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WORKING PAPER SERIES

Herbert Simon's Heritage

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Working paper No. 07/2002



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Abstract

One year after Herbert Simon's death, this paper tries to highlight the most relevant elements for economists in his scientific heritage.

JEL Classification: B31

Keywords: rationality, cognitive economics, path-dependence.

Introduction

They say that in October 1978 economists worldwide were surprised at the news that the Royal Swedish Academy was awarding the Nobel Prize for Economics to Herbert A. Simon. At the time, Herbert Simon was a Professor of Psychology and Artificial Sciences at Carnegie Mellon University, and many economists could not figure out the relevance of "a psychologist's contribution" to Economics. The motivation for the prize "*for his pioneering research into the decision-making process within economic organizations*" did not help them understand, since for most economists the two key-expressions "decision making" and "economic organizations" were

not “critical” aspects of economic theory, and there was little to research into it. This community of economists worldwide, which represents what is usually defined mainstream economics, has always been aware of the relevance of decision making processes in economic events and of the importance of organizations’ (i.e. business firms) role. Nevertheless, the explanations that economic theory gave them (economic agents are omniscient and rational decision makers; their aim is maximizing utility; organizations such as firms are mere functions of production turning inputs into outputs with the aim of maximizing their profits) had made them think that the research into these aspects was the subject of other disciplines, such as psychology or the science of organization. According to most economists Simon should have been awarded the Nobel Prize in other disciplines.

Few of them realized immediately that Simon’s studies would have a revolutionary impact on Economics.

Today, one year after Herbert Simon died in Pittsburg on February 9, 2001, at the age of 84, we can undoubtedly say that Simon helped innovating economics like no other scholar in the century which has just come to an end.

Readers will not find in this paper the celebration of Simon’s biography and works¹, in fact we will try to assess the significance of his intellectual heritage, with a view to the indented coastline of present economic theory.

Precarious Equilibrium

The foundations – you might want to call it the original sin – of economics are to be found in an attempt to discover simple, universal and self-evident laws that might support the general

¹ For a concise biography of Simon see Rizzello 2001. The most extended and accurate account of Simon's life can be found in Simon 1991.

equilibrium theory and become the reference point for every methodological aspect of this discipline.

The equilibrium theory was a distinguishing feature of the history of economics all through the XX century. Several major economists gave their contribution to its development and made it the reference model for the interpretation and explanation of economic phenomena.

Yet – Einstein reminds us - in research and science we ought to make things as simple as possible, still, they should never become simpler than possible. This is the reason why the attempt to discover simple and self-evident laws and to make them the foundation of economic theory is considered by some scholars as the original sin rather than as a virtuous incipit. The equilibrium theory as a whole is to them a hindrance to the development of a science studying complex phenomena. Herbert Simon tried to understand the difference between what happens when a system is in equilibrium and when it is not, with specific reference to economic phenomena. Whereas everything is quite simple in the first case, things become much more complicated in the second.

Simon dedicated his life-long research to disequilibrium systems

What is the origin of the complexity of economic events? The answer is surprisingly simple: history. Economic events are the results of human decisions and actions, taking place in historical time. These actions can never be foreseen completely, and their outcome is often unexpected. On the contrary, the laws of economics – as well as the laws of physics – are simple because they refer to logical time. Probably Simon thought these laws were “too” simple - simpler than possible, to express it with Einstein’s words - i.e. simpler than any possible real application.

In fact, economists’ subject-matter is a world full of flaws, limits and adjustments, both at a micro level (the agents) and at a social level (dynamics among organizations; institutions’ origin, nature and role). Simon worked out new methods and new analytical tools to explore this world, and he also contributed to develop new disciplines, such as cybernetics, artificial intelligence and cognitive sciences. He never stopped crossing those artificial borders which had been traced in an attempt to define different disciplines, and this makes him a pioneer of the interdisciplinary approach to

science². On the basis of the already existing foundations and using his new tools and methods, he reviewed many critical aspects of the economic theory. He thus opened those new scenarios which for the last two decades have been taking concrete forms in new branches, such as the decision making theory, the theory of the firm, neo-institutionalism, experimental economics, path-dependence and cognitive economics.

