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NEUROECONOMICS – INTERDISCIPLINARY SCIENCE OF INVESTIGATION OF THE HUMAN BRAIN FUNCTION AND OF THE DECISIONAL BEHAVIOUR OF THE HUMANKIND

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Abstract

Cet article aborde un domaine relativement nouveau: neuroéconomie.

La littérature montre qu'il existe une science nouvelle qui combine les résultats de recherche sur les plans économique, psychologique et sur le plan du neurosciences.

Dans le présent document nous aprecions que aussi d'autres sciences peut que contribuer à la fondation de cette nouvelle science

Les recherches sur les réponses du cerveau aux différents stimuls, par exemple, les images publicitaires, utilisent des techniques spécialisées et des dispositifs tels que l'imagerie fonctionnelle, électroencéphalogramme, etc. On peut donc déterminer quelles zones du cerveau sont activées pendant que les décisions économiques sont prises, le type d'émotions qui sont générées et les facteurs qui déterminent ou les influencent. Cela pourrait également examiner la décision de neurones.

Les résultats obtenus jusqu'à présent démontre le rôle important que les processus émotionnels ont dans la décision économique et financière plus que les décisions rationnelles

Mots-clé: *neuroéconomie, science interdisciplinaire, neurosciences, pensée, cerveau, imagérie célébrale*

JEL Classification: D87

Introduction

The financial crisis set off in 2007 highlighted the fragility of the econometric models, meaning the models known as rational, besides the caused damage, the series of bankruptcies and the threat of a systemic world crisis, then the economic crisis and its worldwide generalization. These models mean the maximization of profits in given social, technical and economic conditions, on basis of purely rational estimations. The reality of the markets, above all the financial ones, demonstrated that in most cases, the economy based on rational models, also known as "classic economy"[1] is outdated. The Kerviel business[2], the

[1] It is admitted that the classic economy represents an economic thinking whose beginnings are in the Great Britain, and initiated with the publication of the notorious volume "Wealth of Nations" by Adam Smith. NA.

Madoff[3], Caritas[4], FNI[5] scandals, "the end of Wall Street", the new status of the two great investment banks, Goldman Sachs et Morgan Stanley, the fall of Bear Stearns and Merrill Lynch following some emergency mergers, [1] the nationalisation of the Fannie Mae, Freddie Mac funds [2] and AIG, [3] as well as the bankruptcy of Lehman Brothers [4] and Washington Mutual [5] stand as consequences of behaviours where the "economic rationalisation" seems to not have been involved.

Such situations have been, are and will be possible as a consequence of the synergetic interaction of various factors which may be classified as follows:

– factors of the given social-technical-economic environment where an important role is played by the type of society, the values and norms shared by this environment;

– the initiators of certain processes, actions and activities which may be named businesses in the economic language;

– the participants to these businesses;

– the stakeholders involved.

Therefore, the understanding and explanation of such market behaviours is difficult to achieve with econometric models whose heuristic limitation in the field is obvious. People's minds and thinking must be penetrated. The subtle mechanisms that determine people to make certain decisions in emotional, risk, panic, uncertainty, manipulation and other conditions must be decoded. Promising results have been and continue to be obtained within the new field named "neuroeconomics"[6].

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[2] The trader who caused Société Générale to lose many billions of euro as a consequence of very risky placements made with the purpose of exceeding his own performances. The judges ascertained that according to his own declarations, Jérôme Kerviel had an irrational behaviour, an emotional one and not a sick one. "I was in a virtual world" he confessed concluding "I agree that all these had no sense, no purpose, no finality and no objective for me" NA.

[3] The former president of NASDAQ, who gained trust on the market by emotionally exploiting his status in the financial world and managed to achieve the greatest financial theft in history. Over 50 billions of dollars acquired from over 40.000 persons, financial institutions, banks, companies, institutions, etc. NA.

[4] "The Caritas scheme developed by the Caritas firm in Cluj-Napoca, owned by Ioan Stoica would promise the return of an amount eight times greater than the one initially consigned after a period of only six months. Over 400.000 of consigners were thus attracted and the amount reached approx. 1 billion dollars. The scheme functioned between 1991 and 1994 when it went bankrupt, having debts of approx, 450 millions of dollars. Ioan Stoica was sentenced to seven years in prison… in the end the sentence was reduced to 18 months". Wikipedia, online encyclopaedia.

[5] National Investment Fund (FNI), company founded in by SOV Invest, functioned as a pyramid game and led to the impairment of approx. 318.000 investors.

