ISSN 2392-1641
e-ISSN 2450-0097

Economics and Business Review

Volume 7 (21) Number 3 2021

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Poznań University of Economics and Business Press

Paper based publication

ISSN 2392-1641
e-ISSN 2450-0097

POZNAŃ UNIVERSITY OF ECONOMICS AND BUSINESS PRESS
ul. Powstańców Wielkopolskich 16, 61-895 Poznań, Poland
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www.wydawnictwo.ue.poznan.pl, e-mail: wydawnictwo@ue.poznan.pl
postal address: al. Niepodległości 10, 61-875 Poznań, Poland

Printed and bound in Poland by:
Poznań University of Economics and Business Print Shop

Circulation: 215 copies

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Editorial introduction

The coronavirus pandemic has blatantly reminded us that fluctuations are the unavoidable element of economic processes. This calls for even more intensified research into their nature and countermeasures. At the same time a critical reflection on economics' theoretical foundations is much needed. The current issue of *Economics and Business Review* addresses these demands by presenting the results of studies conducted by eight scholars from five countries: Hungary, India, Japan, Poland and Turkey. The authors harnessed both theoretical and empirical approaches to explore their areas of interest. It is hoped that the contributions will assist and inspire scholars for further research as well as provide policymakers with useful guidance.

The opening article **Economic fluctuations in a model with an overlapping structure of employment** by Toyoki Matsue employs a dynamic general equilibrium model to analyse the impact of a positive productivity shock on a labour market. The critical and original assumption is that based on an explicit employment period. In such circumstances it is found that a positive productivity shock induces not only positive but also negative changes in new hiring and employment. These oscillations stem from an overlapping structure of employment. The author investigates further the sensitivity of labour market fluctuations to the period of employment.

The next paper prompts a critical reflection on the current stance of an economic paradigm and its likely future changes. Jan Polowczyk in his paper **A synthesis of evolutionary and behavioural economics** endorses a view that these two economic concepts will merge over time in line with the mechanism of evolutionary cooperation processes. He argues that this synthesis has its roots in the works of the founder of economic science—Adam Smith. Furthermore the author stresses that the incorporation of the achievements of other sciences (especially psychology and neuroscience) may enrich our understanding of economic processes and serve as a nexus between evolutionary and behavioural economics.

Financial sustainability is gaining more and more attention due to the increasing complexity of financial systems. Shivam Kakati and Arup Roy in their paper entitled **Financial sustainability: An annotated bibliography** aim to fill the research gap by preparing a broad overview of this emerging strand of literature. The study depicts the sectorial, methodological and geographical dimensions of the existing literature. The key prerequisites of financial sustainability are also identified.

The following article by Peter Galbács **What did it take for Lucas to set up 'useful' analogue systems in monetary business cycle theory?** enriches the literature on the history of modern economic thought by systematizing one of Lucas's key concepts. The author identifies and discusses assumptions which must be met so that an analogue system can be considered as 'useful' in Lucas's view. This concept is presented in opposition to Keynesian macroeconometric models. The considerations are backed by some excerpts from unpublished works which may be also useful for scholars exploring the intellectual heritage of Robert Lucas.

In the paper entitled **Distortionary effects of economic crises on policy coordination in Turkey: Threshold GMM approach** Metin Tetik and Mustafa Ozan Yıldırım offer an empirical contribution to the literature on the interdependencies between fiscal and monetary policies. Special emphasis is placed on the policy mix in crises times. The empirical analysis differentiates from previous studies by estimating a non-linear Taylor rule with the use of Threshold Generalized Method of Moments (Threshold GMM) methodology. There are two main lessons for policymakers that can be drawn from the case study of Turkey. First, the contractionary fiscal policy supported the effectiveness of monetary policy with respect to inflation control. Second, in the country under analysis policy coordination failed during crisis periods.

The last paper in this issue, **Analysis of the relationship between countercyclical capital buffer and performance and risk indicators of the banking sector**, by Furkan Yıldırım provides new empirical evidence to the debate about the regulatory framework of banking activities. The article focuses on the countercyclical capital buffer (CCyB) introduced in the Basel III Accord in order to reduce the fluctuations in credit flow to the economy during the business cycle. The analysis employing the ARDL model and the Toda Yamamoto (T-Y) causality test for the Turkish banking sector suggests that, in general, the countercyclical capital buffer (CCyB) served its purpose. It proved to be an effective tool to manage macroeconomic and systemic risks. The results of the study may be of interest to policymakers responsible for macroprudential policies.

Monika Banaszewska

Lead Editor

Economics and Business Review, Vol. 7 (21), No. 3, 2021: 16-34
DOI: 10.18559/ebr.2021.3.3

A synthesis of evolutionary and behavioural economics[1]

Jan Polowczyk[2]

Abstract: The article presents the current state of evolutionary economics against the backdrop of changes related to the potential use of the achievements of other social sciences, in particular psychology, as well as dynamically developing neuroscience. The article suggests a synthesis of evolutionary and behavioural economics concepts as a logical consequence of evolutionary cooperation processes in social sciences. Interdisciplinary initiatives create new perspectives on generation synergy effects for all participants.

