgins' concept of "audience tuning" (Echterhoff et al., 2005), meaning that - while communicating - individuals tend to adapt their knowledge to the knowledge of the audience, in a "tuning" activity.

This mechanism shows the strong relationship between individual knowledge and social interaction: this last one modifies partly knowledge of each individual and his/her choices in a sort of "homogenizing" process. This effect answers the need to create a shared reality, in order to reduce significantly structural uncertainty conditions and to give a stronger stability to the external world. This implies that it has a determinant role on the way individuals choose to structure external environment.

Knowledge activation and use as well as part of derived social interaction, described by Higgins' contributions, take place generally *automatically*. This gives the opportunity to explore an important theoretical and experimental tool - the *priming* paradigm - which clarifies some of the sub-processes involved in general learning activity and their role in decision-making mechanisms. *Semantic priming*⁹ is particularly used in experiments on mental automatism¹⁰ - in research on social cognition (Bargh and Chartrand, 2000; Fazio et al., 2000; Castelli, 2000; 2004; Schacter and Badgaiyan, 2001; Mitchell, 2006; Arcuri and Zogmaister, 2007; Kouider and Deheane, 2007; Higgins, 2012).

Priming describes knowledge as organized in complex grids, made up of associative links among several concepts. The activation of a single component of this structure starts automatically the activation of the other components tied to it in a semantic sense. The different components of the grid work as a reference map which rapidly makes it possible the interpretation of data and which addresses to the most appropriate behavior in a certain situation. In this sense, priming seems

⁹ The word "*priming*" was first used by Lashley K. in 1951, referring to temporal internal activation of response tendencies and, then, used to indicate the influence of a previous stimulus elaboration on the evaluation of something and as an experimental technique.

¹⁰ Automatic processes (Bargh, 1997; Bargh and Chartrand, 2000; Fazio et al., 2000; Eitam et al., 2010) constitute a relevant issue for cognitive psychology starting from the second half of the 20th century.

Donald's test is one of the most famous and used priming experiment. After coming in contact with a series of prime stimuli - some tied to negative personal traits ("indifference" or "recklessness"), some to positive ("adventurous" or "independent") - participants read a text where Donald, the protagonist, behaves ambiguously. People who have come in contact with negative prime stimuli tend to judge Donald's actions in a more negative way than the other participants. The techniques used in the experiments can be different. Generally, participants are asked to study some lists of words, or to read a text, or to look at a monitor where some subliminal messages are showed. In the first two cases, participants are aware of prime stimuli, though they are not aware of the aim of the experiment. This sort of experiments are called "supraliminal" or "conscious" priming. In the third case, participants are not aware of priming stimuli, as they are presented subliminally and do not reach the consciousness level. This is the case of "subliminal" or "perceptual" priming (Schacter and Badgaiyan, 2001; Gazzaniga and Roser, 2004; Mitchell, 2006).

Negative priming is a further priming technique (Arcuri and Castelli, 2000; Arcuri and Zogmaister, 2007). Generally, there are two primes simultaneously presented to the participant who has to ignore one of the two. The ignored stimulus is strongly associated to the target element presented in the second stage. This causes an interference with the target one inducing the participant to answer with more difficulty and in a longer time (longer latency response). This interference is due to the fact that also the ignored element is processed, although automatically and unconsciously, and leads to an inhibition process that justifies the delay.

to integrate Hayek's theory on the working of interpretation criteria (the classes of responses in his contribution).

The working of priming can be easily understood if experiments exploiting such paradigm are briefly described. They, generally, consist of two stages: in the first, a "prime" stimulus - presented to participants - has the role to activate some components of a certain mental representation. This effect becomes easily observable in the second stage, where participants are asked to judge some elements, called "target" stimuli. If the target element too is a component of the mental representation experiment wants to activate, its evaluation is strongly affected by the prime element. Such mechanism particularly works when the individual motivational relevance is high (Strahan et al., 2002; Karremans et al., 2006; Eitam et al., 2010).

