
1 Introduction

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In 1937, Friedrich von Hayek wrote what was to become a very famous article, which was published in *Economica*, on the relations between economics and knowledge. It was admired by the economics profession, but its direct influence on economic theory at the time was limited. Fifty years later, with the emergence of the so-called ‘knowledge-based economy’, many of von Hayek’s preoccupations were revisited, and this has given birth to a large literature dedicated to the role of knowledge within economic relations. The economic reality questions the economic theory. The concept of the knowledge-based economy has generated a new ‘economics of knowledge’ or ‘economics of science’. This has prompted greater reflection on the notion of knowledge in analytical areas such as game theory, innovation theory, organization theory, firm theory, spatial economics and growth theory. However, it is not certain whether the numerous contributions on these issues have contributed to a better understanding of the key questions related to the notion of knowledge in economics.

1.1 THE MICROECONOMICS OF INFORMATION, KNOWLEDGE AND GENERAL ECONOMIC EQUILIBRIUM THEORY

The research programme that dominated economic analysis for more than one hundred years – general economic equilibrium theory (GEET) – did not pay attention to the notion of knowledge, and instead focused on information. The argument put forward to justify this focus was that information could be measured. Information theory (see Shannon, 1948) emphasizes that information can and must be codified in order to be transmitted through a digital system. Van Ha (1999, p. 1) notes:

information has the property of reducing the uncertainty of a situation. The measurement of information is thus the measurement of the uncertainty. That measurement is called *Entropy*. If entropy is large, then a large amount of information is required to clarify the situation. If entropy is small, then only a small amount of information is required for clarification.

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Within this framework, computer scientists interested in measuring the volume or weight of information to be transmitted refer to the minimal number of 'bits' needed to transmit some piece of information (a bit being the measure of the smallest amount of computer information storage).

Microeconomic theorists, on the other hand, tend to maintain that knowledge cannot be measured. They generally do not consider practical means for measuring information, although they do concede that information can be coded and is measurable while knowledge is not. However, it should also be emphasized that some economists do not consider the notion of quantitative information to be relevant. For instance Arrow (1974, p. 38, quoted in Garrouste, 2001) stated:

this definition of information is qualitative, and so it will remain for the purposes of this volume. The quantitative definition which appears in information theory is probably of only limited value for economic analysis, for reasons pointed out by Marschak; different bits of information equal from the viewpoint of information theory, will usually have very different benefits or costs. Thus let A and B be any two statements about the world, for neither of which is its truth or falsity known a priori. Then a signal that A is true conveys exactly as much information, in the sense of Shannon, as the statement that B is true. But the value of knowing whether or not A is true may be vastly greater than the value of knowing B's truth-value; or it may be that the resources needed to ascertain the truth-value of A are much greater than those for B. In either case, the information-theoretic equivalence of the two possible signals conceals their vast economic difference.

Another reason why GEET research preferred the concept of information over the notion of knowledge is related to the characterization of this concept within Walrasian economics. In such a theoretical context information was considered objective and symmetric, that is, the same for all economic agents. It was seen also as complete, implying that the agents agreed perfectly on a common characterization of all possible states of the world. It was assumed to be perfect because it was being defined in a world where all the data related to problems of agent-individual choices are known. And finally, the combination of these properties was the basis for making individual rational choices.

Even after the GEET research programme was discontinued, information or its equivalent – coded or codified knowledge – continued for some economists to be more attractive than other forms of knowledge. The 'new economics of science' emerged in the 1990s (Dasgupta and David, 1994; David and Foray, 1995; Cowan and Foray, 1997), an approach that combined mainstream microeconomic analysis with contributions from new institutionalism, and identified information as codified knowledge and treated it as a commodity.

1.2 PERSONAL AND TACIT KNOWLEDGE

There were some, however, who could not accept this identification, on the grounds, first, that some knowledge is tacit. In Polanyi's *Personal Knowledge*, tacit knowledge is described as 'unarticulated' knowledge, which underlies 'the aim of a skilful performance' (Polanyi, 1962, chs 4 and 5), which aim 'is achieved by the observance of a set of rules which are not known as such to the person following them' (ibid., p. 49). Tacit knowledge cannot be reduced to these 'rules': 'Rules of art can be useful, but they do not determine the practice of an art; they are maxims, which can serve as a guide to an art only if they can be integrated into the practical knowledge of the art. They cannot replace this knowledge' (ibid., p. 50). There is no clear dichotomy between tacit and explicit forms of knowledge in Polanyi's approach. Polanyi maintains that articulated or explicit knowledge always requires focal awareness since it implies a fully conscious attitude. However, if tacit knowledge requires subsidiary awareness, this is not to imply entirely unconscious behaviour: 'it [tacit knowledge] can exist at any level of consciousness, ranging from the subliminal to the fully conscious. What makes awareness subsidiary is its functional character' (Polanyi, 1975, p. 39). This explains why tacit assessments and judgements are required at every step in the acquisition of – even codified – knowledge (ibid., p. 31). From this point of view, there is no purely explicit knowledge; in other words, knowledge is always personal knowledge.