Contemporary evolutionary economists present the nature of ongoing innovation-driven economic change as a long evolutionary process. The main creator of the econosphere as a global system is a man–entrepreneur who is also the result of evolutionary processes. For this reason evolutionary economics should take into account the results of behavioural economics' research based on modern psychology and neuroscience. The cornerstone of evolutionary and behavioural economics synthesis are the theories of Adam Smith which should be regarded as his holistic intellectual heritage.

Keywords: evolutionary economics, behavioural economics, evolutionary paradigm, Adam Smith.

JEL codes: B52, D91, E71.

Introduction

The purpose of the following considerations is to make progress in the study of economic theories and to demonstrate the need to combine the concepts of evolutionary and behavioural economics. The basis of the discussion will be the literature on the subject. The considerations are embedded in the concept of theoretical analysis using logical inference, critical analysis and comparative techniques.

Evolutionary economics has been around with the ideas explaining economic and social processes for at least four decades. Among economists, however, there

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is no unanimity as to how to classify it among the various currents of heterodox economics. In the popular classification of J.F. Tomer (2007), evolutionary economics belongs to the broad mainstream of behavioural economics along with psychological economics, experimental economics, behavioural macroeconomics, behavioural finance and the economics of complexity.

Evolutionary economists consider their field of interests as an independent theory parallel to behavioural economics. This position has some justification, because "evolutionists" quite rarely use the achievements of the psychological school of D. Kahneman and A. Tversky (1979) and Tversky and Kahneman (1974). On the other hand it should be emphasized that the psychological school, which can be equated with behavioural economics, marginally refers to the evolutionary concept as evidenced by the works of prominent representatives of this trend: Kahneman (2002, 2003, 2011), R.H. Thaler and C.S. Sunstein (2008). According to Thaler (2015: p. 261):

> accepting the theory of evolution as true does not mean that it needs to feature prominently in an economic analysis. (…) Furthermore, the real point of behavioural economics is to highlight behaviours that are in conflict with the standard rational model.

In recent years opinions have emerged that evolutionary economics should take into account the theory of human behaviour and cognition which describes human creativity and innovation (Schubert, 2014; Nelson, 2016; Markey-Towler, 2018; Schnellenbach & Schubert, 2019). There are also popularizing works that combine evolutionary and behavioural approaches, e.g. E.D. Beinhocker (2007), M. Shermer (2008), J. Haidt (2012), Y.N. Harari (2018).

1. Evolutionary economics

The beginnings of modern evolutionary economics are commonly associated with the book by R.R. Nelson and S.G. Winter *An Evolutionary Theory of Economic Change* (1982) referring to the concept of Schumpeter (1911, 1942) and Simon (1976). According to Simon (2005) Darwin's evolutionary metaphor is applicable to the description of development and changes taking place over time in economic systems or parts thereof—companies or industries (Wach, 2020). All economics can be seen as an evolutionary system with J. Schumpeter's innovations serving as one of the mechanisms of mutation (Lipieta, 2018). Competition between companies in industry can be described as the fight for the survival of the most profitable. Simon's concepts were used by J. Kornai in his work *Anti-equilibrium* (1971) which could be regarded as a harbinger of evolutionary economics (Csaba, 2017).

Evolutionary economics is a work in progress and according to Nelson (2018, pp. 1–2) at the root of the difference between evolutionary economics and mainstream economics is "the conviction of evolutionary economists that continuing change, largely driven by innovation, is a central characteristic of modern capitalist economies, and that this fact ought to be built into the core of basic economy theory". The key assumptions of mainstream economics make demands of evolutionists very difficult to satisfy.

Contemporary evolutionary economists present the nature of ongoing, innovation-driven economic change as a long evolutionary process. They have returned to the perspective established by A. Smith and more recently by J. Schumpeter. Many evolutionary economists have been drawn to the concept of "bounded rationality" developed by H.A. Simon (Kowalski, 2002).

The term "evolutionary economics" suggests relationships with the perspective of Darwinian evolutionary biology which delivers an explanation for the good design that existing animals and plants possess for existing in their environment. Similarly evolutionary economists seek reasons for the often unusual effectiveness of the ways entrepreneurs adjust their businesses to the environment needs within which they work. In both evolutionary biology and evolutionary economics the current state of affairs needs to be understood as a result of a long term development process.

In both systems (biology and economy) constant changes need the permanent introduction of new variety: mutations in the case of nature and innovations in economy. Although there are fundamental differences. The most important difference is the main role played by conscious decision making in the on-going economic evolutionary processes. Additionally, evolutionary economists emphasize the bounded nature of human rationality but they do not treat human actors "as like fruit flies, locked into particular patterns of behaviour by their genes" (Nelson, 2018, pp. 25–26). In general economics actors are able to decide what, when and how they are doing and have the capability to learn not only based on their own experience but from available information.