An increasing number of scholars are today carrying out research into these new branches, which were founded after the equilibrium theory was no longer considered a unifying theory. These scholars try to interpret economic phenomena as complex events.

Simon can probably be considered the major founder of this new approach. His merit (along with very few other scholars) was highlighting the lack of equilibrium in the equilibrium theory.

Mental Games and Irrational Subjects

Decision making is certainly the unifying idea in Simon's polyhedral thought. Talking with one of his students, Simon once defined himself a monomaniac of decision making. He explored nearly every field of application of the decision making theory, from economics to psychology and artificial intelligence, with reference to individual decision makers as well as to organizations.

The starting point of Simon' view on decision making is the awareness of the limits of the decision making theory that economics had been using up to that moment. After the development of the subjective expected utility theory and the application of the game theory to economic processes, he began wondering whether these tools might really apply to the analysis of decision making processes.

² The opportunity to perform pioneering research in many fields was offered to him by Carnegie Mellon University, where he accepted to move since the '50s and where he founded a high number of laboratories, departments and highly innovative research centers.

In his criticism of the subjective expected utility, he pointed out that it could explain neither framing phenomena and set goals, nor the development of new alternatives by individuals. Several lines of empirical research, which have been carried out since the second half of 1950s with the support of cognitive psychology, have pointed out the fact that decision making is a complex process and that the subjects involved show computational and cognitive limits, i.e. those limits of human rationality, which were not duly taken into account by the subjective expected utility theory.

As a result, Simon developed the concept of Bounded Rationality and applied it to the decision making theory³. He demonstrated that the above mentioned limits arise from world's complexity and from agents' incomplete and inadequate knowledge, which account for the inconsistency of individual preferences. In the same time, he started a research program aimed at developing new decision making models, which might apply to economics, artificial intelligence and psychology.

Great progress was made in experimental economics thanks to his research. The first timid contributions to this line of research had already appeared in the 1930s (see Novarese – Rizzello 1999), and in 1953 Allais's paradox (the demonstration of the most famous violations of the theory of expected utility) had marked a great step forward. In the 1970s, Kahneman and Tversky drew on Allais's work and developed it, demonstrating that in a situation of strategic uncertainty individuals make systematic mistakes in making their decisions. The conclusions of their work confute the principle of rational behavior and the theory of expected utility; to explain this result it is necessary to refer to Simon's idea of human mind's computational and cognitive limits. Kahneman and

³ He introduced bounded rationality for the first time in the first part of Chapter 5 of *Administrative Behaviour* (Simon 1947), and then he extended this concept with further explanations in several later economic works. Among the most important works, see Simon 1955; Simon 1957, Chapter 4; March-Simon 1958; Simon 1969, Simon 1976 and 1983. In Simon 1971, the author refers in particular to computational and time limits of the internal environment, i.e. human mind, conceived as a scarce resource in a world full of information. In Simon 1972, he refers to the implications, in economics, of the acknowledgement of the intrinsic limits of rationality (risk theory, uncertainty, etc.). Finally, in Simon 1979, also the uncertainty concerning exogenous elements is taken into account among the limiting elements.

Tversky repeatedly acknowledged that their contributions were made possible by Simon's work on economic agents' rationality in decision making processes.

On the basis of Allais's works and, above all, of Simon's contributions, Kahneman and Tversky (1979) carried out a series of experiments and developed the Prospect Theory. Such theory is coherent with the most recent interdisciplinary views, introducing the biological and emotional dimensions into decision making⁴. Prospect theory postulates that decision weights tend to overweight small probabilities and underweight moderate and high probabilities. In the prospect theory the function of expected utility is replaced by a function of value. The results are weighed with decisional weights which are a function of probabilities, but are not probabilities themselves. The choices' outcomes are assessed with reference to the status quo rather than in absolute terms.