Higgins' theory and priming paradigm clarify the relevance of mental mechanisms both at individual and social level. However, if such mechanisms are physiologically determined by specific neural circuits - as neuroscience shows - the investigation on knowledge production could be integrated with its neurobiological foundations.

5.2 Micro-foundations of cognition: some theories from neuroscience

In trying to suggest an investigation on the neurobiological foundations of cognition, the work focuses on two particular aspects characterizing neural circuits¹¹.

The first is "synaptic reorganization", the phenomenon describing plasticity of neural circuits, meaning the rules according to which each neuron organizes and modifies its connections with the others (Gazzaniga, 2004; Gazzaniga and Roser, 2004). Connections change according not only to the neural synaptic capacity (the maximum level of synaptic connections each neuron can develop), but also according to the activation of ionic and chemical signals which - acting on the postsynaptic neuron - make the synapse possible. When the presynaptic neuron is active, but the activation of the postsynaptic one is weak - cause is has been weakly activated by the other signals - the synapse is doomed to fail.

Synaptic capacity and the activation of ionic and chemical signals are decided by genetic endowment, which contains specific instructions about their development, and by experiences,

¹¹ They are synapses among neurons and, particularly, among the axons of the pre-synaptic nerve cell and the dendrites of the post-synaptic one. This connection activates the transmission of sensorial information through electric or chemical signals. It has been shown that prime stimuli activate neural circuits (circuits in prefrontal and temporal regions are crucial in this sense) whose intensity diminishes at further levels, hence, at each further synapse: the elaboration of the stimulus is activated, but it does not involve cognitive mechanisms of awareness. Nevertheless, it influences thought and behavior processes (Dehaene et al., 2001; Schacter and Badgaiyan, 2001; Fiske and Taylor, 2007; Kouider, and Dehaene, 2007; Ghuman et al., 2008).

which significantly affect the organization of neural circuits, determining the activation of synapses and their spreading force. Such modification process is at the basis of brain evolution, both in a phylogenetic and ontogenetic sense.

Plasticity principle is particularly evident in cortical maps (Gazzaniga, 2004; O’Shea, 2012), circuits of neurons distributed at cortical level and representing maps of all the sensorial parts of human body, proportionally to their sensibility, importance and use frequency. They answer to those stimuli acting on the body’s surface which can, in time, modify their original neural distribution.¹²

The second interesting aspect concerns the capacity of some complex neural circuits (in primary cortices and in the interposed areas) to form topographical representations of external stimuli, providing - in this way - the neural bases of mental images. This property has been explained by the Portuguese neuroscientist Antonio Damasio¹³ (1994; 1997; 2003).

The neural disposition of images is instructed by specific “dispositional neural schemas” which - genetically acquired and evolving through experience - are included in different groups of neurons (“convergence regions”) collocated in the associative cortexes of frontal, parietal, temporal and occipital regions, in basal ganglia and in the limbic system (amygdala and anterior cingulate cortex). Each schema provides the representation of a specific aspect of the image and also contains rules regulating its evolution.

Schemas in prefrontal cortex - particularly, the ventromedial area – seem to be crucial for imaginative production as they integrate also past emotional experience. Secondary emotions, in fact, are not elaborated only in the limbic system - as for primary emotions - but also in the prefrontal cortex. The automatic emotional answer activated by prefrontal dispositional schemas passes through the limbic system which activates the autonomous nervous system and the peripheral nerves, regulating, so, motion and facial expressions and, also, sending chemical signals to different brain regions in order to complete the elaboration of the emotion. Feelings, which origin from emotions, have consequently the same physiological source.

¹² From some experiments on monkeys, it has been showed that a particular change - such as the repression of nerves from a finger - leads to a deep modification of the corresponding cerebral map. This last one cannot receive any nervous signal, but - after a period – it becomes again active, as it starts to answer to external stimuli coming from the adjoining finger. In studies on human kind, one important evidence is represented by cerebral maps corresponding to fingers of musicians playing the strings: such maps are more developed than in people who do not play such instruments.