[6] Interdisciplinary science based on knowledge in the fields of neurosciences, endocrinology, economy, psychology, sociology, cerebral imagery used in the decision making at individual and collective level, as well as the processes, actions and activities developed on basis of this knowledge. The definition belongs to the author and may be improved. Many specialists only consider the neurosciences, economics and psychology. We consider that following the involvement of a great number of persons in businesses of the above mentioned type, social processes emerge. Also, the influence of hormones on the

Review of the specialist literature concerning the subject

It is generally accepted that the first one to use the word "neuroeconomics" in the economics literature was Paul W. Glimcher in 2003[7].

Since the award of the Nobel Prize for economics in 2002, to the psychologist Daniel Kahneman[8], the great universities have developed their own multidisciplinary research laboratories and have added to their university curricula subjects such as neurosciences, neuroeconomics, neuromarketing. A rich specialty literature was published on this subject; we herein present some titles: *Neuroeconomics*[9], *Neurosciences et neuroéthique: des cerveaux libres et heureux*[10], *La neuroeconomie*[11].

The specialist literature highlights that neuroeconomics is a new science combining research results from the economics, psychology and neurosciences fields.

In this paper we advance the idea that other sciences contribute or will contribute as well to the foundation of this new science.

Within the research concerning the neuroeconomics, the responses of the human brain to different stimuli are analysed, for example the images published with the help of certain techniques and special equipment, such as the functional imagery, the electroencephalogram, etc. Thus, the brain areas activated during the economic decision taking can be determined, the type of the generated emotions, as well as the factors determining or influencing them. Therefore, the basis of the neuronal decision can be researched.

The results obtained so far demonstrate the important role of the emotional processes in the economic and financial decision taking which seem to prevail in practice against the rational decision.

The research in the field of neuroeconomics also involve serious research ethic problems on one side and ethics in use of the results of these research, as by penetrating the profound and subtle field of the thinking mechanisms, its understanding premises are created and, once understood, manipulation techniques and methods cam be imagined.

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functionality of the human brain cannot be doubted and, therefore, knowledge in endocrinology is also necessary.

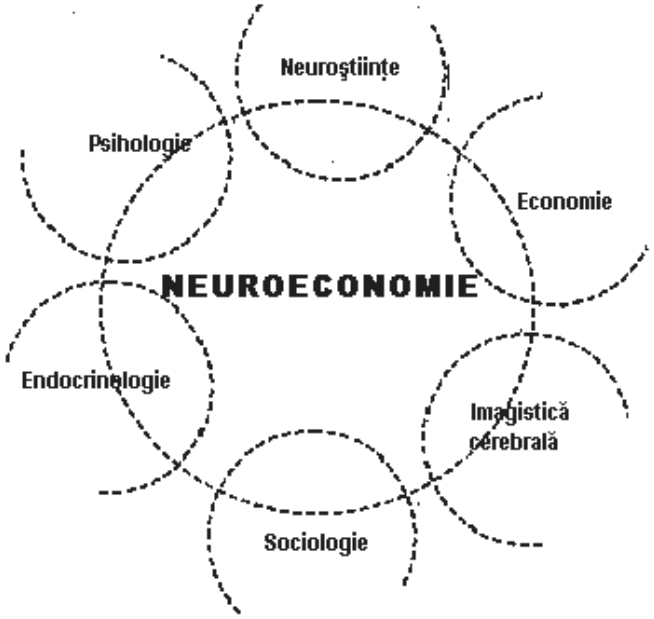
[7] *Decisions, Uncertainty, and the Brain: The Science of Neuroeconomics*, by Paul W. Glimcher, MIT Press, Cambridge, Massachusetts, 2003.

[8] Nobel Prize in 2002 "for having integrated the advance of the psychology investigation in the economic science especially with regard to the human judgement and the adoption of decisions in insecure conditions", NA.

[9] Neuroeconomics, Editor in Chief: Paul W. Glimcher Hardbound, 556 pages, publication date: OCT-2008, ISBN-13: 978-0-12-374176-9, Imprint: ACADEMIC PRESS

[10] Hervé Chneiweiss, Neurosciences et neuroéthique : des cerveaux libres et heureux, éd. Alvik, Paris, 2006, 235 pages.

[11] Sacha Gironde, La Neuroéconomie. Comment le cerveau gère mes intérêts, éd. Plon, Paris, 2008, 228 pages.