Second, for Polanyi, the introduction of tacit knowledge is strongly related to 'personal knowledge'. According to Polanyi, knowledge can be seen as the product of subjectivity. 'Personal knowledge' refers to knowledge anchored in individuals and is the product of personal commitment. For example, before the scientist becomes committed to 'pure' research he or she has a personal vision and an intuition, which are constrained by the tradition of the particular discipline. Some of the assumptions made, according to Polanyi, were due largely to the 'logic of tacit inference':

Upon examining the grounds on which science is pursued, I saw that its progress is determined at every stage by indefinable powers of thoughts. No rule can account for the way a good idea is found for starting an inquiry, and there are no firm rules either for the verification or the refutation of the proposed solution of a problem . . . It appears then that scientific discovery cannot be achieved by explicit inference, nor can its true claims be explicitly stated. Discovery must be arrived at by tacit powers of the mind and its content, so far as it is indeterminate, can be only tacitly known. (Polanyi, 1964, p. 138)

Tacit knowledge, therefore, is rooted in personal knowledge and is generated through the specific engagement of the scientific (or any other) agent

with his or her daily activity. This kind of tacit ('pre-verbal') knowledge is difficult to articulate. The articulation or codification of knowledge has been the subject of intense debate among economists (see Cowan et al., 2000).

1.3 SITUATED AND DISTRIBUTED KNOWLEDGE

The third reason for the refusal to identify knowledge with information or codified knowledge was the distinction between situated and distributed knowledge. The theory of 'situated cognition' states that cognitive resources in the environment complement the cognition of agents and are exploited by them. Knowledge is anchored not only in the mind, but also physically in the environment. This theoretical proposition was developed by Suchman (1987), who emphasized that cognition is rooted inherently in action: that is, the physical, technological or social environment is essential for building human knowledge. Suchman's analysis suggests that the spatial arrangement of the environment (notably a specific division of labour and local division of tasks) is decisive for understanding human problem-solving capabilities (Lorenz, 2001). Nooteboom (Chapter 15 in this volume), demonstrates why situated cognition departs from the representational vision of knowledge described by Newell and Simon (1964). It suggests that cognitive structure is not fixed, but is built in action, and that knowledge is local in character because it can be understood fully only within a specific context. In Chapter 15 Nooteboom quotes Polanyi (1962) in arguing: 'Situated action entails that knowledge and meaning are embedded in specific contexts of action, which yield background knowledge, as part of absorptive capacity, which cannot be fully articulated, and always retain a "tacit dimension".'

This vision is shared by advocates of the notion of 'community of practice' (Brown and Duguid, 1991; Lave and Wenger, 1991, Wenger and Snyder, 2000), proposed by researchers at the Palo Alto Institute for Research on Learning in the 1980s. A community of practice is defined as a group of people bound by informal links, engaged and interested in a common practice. They develop knowledge in action through practice and a shared language and common understandings, which most of the time remain tacit and implicit for most of the community.

In Chapter 18 of this volume Amin and Cohendet discuss why community provides some degree of coordination during knowledge creation:

Communities are thus 'suppliers' of sense and collective beliefs for the agents and play a central role of coordination in the organization. The community

framework provides the context within which are built the collective beliefs and the reference systems that structure individual choice. Adopting the idea that knowledge creation is primarily realized in contexts of action and that the action is always collective, the consideration of the intermediate level of communities is thus necessary to focus on the learning in the processes of action (Dupouët and Laguecir, 2001).

Situated and distributed cognition are separate and complementary. What distinguishes these two visions of knowledge is the role of the cultural determinant in the cognitive process (Lorenz, 2001). Edwin Hutchins, a famous American researcher in the field, subscribes to these views. Hutchins (1986) sees cognition as occurring via technological artefacts and social interactions, and human cognition as being mediated by technological artefacts that act as external memory (part of the cultural heritage of humankind). Individuals in interaction with their environment solve problems and perform particular tasks by exploiting these technological tools. Cognition is mediated through such tools and distributed via artefacts through a specific ‘*agencement*’ and social interaction (e.g. in the US navy the channels for the transmission of knowledge are mostly formal rules and organizational relations). External memory affects the process of routinization by introducing new knowledge and new tasks into the division of labour. Artefacts create new kinds of memory that facilitate cognitive activities, and enable the articulation of formerly tacit practices, through common references (Lazaric et al., 2003).