Kahneman's and Tversky's experiments represent a fundamental step for experimental economics. Simon's ideas influenced also a line of research which has been developing above all during the last decade: the research into path-dependent and differentiated learning processes. The starting point of these studies is the subjectivist hypothesis that individual mental and neurobiological idiosyncrasies affect decision making processes. Such idiosyncrasies, along with all previously developed mental schemes, are at the origin of differentiated learning paths⁵. As already stated elsewhere, these

⁴ By extending some aspects of Prospect Theory and in the light of some important contributions of contemporary neurobiology, it is possible, in fact, to incorporate feelings in decision making processes. Rizzello 1999, especially ch.IX, and Elster 1998, for example, propose to include Damasio's theory of somatic markers in decision making. Somatic markers are created by secondary emotions and have been connected through learning to foreseen future outcomes of some settings. They are impulses which lead reasoning in the form of feelings or unconscious tendency (Damasio 1995, 245; see also Johnson- Laird and Oatley 1992). Damasio is a contemporary neurologist and author of *Descartes' Error* (Damasio 1995), a book that draws an intimate connection between emotion and cognition in practical decision making. These ideas have been confirmed also by Barnes and Thagard (see Barnes and Thagard 1996 and 1997).

⁵ These hypotheses derive from Hayek's model of mind (Hayek 1952). See also footnote 7.

concepts pave the way for interesting studies concerning the repeated game theory (Rizzello 2000)⁶.

We might draw a parallel between limited and procedural rationality on the one hand, and experiments on expected utility and differentiated learning processes on the other.

Bounded rationality can be considered the destruens dimension of Simon's contributions to neoclassical theory, while procedural rationality is the attempt to develop alternative models. Similarly, the line of research started by Allais and continued by Kahneman and Tversky represents

⁶ As is well known, the most probable result of non-cooperative games is a Nash equilibrium. However, Axelrod (1984) held that, in the case of repeated games, it is possible to reach a Pareto equilibrium, thanks to the learning processes of the individuals involved in the game.

Which criteria lie at the basis of the strategic behavior assumed by the theory of games? There are many problematic issues to be discussed, and Rapoport (1962) has already pointed them out many years ago. The weakest point in the theory lies in the assumption that every individual should possess a payoff function, which presupposes a scale of values that can be given to the events. This assumption is once again inconsistent with the realistic idea of the limited cognitive skills of human mind. Furthermore, in the case of repeated games, the expectations of someone's behavior arise from individual learning processes, which bring out categories such as trust, non-belligerency, etc. The rational behavior assumed in the theory of games meets the same criticism that has been directed to the theory of expected utility, with the important addition that in repeated game learning matters in such a relevant way, that it leads to Pareto-efficient results.

Game theory assumes that agents are characterized by homogeneous learning criteria. But if we pay attention to what comes out of the recent neurobiological studies - learning processes differ (neurobiologically) from an individual to another - it becomes harder to maintain the validity of the outcome of repeated games. In fact, in these games the agent A creates his expectations of the behavior of agent B according to his own perception and learning criteria, and vice versa. But if perception and learning are strongly influenced by subjective criteria, the uncertainty about the behavior of others increases. Learning is linked to individual "cognitions" of the surrounding environment and to how these cognitions determine behaviour. The fact that perceptions are differentiated, subjective, and idiosyncratic confirms the assumption of non-homogeneous learning processes. If learning processes are heterogeneous for these reasons, then we cannot be sure about the possibility to predetermine the outcome of repeated games.

the criticism to the mainstream major decision making model, while the studies on differentiated learning processes and on coordination processes is an attempt to develop alternative proposals (Cohen and Bacdayan 1994, Egidi and Narduzzo 1996).

