

**A MODEL DEDICATED TO FORECAST THE EVOLUTION OF THE REAL ECONOMY AND  
FINANCIAL MARKETS SYSTEM FROM ROMANIA USING CONCEPTS FROM OPEN SYSTEMS  
THERMODYNAMICS – PROJECT DESCRIPTION\***

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**Abstract:** The project aims to create an econometric model which allows the forecasting of the evolution of Romania's real economy, as well as the evolution of the system of Romanian financial markets. The study basis is represented by the assimilation of real economies with physics systems which are appropriate to the modeling with the aid of statistical physics and thermodynamics of open systems. Where certain data come under record, some economic and market processes can be assimilated with afferent processes to some Brownian systems.

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**Key words:** real economy, financial markets, forecast model, open systems thermodynamics

### 1. Importance and relevance of the scientific content of the project

Within the multitude of trials of mathematical modeling of the markets' behavior with the purpose of achieving forecasts, the fewest successes have been obtained on the financial markets. The phenomenon is somehow paradoxal because of the fact that the financial markets present a high level of liquidity, and, therefore, their mathematical modeling can be approached not only to the statistical level but also with the aid of continuous functions. The mixed approaches of a statistical-continuous type can be used as immediate alternatives. The mathematical systems inspired by the physics of the Brownian systems present a novelty character, such as statistical physics and the thermodynamics of open systems. These types of models could be very successful if they present the advantage of adapting the econometric models to consecrated and checked mathematical models from the classical physics. In addition, these models, although having the shape of some systems of differential equations or equations with partial derivatives, by themselves difficult to solve on concrete cases,

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present the advantage of developing some studied solving methods and processed during long periods of time and confirmed by experience.

An important characteristic of the methods inspired of physics is represented by the fact that, for each type of general characteristic of the studied market a physics size can be assigned, so that the market to be thought as a continuous environment which interacts with the exterior – for the nonce with the real economy and other markets. A critical advantage of this approach is that, in this manner, a model for each market can be achieved, if all markets are practically reported to the same real economy. The financial markets, due to the high level of liquidity, are best appropriate to this type of modeling due to the fact that they can be best assimilated to some continuous environments.

In case of a formal assimilation with a physics environment, a market can be studied implicitly by endowing the environment to which it was assigned with quantity sizes, movement sizes, dynamic sizes and, where possible, with condition potentials. These types of sizes – by themselves of physics aspect – allow profundity interpretations at the level of dynamic evolution in time of the financial markets – thought as a physics environment – and their systemic reference to the economic environment as well as other markets.

In this context, the importance of the research theme is given by the fact that it aims to create a model for the Romania's real economy, written in condition sizes, and a model for the Romania's financial markets, written in process sizes. Afterwards, the connexion level between the model of real economy and the market model shall be noticed, by the interpretation and comparing the obtained dynamic answers after solving the models, as well as their connexion level with the phenomena already occurred and in course of development. At the same time, taking into account the approach of top-bottom type which shall be used in the construction of models, there shall be created (as a secondary objective) economic and market models at a global level (it is true, models more simplified than those which shall be created for the Romanian economy).

The relevance of the research theme is explained by the original elements and the innovative aspect of the approach. Thus, in the construction of models, there shall be used both notions of macroeconomics and international economy, mathematical analysis and statistical physics. The study basis is represented by the assimilation of real economies with physics systems which are appropriate to the modeling with the aid of statistical physics and thermodynamics of the open systems. Where certain data come under record, some economic and market processes can be assimilated with afferent processes to some Brownian systems. The passing from strategically built models (difficult to solve) to models with sizes with continuous evolution shall be aimed.

## **2. Project objectives**

Through the project suggested by the research team it is aimed the development of knowledge by fundamental research (the purpose of the research project of exploration of IDEI type), the project bordering within the strategic objectives of the CDI system included into the national Strategy in the research, development and innovation field: knowledge creation. At the same time, through the interdisciplinary approach of the research theme (economy, economic and physics statistics) we consider that the project shall contribute to the formulation and ratification of some original

hypothesis, as well as of some new conceptual models. At the same time, the research project is situated within the Social and economic and humanistic Researches field, a priority field included within the national Strategy in the CDI field, having as an objective the creation of a model for the Romania's real economy and one for the system of Romania's financial markets, able to have a minimum anticipative character.

Through the research project, the members of the team have in mind reaching the following objectives:

I) Creating a model designated to the forecast of real economy evolution and the system of Romania's financial markets (main objective);

II) Creating a model (more simplified) designated to the forecast of the global real economy evolution and the system of financial markets (secondary objective).