Both evolutionary economics and evolutionary biology underline that the present is a part of long historical processes. Theories that human culture and institutions evolve, in the sense of evolution in evolutionary economics, long preceded Darwin's theory by Hume's, Mandeville's and Smith's works. After that a number of economists (Veblen, 1898; Marshall, 1890; Penrose, 1952) proposed that economics as a field of scientific analysis is much closer to biology than physics.

Among contemporary evolutionary economists there is no consensus on core principles of their realm. But there is general agreement on a few shared basic assumptions. Evolutionary economists assume a changing, complex world that generates novelty. Agents therein have limited cognitive capacities and assume that the rationality of others is similarly bounded. Complex phenomena can emerge through self-organisation rather than comprehensive overall design (Hodgson, 2019, pp. 24–25). Complex systems are formed by structurally distinct realms that coevolve (Almudi & Fatas-Villafranca, 2021).

2. Behavioural economics

Undoubtedly the importance of behavioural economics was strengthened by Nobel awards in economics[3] for Kahneman and then Thaler as well as G.A. Akerlof and R.J. Shiller (2009) and earlier Simon. Evolutionary economics does not have such achievements. It is also worth recalling the often quoted definition of economics formulated by L.Ch. Robbins (1935, p. 15), that "Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses". The first part of its definition indicates the importance of studying human behaviour. It is also a permanent element of many contemporary definitions of economics as a science (Backhouse & Medema, 2009; Wójcik & Ciszewska-Mlinarič, 2020). It can therefore be assumed that in modern economics there is some consensus that the basic subject of economics as a scientific discipline is man and his behaviour related to broadly understood economic activities (Baharuddin & Ab Rahman, 2021).

For many decades the rational *Homo oeconomicus* model was the prevailing mainstream economics paradigm. A significant event undermining this paradigm was the theory of the perspective by Kahneman and Tversky (1979). Kahneman (2002) transferred to the field of economics psychological concepts of two thinking systems referred to as System 1 and System 2. System 1 is called fast, intuitive, emotional or automatic. System 2 is referred to as slow, reflective or analytical. System 1 is based on innate, evolutionarily shaped heuristics and natural propensities that support survival. Our "lazy" brains do not like analytical considerations under System 2. This is justified because the cerebral cortex which is evolutionally the latest part of our brains specializing in analytical thinking consumes a lot of energy. The majority of our decisions, also in business, are made by System 1 (Thaler & Sunstein, 2008; Koczetkow, 2019).

In the last two decades, based on observations and experimental research, a catalogue of these fast inclinations, often called cognitive biases, has been created (Kahneman, 2002; Thaler, 2015; Gino & Staats, 2015; Polowczyk, 2017). The term "cognitive bias" is not, however, an apt term just as the dichotomy rational-irrational is wrong in this context. The decisions (behaviours) resulting from System 1 are named often irrational (e.g., Ariely, 2008, 2009; Aumann, 2019). However it should be remembered that these behaviours are the result of a long selection process of natural evolution which ensured the survival of the best individuals. Therefore they cannot be called irrational but rather intuitive, emotional or innate.

Kahneman and Tversky as psychologists did not refer to the economic theories presented by A. Smith in his book *Theory of Moral Sentiments* (1759) which should be considered as a cornerstone for the theory of perspective. They, with-

[3] The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel.

out knowing after 220 years, repeated what Smith had previously written without using the term "loss aversion". Smith described an experimental phenomenon: pain as a sensation much more felt than pleasure (1759/1853, pp. 176–177). The role of Smith as a pioneer of behavioural economics should be underlined. Thaler (2015) as a professor of economics appreciated it partly in his book.

3. Evolutionary-behavioural economics

The cornerstone of evolutionary and behavioural economics synthesis are the theories of Smith presented in his two books: *Theory of Moral Sentiments* published in 1759 and *Wealth of Nations* published in 1776. The evolutionary part is supported by the second work and the behavioural by the first one. Although Smith did not refer in the second book to the ealier one both works should be regarded as his holistic intellectual heritage.

When Smith was writing *Wealth of Nations* (1776) he was undoubtedly aware of these changes introducing civilization to the next levels of development. It should be emphasized that, according to Smith, man was part of earthly nature and the most socially developed representative of the animal world (1776/2003, pp. 22, 122, 201). Smith was aware of development processes that led from the era of hunting, gathering, farming to his contemporary beginnings of the industrial revolution. He admired the perfection of this movement towards the growing prosperity of humanity. However he did not yet know the concept of evolution in the sense of C. Darwin and considered God the main culprit of developmental processes calling him most often Nature (1759). If all phrases referring to Nature (or the Creator) in Smith's work were replaced by the term "evolution", it would have a very contemporary dimension. Contemporary comparative literature studies show that many modern behavioural concepts considered innovative have been previously described and interpreted by Smith (V.L. Smith, 1998; Ashraf, Camerer, & Loewenstein, 2005; Evensky, 2005; Polowczyk, 2010; Thaler, 2015; Montes, 2019).