Today experimental economics is quite a composite branch. Nevertheless we can single out its main issue: the process through which individuals try to mentally represent a problem not knowing its objective structure, only on the basis of their own representation. This is certainly true for that important part of experimental economics accepting the cognitive approach. In this context the studies on learning processes, framing and feedback are crucial, since in cognitive terms learning is connected with individual “cognitions” of the surrounding environment (perception, interpretations, etc.) and with the way how such cognitions determine behavior. Simon dealt with these issues as early as the late 1950s (Simon – Newell, 1972); a few laboratories of experimental economics have further developed them for the last few years, drawing on both Simon’s contributions and on the studies on the application of neurobiological processes to economic theory, which were carried out for the first time by Hayek (1952)⁷.

⁷ Hayek focused his attention on the process of perception of external stimuli on the part of agents, and he found out that such process is subjective and idiosyncratic.

To summarize, this is how this mechanism works (please, take into account all the limits due to the necessity of summarizing). The subject perceives external stimuli by means of a process, whose first result is attributing a meaning to those stimuli. They are classified by means of mental schemes, whose (genetic or social) nature is innate; yet they keep changing through experience. Our brain’s cytoarchitectonics or neural map, keeps changing its synaptic structure, and this is due to the above mentioned schemes, which either consolidate or change, according to the acquired experience.

Actions are thus the result of a rather complex process, starting from perception and subjective interpretation of external stimuli: it then continues by means of a process of endogenous development of the consciousness, essentially based on the interaction between mental schemes and experience, and it is completed by a feedback process, consisting in the application of knowledge to the environment (action). Actually, a feedback process is present in all the processes we listed, but in the first two phases it is essentially tacit and unconscious, while in the last one it might have a conscious

Contemporary economics must cope with another crucial issue connected with decision making and consequently with the analysis of individual learning processes: the coordination problem. If we refute the neoclassical hypothesis of individuals' optimizing behavior leading – with no friction - to a Pareto result, we need to understand the coordination mechanism: i.e. how coordination is reached by individuals who make systematic errors in decision making processes, whose outcome mostly depends on the subjective relation between the subject and his perception of the environment.

Simon's answer is quite complex. As regards organizations the problem is analyzed with reference to organizational learning, i.e. hierarchical organizations' capacity to develop routines on the basis of heuristics. This issue has been dealt with above all by evolutionary economics; Nelson and Winter – the major representatives of this line of research - have explicitly acknowledged that they have drawn on Simon's studies. Evolutionary economics is a key branch of contemporary economics, because it explains both exogenous and endogenous technological and organizational change. Yet, this line of research does not exhaust the coordination problem, since, along with its organizational nature, it has also an institutional dimension. This aspect will be briefly dealt with below. Here we want to highlight that this issue is studied also by experimental economics⁸, and that it is once more directly linked to Simon's thought. If we abandon the optimizing perspective, we may as well dispute the assumption of economic agents' self-interested behavior, and assume that there might be a tendency towards cooperation. When you analyze, at an experimental level, individual behavior in conditions of structural uncertainty and bounded information, a tendency towards cooperation and unselfish behavior emerges as an extremely interesting hypothesis of experimental analysis: individual behavior might be characterized first of all by epidemiologic mechanisms, i.e. imperfect imitation and moral self-assessment in a dimension of social cognitive

dimension. This is – in brief – the process we carry out when we perform an action (this is confirmed by contemporary neurobiology).

⁸ See Novarese - Rizzello 1999 and 2002

learning. This hypothesis is suggested by the social cognitive theory elaborated by Albert Bandura (1977), who describes mind as an active device that builds up its reality (we could say the agent's knowledge) by selectively collecting information. Cognitive activity develops on two complementary mechanisms of learning. The first way of learning is rooted in the perception of external stimuli which are spontaneously interpreted and classified by the mind, according to previously existing innate mental structures and acquired interpretation of similar stimuli. The second mechanism of learning is rooted in the social dimension of reinforcement learning, which Bandura defines as vicarious learning. It leads to a standardization of human behavior, thus favoring the reinforcement of social and institutional rules. At the end of this brief description, the further evolution of experimental economics in the wake of Simon's contributions might be divided into three promising complementary directions:

- i) studies on individual and organizational learning processes;
- ii) the relevance of emotional processes in decision making;
- iii) the explanation of social coordination processes.