1.4 SUBJECTIVE AND DISPERSED KNOWLEDGE

The division of labour and dispersion of knowledge chimes with the Hayekian vision of cognition. In this perspective, knowledge is conceived not only as being distributed relative to one’s sensory-motor system, but also as being distributed in time and space (Lazaric and Lorenz, 2003). According to Hayek (1945), the dispersed and locally contextualized nature of knowledge makes it quite impossible to centralize all economic decision making. Hayek provides a subjectivist interpretation of this dispersion of knowledge based on two main reasons. The first, which is cognitive, is discussed in *The Sensory Order* (Hayek, 1952), where Hayek champions the idea that the brain functions in a connectionist way. This means that the point of departure for a mental representation is not the physical order of things, as ‘scientific objectivism’ (to use Hayek’s expression – cf. Hayek, 1952, ch. V), would have it, ‘but the product of abstractions which the mind must possess in order to be capable of experiencing that richness of the particular [of the reality]’ (Hayek, 1978, p. 44). The conscious

experiences that individuals regard as relatively concrete and primary and that are attributed to the intrinsic properties of the physical order 'are the product of a superimposition of many "classifications" of the events perceived according to their significance in many respects' (ibid., p. 36). Thus there are as many subjective forms of knowledge as there are individual 'nervous systems', that is, as there are individual heterogeneous agents. The second justification for Hayekian subjectivism is found in what Hayek calls the 'social division of knowledge'. For Hayek, as a civilization develops, the knowledge of its society becomes more complex and specialized. However, no single agent has access to all this knowledge: it is dispersed within and among the individuals constituting society, who have access to very small parts of this social knowledge and especially to the processes by which social and economic activity is regulated and reproduced globally. Hayek's subjectivist methodological choice led him to investigate the features of a 'cognitive' individual rationality. The cognitive capacities that individual agents must mobilize refer to their 'mental maps'. Hayek describes these 'maps' as a 'semi-permanent apparatus of classification', which 'provides the different generic elements from which the models of particular situations are built' (Hayek, 1952, p. 89). The notion of a mental map conveys the idea of cognitive limits to the mental considerations of individuals. Rather than 'a sort of schematic picture of the environment', mental maps act as 'a sort of inventory of the kinds of things of which the world is built up, a theory of how the world works' (ibid.).

1.5 KNOWLEDGE AND RATIONALITY

Nooteboom (2006) suggests that various visions for considering learning and knowledge can be endorsed. The French philosopher Blaise Pascal, writing in the seventeenth century, made the distinction between '*esprit de géométrie*', 'which abstracts drastically from reality to enable grip for rigorous formal reasoning and an "*esprit de finesse*", which stays closer to complex reality, that allows less for formal analysis' (Nooteboom, 2006, p. 3). Simonian and Hayekian interpretations of knowledge and information differ. Alan Newell and Herbert Simon (1964) developed the perfect illustration of '*esprit de géométrie*', that is, a classic statement of the information-processing or physical symbol system view of human cognition and knowledge. The basic premises of this approach are that knowledge consists of rule-based representations or collections of abstract symbols that are stored in the mind, and that problem solving can be understood in terms of search procedures that select among means to transform the initial into the goal state. This view of human knowledge

and problem solving underlies Newell and Simon's (1964, pp. 282–3) claim that, at the level of information processing, the computer and the human mind are comparable. They justify their epistemological stance by suggesting that computer simulation techniques can be used to provide psychologically realistic characterizations of human problem-solving behaviours, which contrasts with Hayek's vision of knowledge as more strongly rooted in a traditional '*esprit de finesse*', that is, a vision of knowledge that goes beyond its symbolic representation.

However, it is the Simonian representation of knowledge and the procedural rationality it legitimizes that contributes most to improving our deliberations over decision making. This symbolic approach to cognition is adopted explicitly by several economists, notably Egidi (1992, p. 154), for whom 'a problem is represented by means of a symbolic structure . . . and finding a solution means finding the program or procedure which leads to a solution'. Drawing on Newell and Simon's (1972) classic discussion of human problem solving, Egidi argues that in searching for a solution individuals use conjectures to decompose a problem into a set of presumably solvable sub-problems. This conjectural division of problem solving gives rise to a division of knowledge that is efficient because it economizes on memory and thinking. Herbert Simon's information-processing approach to human cognition naturally gives rise to an understanding of knowledge and learning as symbolic expressions stored within the minds of the organization's members. This symbolic way of storing and representing knowledge at the individual level may explain interference in the decision-making process in a context of bounded rationality. It refers to decision making in a context of incomplete information.