Regarding the relevance of the scientific objectives of the project in the context of the researches in the field on international level, we must mention the following: analyzed separately, the two disciplines (general) which interpenetrate within the suggested research project (economy and physics) knew an effervescent evolution regarding the research; we may remember here prestigious authors in the economic field aimed by the research theme (Paul Samuelson and Willian Nordhaus, Economics, 2004; Michael Parkin, Macroeconomics, 2007; Paul Krugman and Maurice Obstfeld, International Economics: Theory and Policy, 2006; Jeremy Siegel, Stocks for the long run, 2007; Paul Embrechts and Makoto Maejima, Selfsimilar processes, 2002 ) and in the physics field (thermodynamics of the open systems) aimed by research (Yunus Cengel and Michael Boles, Thermodynamics, 2004; Michael Moran and Howard Shapiro, Fundamentals of engineering thermodynamics, 2007; Claus Borgnakke and Richard Sonntag, Fundamentals of thermodynamics, 2008); in spite of all these, taking into account the original character of the project, strictly on the suggested research theme there are not known national or international researches.

We consider that the original elements of the project consisted in combining the elements of economy and economic statistics with physics, more exactly, using the mathematical systems inspired by the statistical physics or thermodynamics of the open systems, in the attempt of building a model for the Romania's real economy and one for the system of Romania's financial markets, able to have a minimum anticipative character.

The importance of the suggested theme for the research field must be judged in the context in which there existed attempts of mathematical modeling of the markets behavior with the purpose of achieving forecasts, and the fewest successes have been obtained on the financial markets. The importance of the theme consists in the fact that these types of models could be very successful if they present the advantage of adapting the econometric models to consecrated and checked mathematical models from the classical physics. In addition, these models present the advantage of developing some studied solving methods and processed on long periods of time and confirmed by experience.

The estimated impact of the project is a relevant one, meaning that the built models can aid in orientating the investment policies both to the governmental resolution factors, banks and private investors, and to the management of the operations in the foreign commerce. Ideatively speaking, such models would aid to the better placing and connecting the Romanian economy to the global economy, thus increasing the chances of the economic success.

Regarding the interdisciplinary character of the project, it is generated by the fact that the project implies different disciplines (on one hand, it comprises elements of economy and economic statistics, and on the other hand, physics elements), fact that stimulates the exceeding of the disciplinary border (mathematical modeling from the economic field).

Concerning the chosen research theme, it is started from the premise that, if, for the mathematical models in physics, the problem of the conditions at limit related to space and the initial conditions related to time is an explicit definite problem, for the mathematical models from economy the exposing of this problem presents a maximum difficulty.

### **3. Methodology of the research**

The research methodology is grounded on an analytical process able to identify the necessary instruments within the social and economic analysis, including the achieving the models which shall allow the members of the team to collect and process the scientifically data in a systematic manner.

Thus, the research methodology is grounded on two research types:

1. qualitative research (collecting data, analysis and interpretation of the qualitative data);
2. quantitative research (research grounded on statistical market research, questionnaires designing, sampling, statistical methods of data processing).

The research methodology shall be grounded on the general principles of thermodynamics, mainly the thermodynamics of open systems and the thermodynamics of irreversible processes. It is generally accepted that the processes which occur on the financial markets are entirely irreversible processes. The irreversibility character of these processes is given by the evolution itself of real economies at a global level.

The diversity and the different level of evolution at a conjunctural level of the world economy allow in a great measure its assimilation to an open thermodynamic system. Although there are controversies, it is considered that national economies can themselves be assimilated to the thermodynamic systems which mutually interact, therefore the global economy is a thermodynamic system formed of parts which obey to the general law of overlapping and parties equilibrium.

In order to build anticipative models related to the financial markets behavior it is necessary an evaluation of the global economic conjuncture. We're talking about two collateral thermodynamic systems: a real one (real economy) and a formal one (stock markets). Ideatively speaking, the global economy and the markets should be in a perfect correlation. The purpose of the research consists in tracking down the factors which lead to the disjunction of the financial markets behavior from the real economy behavior. The research shall focus on two plans: real economy and financial markets.

A) Regarding the real economy, the research methodology shall concentrate on the following stages:

A.1.) One shall try to track down some condition parameters of the global economy and with their to be able to assimilate this economy with an open thermodynamic system (the importance of the test economy parameters – USA, the importance of the parameters of G7 economies, the importance of the parameters of G24 economies, the economic parameters of the resultant economies, depending on the geographical positioning and currency used in establishing the rate of national currency). The data shall be collected from the main national and international financial

institutions which collect and elaborate data bases with the main macroeconomic indicators at a national, regional and global level.