¹³ One of its most famous contributions concerns “*somatic markers*” (Damasio, 1994) described as those emotions and feelings which “...have been connected, by learning, to predicted future outcomes of certain scenarios. When a negative somatic marker is juxtaposed to a particular future outcome the combination functions as an alarm bell. When a positive marker is juxtaposed instead, it becomes a beacon of incentive.” (Damasio, 1994, p. 174).

Antonio Damasio’s theories are already exploited by some areas of economic analysis, like *behavioral economics* and *neuroeconomics* (see Altman, 2006; Glimcher and Fehr, 2014). This study places Damasio’s theories inside the cognitive approach to economics (for the main differences among behavioral and cognitive approaches, see Ambrosino et al., 2015; for neuro-economics, see section 2) and, particularly, for the explanation of some neuro-foundations of institutional norms.

Synaptic organization and neural dispositions of mental images describe some interesting aspects of micro-foundations characterizing knowledge production process. On the one side, they show the complex neurobiological filter regulating the relationship between individuals and external environment; on the other one, they identify those neural evolutionary mechanisms providing the basis for innovative solutions in problem-solving conditions.

5.3 Beyond individual knowledge: social representations

Theories and analytical tools provided by cognitive psychology as well as the extended social cognitive theory derived by Hayek's and Bandura's contributions (par. 4.1) - though describing the relevant influence of social interaction on knowledge production – stay focused on the individual level of analysis. This study suggests to integrate them with some theories clarifying mechanisms of genesis and evolution of social knowledge constructs, systems of knowledge shared by social groups.

The contributions here proposed are the *social representations*' theory formulated by the Romanian psychologist Serge Moscovici and a part of its further - more recent - development elaborated by the French psychologist Jean C. Abric.

Moscovici's theory¹⁴ (Moscovici, 1961; 1984; 1994; see also Marková, 2003) focuses on the rules according to which individual knowledge is structured by groups and organized in a social representation. Social representations are dynamic phenomena, originated from human interaction and communication and constructed around a certain element. This is, generally, a critical or conflicting social fact which induces individuals to construct a coherent knowledge system around, in order to interpret it and to decrease uncertainty and conflicts. In this sense, social representations give an interpretation of the external environment and provide a guide for social behavior.

Anchoring and *objectifying* processes are the two mechanisms through which the new element becomes a social representation (Moscovici, 1984; Santambrogio, 2006; Palmonari and Emiliani, 2009).

¹⁴ The sources of such work can be found in developmental psychology as it has been elaborated by the Swiss psychologist J. Piaget's and, particularly, in his theory about children's representational knowledge and communication system. On the contrary, Moscovici's theory is less tied to Durkheim's concept of collective representations, especially because of their static nature (Marková, 2003). Moscovici's contribution is part of that scientific effort – beginning from the second half of the 20th century and spreading particularly in Europe – to integrate social psychology with cognition theories. Bandura's social cognitive theory and Piaget's developmental psychology have to be included in this current. This European approach is alternative to the social cognition model developed in US, characterized by an individualistic perspective in the explanation of social behavior (De Rosa, 1992; Palmonari and Emiliani, 2009).

Through *anchoring* the unknown element is shifted inside traditional knowledge system and interpreted: it is adapted to the interpretative categories shared by the group. *Objectifying* describes the process through which the element resulting from anchoring - which is abstract - is transformed in a concrete and physical object, through the use of symbols. Particularly, some specific features of the element are selected, forming a figurative nucleus with a physical and visual dimension.¹⁵

Social representations have been further elaborated through the *central core theory* described by Abric (Abric, 1993; 2001; read also: Marková, 2003; Palmonari and Emiliani, 2009).

He argues that each representation is made up of two parts: a central core and a peripheral system. The central core generates and structures the meaning of the representation and has a prescriptive value, guiding decision-making processes of the group. It is extremely tied to the values system of social groups, as well as to their identity and history; for this reason, it is very resistant to change. The peripheral system is the dynamic part. His flexibility makes representation able to adapt itself to the external context, by integrating new elements or changing some existing ones. Such evolution is, however, coherent to the central core, preserving this last one from external shocks. Only changes in the central core lead to the real modification of the social representation: this takes place when a shocking and irreversible social fact happens, determining the crisis of the founding values of the group and forcing to create a new knowledge system, which can give a sense to the modified external context.