The evolution theory of Darwin from 1859 marked a great breakthrough in science. According to Darwin all species existing in nature come from earlier forms and the main law of evolution is the process of natural selection. The contemporary synthesis of evolution that took place in the mid-twentieth century confirmed Darwin's conclusions that the basic mechanism of evolution is a process of constant change the accumulation of which causes the continuous emergence of broadly understood newness. In its modern form Darwin's scientific discoveries are not only a theory explaining biodiversity but also unifying social sciences (Hodgson, 2019; Gintis, 2007; Wilson, 1998).

H. Gintis (2007) proposed an evolutionary theoretical framework for the integration of behavioral sciences. According to him behavioural sciences include economic sciences, biology, anthropology, sociology, psychology, political sciences as well as their subdisciplines, including neuroscience, archeology or paleontology. Each of these disciplines studies human behaviour although their models are not compatible. Efforts must be made to integrate social sciences based on the theory of evolution, both genetic and cultural (Gintis, 2007).

The sciences mentioned by H. Gintis deal with human behaviour both on the scale of individual and social behaviour. Interdisciplinary research areas are emerging such as neuroeconomics (Camerer, Loewenstein, & Prelec, 2005), referring to the knowledge of the biological basis of human functioning (Pagano, 2020). This research direction will probably be strengthened under the influence of the expected increase in knowledge in the field of the brain's functions resulting from research intensification.

Socio-economic change processes are a consequence of general evolutionary processes. The basic paradigm in the broadly understood social sciences should become the universal law of evolutionary development whose movement is described by the generalized 3-phase formula: differentiation (mutation, variation)—selection—dissemination (replication, amplification, retention). In future the idea of a consilience (unity) of the sciences around natural sciences may come true, which was described by E.O. Wilson (1998). In this way social sciences including economics, can gain new foundations that will strengthen their scientific status. Evolution therefore has the potential of a scientific metaparadigm.

It is estimated that the economic activity of hominids on Earth with the first primitive tools began more than two million years ago. Development was gradual: first very slow, almost imperceptible and then faster and faster. Three phases of the development of human economic activity on Earth are commonly distinguished: the era of the hunter-gatherer, settled agriculture and industrial. The last two epochs (covering about 12,000 years) constitute less than 0.5% of the econosphere's development time (Beinhocker, 2007, chapter 1).

The evolutionary approach should be strenghtened by the concepts of K.E. Boulding (1991, p. 9) who wrote the opennig article in the first issue of *Evolutionary Economics Journal*:

> In its largest sense, evolutionary economics is simply an attempt to look at an economic system, whether of the whole world or of its parts, as a continuing process in space and time. Each economy is then seen as a segment of the larger evolutionary process of the universe (…) in four-dimensional space-time.

Boulding distinguished three main stages of evolution:

1. Physical and chemical evolution producing stars and planets, the elements, compounds, air, water, rocks, etc.
2. Biological evolution based on DNA producing living species.

3. Societal evolution beginning with *Homo sapiens* and our extraordinary capacity for creating knowledge and for producing artifacts.

An economy is part of societal evolution but it is affected by physical and biological evolution to some degree through earthquakes, natural catastrophes, the geological accumulation of fossil fuels, climate change, or epidemics. An economy consists "of activities and institutions which are organized primarily through exchange, and the production and consumption of human artifacts, which enter into some sort of accounting systems and are evaluated by some measure of value, usually money" (Boulding, 1991, p. 9).

Processes in an economy have strong resemblances to processes in biological ecosystems. The progress in productivity of land, labour and capital as a result of changes in human knowledge and innovations is strikingly parallel to the role of mutation as a selection in biological evolution. Biological selection is a kind of learning process. It selects those mutations which produce populations that have niches in an ecosystem.

Evolution is strongly affected by "empty niches" in existing ecosystems which can be filled either by genetic mutation or by the migration of species (e.g., rabbits in Australia). Cars with the internal combustion engine exploded in number (like rabbits) at the beginning of the twentieth century and occupied the mobility service niche for more than one hundred years.

K. Dopfer in presenting the theoretrical framework for evolutionary economics (2005, pp. 21–23) introduced the concept of *Homo sapiens oeconomicus* (HSO) as the basic unit of an evolutionary microeconomics: "The distinction between this concept and *Homo oeconomicus* is that it expressly recognizes the traits of human nature". Dopfer underlined that both evolutionary biology and evolutionary psychology describe the human brain as a product of long biological evolution. Thanks to this the evolution of culture and material artifacts is possible. According to Dopfer (2005, p. 23), HSO which serves as an explanatory platform for economic analysis must include simultanously achievements of the neurosciences and the cognitive and behavioural sciences. He underlined (2005, p. 54) that HSO should become a relevant concept for evolutionary economics.

