

# NEUROECONOMICS: THE EFFECT OF CONTEXT IN DECISIONS RELATING TO THE BRAZILIAN ELECTRIC SECTOR

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## ABSTRACT

Economic agents use to have serious limitations on the process of "rational" decision making in their economic lives. Even those who are prepared to make decisions in the very competitive environment of nowadays markets may have unconscious stimuli. A good example of this reality is the "panic" caused by the crisis in 2008 that reached the economic agents in particular, the economic analysts, governments, etc. Today they try to find explanations for the explosion of the crisis. A major bias is found in the way decisions are presented to agents, concerning to the "context effect" on decisions. Given the inability that "school of rational economy" has to explain the economic problems, neuroeconomics comes to take this place aiming to explain these problems by studying the brain of economic agents. As a result, neuroeconomics may become a way to find solutions to problems that for several decades economists could not find an explanation to the consumption and investment decisions of individuals in the economy.

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### KEY WORDS

Neuroeconomics, neuromarketing, decision-making, effect of context, bounded rationality, biological value.

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## [I] INTRODUCTION

Neuroeconomics is the fusion of neuroscience and economics as its name suggests but it is also the junction with many other disciplines (biology, physics, chemistry, statistics, mathematics, psychology, or pharmacology, for example). This makes the decision-making more realistic and appropriate to everyday economic agents. Indeed, neuroeconomics arose from the need to achieve more reliable results about the economic decisions of individuals.

Neuroeconomics, being a new field in economics, analyzes the relationship between the internal organization of the brain and the behavior of the individuals, when individual decision-making, social interaction or institutions like the market are considered – see Sandroni [1]. Neuroeconomics is directed to investigate the variables that actually determine the choices of economic agents. It can be stated in a general way that this approach analyzes the decision-making based on the viewpoint of man as a being who makes his economic decisions in a cognitive way. In short, opposing to the proposed idea of Homo economicus, it is clear that men and women appear emotional, contradictory, fearful, or very human – see Teixeira and Porto [2]. Neuroeconomics consists in an attempt to take the humanization of the behavior of economic agents (in the existing economic models) to better understand and accurately measure the sensitivity of economic variables on the different situations in the present life of man as economic being – see Chavaglia and Filipe [3].

A recurrent problem in the economy is the "effect of context". This effect implies the fact that people are influenced through the way by which decisions are made, in particular, options that involve a positive and a negative version.

Thus this study has the general objective of confirming the existence or not of the context in decisions. The objectives of this study consist on peripheral conducting tests with students of MBA FGV Fundação Getulio Vargas (Brazil) and with doctoral students of business courses at ISCTE / IUL – Instituto Universitário de Lisboa (Portugal).

## [II] NEUROECONOMICS

Neuroeconomics is a multidisciplinary science encompassing the fusion of two distinct disciplines (neuroscience and economics), using some others as, for instance, quantitative methods, biology, pharmacology, psychology or sociology. This combination has generated great contributions to the understanding of the process of decision making by economic agents. Thus, the understanding of the mental decision-making processes can contribute significantly to the improvement of the explanation, prediction and stimulation of phenomena related to the agents' behavior.

Some authors argue that neuroeconomics is simply the union of

neuroscience and economics. However, despite the deserved prominence, these definitions are too simplistic, especially considering just how the brain works in decision making not considering the final results, which are as important as the functioning of the brain mechanisms.

This new field of study is in essence the premise that man is basically irrational and is driven by cognitive biases derived from the unconscious. Hence neuroeconomics offers an opposing view to the traditional view of the economy, what guarantees a recognized and particular importance of neuroeconomics in the development of economic studies, what represents a more reliable way for decision making and understanding of complex economic problems in the nowadays life.

However, before going deeper in the concept of neuroeconomics, it becomes necessary to understand a little better the factors that led to economic theory to this point in history. Therefore, it is advisable to make a clarification on relevant developments in the behavioral approach to economics, culminating in the emergence of neuroeconomics itself.