Social representation of democracy (Marková, 2003) is an useful example in order to clarify such mechanisms. Items such as freedom, justice and human rights are undoubtedly parts of its central core, while peripheral elements could be represented by citizens' civic sense, education towards citizenship and incorruptibility of governments. "If, for the sake of argument, the local government becomes corrupt, citizens may search for reasons of corruptibility in human nature or in bad policies, rather than in democracy as such. In this manner, peripheral elements absorb the shock by reference to other phenomena, thus defending their existing social representations of democracy." (Marková, 2003, p. 180).

5.4 Implications for the institutional analysis

Here, are just outlined the main institutional implications that could be derived from the adoption of theories described above, leading the way for future further considerations.

¹⁵ In Moscovici's study on psychoanalysis theory, the anchoring process led such theory to be considered from some social groups as part of the typical "American way of life". Through the objectifying process, psychoanalysis theory led to the emergence of some new social categories, such as the "repressed" people.

Higgins' analysis of knowledge production sub-processes and the priming paradigm seem to contribute, particularly, to explain genesis and standardization of institutional norms.

When a successful pattern of behavior benefits the group, the cognitive activation and the use of the relative knowledge become rapidly automatic. In fact, the convenience of the behavior makes the relative knowledge significantly available, accessible and ready to be used in decision-making processes. In other words, there is a strong association between the knowledge and the behavior it prescribes.

The priming mechanism makes this association possible through the working of an associative circuit: every time individuals deal with a problem requiring the application of that behavior, semantic priming connects inputs deriving from the problem to the decision-making process consistent with the behavior, through the activation and the use of the relative knowledge.

Such learning processes answer also to the "homogenizing" effect described by Higgins and explaining the need to construct a shared reality, in order to decrease uncertainty. This effect fosters the vicarious learning, leading to a certain modification of individual knowledge, that is adapted to knowledge produced by the others, if it contributes to create a shared level of coexistence. The influence on individual choices are evident: the successful behavioral schema - coherent with the shared dimension of social life - becomes a model individual behavior adjusts to. This is the emergence of an informal institutional norm which can be eventually legalized by public authority, becoming a formal norm.

An institutional norm can modify in time and be replaced by another one considered more effective by the social group. In this case, priming process seems to work in an inhibitory sense: the availability and automaticity levels of knowledge regulating the norm decrease significantly, preventing its activation and use and forcing learning process to find new circuits in the elaboration of external stimuli and to produce a new behavioral model.

Such evolutionary process finds its micro-foundations in the plastic nature of neural circuits – explained by neuroscience. Neural circuits reorganize themselves to elaborate new data or to find new successful solutions to the interaction with external environment. This reorganization works at the level of the single sub-connections inside circuits (each synapse).

The same mechanisms can clearly explain not only change, but also the emergence of norms. The searching for new solutions in order to deal with the complexity of external context leads to the creation of new associative circuits, which elaborate those new external data that cannot be adjusted to the pre-existing semantic connections. Such process generates knowledge regulating the new patterns of behavior. The physiological basis of such cognitive activity is constituted by new neural

connections involved in the transmission and the elaboration of sensorial information or derive from the modification of the existing ones.

Moreover, if Damasio's theory on the neural basis of imaging capacity is taken into account, dispositional neural schemas can be considered as the physical filter between data perception and knowledge production; hence, a system of rules regulating part of the cognitive processes underlying institutional genesis and evolution.

Theories on social representations seem to clarify some cognitive mechanisms generating institutional norms and strongly dependent on the knowledge shared by social groups. *Anchoring* and *objectifying* processes, described by Moscovici, create social representations, making it possible to reinforce and legitimize social interests and show the sharing of analogous values as one of the most relevant source of institutional norms.