1.5.1 The Frame Effect

In economics, framing effects emerged in relation to observed occurrences of fairness in subjects' behaviour in experiments. Frey and Bohnet (1995) suggest that we need to examine institutionalist elements to observe the impact of fairness on economic outcomes. Framing effects are defined as 'norms, perspectives, contexts and other social cultural elements' (Elliot et al., 1998, p. 456) and refer more generally to the way decisions are presented and how they shape human judgements in specific settings. Kahneman and Tversky (1979) suggest that framing effects are a preliminary stage that precedes the decision problem, the second stage being the period of evaluation. They define framing effects as 'the manner in which the choice problem is presented . . . [according to the] norms, habits, and expectancies of the decision maker' (Kahneman and Tversky, 1981, p. 455). Thus framing effects represent the heuristics interplaying in

the decision-making process before the problem is solved (Gabaix et al., 2001). This means that, underlying many of our intuitive inferences, are representativeness, availability and anchoring.

This is not a new idea. The social sciences refer to it as cognitive frameworks, which result from internal processes and the local and cultural environment (Bandura, 1986; Witt, 1999). Cognitive frameworks are the outcome of the co-constitution of action and perception, proposed in the constructivist approach (see notably Weick, 1979, on this dimension). For Boulding (1956), images play this role of intermediation between the perception of raw data and the internal value system. Every human action is induced by the person's image, which, in turn, may be revised by the action. Images provide a way to interpret information and make sense of the environment. They create temporarily stable cognitive frameworks with individual and collective regularities. For instance, in Chapter 6 of this volume, Patalano says: 'individual imagery has a relevant social function because it enables collective sharing of values and meanings . . . the image has cohesive power that may exert a strategic function in both organizational contexts and cooperative interaction.'

1.6 KNOWLEDGE, LEARNING AND ROUTINES

In the historical evolutionary economics debate, collective learning rests on individual habits, routines and other types of more or less formalized practices (Commons, 1934; Veblen, 1914). Veblen developed an anthropological approach to capitalism and believed that it evolved with technical and social changes (Veblen, 1904, 1914). From this perspective, the question is not how a set of behaviours or actions becomes stable and balanced over time, but how it evolves (Veblen, 1919, p. 8). Individuals have certain habits and behaviours that are conditioned by experience (*ibid.*, p. 79), which is why the cumulative and self-reinforcing process of a set of routines and habits on which the economic order rests needs to be depicted. These habits and propensities, embedded in social structures, tend to reproduce themselves, hence the potential for inertia.

Interest in the notion of routines was reawakened by Nelson and Winter's (1982) work, which highlights the relative permanence of firm behaviours, but also the capacity of firms to innovate. The notion of routine is increasingly used to analyse microeconomic change (Becker et al., 2005). Therefore a re-examination of the role of institutions would allow us to identify and understand the forces behind these changes, which are not related exclusively to cognitive contingencies (Nelson and Sampat, 2001).

The interplay of the individual and the collective levels of action is

far from neutral (Dopfer, 2007). For instance, entrepreneurs shape their judgements, beliefs and acts by themselves, but also in interaction with others. These micro interactions can produce ‘recurrent interacting patterns’ that need to be observed carefully (Cohen et al., 1996). Commons (1934, 1950) proposed an interactions taxonomy based on the type of knowledge involved (see Dutraive, Chapter 13 this volume). ‘Routine transactions’ are related to habitual activities involving stabilized knowledge (embodied in rules); ‘strategic transactions’ are those related to novel situations requiring new practices and implying new opportunities, for which there is no stabilized knowledge or rule of thumb. In other words, routine transactions are stabilized procedures that are deeply entrenched in the entrepreneur’s procedural memory, while strategic transactions are related to new ways of doing things, not yet classified by the human mind. For Commons, the processes of deliberation and calculation are not always mobilized, but may rely on past habits when they are appropriate. In certain circumstances, the mind may reveal ‘a creative agency looking towards the future and manipulating the external world and other people in view of expected consequences’ (Commons, 1934, p. 7; see also Hodgson, 1988). Thus institutions must be understood as the working rules of collective action that may restrain individual deliberation and can play a cognitive role by creating ‘institutionalized minds’ and ‘institutionalized personalities’ (Commons, 1934, p. 874).