Dopfer's argumentation opens possibilities for intellectual cooperation with behavioural economists. But some evolutionary economists are less inclined to absorb undoubted behavioural economics achievements. For example Nelson (2018, p. 13) indicates that "behavioural economics has focused almost exclusively on human behaviour that is logically inconsistent".

Hodgson (2019, p. 24) underlines that evolutionary economists have been influenced by Simon's (1976) concept of "bounded rationality". During the next decades behavioural economics had been created by Kahneman and Tversky (1979) who presented the seminal concept of "prospect theory". It is very effective to explain different phenomena in the real economy and business based on such concepts as: risk aversion, herding effect, endowment effect, status quo bias, myopic bias, framing, anchoring, availability, overoptimism, reciprocity, trust, etc. but it is not even mentioned in works of such prominent evolutionists such as Nelson (2018) and Hodgson (2019).

4. The econosphere as a complex adaptive system

Many works published in the last three decades of the 20th century, including J.H. Holland (1975), S. Kauffman (1993) and E. Beinhocker (2007), contributed to the creation of the general theory of evolutionary systems. The basis of this theory is the formula: differentiation (mutation)—selection—dissemination (replication). The same process that drives the increase in the complexity of the biosphere directs the increase in the complexity of every other evolutionary system including the econosphere. Evolution is often thought about in a biological context. Meanwhile the modern general theory of evolutionary systems treats it as something much more general: as a universal algorithm which is based on the above three-stage formula. In contrast with the physicalist neoclassical approach evolution is based on neutral evolutionary algorithm influenced by random processes.

Both socioeconomic and biological systems are subclasses of the more general and universal class of evolutionary systems. Therefore scientists believe that there are general laws of evolutionary systems (Holland, 1975). As with gravity in physics evolution is a universal process which means that its course is similar in both biological organisms and socio-economic organizations. However evolution is influenced by environment and it is exposed to random interferences. The saying that economic systems are similar to biological systems says nothing that would be scientifically useful. Only the statement that both economic and biological systems are subclasses of the more general and universal class of evolutionary systems acquires meaning.

It is assumed that evolutionary systems belong to complex adaptive systems. In such systems interactions at the micro level lead to some regularities at the macro level. There is no single winner in the evolutionary system and there is also no best strategy. The winners are all those who manage to survive. It is in nature and it is in the ecosphere. It happens that one company dominates the market for some time. However sooner or later an innovative competitor appears and becomes a new leader. Competitive advantage is always temporal.

The process of evolution is bottom-up. It is not a perfect process and always the same. It is exposed to random errors and disturbances. Evolution is a neutral algorithm that works in various environments. Evolution is recursive. The results of one cycle are input data for the next cycle. The beginning and end of the cycle are conventional terms and it is difficult to see them during evolution. Actually they can only be assessed *ex post*.

D. Dennett (1995, pp. 28–34, 48–60) called evolution the method of "creating design without designer". Evolution creates "projects" in the trial and error process. According to Dennett evolution is a research algorithm of "finding needles of good intent in haystacks of possibilities". Evolution is an effective process of creating innovation by finding the most-tailored projects in the vast space of potential projects because it involves parallel search. As a result each member of the population conducts their individual exploration experiment. The evolution process never stops because the environment changes. The evolutionary search never ends. Evolutionary systems do not have a lasting balance, because stagnation is synonymous with destruction.

If we assume that man is part of nature and the most developed form of life on Earth then we can assume that biological evolution creates the basis of evolutionary processes that deal with other scientific fields. The boundary conditions of biological evolution are determined by the laws of chemistry and physics, disciplines which are fundamental to biology. Changes in life forms are a special case of the evolution of dynamic systems in the world of chemistry and physics (Kauffman, 2000, p. 35).

Dynamics of complex adaptive systems can be explained by their structure. A system structure is created by a combination of two kinds of feedback: positive and negative. Positive feedbacks cause system destabilization. They have the character of strengthening upward or downward trends (they cause the so-called snowball effect, i.e., exponential decreases or increases). Negative (or goal seeking, or adaptive) feedbacks have a stabilizing effect. They balance the positive feedback effect and give the variables sinusoidal fluctuations. Different physical, biological, economic or social systems can have similar structures (Forrester, 1968; Polowczyk, 1990). Due to this the majority of physical, biological as well as economic and social processes are not linear but exponential. Boulding (1991, p.14) presented the effects of positive feedback process in the following way: "the more we know, the easier it is to know more; the more we make, the easier it is to make more; the richer we are, the easier it is to get richer".

5. The growing volatility. What drives evolution?

Evolution is a universal development algorithm and generates continuous variability. Moreover, each new invention increases this variability because it generates combinations of new inventions and processes at an exponential rate. Therefore it is reasonable to say that the only certainty in social sciences is that nothing is certain (Taleb, 2007). For over 40 years the rhythm of technological progress has determined a roughly two-year microprocessor modernization cycle involving doubling their computing power. Therefore we are dealing with an exponential trend called the law of Moore, one of the co-founders of Intel.