In this sense, Moscovici's theory is in line with the contributions of the economist K. Boulding and the philosopher C. Castoriadis (Boulding, 1956; Castoriadis, 1987; read also: Patalano and Rizzello, 2002; Patalano, 2007) - that are briefly recalled here - on the construction of shared social images and their connection with institutions. According to their work, each individual produces knowledge coherent with the mental images he/she forms about himself/herself, the external environment and the system of relationships with the environment. The development of similar images among individuals determines the sharing of analogous values. In this sense, shared images are an important factor of social cohesion: they produce standardized behaviors and, for this reason, represent the basis of institutional norms.

These theories should be integrated with North's contributions on shared mental models and the link with institutional norms. North maintains that collective learning arises from the interaction among individuals, which makes it possible the sharing of mental models. Collective learning first takes place in basic organizations (families, schools, neighborhoods..). Then, it is transmitted in time and across generations, by means of symbols. It represents an indirect learning process which homogenizes individual mental models and facilitates its transfer among generations. This is the starting point to understand dynamics of institutional emergence and evolution (Denzau and North, 1993; North, 1994a; 1996; 2005; Mantzavinos et al, 2004; North et al., 2006). Institutions are "nothing more than shared mental models or shared solutions to recurrent problems of social interaction" (Mantzavinos et al., 2004, p. 77). They are built up on social belief systems.

Finally, Abric's central core theory suggests a further analytical key for institutional analysis: it could explain, particularly, the resistance to change of those social representations which are considered critical for the survival of the founding values of some social groups and - in the most relevant case - of the entire society.

6. Concluding remarks

The development of economic theory – particularly starting from the second half of the XX century – is characterized by the emergence of new economic programs whose analytical framework partly derives from other social sciences. External contributions enrich significantly economic analysis, equipping this last one with new methods and research tools. Interaction between economics and the other sciences, however, is complex: in some cases, it reflects the traditional dominant approach of economics; in other ones, it makes it possible a more balanced integration (Fontana, 2013; Davis, 2012; 2013).

According to these different mechanisms, each research program appears more or less oriented towards standard economic theory or towards more heterodox fields of research.

The present work arises from the necessity to clarify this tangled scenario.

The starting point is represented by some contributions of John Davis (Davis, 2008; 2006) which offer an interesting key of interpretation of some new economic research programs. Particularly, Davis distinguishes between *inward oriented* programs - which steer their research towards the traditional core of orthodox and mainstream theory, offering improvements and partial revisions – and *outward oriented* programs, that push research towards the boundaries of economic theory, providing the basis for the emergence of more autonomous research strands.

The work tries to develop further such framework. Once having defined interpretation of orthodox, mainstream and heterodox categories (Fontana, 2014), it has proposed an updating of Davis' work which includes a simple graphical model trying to reflect the main interaction forces between the new research programs and the traditional theory, meaning orthodox and mainstream economics.

It has considered, on the one side, the recent development of those research programs Davis dealt with; on the other side, it has integrated some recent strands not included in Davis' work.

It has been argued that the positioning of some of them - for instance, *evolutionary* and *experimental economics* - is controversial as, on the one side, they try to work on the boundaries of economic theory; on the other side, their recent development reveals some relevant limits, pushing towards the safeguarding of standard economic methods.

The second part of the work has focused on the outward oriented group of research programs as it includes some interesting cases of different interaction between economics and other social sciences.

Then, the case of *institutional cognitive economics* has been analyzed more in depth (Ambrosino, 2012; Ambrosino et al., 2015) for two main reasons: it is one of the most recent research stream and it is a representative case of an economic program which needs to absorb not

only methods, but also theories and analytical tools from outside. Its most relevant assumption, the reciprocal bond between mind processes and institutional genesis and evolution mechanisms (which places it at the borders between old institutional economics, Hayek's theory on mind and institutions and the contributions provided in this sense by D. North) entails the absorption of those theories explaining cognitive processes underlying the emergence of behavioral regularities and their standardization and crystallization in an institutional norm.