Both Commons and Veblen invite us to scrutinize the mechanisms of change brought about by the individuals (the ‘upward causation’ that has an impact on the organization), and the changes within the organization (the ‘reconstitutive downward causation’ that affects the individual) (Hodgson, 2007, p. 108). Routines lie between these two levels of analysis because they are enacted by individuals in a social context, which regulates the relative level of autonomy (Becker et al., 2005; see also Giddens, 1984).

This interplay of the individual and collective dimensions is described in the literature in terms of entrepreneurs not always able to take the ‘best’ decision because of the amount of unreliable information. They may need to employ heuristics derived from other contexts in order to analyse the competitive structure of the environment (Porac and Thomas, 1990). The entrepreneur’s images are framed by collective actions within the local environment, which may ‘tie’ them, not because of the entrepreneur’s own cognitive limits, but because of the vast quantity of information available that may not be relevant to the decision involved. This may promote the adoption of mimetic behaviours to deal with the uncertainty in forming personal judgements (Greve, 1998). Mimetic local behaviour, in some circumstances, may avoid the necessity of weighing up all the possible actions (Kahneman, 2003), based on voluntary ignorance of some facts and data

and also on the willingness to reduce the level of learning and the information search costs (Kirzner, 1979). This localized learning – induced by various vicarious learning processes – occurs at the level of industry and also at the local level (Maskell and Malmberg, 2007). It can induce a deliberate unwillingness to absorb new knowledge in order to avoid redefinition of deeply entrenched procedural knowledge to match the current vision (see Chapter 7 by Lazaric in this volume, on the discussion and definition of declarative and procedural knowledge). This willingness to continue with ‘routine transactions’ and steer clear of creating new ‘strategic transactions’ is exemplified by the famous exploration/exploitation dilemma (Levinthal and March, 1993; Greve, 2007). The compromise required shows that exploitation not only increases the probability of repeating organizational routines, but simultaneously avoids exploration by reducing the resources available for research. Innovation may arise from an innovator modifying current thinking on the economic activity thanks to the emergence of less stereotyped images in some specific context (see Chapter 6 by Patalano, this volume).

Regularities are rooted in ‘cognitive automatisms’, which are generated by the stabilization of the ‘procedural knowledge’ that allows faster memorization in circumstances that appear to be similar (Bargh, 1997; Cohen and Bacdayan, 1994). These potential automatisms, which are rooted also in ‘declarative knowledge’, that is, the representational level, help human beings to identify predictable behaviour in dynamic environments and to integrate some plasticity into the solving of new problems not yet memorized (see Lazaric, 2008, for a longer discussion). Images are part of this system because they produce regularities inside the procedural knowledge as well as new insights in the declarative knowledge that are not always put into practice – that is, transformed by the mind into a purposeful cognitive act.

Mindful reflexivity (Langer and Moldoveanu, 2000) and motivation related to organizational change are necessary, but not always sufficient, to overcome these obstacles (Howard-Grenville, 2005). This implies that motivational factors within current practices should accord with the change introduced at the cognitive level. The perception and image of change are crucial and relate to both the declarative and procedural forms of knowledge, that is, to the representation of change and its effective implementation. In this perspective, changes to routines should not be seen as fateful coincidences related to external and disruptive factors, but as ingredients crucial for the revitalization of individuals and organizations.

This echoes recent research on organizations, about mindfulness, or attention to weak cues and learning from rare events (Rerup, 2005), and the place of mindful and less mindful attitudes as necessary for

organizations to evolve and survive. Indeed, ‘learning to be surprised’, that is, reflection in action in a context of high-reliability organizations, seems vital for their adaptation (Jordan, 2010). In this latter approach, sense making is important at the individual and collective levels and is not always opposed to organizational routines (Rerup and Feldman, 2011). Thus attention becomes critical and induces some reflexivity on routines. Mindfulness matters and materializes by the intention and capacity to absorb change – at both the motivational and cognitive levels (Huet and Lazaric, 2008; Lazaric et al., 2008). In the field of interest here, a mindful attitude can be defined as the capacity to go beyond routine transactions in order to change the procedural knowledge embedded in entrepreneurs’ minds and ways of doing things. A mindful attitude is the explorative behaviour that must be adopted to generate a strategic transaction, that is, a transaction that is not always known in advance and that may trigger unpredictable change inside the organization.

1.7 CONTENT OF THE VOLUME

Part I of this *Handbook* provides a historical perspective on how knowledge is dealt with in various economic traditions.