Simon is certainly a path-finder in this field, but – as Simon himself acknowledged⁹ – his ideas have been further developed thanks to the convergence of different disciplines. As regards differentiated processes and their relevance for institutional and economic processes, the reference point is Hayek, and specifically his works on neurobiology, information and the emergence of rules. As regards the relevance of emotional processes in decision making, the reference point can be found in a few lines of research of contemporary neurobiology and in particular in Antonio Damasio's works, while for social coordination we refer once more to Hayek and to Albert Bandura's social cognitive theory and social learning¹⁰.

⁹ Herbert Simon acknowledged this view in a recent private correspondence with the author of this paper.

¹⁰ On the relevance of social cognitive theory for neo-institutional economics see Witt 2000 and Rizzello - Turvani 2002.

A Path Finder

As the neoclassical theory is no longer considered a unitary paradigm for economics, several problems remain unsolved. One of them is explaining the outcome of a decision making process, both at a microeconomic and at a macroeconomic level. Among the many different approaches that have been proposed by different schools in the last decades, mainstream economists have always shown a preference for the equilibrium theory, since it is coherent with the optimizing approach. If we abandon this perspective in favor of alternative explanations, which are coherent with the hypotheses of bounded and procedural rationality, structural and strategic uncertainty, and satisficing processes, we need to find a new analytical mechanism replacing the elegant neoclassical models.

This problem is still unsolved, though it is possible to foresee successful advances. In any case, our first remark is that this issue is no longer as crucial as it used to be for orthodox economics. It is well known that in the general equilibrium theory - keystone of mainstream economics - the economic system has a static dimension, and that partial equilibriums – despite the wealth of their theoretical content – represent a tendency of the system towards general equilibrium. Defining the many possible different equilibrium levels is the key problem in a theory which assumes a static system.

On the contrary, the multifarious heterodox approaches – in spite of the different perspectives – share the view that economic facts are essentially dynamic. This means that the “process” is more relevant than the outcome.

Nevertheless, the problem exists and it must be dealt with at a theoretical level. Though it is no longer considered as a crucial issue (as it was in the mainstream approach), the definition of the outcome – regardless of whether it is temporary, partial and unstable – of a dynamic process is the most important challenge for heterodox economists today.

Let us have a look at Simon’s view, state of art, and future perspectives.

According to Simon, decision making processes – with reference to individuals, teams and organizations - are carried out through the development of heuristics and routines, and through the assessment of the outcome on the basis of aspiration levels, which depend on the individual capacity to mentally represent the environment and on the previously acquired experience. A satisfying outcome – which also means a satisfying feedback with the environment – will reinforce the decision making processes carried out; an unsatisfying outcome, on the contrary, will let the searching process open and might bring about a change in the aspiration level¹¹.

Which decision-making path will individuals choose among those at their disposal? This is a crucial question. If we answer that the choice is casual, we will have to explain how a situation of social order may arise from casual behavior.

A few economists proposed an interesting answer which is consistent with Simon's thought. They think that these decision making processes are path-dependent. They all share the general idea that it is impossible to explain the state of the world without taking into account the process through which such state is reached. By extending that idea to neurobiological processes, they reach the conclusion that decision making processes and their outcomes are deeply dependent on subjects' psycho-neurobiological characteristics and on their previously acquired experience. These two mechanisms are present in the processes of perception and representation of problems, as well as in the processes of assessment of the outcome obtained. Moreover, previous choices that have proved satisfying reinforce known paths, both in neurobiological terms (capacity to identify external stimuli and to choose a specific interpretation among the many possible meanings) and in terms of experience.