The main theories and research tools of the strand have been described. Particularly, it has been argued that the current theoretical scaffolding - represented by an integration between Hayek's theory of knowledge production and the *social cognitive theory* of the psychologist A. Bandura - focuses mainly on the individual level of knowledge production, without taking sufficiently into account the relevant role of social knowledge systems, meaning knowledge structures shared by social groups.

Hence, a potential extension of the strand has been suggested. On the one side, a deeper investigation on mechanisms underlying individual knowledge production, considering also the influence of social interaction - defined as the *first dimension* of knowledge. Some contributions derived from cognitive psychology have been suggested: Higgins' theory on the reciprocal influence characterizing individual cognition and social interaction mechanisms and the *priming* paradigm on the activation of stored knowledge in learning process. Moreover, the study has proposed *synaptic reorganization* process explained by neuroscience and Damasio's theory of *dispositional neural schemas* as the neurobiological foundations respectively of cognitive evolution and imaginative capability.

On the other side, this study tried to fill the gap deriving from the missing analysis of social knowledge systems - defined as the *second dimension* of knowledge production. It has proposed the theory of *social representations*, formulated by the psychologist S. Moscovici and further developed by the psychologist J. Abric. Such contributions explain rules according to which individual knowledge is structured through perception and elaboration mechanisms shared by certain social groups.

Table 2 summarizes the second part of the paper. It offers a schema of what the study considers as the main dimensions of knowledge production, specifying for each dimension the already used theories and tools of institutional cognitive economics (coming from cognitive economics; cognitive psychology; biology; philosophy) as well as those new ones proposed (from cognitive psychology; neuroscience; social psychology), and the main institutional implications.

Table 2 – Theories and analytical tools in institutional cognitive economics

First dimension of knowledge production	Existing theories (cognitive economics; cognitive psychology; biology; philosophy)	Potential new theories (cognitive psychology; neuroscience; social psychology)
<p>Individual knowledge production as the result of cognitive processes moulded by social interaction mechanisms and cultural dimension</p>	<p><i>Hayek's</i> model of the mind: knowledge produces the emergence of a behavioral schema which can become an institutional (formal or informal) norm if socially adopted. Main transmission mechanism: vicarious learning</p> <p><i>Bandura's social cognitive theory</i>: vicarious learning and self-evaluation at the basis of the selection of behavioral patterns and of standardization and evolution of institutional norms</p> <p>Analytical tools clarifying cognitive processes regulating some aspects of institutional genesis and evolution:</p> <p><i>neurognosis-exaptation</i>: resistance to change and evolution of mind;</p> <p><i>cognitive path-dependency</i>: role of genetic and experiential dimension of individual and of feedback he receives from outside on learning</p>	<p><i>Higgins' theory</i>: learning sub-processes, social interaction and “homogenizing effect” at the basis of standardization of institutional norms</p> <p><i>Priming paradigm</i>: stored knowledge works as an associative automatic circuit and as a self-reinforcing mechanism for social norms.</p> <p><i>Synaptic reorganization</i>: plasticity of neural connections as the micro-foundation of cognitive and institutional evolution</p> <p><i>Damasio's theory on dispositional neural schemas</i>: neurobiological filter among perception and elaboration of data</p>
<p>Second dimension of knowledge production</p> <p>Individual knowledge is further structured according to learning systems of social groups and organized in social</p>	<p><i>Boulding' and Castoriadis'</i> contributions on the link between shared social images and institutions</p>	<p><i>Moscovici's</i> theory explains rules – <i>anchoring and objectifying</i> - structuring individual knowledge in <i>social representations</i> shared by social groups;</p> <p><i>integration with</i>: <i>North's</i> shared mental models: collective learning homogenizes individual mental models</p> <p>Social representations (shared mental models) produced behavioral regularities contributing to the emergence of institutional norms</p>

representations (shared mental models)		<i>Central core theory of Abric</i> : genesis and evolution of social representations strictly tied to the balance between the periphery and the central core of the representation
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