In this two-year rhythm the power of computers and the growing amount of equipment using the digital technologies doubles (Kurzweil, 2006).

The problem of growing uncertainty about the future is often taken up by economists. According to Schumpeter (1942), economic life takes place in a social and natural environment that is changing and these changes in turn change the parameters of economic operation. A change is an important economic category. Economics is a more difficult science than mathematics and physics because the subject of its research is in constant motion and undergoes constant change. Evolutionary economics responds to these challenges. Its purpose is to understand and describe the ever-changing variability of economic processes.

As already mentioned Smith did not use the term evolution and the key term was "Nature". However he was aware of human development processes from the era of hunting to the modern beginnings of the industrial revolution. He closely observed the first applications of the steam engine. According to Smith (1759/1853, pp. 263–264), the economy is fuelled by the false belief that prosperity brings happiness: "pleasures of wealth and greatness (…) strike the imagination as something grand, and beautiful, and noble, of which the attainment is well worth all the toil and anxiety which we are so apt to bestow upon it. " And immediately he adds, that "it is well that nature imposes upon us in this manner. It is this deception which rouses and keeps in continual motion the industry of mankind." It can therefore be concluded that, according to Smith, the basic driving force of human progress is the pursuit of happiness the equivalent of which is wealth.

The above motive of standing out through property status appeared in T. Veblen's (1899) theory of "conspicuous consumption". According to Veblen people strive to make their standard of living visible through this " conspicuous consumption". This type of consumption derives its value not so much from the actual value of consumption but from the fact that it allows people to be different from others. In turn, according to A. Maslow (1970), human needs form a permanent hierarchy that determines the order in which they are met: the needs occupying a higher position in the hierarchy are activated only when basic needs are met: man is a demanding being and reaches full satisfaction rarely. If one desire is satisfied another appears in its place (Maslow, 1970).

Maslow's views have a lot in common with Schumpeter's ideas (1911) according to which the entrepreneur's motive is not only the desire to obtain material benefits for himself and to satisfy his consumption needs but also to gain a satisfying social position, achieve a sense of power and independence and the desire to gain: willingness to fight, to show superiority over others, to win, not for its fruit but for victory alone. Finally there is the joy of creating, doing something or simply using your energy and ingenuity.

The dissemination of innovations is reinforced by a natural tendency to imitate also called the herding instinct. It manifests itself in the copying (reproduction) of "best business practices" (e.g., in this way clusters are created), in the operation of financial markets (investors behaviour), or in the purchase of products considered modern or fashionable and even in the development of scientific research.

Undoubtedly the main driving force of evolution is the development of science and technology. After the age of steam our civilization has passed into the age of electricity and now into the age of digitization. There is a transformation of energy sources towards renewable sources (sun, wind, water). G. Moore's law explains the exponential progress in digital technologies that are widely used in all industries and changing lifestyles of entire societies (Bauer, Veira, & Weig, 2013; Kurzweil, 2006). Each new invention increases the possibilities of combining production and innovation factors in line with Schumpeter's concept (1911).

Finally the demographic factor is important. The population of the Earth is increasing exponentially. Over the last one hundred years the population has increased by almost 6 billion (from 2 billion in the early 1920s to almost 8 billion today). The number of well-educated people who can communicate and cooperate through the Internet is growing at an equally exponential rate. Research centres and open source internet platforms employ millions of experts and volunteers working on the next innovations by conducting the aforementioned parallel search for "needles in a haystack of possibilities". Digitalization and artificial intelligence speed up innovation processes.

6. The hunter's dilemma. Does evolution lead to optimization?

An important question in the study of evolutionary processes is whether and to what extent they lead to the optimization of a specific goal function. This is a key problem in both the theory of biology and economics. Some influential researchers (including Aumann, 2019) share Dawkins's view (1982, p. 189) that individuals do not consciously strive to maximize anything but behave as if they maximize. If resources are limited then the efficiency of the individual depends not only on his own actions but also on the actions of other actors. This applies not only to biology but also to social sciences, especially economics (Lehmann, Alger, & Weibull, 2015).

The achievements of terrestrial civilization were possible thanks to the cooperation of members of society, ranging from mutual support within one tribe, to cooperation between societies, states and corporations on a global scale. Cooperation (especially long-term) is based on mutual trust between all parties involved. The literature on the subject indicates the great importance of psychological factors for developing cooperation relationships that has been supported by the game theory (Camerer, 1985).

The basis of game theory is the assumption that participants (agents) are able to predict the actions of other participants. This theory explains the phenomenon of mutual benefits through the concept of win-win games in which cooperation brings a synergy effect. Positive sum cooperation helps in survival and is widely used in biological evolution. This problem was dealt with by J. Nash, who investigated why two parties to a contract come to an agreement. Nash (1950) stated that two or more parties share exchange gains depending on how they value their transaction benefits and what alternatives they have. Everyone cares about their best benefit and the transaction is made at a point where nobody wants to change position given the other party's activities. This is called the Nash equilibrium point.