A.2.) Establishing the conditions at limit for this thermodynamic system, which we consider open. In this context, the conditions at limit shall have relatively complex mathematical formulations, meaning that it shall be emphasized the direct dependency of time of these forms. As it is possible, one shall chose the continuous modeling and we shall confine ourselves for the conditions at limit for differential forms of I<sup>st</sup> order in the condition parameters previously defined (PFAFF forms). In the end there shall be chosen only a few condition parameters which shall be considered relevant, and, if it's necessary, there shall be written the dependencies on time of these condition parameters (implicit functions).

A.3.) Establishing the initial conditions afferent to the developed model. These refer to the definition from the qualitative point of view of the economic conjuncture from the moment of the beginning of the study and their quantification in quantitative terms. Practically, we're talking about the quantitative evaluation of the initial values for the condition parameters previously defined. There is the possibility that these initial values not to be necessarily fixed values. There is also the possibility that these initial conditions not to depend on the moment of time of the beginning of the research, but on a previous moment of time. The purpose of the methodology applied within this research stage is to establish the economic cycle where we are and to identify the debute of this economic cycle.

A.4.) Establishing adjacent conditions at limit, which depend on interactions with a more special character of real economies with evolutions which depend fundamentally on the markets behavior (petroleum price, gold price, in a word – commodities).

A.5.) Regarding the economic cycle in which we established that we are found, an estimation at a global level of the level of commodities and services supply and demand shall be attempted , in order to establish the level of economic optimism. This study of the level of economic optimism on short term may suggest the proximate dynamic of global economy, being able to bring possible adjustments to the initial mathematical model. Data and forecasts of the World Bank, International Monetary Fund, European Investment Bank, BERD shall be collected and processed, as well as of some powerful investment banks.

A.6.) The evaluation of the economic cycle where Romania lies, which can be sensitively different (in terms of quantity and not quality) from the global economic cycle, and the relation of the evolution of the parameters of this cycle to the initial conditions of the global cycle. Regarding the special case of Romania, it shall be taken into account that Romania has a yet not restructured economy, with a simple infrastructure, with a simple banking system and a low level of economy monetization. There shall be collected and processed data from the Ministry of Finance, National Institute of Statistics, National Commission of Forecast and National Bank of Romania. Regarding the data processing, there shall be used the linear regression, the not linear regression and the interpolation.

A.7.) The evaluation of the condition of Romanian economic actives (structure, diversity, their price, the dynamic of their price) and the manner in which these contribute to the gross domestic product formation. The conclusions of this evaluation shall represent, on one hand, in limit supplementary conditions for the mathematical model afferent to Romania, but also within the initially supplementary conditions. In

this stage, it shall be aimed the building of a model for the global economic evolution (a little more simplified) and a more complex mathematical model designated to Romania.

There shall be collected and processed data from the Ministry of Finance, National Institute of Statistics, National Commission of Forecast and National Bank of Romania. Regarding the data processing, there shall be used the linear regression, the not linear regression and the interpolation.

A.8.) The evaluation of the impact of the macroeconomic policies upon the real economies. This evaluation is difficult to determine if it shall be constituted in an entrance size, condition size or exit size.

A.9.) Establishing a set of entrance sizes, condition sizes or exit size (or combinations) afferent to the global model. The tracking down of some possible disturbances and their mathematical modeling (as much as possible).

A.10.) Establishing a set of entrance sizes, condition sizes or exit size (or combinations) afferent to the model designated to Romania. The tracking down of some possible disturbances and their mathematical modeling (as much as possible).

B) Regarding the financial markets, the research methodology shall concentrate upon the following stages:

B.1.) The evaluation of the spot financial markets and futures markets condition, concentrating on indicators such as volume, profundity, wideness, liquidity, spread size and so on, and introduction of some condition parameters able to surprise the connections between them.

B.2.) The evaluation of the connexion level of the financial markets with the real economy which would characterize the dynamic of the markets and the quantitative quantification of these sizes. The mathematical modeling of the connexion level of these process sizes and the evolution of the condition parameters of real economy.

B.3.) The quantification of the psychological factor in the evolution of the financial markets. For this purpose it shall be used the theory of differential equations with singular solutions such as the theory of catastrophes.

B.4.) The quantification of the effects of macroeconomic policies upon the financial markets. The evaluation of the answer level to these policies of the markets at the global level. The establishment and the quantification of the delaying factor which separate the answer of the financial markets and the real economy to the macroeconomic policies.

B.5.) The accounting of all real catastrophes occurred after 1945 and the review of the effect which they had upon the markets. The forecasting of catastrophes possible to happen in a predictable future and the evaluation by comparison of the impact which they may have upon the financial markets. Also it shall be used the theory of catastrophes.