The first consistent criticism against orthodox economics was presented in Karl Marx's "Capital" (1867), where a critique to capitalism and free markets were made. Later, with the great depression of 1929 and the crash in the New York Stock Exchange, classical theory in its purest form got unsustainable. This event contributed definitively to the appearance of a new and strong criticism of the liberal economy. The work of Keynes (1883-1946) was the one that most has influenced the reality during this crisis. Keynes especially challenged the rationality of economic agents and later would introduce the concept of animal spirits, which was considered by Keynes partly responsible for the economic fluctuations. In 1971, the work of Daniel Kahneman (1934- ) and Amos Tversky (1937-1996) made possible the emergence of neuroeconomics. In 2002, they would earn the Nobel Prize in Economics. In 2001 George Akerlof (1993), Professor of economics at the University of California, would also receive the Nobel Prize. Another researcher who has received this award (Nobel Prize in Economics in 1992) was Gary Becker (University of Chicago). His article "The economic approach to human behavior" (1976) was particularly recognized. In the 80s, the economist Richard Thaler (2008) continued the studies of Kahneman and published an article containing the essence of what would be the positive theory of consumer.

Nowadays neuroeconomics is well organized as a discipline. Specific studies and education on the subject are being developed worldwide. The Society for Neuroeconomics has some of the major research centers in this area (in Duke University, University of London, Harvard, MIT, among others). Additionally, search techniques are becoming increasingly sophisticated with the use of revolutionary techniques such as Functional Magnetic Resonance Imaging (fMRI), positron tomography, electroencephalogram (EEG),

Eye tracking, facial reading of micro expressions, and physiological excrement collecting for laboratory tests.

Today, after the turmoil of one of the major financial and economic crises, many economies in the globalized world became very affected. New sources of dissatisfaction with the traditional tools of economic analysis became a reality. This time the economy has the collaboration of neuroscientists in the searching for results closer to reality. This fact allowed that neuroeconomics become more important, becoming away from its position of marginal situation to be launched in a prominent position in the global economy.

### [III] BIOLOGICAL VALUE AND ECONOMIC DECISIONS INFLUENCE

Professor Antonio Damasio, specialist in Neuroscience, Neurology and Psychology at the University of Southern California, may be considered as the father of the theory concerning the biological value. The studies of this neuroscientist generated very interesting results for the analysis of the value from the perspective of neuroeconomics.

The impending clash between conventional economics and neuroeconomics is inevitable. The orthodoxy defended the idea of an economic agent aware of his actions and decisions, what is contrary to the basic idea of neuroeconomics. Neuroeconomics accepts that man is partly rational (conscious), but points to the fact that the vast majority of decisions are made unconsciously. Thus the concept of value to the light of neuroeconomics cannot be achieved without understanding the biological factors endogenous to the process of decision making.

However, it should be necessary, before anything else, to conceptualize the relationship between consciousness and unconsciousness in the process of decision making. Briefly, the conscious and unconscious processes exist in parallel and, moreover, some unconscious processes are important for survival and occur without any involvement of consciousness.

Due to the evolutionary process a human has different types of brain, with respect to mind and consciousness. Thus, the constant pursuit of maintaining bodily chemical parameters compatible with a situation of healthy life is the most important thing any living being has. In this sense, the concept of biological value is itself essential for understanding the evolution of the human brain, as far as the brain development and the brain activity itself.

In a vulgar manner, the traditional economy applies the concept of price in the lives of agents. It is true that the price of goods is responsible for managing the gap between what is available for offer and demand. The price submits the order of acquisition of goods and services, alongside the budget constraint applies.

Some assets are more useful than others (utility value). However, just when inserting the concept of need is possible to explain the essence of biological value. That is the question of living individual who strives to maintain life and the needs arising from this effort. However the reason that leads people to assign value to a good or service goes through the logic of maintaining life and needs that emerge from this logic. For the economic life this indicates the first step for understanding the question concerning the value of goods and services – see Hunt [4].

Neuroscience allows now revolutionizing the question of the value in the economy, primarily because it gives an understanding of the process of decision making at the time of release of certain chemicals in the brain when in situations of reward and punishment, which are directly related to the question of value. Moreover, neuroscientists began to give greater importance to the study of brain nuclei (reptilian brain) and that generally are the most responsible for decision making by humans.

But that is not all. The value is linked to the need, which is connected to supporting life. Moreover, the quality of life is also essential to humans. This happens when choosing a holiday destination in summer, the next cell phone fashion, luxury car or a Doctorate in Miami.