Source: Personal representation

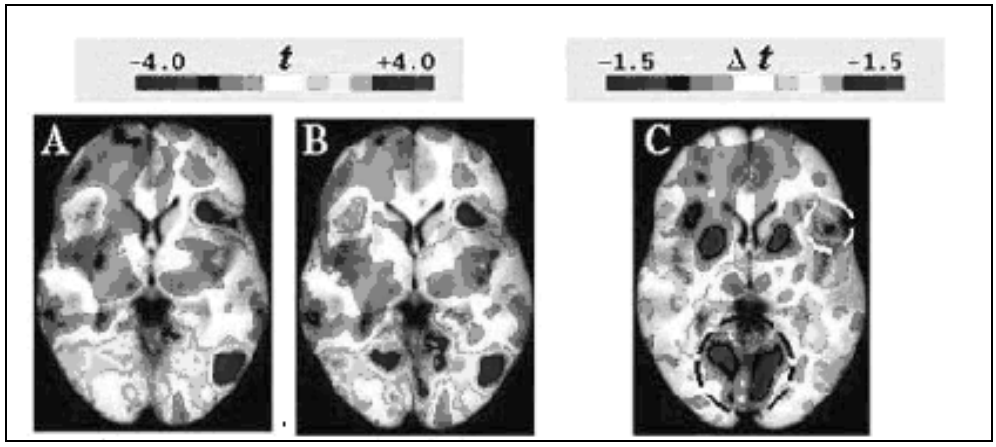
Fig. 1. *The main sciences contributing to the founding of neuroeconomics*

As it can be observed, neuroeconomics is an interdisciplinary science and it represents the geometrical locus of certain knowledge in different fields and knowledge pertaining to the new science. We must mention that none of these sciences can substitute neuroeconomics and the latter cannot substitute either one of the sciences participating to the foundation of its knowledge corpus.

We must start from the idea that the thinking mechanism and the human brain functionality are not enough known and there are still totally unknown areas, although great advancements have been made in their research recently. These will probably bring new surprises in the field of knowledge in the future. The functional imagery and investigation of the human brain have opened the way to the understanding and founding of the new science: neuroeconomics. Neurology, which is a medical science concerned with the understanding and care of the nervous system should not be confused with neuroeconomics. The latter is placed at the intersection of the behavioural economics with the neurosciences and its purpose is the understanding of the brain function in the process of taking decisions based on stimulus and information analysis coming from the exterior while using the own internal possibilities, algorithms and procedures.

With the help of the current technical investigation means, images of the brain activity can be taken while thinking, dreaming, resting, imagining or taking a decision or managing the functionality of the human body. This does not mean that

there are images of the thinking, dream, rest, imagination, decision, etc., but sequences from the functional processes of the brain subsequent to which these cerebral activities are produced. Such neuro-images can be taken in any area of the brain. The equipment used are the CAT Scan Type, DIE (Diagnostic Imaging Equipment) fRMN, etc. Also, the functional activity of the brain can be investigated with the help of the elecro-and magneto-encephalograph. The gathering and processing of the information as survey or test opinions of the subjects and their corroboration with the cerebral neuroimages and the encephalograms obtained allow a better knowledge of the cerebral mechanisms standing at the origin of the decisions regarding the choice of a satisfactory type out of a range, the link between this decision and the rational opinions of the subjects, the tracking of the emotional components and the factors inducing them, the physiologic and psychological implications of the decision process, as well as the cognitive factors, the neurofunctional factors and the ones that stimulate the long and short term memory. The obtained neuroimages shall look like the ones in figure 2. For the administration of different stimuli and for the different decisions taken, there are neuroimages obtained with different cortical areas. These allow the localization of preferences for different factors and the corroboration or even "verification" of the honesty and correctness of the surveys, as well as the discovery of tastes, preferences, motivations and finally the real decisions the investigated subject has to take.



Reaction Stimulation Variation

Source: http://www.ethique.gouv.qc.ca/index.php?option=com_docman&Itemid=7

Fig. 2. *Neuroimages reflecting the functionality of the brain in different circumstances*

Therefore, this is how precise data regarding the behaviour of the consumers who may be able to influence the strategic directions of development and evolution can be available for the satisfaction factors' suppliers of the advertising companies of the stakeholders. This is how the necessary information for developing new products is obtained, the information for developing new communication,

advertising strategies, how the neuronal activities connected to the studied satisfaction factors which allow the adaptation of the products and strategies according to the information provided by the neuronal activity with major implications upon the fabrication and operation costs are identified.