Those who are familiar with the literature on path-dependence certainly know that this line of research belongs to the domain of economics of innovation (David 1985, Arthur 1988), and that Simon has never dealt with it directly. Nevertheless, this analytical category has been recently

¹¹ For more details see Rizzello 1999, Chapter 5.

extended also to individual (Rizzello 1997) and to institutional (North 1990, Denzau – North, 1994; Rizzello – Turvani 2000 and 2002) decision making processes.

In the “classical” literature on path-dependence processes might result in lock-in situations, which were sometimes defined also suboptimal multiple equilibriums. An example is Arthur (1989), who demonstrates that competition among technologies can be considered as a self-enforcing and reinforcing mechanism, which may end up in a lock-in situation in which no element can prove that an optimal equilibrium has been reached.

Though the research into path-dependence has been further developing for the last few years, one question is still unsolved: the explanation of how the system can find a way out of a lock-in situation. If we extend path-dependent analyses to individual and institutional levels we may probably succeed in explaining the path dependent dynamics leading to a lock-in situation and also the way how either a decision maker or a system may find the way out from that situation and start a new path (Egidi 2000)

We are here referring to pioneering literature and to studies which are still in progress rather than to consolidate results. In fact, the aim of this paper is also trying to understand the relevance of Simon’s contribution to possible future scenarios in contemporary research.

Simon proposed a path-dependent interpretation of the processes of environmental representation, of individual framing, and of the nature of aspiration levels. In Simon’s opinion the procedures developed by decision makers deeply depend on their capacity to mentally represent the problematic situation and the possible solutions. They both depend on mental structures, whose shape is affected by the individual idiosyncratic experience, i.e. they are mental paths depending on the subjects’ psycho-neurobiological conformation and on their experience. The outcome of a satisfying or unsatisfying decision making process depends in turn on the levels of aspiration. The latter are the result – once again – of an endogenous process of the subject: if the levels of aspiration are easily satisfied they will rise, and vice versa.

The explicit extension of path-dependent analyses to individuals' cognitive dimension makes it possible to understand which path individuals choose among the many possible, and also why decision makers can be caught in cognitive traps (Egidi, 2000). As demonstrated in several experiments (see, for instance Egidi – Narduzzo, 1996; Cohen and Bacdayan, 1991), individuals tend to fix upon a mental representation even when it is far from being perfect, since they otherwise need to apply so much energy to re-represent a problem.

Recent works (Egidi 2000, Marengo 2000) have demonstrated that, during decision making processes in jigsaw puzzles, individuals tend to converge towards steady results rather than towards lock-in situations. Therefore there is a chance to define a new dynamic model, which might explain in detail the changing processes and the way how steady rather than rigid paths are chosen.

Finally, the fact that human mind's perception of external stimuli reinforces the interpreting categories suggests a new direction for our research: path-dependent mechanisms may work also as a mechanism of resistance to change, rather than as a simple influence of the previous path on the development of organisms. This idea was expressed by Laughlin, who underlines that the main characteristic of our brain is its capacity to evolve in a self-regulated way, including a degree of elasticity that allows it to explore and interpret its world actively; it "imposes its relatively conservative order upon the experience it constructs" (1996, p.365)

Reason in Institutions

In the last two decades neo-institutionalism has put forward the question of the relevance of institutional aspects in the comprehension of economic processes. Oliver Williamson, one of the major representatives of this school, has repeatedly acknowledged that he felt a debt of gratitude towards Simon for his bounded rationality theory. What has been said underlines the importance of Simon's thought for this line of research, and we might mention several other instances of Simon's

influence on neo-institutionalism. Yet what we want to point out now is the possible future development in this theoretical ambit. Once again, the cognitive approach is full of interesting potentialities. Among the unsolved problems of institutional economics we may list its limited understanding of: individual behavior in institutional settings; the emergence and spread of innovative behavior; the way how individual behavior influences the creation of norms and vice versa.