Chapter 2 by Ludovic Ragni re-evaluates Pareto’s contribution to economics and sociology in the light of the current literature on the role of knowledge and beliefs in economic relations. More precisely, Pareto’s action theory is described as pioneering work in the field now referred to as cognitive or behavioural economics, and focused on how people acquire and treat information, and elaborate beliefs or ways of thinking by interacting with each other. It is interesting that Pareto’s focus on human behaviour is the result of a methodological perspective that tries to integrate other disciplines such as psychology or sociology into economic analysis.

Brian Loasby’s contribution (Chapter 3) is devoted to Marshall’s view of knowledge and its centrality in his explanation of how economic systems work. Beyond the traditional reasons why Marshall focused on knowledge (observation of the remarkable industrial developments that occurred during his lifetime and that rested on the organization of the growth and application of knowledge, and his desire for improvements in the condition of the people), Loasby refers to Marshall’s ‘kind of intellectual crisis’ in discussing the sources and reliability of human knowledge. This crisis, which is documented by Tiziano Raffaelli (2003), led Marshall to develop his own model of an evolutionary, contingent and fallible process by which the human brain could develop classification systems

for interpreting phenomena and planning action. Like Hayek, Marshall emphasized the limitations to human cognition and the importance of organization in the coordination of economic activities.

In Chapter 4, Agnès Festré discusses the role of knowledge in the Austrian tradition. While it has become common now to refer to Hayek's pioneering work on the relation between economics and knowledge (see Section 1.1 above), other Austrian economists have not endured to the same extent, although their contributions to our understanding of how knowledge moulds behaviour and helps to coordinate economic activities are far from being negligible. It is especially interesting that the work of the founding father of the Austrian School, Carl Menger, paved the way to various attempts to deal with the role of knowledge in economic activities. This chapter contrasts Menger's conception of knowledge with that of his direct successor, Friedrich von Wieser, and shows that, although they had a shared interest in how institutions emerge in an environment characterized by individual heterogeneity, time and spatial constraints, they developed divergent perspectives of institutional dynamics.

Along similar lines, Véronique Dutraive argues in Chapter 5 that old American institutionalism, in particular Veblen and Commons, anticipated some of the trends of contemporary economic analysis in dealing with the interactions between knowledge, cognition and institutions (e.g. Denzau and North, 1994). Dutraive stresses that Veblen and Commons, building on American pragmatist philosophy, pioneered the focus on the importance of the interaction with institutions and mental processes for our understanding of the dynamics of economic phenomena in modern societies, and made early claims that economics must interact with other sciences – and particularly with the psychological sciences.

Roberta Patalano's contribution (Chapter 6) analyses more deeply how mental representations and knowledge interfere, by focusing on Kenneth Boulding's theory of action in *The Image* (Boulding, 1956), a work often neglected by economists, which is based on perception and imagination. Patalano makes a comparison with Hayek's theory of knowledge developed in *The Sensory Order* (1952), to show that both authors anticipated some modern developments in economics (cognitive economics, neuro-economics), and to emphasize the relevance of the neuro-psychological and psychic underpinnings of economic behaviour that emerged over half a century ago. While some of the ideas proposed by Boulding, and especially by Hayek, have been developed using modern instruments, others have been neglected and would be worth rediscovery. Roberta Patalano argues that the most significant one might be imagination, that is, the attitude of mind involved in framing situations and developing images of

what might happen in the future. She argues that this notion should be investigated in order to clarify its influence, in economic terms, on individual and collective behaviour.

In Chapter 7 Salvatore Rizzello and Anna Spada focus on the debates of the 1950s that opposed the defenders of rational choice theory and those interested in developing new tools, which constituted the ground for a psychology-based theory of decision. Rizzello and Spada argue that the problem of uncertainty in decision making is at the core of the debate on economic decision making, while knowledge is often regarded as implicit, that is, as a method of facing uncertainty, or is neglected. Here, Simon's work is illuminating because he regarded knowledge as connected to procedural rationality. Unlike those GET economists who focused on information and risk (see Section 1.1 above), Simon took up the challenge to address the problem of uncertainty and developed a theory of decision making grounded on the concept of 'pragmatic' rationality, which is built around human knowledge.

Part II of the book deals with the conceptions, role and use of knowledge in economics in general.

Chapter 8 by Giovanni Dosi provides an overview of the contribution of economic theory to the understanding of knowledge-based economies, observing that all economies that we know were profoundly knowledge-based as much as a century ago and are still so today. However, he also argues that there is a need to develop an adequate toolkit in order to identify what distinguishes the contemporary role of knowledge (in relation to basic economic mechanisms of demand formation, accumulation, employment generation etc.) from what Marshall and Schumpeter were observing a century earlier. Although recent developments in the economics of information and of innovation have brought important insights into the processes of generation and diffusion of knowledge, and their economic consequences, many streams of macroeconomic analysis are being very slow to adopt them.