At the same time, cerebral mechanisms that influence the decision process in choosing and acquiring certain satisfaction factors that would "solve" the human needs and necessities – the latter being understood as being human requirements valued through the value-norm system specific to a social-technical-economic and cultural given space and partially or totally assumed at an individual level – are identified. In this context, "the satisfaction factors" represent "stimuli" for the human subjects and the "treatment" and "processing" of these influences they have upon the subjects' behaviours represent a complex process that can be deciphered exploring, analysing and interpreting all or as many as possible factors determining this process in all its sequences. Theoretically, the main block sequences that are the object of the research in the neuroeconomic field are "the symbolic representations of the satisfaction factors" "the current behaviour of the human subjects" "the human subjects behaviour in connection with a range of satisfaction factors" "the behaviour of the human subjects in connection with the symbolic representations of the satisfaction factors of the brand type, presented as stimuli in different advertising formulas" and "the obtainable economic or other effects".

Neuroresearch regards any satisfaction factor from the ones aimed at the material, spiritual, social cohabitation necessities of the society. In the real competitive economy there are multiple suppliers for each of the satisfaction factors. We can mention here the car, a certain type of aliment, a drink, a television brand, a perfume of another cosmetic product, a type of service, a cultural product, an electoral offer etc. For each of the satisfaction factors belonging to different or potential suppliers there can be made different presentation variants that can work as neuromarketing stimuli (symbolic representations such as presentation handouts, images, models, layouts, where possible – the products themselves, logos, brands or more complex products such as ads etc.). On basis of certain sample algorithms, survey and research volunteer groups are selected. The same conditions and stimuli are applied to all of them. The neuroeconomy and neuromarketing research highlight the current behaviour of these human subjects and their reactions towards the satisfaction factors as such and their symbolic representations as mentioned before. This is how conclusions can be drawn with regard to human being's ontology and knowledge can be obtained regarding the rational-emotional balance in the decision act at the neocortex level, which is a relatively random one, implying an amount of relativity and interchangeability. The state of the functional brain when the decision is taken must be specified, its integrity, normality and health, the quantity and type of hormones, as well as the quantity and type of psychotropic or other substances present in the circulatory system, etc. The cerebral activity is also influenced by the psychic state of the subject, as well as by the psychological and sociological context he/she is in. On the other side, the thinking, as result of the brain functionality, is a complex, auto-generative process as "thinking is being thought" and it, therefore, has individual and collective particularities. These particularities can be stimulative, inhibitive or constrictive.

That is why images alone are not enough for the interpretation of the research results of neuroeconomic nature but these results mean taking into consideration the factor complexity that determines or influences the decisional and cognitive brain processes.

Simplifying, we could say that the economics are a sum of options and actions based on econometric models, in the case of the classic economy and on neuro-options and neuro-actions in the case of neuroeconomy. The research in neuroeconomy, neuromarketing, neuromanagement, neurofinances, etc. provides unprecedented information regarding the intrinsic and profound behaviour of the consumer that transcend the information obtained through current techniques, survey, questionnaire, brainstorming, etc. and which, whether consciously or not are filtered, sometimes are censored by the subject of the research. On the other hand, even when such censorship mechanisms or filters do not manifest themselves, the research can be influenced by the training level and the perception and manifestation capacity of the subject. The neuroeconomics research allows the investigation of the subjects' reaction at different stimuli and allows the comparative analysis of their intern function at cerebral level with the reaction expressed mediately and which had passed through their rational filter.

There has been serious international neuroeconomics and especially neuromarketing research ongoing, requested by big companies such as Coca Cola, Pepsi Cola, Renault. As a consequence, reserves and even opinions against neuromarketing have emerged, as some have considered it affects the client's freedom of choice.

That is why there are certain recommendations with regard to the results of these researches and the initiation of a multidisciplinary research programme that should rejoin researchers from the field of neurosciences, social, administration sciences that should follow up the results of these researches.

At a global level, the researches advance quickly and new magnetic resonance imaging techniques are developed. Today, these allow not only a very accurate 3D photography of the brain, but also the registering and localization of the activity of its different areas in time with the help of the functional magnetic resonance imaging (fMRI). This new instruments allow the observation of the cerebral activity of the consumers when they are subjects to different stimuli for the analysis of the reactions triggered by the satisfaction factors or by the advertising stimuli and which can set off the pleasure of the consumer, before making great financial efforts to develop different products. We can, therefore, see a new important direction in the resource saving.