In general, the most essential of the value for all organisms is the survival and a healthy age-compatible to reproduction. Natural selection has refined the homeostatic mechanisms so that the target can be achieved.

Therefore, the origin of the biological value is a derivation of the physiological factors. Thus, the biological value leans toward one scale on the effectiveness of the physical life of the individual.

When humans assign the values to objects, activities have some kind of relationship, even indirect it may be. There are some conditions: first the overall maintenance of living tissue must be within the homeostatic limits appropriate to the context in which it is; secondly, conditions necessary for homeostasis work in a sector of the body that allows the well-being on the context in which the organism is.

Chemical components of the brain allow an unconscious monitoring of what deviates from the homeostatic boundaries, as some kind of sensor in terms of the levels of internal necessity. For example, when the homeostatic limits are exceeded corrective actions are taken by the body promoting incentives or deterrence actions. This depends on the urgency of the response. The record of these actions helps the body to predict future conditions. They begin to experience pain and pleasure.

The human being is in essence the impetuosity to move. This was one of the evolutionary advantages that allowed a man to

be what he is today. But every action requires an incentive, which is why some actions are chosen over others.

Until then all the mechanisms described above do not point to the existence of consciousness, only automatic and unconscious processes. However, this is directly related to the economy.

The incentive is therefore an important variable to the biological value. The sensations triggered on the pain, pleasure, etc.. in everyone involved in these states or sensations are the hormones and neurotransmitters. In the case of humans, there is the detection and prediction of possible advantages and threats to the body. For example, when you have the expectation of pleasure, the brain releases the neurotransmitter dopamine. But when one is facing a possible threat there is the release of cortisol. In terms of prediction, if two stimuli occur one following the other, a third stimulus would certainly be expected.

The results of the whole system indicate the following: first, the possibility of a differentiated reaction in each context; second, optimized reactions.

As the organisms have evolved, the underlying homeostasis programs have become more complex as regards the condition that triggered the action and its range of results. These more complex programs gradually became what is now commonly known as drives, motivations and emotions.

Humans possess the more advanced motivational system and a keen sense of exploration and sophisticated warning systems directed to future needs, all of them aiming one goal, to keep the body in constant search for "wellbeing".

The emotional feelings are reflections of bodily states or results altered by the emotions, so that feelings serve as indicators for the management of life.

Most regulatory activities are a result of the unconscious and are essential to the survival of the organism. After all, it would be extremely complicated if humans could manage their own endocrine aspects or the immune system.

Before one has in mind the consciousness as something harmful, it is important to note that it is due to the reasoning ability of man, that it was always possible to shape some kind of ways for man survival in different situations (as what has happened for example in extreme cases in the human history in earth or even in the moon). The new combination of factors producing goods and services allows humanity to adapt to any possible environments, so man invents materials to live anywhere in the world.

The development of the conscience allowed man to have a vital regulation more centered on the development of one only mind in each person, focused on survival but also on the "welfare". This allowed that aspects of people's daily lives have arisen, such as the economic exchanges, religious beliefs, social conventions, ethics, law, science, or technology.

Finally, the biological value depends on the idea that the brain is for managing the life within the body. An economic analysis based on the biological value is fundamental for the understanding of human behavior and to stimulate economic behavior of agents – see Damásio [5].

#### [IV] THE HUMAN BRAIN

The brain is the organ responsible for thought, beliefs, memories, behavior and "states of the soul." The brain is also called the control of the body and coordinates the powers of movement, touch, smell, hearing and alert states. Of course it provides the ability to reason and make rational decisions (at least some) as well.

The human brain is comprised by 78 percent water, 10 percent fat, 8 percent protein, 1 percent carbohydrate, 1 percent salt, 2 per cent other components.

Taking into account the anatomy of the nervous system, it is considered divided into two parts: the central nervous system and peripheral nervous system. The central nervous system (CNS) is bilateral and symmetrical, compounds itself brain and spinal cord. The peripheral nervous system (PNS) is a nerve net which serves as a connection between the brain and spinal cord and the rest of the body. The three components of the brain are: the brain, the brainstem and cerebellum. The brain - seen from above - is divided into two parts, the right hemisphere and left hemisphere. These parts are connected by nerve fibers in the center, the corpus callosum – see Robert [6].