Massimo Egidi's contribution (Chapter 9) discusses the many attempts to provide cognitive foundations to the limitations of (conscious) rationality. He points out that this trend has been hampered by Harrod's (1939) evolutionary justification of marginalist economic rationality, and Friedman's (1953) positivist methodology (his 'as if' hypothesis), which completely disregards the psychological aspects of decision making since, in this view, even low individual awareness is not supposed to be incompatible with full rationality. This 'cognitive gap' could be reduced, even in an evolutionary perspective, through the provision of cognitive foundations to a bounded-rationality approach to decision making. The solution offered along these lines is related to the question of consciousness

and, ultimately, to the distinction between tacit and explicit knowledge. This distinction may be cognitively grounded through reference to the distinction between *conscious* and effortful and *automatic* and effortless reasoning, as described by many cognitive psychologists such as Daniel Kahneman.

Chapter 10 by Pier Paolo Saviotti provides a characterization of the processes of knowledge generation and utilization, something that is missing from the economic literature despite the growing interest in knowledge for innovation and economic development in the so-called knowledge-based societies. This description uses a theoretical framework to represent, model and measure knowledge. It is based on two properties of knowledge: (a) as a co-relational structure, meaning that knowledge generally involves connections between variables making it possible to deduce the value of unknown variable from the value of known or linked variables; (b) as a retrieval/interpretative structure. This is not a complete representation of knowledge, but is intended to help interpret the collective processes of knowledge creation and utilization involving different types of organizations (firms, public research institutes, universities etc.) and taking place in knowledge-based economies.

Chapter 11 by Jacques Durieu and Philippe Solal provides an overview of the literature on learning in evolutionary game theory. The hypotheses commonly related to game-theory models are bounded rationality justified by lack of information about the game structure (payoff functions or the rationality of other players), and a stationary environment in order to simplify the decision task. The authors distinguish between two kinds of models depending on hypotheses concerning the behaviour of the other players: one family of models assumes that agents do not elaborate their beliefs about their opponents' behaviour; the other considers that agents form (naive) expectations about their opponents' future play. For each category of adaptive learning models, the authors show that repetition of physical interaction among agents can overcome the problems of lack of strategic information and the limitations of rationality, suggesting that knowledge acquisition is embedded in inter-individual interactions.

Chapter 12 by Dominique Foray deals with experiential knowledge defined as a kind of knowledge that springs from the experience of individuals and organizations, which is local and specific, sound, rational and effective, although it does not have the status of scientific knowledge. Knowing how wind flows vary can help to avoid forest fires is an instance of experiential knowledge. The properties of experienced knowledge (it is local, disturbing and disruptive) lead to specific problems (deterioration, disinvention and deactivation) that can jeopardize the community, in

particular when experienced knowledge is collective (to be distinguished from private experienced knowledge, like a trade secret).

Bengt-Åke Lundvall (Chapter 13) provides a critical assessment of the policy maker's concept of knowledge base, and proposes the idea of numerous separate knowledge pools that constitute 'community resources' that are not easily transformed into private property. This concept of knowledge pools could inspire innovation policy in both the more and less developed parts of the world. For example, in developing countries there is a need to build absorptive capacity in order to access the knowledge pools in the richer parts of the world, and an accompanying general need to reconsider the rules of the game related to intellectual property rights. In the rich countries, finding ways to connect specific separate pools of knowledge could be seen as key to stimulating radical innovation by exploiting knowledge diversity.

André Orléan's contribution (Chapter 14) is a tribute to Keynes's outstanding work on collective knowledge or beliefs and their criticality for economic decision making in conditions of uncertainty. This approach is at odds with economic and financial theory that relies on objective values (e.g. the fundamental value of securities) and deriving efficiency theorems (e.g. the informational efficiency hypothesis of Fama), and takes it for granted that those objective values exist. This oversimplification explains why many financial models cannot provide satisfactory explanations for phenomena such as financial bubbles. It is also not consistent with the idea that (financial) markets improve or even transform the functioning of the economy. Orléan advocates for a conventionalist approach to finance, which differs from the standard approach that considers the knowledge that agents are capable of producing in relation to the future development of the economy. Rather than considering finance as an *a priori* fact resulting from an objectively defined future, we should conceive it as the contingent product of opinion-based reasoning.

Part III extends the contributions in Part II, focusing more closely on the role of knowledge in organizations.