Internationally, such cognitive methods have already entered the range of methods used by the best-known brands Unilever, Nestlé, Procter & Gamble, DaimlerChrysler, LVMH and L'Oréal, etc. for the testing, adaptation and optimisation of their products, as well as of the advertising campaigns.[12]

[12] Business Week, 8 October, 2007 "This is your brain on Advertising".

Within a won project that is still ongoing within the Partnership programme[13] there are researches aiming at neuromarketing aspects in Romania, a social-technical and economic space with specific particularities in comparison to the researches made in the developed countries where such researches have been accomplished so far. The behavioural paradigm of the consumers from an emergent space such as the one in Romania, with excessive polarizations of the purchase power, is expected to be different from the "established" spaces regarding the balance of the consumers having a medium purchase power. Also, the mentalities of human subjects who have lived 50 years under a centralised and planned system are expected to influence the purchase decision.

In figure 3, we present one of the investigation means used in the field of neuroeconomy, the CAT scanner; in figure 4 there is the photography of a combined MRI- Encephalograph that offers the possibility of combined simultaneous recordings MRI (magnetic resonance) and EEG (electroencephalogram). In figure 3, as you can see, the subject is wearing an EEG helmet that allows the simultaneous determination of the cerebral activity registered with the help of the helmet and the MRI. This combination allows the simultaneous provision of very precise spatial and temporal information regarding the cerebral activity.

Source: http://www.virtualcancercentre.com/healthinvestigations.asp?sid=2

Fig. 3. *CAT scanner*

[13] Interdisciplinary researches regarding the neuromarketing and the subjects' behaviour in relation to the branding, advertising and satisfaction factors, 92125/1.10.2008, project financed by ANCS, project coordinator S.C. SETKO IMPEX SRL, director Corbu Ion.

Source: Inauguration du Brain Behaviour Laboratory 12 mars 2009 Photos: Dorothée Baumann

Fig. 4. *MRI-electroencephalograph combination*

The emergence and development of the neuroeconomy and the complementary sciences, the neuromarketing, neuromanagement, neurofinances, etc. confirm what the philosopher Thomas Samuel Kuhn said [6] with regard to the leap evolution of scientific knowledge. The scientific knowledge has stability periods dominated by a scientific paradigm, a set of values, models, beliefs, procedures and techniques accepted and used generally by the members of the scientific community. Along the entire stability period, the theory, seen as a hypothetic-deductive corpus of non-contradictory correlated assertions that are interrelated one with the other so that none is left aside, is developed by finding solutions to the problems connected to the evolution of the field in relation to the accepted paradigm. At the same time, as consequence of the impossibility to solve all the issues and the impossibility to prevent the emergence of new ones outside the existent paradigm, anomalies and contradictions of the paradigm emerge and accumulate. Solving them often leads to the emergence of a new paradigm that satisfies and finds solutions to many problems. Therefore, we think that the neuroeconomy paradigm has developed and tends to replace the classic economy paradigm.

In a recent logics course, the following is ascertained: "For over 23 centuries-taking into consideration the space and time of the European culture beginning with the «Greek miracle»– there are certain people who have asked themselves: **how do we think**? We will never thought be able to pretend a precise, full and reasonable answer to the question **what do we think**? I do not think it would be of great importance to answer the second question as, in a really civilised world, the common sense impulses us to admit that **thoughts are free** – every person has the right to think **whatever** he/she wants and can.

And in the end, history or hazard has selected and sanctioned – positively or negatively – what still remained from what has been and is thought. There are people who have asked themselves why we are thinking what we are thinking. What makes

the difference between those who ask themselves how? And the ones who struggle to find out why? Is that the first ones are the logicians and mathematicians and the other ones can be philosophers, psychologists, sociologists, historians, jurists etc." The economists, psychologists, sociologists specialised in neurosciences, endocrinology and the specialists in neoro-imaging are trying hard to get closer to the core of this miraculous process of the human being that is the thinking, starting with the necessity of understanding the mechanisms of economic thinking.

Conclusions

The study of the cerebral activity while the decisional activity and mainly during the analysis and elaboration of the economic decision highlighted the fact that these decisions are closely related with sensations and emotions.

Neuroeconomics, as emergent science, is ascending and enlarging the interest field of experimental and behavioural economics and will change the economy known as classic.

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