The cerebral hemispheres are covered by the cerebral cortex, which is organized into lobes (occipital, parietal, temporal, and frontal), including the cingulate cortex, seen only on the inner surface - medial. The insular cortex, hidden under the parietal and frontal regions, and the hippocampus, a special cortical structure hidden in the temporal lobe.

Below the cerebral cortex, the central nervous system includes deep agglomerates of nuclei as the basal ganglia, the forebrain, the amygdala and diencephalon (the combination of the thalamus and hypothalamus). The brain is connected to the spinal cord through the brain stem, which is located behind the cerebellum, with the two hemispheres.

The human brain is divided into three parts (neo-cortex, reptilian brain and limbic system is the proposal developed by MacLean (1913-2007)) in addition to the usual division in the literature (right and left hemisphere). Economic decisions are processed, felt and performed by the brain in general, yet only one brain region (the reptilian brain) is responsible for about 95% of the decisions on the purchase of a product.

The neo-cortex is responsible for the reason, represented by the speech, writing, reasoning. In the action of purchasing a good,

the consumer first makes the decision after he justify it. It is in this moment of justification that the cortex comes into play.

In the evolutionary process, the neutral ampoule always continued to be developed: two lateral ventricles were born, occupying their place symmetrically in the right and left, in the interior of the cerebral hemispheres. The regions of the cortex react in a very short time, and although constructed according to the same model, each one of them retains its original function. For example, recognizing a face, a place, a smell or a poem does not require all the cortical cells, just some special cells.

The cortex is thus very important to capture aspects of sensory stimuli, which are studied in neuromarketing and neuroeconomics. This means that the five senses in the process of buying and selling products and services in the market are used.

The limbic system is responsible for processing emotions. When a client moves to buy a Beatles album or to buy the first car, the first house, the trip of a lifetime, or anything else he gets emotions about. When he watches the TV commercials and when a commercial appeals to emotional feelings like surprise or fear, then the limbic system is activated.

The brain structures in the formation of emotions in the limbic system are the amygdala (fear), the hippocampus (long-term memory), the thalamus (connection with other parts of the limbic system), the hypothalamus (to control the autonomous system), the cingulate gyrus (emotional reaction to pain and the regulation of aggressive behavior), the brainstem (action, alertness), the ventral tegmental area (pleasure), the septum (orgasm).

The limbic system is responsible for the memories. The repeated memories, guided by the experience, allows the learning which is essential to the daily life and to the exercise of a profession, and other economic actions of everyday's life.

The reptilian brain is the brain's decision-maker, where the electrical impulses that lead to action are processed. The customer buys by impulse, the customer buys without thinking. Let see again the example of the purchase of a product: first the decision is made, then it is justified.

The reptilian brain, which comprises the "butcher" brain, regulates the basic elements of survival, such as homeostasis. It is compulsive and stereotyped. MacLean illustrates this function by suggesting, for example, that it organizes the processes involved in the return of sea turtles to their birth place for their reproduction.

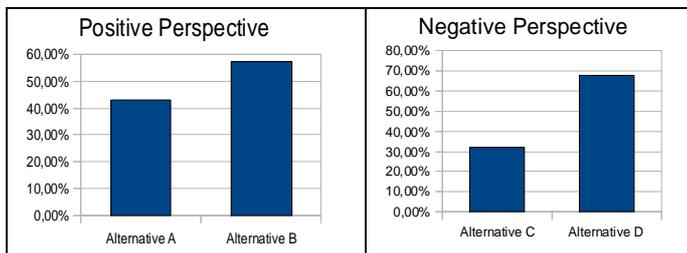


Fig. 1. Positive Perspective

Fig. 2. Negative Perspective

Source: Own Research

Therefore, for the formation of individual demand, the non-inclusion of variables such as context, perception, emotions, decoys (like free effect), can be fatal to the results of a marketing campaign for a product or service on the market.