Bart Nooteboom's contribution (Chapter 15) is centred on the debate over the notion of 'embodied cognition' (cf. Section 1.3 above). The notion of embodied cognition refers to Polanyi's concept of 'personal knowledge' defined as knowledge rooted in an agent's body that is physically positioned and interacting with the world. Consequently, the embodiment of cognition entails a continuum rather than a Cartesian duality between rational evaluation, feelings and underlying physiological processes in the body. This perspective has far-reaching implications for economics and management, and enables improved understanding of the 'knowledge

economy' and the 'network economy'. Clearly, if knowledge arises from interaction with others, in a 'knowledge economy' interaction between firms in networks becomes crucial.

In Chapter 16, Ulrich Witt, Tom Broekel and Thomas Brenner offer a conceptual clarification of the economic properties of knowledge. They evaluate the many distinctions that economists have used to describe the characteristics of knowledge, starting from Polanyi's distinction between implicit and explicit knowledge, through the difference between encoded and non-encoded knowledge, to the different categorizations of knowledge as a public good, a locally public good or a private good. In accordance with evolutionary approaches, the authors show that the characteristics of knowledge should not be viewed as intrinsic since they depend strongly on the state of the knowledge technology, that is, on how knowledge can be acquired, stored, used and communicated.

Paul Nightingale focuses in Chapter 17 on the notion of tacit knowledge, discussing its topicality and relevance, mentioning the many findings in the neurosciences that support it, exemplified by experiences led by Damasio (1994) on 'somatic markers' and Edelman (1992) on learning. Nightingale argues, in line with Polanyi's reasoning, that the concept of tacit knowledge should be used to move explanations outwards from agents, and to become a foundation for understanding the more complex causal processes at work, rather than a variable that explains everything. He concludes that tacit knowledge is a useful concept when used properly, but its flexibility means that it can be used to explain 'anything' or to justify any policy position.

In Chapter 18 Ash Amin and Patrick Cohendet discuss knowledge shared by communities of practice (Brown and Duguid, 1991), defined as a group of people bound together by informal links engaged in a common practice. The community framework provides the context within which collective beliefs and reference systems that structure individual choice are built. This supports the conception of knowledge creation anchored in *collective* action, and its consideration permits a better understanding of the learning processes at work at intermediate levels in the firm's organizational structure. This has strong implications for knowledge management. For instance, it could mean that firms should devote great attention and energy in order to benefit from the 'spontaneous or intentional emergence of the cognitive platforms' that are vital for innovation and creativity inside the firm.

Mie Augier and Thorbjørn Knudsen (Chapter 19) take up the challenge of modelling knowledge organization by introducing a new, unifying way of thinking about the organization of knowledge. The organization of knowledge is conceived as an architecture whose design

requires consideration of the cognitive skills of potential employees, the distribution of alternatives available in the business environment, and the costs associated with alternative modes of employment. Like Simon and March, Augier and Knudsen view organizations as helping economic agents to take decisions by constraining the set of alternatives. In a context of low communication costs and increased connectivity of various media, phenomena commonly associated with the knowledge economy, an investigation of what kind of architecture is the most appropriate to help boundedly rational agents to make better choices and avoid costly, irreversible decisions is a crucial theoretical and empirical issue.

Chapter 20 by Markus Becker offers an in-depth investigation of the implications of distributed knowledge for organizations, distinguishing between different types of architectures, that is, different ways of linking people depending on the degree of specialization and the degree of overlap in the knowledge held by agents. A serious difficulty arises in the attempt to disentangle the effects due to the relation between the dispersion of knowledge and the division of labour from the whole set of non-ambiguous effects of the dispersion of knowledge on organizations. Although the dispersion of knowledge has been acknowledged by many economists (in particular Smith and Hayek) as a fundamental theoretical issue, and has given rise to many applications in management (e.g. Taylorism), the problem of its coordination (including its coordination in time) is deserving of more attention.

The *Handbook* concludes with a chapter by Nathalie Lazaric that explores what drives change in knowledge. Lazaric draws on Anderson's (1983) distinction between declarative and procedural memory, and recent findings in the cognitive sciences. She tries to disentangle the cognitive mechanisms by which declarative memory, that is, a form of memory that is focused mainly on the recollection of facts or events, can be converted into procedural memory, that is, a form of memory that concerns how things are done or the knowledge that is put to use. Both kinds of memory are subject to change and are intertwined, corroborated by the work of Shiffrin and Schneider (1977) and Kahneman (2003) on the relation between automatic and deliberately controlled forms of cognitive processes. Lazaric draws an analogy between the individual and the organizational levels. Although individual and organizational forms of memorization are distinct, their theorization involves similar difficulties: how are representations made to change? How can a repertoire of knowledge that is used daily be changed and improved? And how can new knowledge be created?

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