An often cited example of a game with a positive sum is the so-called prisoner's dilemma (e.g., Poundstone, 1992). Many authors (e.g., Beinhocker, 2007) treat this dilemma as crucial for understanding the processes of cooperation between econosphere participants. It shows the reasons for cooperation between two participants in the smallest possible social scale. The prisoner's dilemma is very far from the real economy and making business decisions. In free market realities competitors are not isolated from each other. On the contrary they can communicate with each other, negotiate and agree on details of possible cooperation. They decide how, when, where and with whom they will achieve their goals.

Looking for the oldest evolutionary "business projects" the hunting of primitive hunters two million years ago is arrived at. The daily "work" of a hominid-hunter (to put it simply) was to get food for the whole family. Two hunters working together could hunt more than if each of them hunted alone. However, if during the distribution of prey one of the hunters lost the desire to cooperate and forcibly took away all or most of the hunted prey then the other—focused on cooperation, was the loser. Before the next hunt the cooperative hunter had to consider whether further cooperation with a disloyal partner pays off. This type of dilemma had to accompany our ancestors every day. We will therefore call it the hunter's dilemma which fits well with the concept of evolution.

Based on comparisons of several competing computer algorithms it has been proved (Axelrod, 1997) that the best rule in iterative double-sided games (e.g., the hunter's dilemma) is the tit-for-tat strategy developed by A. Rapoport, a psychologist and mathematician. The tit-for-tat strategy rules are very simple. The first move should always be cooperative and each subsequent reaction should be a mirror image of the immediately preceding decision of the opponent: cooperative to friendly actions of the rival, or competitive if his actions are of such nature. Tit-for-tat is therefore a strategy based on reciprocity (Ioannou, 2014). It is also proof of the effectiveness of natural evolution processes. The tendency to reciprocate has increased over the hundreds of thousands of years. In this way natural evolutionary processes have equipped humanity with intuitive, self-defense responses that help survival.

Evolution has made mankind naturally focused on cooperation and obtaining the effects of positive-sum games. Man is equipped with sensitivity to fraud and the expectation of justice (Smith 1759/1853, p. 125). Evolution has provided us with an intuitive search for Nash equilibrium points and justice detectors enabling groups of people to form a coalition against fraudsters and excessive individualists (free riders).

7. Using the achievements of neuroscience

Neuroscience (also known as neurobiology) is an interdisciplinary scientific study of the nervous system. The results of research on the human brain are increasingly used in social sciences. They are used in marketing, finance, economics, sociology, psychology, law, anthropology and many other disciplines. Because cognition, emotions and social perception are located in the central nervous system and brain both evolutionary and behavioural economists should be interested in the possibility of exploiting the achievements of behavioural neuroscience.

Behavioural neuroscience includes subdisciplines that associate brain activity with: reputation, status, cooperation, trust and altruism (social neuroscience); learning, perception and decision making (cognitive neuroscience); feelings, passion and motivation (emotional neuroscience). This knowledge is already used in neuroeconomics (Camerer et al., 2005), neuromarketing (Kennig, 2014), neurofinance (Kuhnen & Knutson, 2005) or neurostrategies (Powell, 2011).

Economists striving to use effectively the achievements of neuroscience should include their problems within the evolutionary framework and more precisely: in the logic of the algorithm of evolution and modern knowledge about man. All sciences reaching the achievements of neuroscience should adopt the paradigm of evolution and develop their research within its frame. This postulate, as already mentioned, was made by Wilson (1998) and Gintis (2007) in the last decade as was mentioned above.

Advances in cognitive neuroscience enable learning about brain activity when making decisions. Researchers are increasingly using many methods simultaneously, e.g., combining mathematical modelling, computer simulation, behavioural experiments, field research and brain scanning. As a result they gain multiple perspectives for the same phenomenon and old theories obtain additional explanations.

The reciprocity mentioned above can take two extreme forms: gratitude and revenge. E. Fehr and S. Gachter (2000) conducted a series of experiments showing how we derive satisfaction from punishing dishonest people and how the possibility of punishment limits selfish behaviour and also increases cooperation. During research on revenge processes the brains of participants in the experiments were scanned. It turned out that brain activity was concentrated in the *striatum* during punishment. This is the part of the brain associated with rewarding experience. Thus the decision to punish a disloyal or greedy partner is associated with a feeling of satisfaction ("revenge is sweet"). Moreover, those whose brains showed greater *striatum* activity punished their partners to a greater extent.

These studies suggest that the desire for revenge, even if it comes at a cost and appears to be completely irrational, has biological justification because it increases the likelihood of survival. *Homo oeconomicus* according to traditional economics should not do that. If they were selfish individuals then the punitive behaviour should generate the same behaviour as without punishment because punishment would be irrational due to additional costs.