## [V] RESULTS

### 5.1. Test Context - Part I

To ascertain whether or not the "context" is important in decision making, we performed a test (see Chavaglia et al, 2012) with 72 students of MBA in Business Management at Getulio Vargas - FGV in Belém, PA. The test was adapted from the studies of Tversky and Kahneman [7]. The researchers presented the dilemma of the disease, in which respondents had to choose between some types of treatments in a positive perspective and others in a negative outlook. An experimental research was used (experiments type before / after - 2 groups), which showed the control group and the experimental group before stimulation, then the stimulation applied in the experimental group, checking the difference between the experimental group (stimulated) and control (without stimulation). The difference between the two was the measure of the applied stimulus (context).

For this study we made some adjustments to the study of Tversky and Kahneman, instead of sick people. Homeless families were considered. The primary objective of the test was to identify the students' decisions concerning the construction of a hydroelectric project. The test was conducted as follows:

1. First the students should consider a decision about a flooded area comprising 600 families, under the following optics:

- Alternative A - 200 families would be preserved on site;
- Alternative B – a probability of 1/3 that the 600 families would be held in the place and 2/3 that no family would remain there;

2. In a second step, students should respond in a negative perspective, considering:

- Alternative C - 400 families would lose their homes, and
- Alternative D – a probability of 2/3 that the 600 families would lose their homes and 1/3 that no family would lose their home.

The issues mean the same phenomenon in both questions.

However each one represents a different approach. Alternatives A and B represent the decision in a positive perspective, and the alternatives C and D represent the decision-making in a negative perspective.

Considering the "positive results" [in the Figure-1], 57% of the students of MBA FGV responded that Option B would be the best choice, while 43% claimed that option A would be better. Considering the results for the negative context [Figure-2], 68% of students responded that Option D (which is exactly the same as Option B) would be the best choice to be made while 32% said that Option C would be the best among the possible. These results presented in the test carried out in the study and based on issues raised earlier in this chapter can be stated:

1. First, the agents are not as rational as traditional economic theory assumes;
2. Second, variables - hitherto less important to the economy - such as respect, influence in decision making.

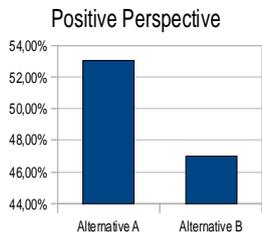
The first statement means that, unlike traditional economics suggests that, from where the concept of *Homo Economicus*, which seeks the maximization of economic actions in favor of their own gains, the results were not satisfactory in this sense (rationality), because the change of opinion on a new perspective (positive vs negative outlook perspective) implies that the numerical results alone do not influence the final results, unless they are presented from a specific perspective, after all, the change 43% (Option A) to 32% (option C) is quite significant and 57% (option B) in a positive context for 68% (option D) in a negative context - noting that both alternatives (A, B and C, D) show the same result.

The second assertion can be evidenced, and concluded that the presence of context - that is completely disregarded by an information theory approach of traditional economic analysis - was crucial to the results obtained in this study. What in general is that agents, when faced with economic decisions are strongly influenced by the context in which information is presented.

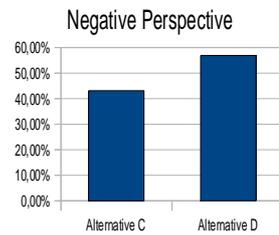
### 5.2. Test Context - Part II

To test the results obtained in the previous context, it is necessary to extend the test. It was decided to conduct the same inquiry applying it to the students from a doctoral course in Lisbon (Portugal).

All the assumptions concerning the previous test were kept. The goal is to confirm if more qualified people or more familiar with the studies in the Economics area, management or marketing, were less susceptible to the bias relative to the context effect.



**Fig: 3. Positive Perspective**  
Source: Own Research



**Fig: 4. Negative Perspective**  
Source: Own Research

Once again the results were very interesting in the sense that they confirm the existence and the importance of the context in the economic decisions.

On the positive outlook [Figure-3] the majority (53% of doctoral students) has chosen the alternative A and 47% opted for alternative B. Now considering the same options on the negative optical [Figure-4], the result has changed, the alternative C (which is the same as A in the positive context) changed to 43%, while the alternative D was chosen by 57% of PhD students, representing an increase to over 10% more in parallel with this same option in the positive context.