B.6.) The evaluation of the impact which the periodical macroeconomic data, communicated especially by the economies with large share, have upon the financial markets.

B.7.) The evaluation of the Romanian financial markets condition. The definition of some parameters which would characterize the connection between these financial markets and the real economy of Romania.

B.8.) The establishment of the influence level which the evolution of the traditional financial markets have upon the Romanian financial markets.

B.9.) The identification of the key macroeconomic parameters which critically influence the financial markets in Romania.

C) It shall be noticed the connexion level between the models of real economies and the market models through the interpretation and comparing the obtained dynamic answers as a result of solving the models, as well as their connexion level with the real phenomena already occurred and in course of development.

#### **4. Project feasibility**

The realism of the suggested solutions is demonstrated from the conceptual, costing and research duration point of view.

Conceptually, the project shall bring a significant contribution to the improvement of the forecasting methods of the evolutions in real economy and of the system of financial markets, both at global level and especially at national level. The theme of the project was chosen taking into account the importance of the system of analyzed markets. This demarche is adequate as it is acknowledged a moderate success in the mathematical modeling of the mathematical processes, especially those related to the financial markets. The purpose of our research is to contribute to the creation of a model capable to have a minimum anticipative character (to be able to create credible forecasts). The study basis is represented by the assimilation of real economies with physics systems which are appropriate to the modeling with the aid of statistical physics and thermodynamics of open systems. Where certain data are appropriate under record, some economic and market processes can be assimilated with afferent processes to some Brownian systems. It shall be aimed the passing from models strategically built (difficult to solve) to models with sizes with continuous evolution.

We achieved the estimation of the costing implied by the project development by taking into account the complexity of the objectives, of the necessary volume of work, of the insurance of an adequate informing level and technical and material endowment. We carefully analyzed each component of the budget, in the allocation, on activities, of the expenses taking into account the specific aspect of research of the chosen field. In this regard we budgeted the expenses with wages according to the GD 327/2003, these bordering within the covers established by Decision for each didactic position. Also, the implying into the master knowledge's in this field facilitate for the young researchers the participation to new projects of a bigger span.

Concerning the estimation of the material costs with the inventory objects and equipments we took into account the real necessities for the development of the project and the technological endowments and the infrastructure made available by the faculty. We consider that in this way we shall succeed in exploiting under conditions of maximum efficiency the financial resources in order to integrally accomplish the project.

The duration of the research is of 36 months, because of the great volume of work implied by the research.

The support level of the suggested contributions through previous results of the team is high.

At the basis of this information stand the scientific results of the team, materialized in publications, acknowledgment of the members of the team within the academic environment which, although it has young members, these are recommended in order to held lectures and specialty courses. The contributions of the project as a natural continuation of the research activity of the members of the team. The project feasibility is supported also by the abilities previously proven by them regarding the team work for the projects above mentioned.

The risk level of the research is low, but the members of the research team would have to take into account also the possibility of the arising some risks related to the arising of some errors in modeling, as well as the lack of coordination. In this case the research team shall proceed to adjustments within the model, and also to the achievement of an efficient control upon the activities of the project constantly and compelling, as it was previously described. Depending on the risks that shall arise, the members of the team have in view the adjustment of the research process, so that its quality shouldn't be affected, and the obtained results to truly reflect the reality. The settling as a research object of a theme that presents a great importance for the governmental resolution factors, banks and private investors but which is less known and analyzed, doubled by a careful and in depth studying of the specialty literature in this field confers a strong practical character to the research theme, by the possibilities of efficient use of the results by the target group above mentioned.

#### **5. Measures provided in order to respect the research**

In the context of abiding the deontological provisions of the university research, the members of the research team commit themselves to stimulate the creativity and originality in reaching the aimed objectives. The demarches in research shall be characterized by objectivity and responsibility. Also, it shall be aimed the insurance of a correct and complete informing in the micro and macroeconomic field. Both in using the documenting modalities and the process of dissemination of the results, the provisions of the copyright law shall be abided. Thus, the bibliographical used sources shall be mentioned with rigor and any material shall be published only with the consent of its authors. The members of the research team commit themselves to put at the disposal of all interested persons the materials used for the accomplishment of the research. The selected data shall be scientifically dealt with, eliminating any subjective interpretation, and the research team commits to truly present the research results, without distorting them, even in the situation when these shall not certain hypotheses determined at the beginning of the research. Equally, the real data from the Romanian economy selected by means of questionnaires and interviews shall be published only with the explicit permission of the aimed subjects. In order to draw up the research results and the analysis of the statistical data there shall be used informatics programmes and statistical applications with license for use or edited by the members of the research team.

#### **REFERENCES**

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