The universal nature of strong reciprocal attitudes has been found in various groups of people, from modern industrial societies to hunter-gatherer tribes. There is an ongoing debate as to whether or not they are genetic or cultural. There are three strong evidences of genetic origin. First, research shows that strong reciprocity exists in very different societies with different cultural roots. Secondly, some non-human species exhibit similar behaviour. Thirdly, a biochemical basis for such behaviours has been discovered—oxytocin, a brain hormone that plays a key role in generating feelings of trust and supports cooperation among people (Zak, Borja, Matzner, & Kurzban, 2005; Haidt, 2012). Based on experimental research it turned out that the level of oxytocin increases when a person realizes that someone trusts him and 98% of the surveyed people are subject to this general regularity. Thus it is probably oxytocin that constitutes the social "binder" and enables the creation of the econosphere (Fehr, Fischbacher, & Kosfeld, 2005; Zak, 2017).

Although strong reciprocity is universal it manifests itself in different ways in different societies. This in turn points to its cultural background. The evolutionary logic of reciprocity has its justification: conditional cooperation gives better results than purely selfish or purely altruistic actions. Impunity encourages any criminal or cheater.

Revenge, though it may seem irrational and unnecessary cruelty, in reality (i.e., a repetitive game) protects against losses. People often react disproportionately to what happened because their reactions are proportional to what could happen if an event were to happen again. This is called the shadow effect of the future in iterated games (Heide & Miner, 1992). In turn altruism in a single game may give the impression of a naive attitude but in a series of repeated games it can bring more benefits than egoism and fierce competition.

Research suggests that the desire for revenge, even if it comes at a cost, is biologically justified because it increases the likelihood of survival. This in turn confirms the thesis that the brains of all animals are built to please their owners when they do something that is important for their survival (e.g., food, sex). The dopamine neurotransmitter is responsible for this (Haidt, 2012, chapter 4; Aumann, 2019).

Most human decisions are based on emotional responses using heuristics (System 1) and not on detailed analysis (System 2). Research conducted in neuroscience has provided a much better understanding of how people make decisions. Emotions are the result of specific biochemical processes. Our feelings are rather biochemical mechanisms that all creatures use to quickly calculate the probability of survival and reproduction (from food selection to partner selection). Human intuition is actually pattern recognition and is shaped by experience. Biochemical algorithms of the human brain are not perfect. They are based on heuristics, which with some delay, adapt to new conditions created by the environment.

Emotions are not the opposite of rationality but are a reflection of the evolution of rationality. Feelings of a moral nature (indignation, guilt, forgiveness) originate from the mechanisms of the nervous system which developed to allow cooperation in a group. All these biochemical algorithms have improved over millions of years of evolution through natural selection. *Homo sapiens,* like all species, uses emotions to quickly make decisions about life and death. Anger, fear and desire are inherited from ancestors each of which has positively passed the strictest quality control tests, i.e. the natural selection test (Harari, 2018, chapter 3).

Conclusions

There are a large number of overlapping and interpenetrating paradigms at all stages of the evolution of science (Kuhn, 1968). Paradigms do not change suddenly and do not appear suddenly in a mature form, but—on the contrary—their emergence is the result of victory in a long process of intellectual competition. This quote is a great description and exemplification of the three-phase evolutionary process: differentiation–selection–dissemination.

The biggest challenge and at the same time the most interesting aspect of economic sciences is the permanent variability of the studied phenomena. What is more this volatility accelerates. Social and economic processes that once took hundreds of years are now taking place within months. Evolutionary economics introducing the dimension of time and volatility is trying to answer this challenge.

Evolutionary economists underline that human agents have limited cognitive skills and bounded rationality. Behavioural economists described in detail different cognitive "biases" and how to avoid or neutralize them. Thaler and Sunstein (2008) presented the concept of choice architecture. It is the activity for organizing the context in which people make decisions. A good example of improving strategic decision-making is a quality control process based on checklist presented by Kahneman, Lovallo and Sibony (2011).

The natural efficiency of evolutionary processes is explained and confirmed by modern science. Advances in neurology help us learn about brain activity when making decisions. Researchers are increasingly using many methods simultaneously such as combining mathematical modelling, computer simulation, behavioural experiments and brain scanning. As a result they obtain a multitude of perspectives for the same phenomenon and old theories obtain additional contemporary explanation.

A synthesis of evolutionary and behavioural economics is a logical consequence of evolutionary cooperation processes in social sciences. For example Aumann (2019) proposed a synthesis of behavioural and mainstream economics. Cooperation generates synergy effects for all participants. Interdisciplinary initiatives create new perspectives on the real contribution to the future prosperity of our civilization. Both evolutionary and behavioural economics care about their identity (*status quo* effect). However this carries some threats. Closing oneself within one's borders usually leads to autarky.

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