At this point very definitive conclusions are not possible. But it seems evident now that the effect of context seems to influence the choices of economic agents. Perhaps this may be because the details relating to the evolutionary process; the mechanism that protects man from the dangers of the world brings us closer to pleasurable situations, which ends up by generating the perception or the distortions arising from it.

### [III] DISCUSSION

It is now necessary to make some notes about the results.

Like most of the studies carried out in neuroeconomics, this study permit to conclude that the idea of rational economic agents is not applicable. The effect of context, which is within the specification of the theoretical ground for neuroeconomics and for the analysis made in this study, is considered. This implies that agents decision are greatly influenced by how decision options are presented.

To test this theory, an experimental research was carried out with students of business management and other courses related to the business world.

It is not possible to guarantee that the results are definitive with regard to the condition of irrational agents. To this statement, it is necessary evidently to conduct an investigation involving more complex search techniques for brain imaging, as it is the example of functional magnetic resonance or computed tomography.

But the results can contribute to understand this feasible effect that happens in the decision-making of economic agents. According to the experiment carried out, it is possible now to highlight the following notes:

- The effect of context actually influences the decision making of agents;
- A considerable level of education in management does not free agents of being affected by this effect;
- The positive effect reflects modest responsibility for agents;
- The negative effect shows that the agents choose according to decisions that seem to be more secure.

Therefore, the results apparently indicate the existence of the effect in the economic context. Because it is an unconscious stimulus or situation, agents do not control or cannot defend themselves against the deleterious consequences of the effect of context.

### [IV] CONCLUSION

Neuroeconomics permits to analyze effectively about people's decisions and the process of decision making in the market. In this study an example used for the energy sector is presented. However, in many other situations in life, people are faced with this kind of conditions. And often non scrupulous people have important capacity to influence in matters that are considerably important for many people. Sometimes the context is unaware about who does "it" (in the sense of knowing about what you're doing) and in other situations, the effect can occur when the context may help agents to make better decisions. This should be what governments should do, for example.

A point that is usually discussed is the ethical issue concerning the "property" of the concepts and discoveries in this area, considering their origin in neuroeconomics or in neuroscience. In our view, both are used by each other and no conflicts are relevant. In some specific areas, there are some problems. For example, France government is reluctant about the experiments with functional magnetic resonance for economic purposes – see Oullier [8].

Some countries, like U.S.A., Brazil and Chile in America or the Netherlands and Portugal in Europe, are presented as a reference in terms of scientific research and respecting to the professionals working in neuromarketing and neuroeconomics. Surely this is an interesting discussion.

Anyway the main objective of this study is to work on the existence of the context in the economy. In our opinion the criticisms of neuroeconomics have been so far based on the continuation of the status of some defined group of professionals, more orthodox.

In what tests' results is concerned, it seems that the context is relevant in terms of economic decisions. In most of the sciences that study the behavior of people, the way people interact with the environment in which they live, considering physical and chemical factors, is relevant in an analysis for which there are many conditions involved. People have no enough knowledge about the real conditions they face. If they could know effectively about the environment, every person would

manage easily the consequences of their actions. They would overcome easily any bias encountered in their everyday life.

Consequently, it may be concluded that the effect of context is decisive for the choice of agents. For how, it is easy to understand that choices may influence the final result. The brain acts to choose the odds. The genetic and memetic determine the behavior of each agent, i.e., the evolutionary factors and lessons that humanity carries across the time for a long time determine how the human brain decides.

The effect of context is placed on the agenda of the evolutionary questions, such as: is this good or bad for me? I must run away or fight? In this study, the students of MBA and PhD were faced with the possibility of making decisions of facts that affect positively or negatively families housed in close proximity to a region that would be flooded by the construction of a hydroelectric power. The presence of the effect of context was revealed. The answers to the questions presented in the negative context showed that agents may change their minds. The questions were exactly the same.

Thus, in order to make an exhaustive economic analysis which may consider the biological value of people a first step is necessary like the one presented in this study. This may contribute to allow people to choose what is the best for them. Unfortunately people do not know what they want - and preaching common sense - until they are encouraged to make a choice. The study of the effect of context can be in fact an effective way to guide people.

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#### CONFLICT OF INTERESTS

Authors declare no conflict of interests.

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