Since the beginning of the 1990s (North 1990) - and particularly for the last few years - the neo-institutionalist analysis of institutions' role, nature and evolution has been taking into due consideration the connection between mind structure and origin of behavioral norms.

In as few words as possible and with reference to this approach we can state that social behavioral norms emerge spontaneously as a consequence of the need to standardize and simplify the ambit in which individuals use their (limited) mental capacities in decision making processes.

This idea was anticipated by Hayek (1942) and well summarized by North: "the relationship between mental models and institutions is an intimate one. Mental models are the internal representations that individual cognitive systems create to interpret the environment; institutions are the external (to the mind) mechanisms individuals create to structure and order the environment" (North, 1994: 348).

The approach suggested by North (and partly also by Williamson) is based on the findings in cognitive science (Herbert Simon and his approach). However, there are other approaches, such as connectionism, whose analytical focus is the interaction process between the micro (cerebral) level and the macro (socio-institutional) level.

This mechanism is quite complex¹². What we want to underline here is that if we apply the path-dependent and cognitive approach, based on Simon's thought, together with Hayek's view on the nature of behavioral norms, we obtain a formidable analytical key, allowing us to understand institutions' role in the explanation of economic facts. From this perspective every institutional

dynamic process eventually rests on individuals' perceptive capacities and on intrinsically creative and spontaneous mechanisms, as well as on the tendency to share common social cognitive paths, guaranteeing a certain level of standardization

Concluding remarks

One year after Herbert Simon's death this paper has looked for the most relevant elements for economists in his heritage. We pointed out that this heritage regards three fields: experimental economics, and in particular the research into coordination and learning processes; path dependence theory and the explanation of individual and collective learning processes in dynamic terms; institutional economics.

Simon focused his attention on the mental phenomena that are considered crucial in the comprehension of human behavior and social dynamics, and for this reason he can be considered the father of the discipline we call today cognitive economics, i.e. an interdisciplinary approach to the study of human problem solving, choice, decision making and change, to explain economic transactions, the nature and evolution of organizations and the nature and evolution of institutions, in a context characterized by structural uncertainty, scarcity and incentives (Egidi and Rizzello 2002).

Profiting from his studies, today's economists can take up the challenge of further applying the experimental method to economic science, so as to make theory closer to economic reality. And to improve the methodology of the application of the experimental method to economics. Secondly, Simon helps us go back to a dimension which is typical of social sciences, for which history matters. As regards this aspect, Simon - along with other scholars - developed useful instruments for the analysis of path-dependent dynamic processes, especially with reference to the connection

¹² For a deeper analysis see North 1994, Rizzello - Turvani 2000, Fiori 2002.

between mental, organizational and institutional levels, which may be used to understand the outcome of dynamic processes more effectively. Finally, while suggesting that we should take into account the institutional dimension if we want to understand economic phenomena, Simon once again reminds us that mental processes are the analytical foundations of institutional dynamics. Studying the mind is then a necessary part of a unified analysis of economic processes.

Simon's contribution to social sciences is certainly more relevant than what we could describe in this brief paper, ranging from psychology to artificial intelligence, from economics to the science of administration. His heritage is undoubtedly a difficult one, since only those researchers who can actually carry out polyhedral analyses will be able to exploit it. Simon's death will leave an unfillable void, unless contemporary economic theory is ready to meet and share views with other disciplines and to accept criticism. In fact, if economics proves unpretentious and ready for dialogue and confrontation and can meet the need for growing correspondence between theory and reality, it will be able to develop along the way a great and revolutionary genius paved for us. It consists in the exploration of the characteristics and potentialities of human mind, as a necessary step towards the interpretation of human phenomena in interdisciplinary terms. This has been cognitive sciences' challenge for many years now, and Herbert Simon has been one of its most famous supporters. This looks quite a difficult way to go, yet it represents the future of social sciences and economics cannot but cover it thoroughly.

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Paper presented at the INEM–ASSA Session "Austrian Economics and Game Theory". Boston. January 8, 2000.