LINIARITY OF THE ECONOMIC SYSTEM

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Abstract
This paper aims to achieve a critical analysis on the condition of linearity in relation to the economic system, in terms of systems theory. In this context the benefits are captured and methodological limitations arising from systemic approach to the economy. Critical analysis is done from a perspective that captures cyber connections between economics and its concepts of theoretical physics and especially concept derived from quantum mechanics. Special emphasis is given to the nonlinear nature of economic systems and the consequences that flow from it in the process of shaping the economic phenomenon. The condition of linearity to the default assumed the current economic model is systematically demolished by the reality of the crisis phenomena, but without this phenomenon shaping economic conditions is impossible. This contradiction is also assumed strong point of the analysis of economic phenomena and the "Achilles heel".

Although there is no logical solution to eliminate this contradiction, but clarification and assuming this level may help to optimize the modeling process. To achieve this, however, it is necessary to clarify the conceptual framework in which the modeling took place. Thus,methodological clarifications to the work provides a new perspective on the economic crisis in general and the study of the mechanisms of formation of bubbles in particular.

Key words: economics, systems, liniarity, quantum mechanics.

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Introduction

The theme addressed in this article aims to contribute to the clarification of some aspects related to the modeling of economic systems. So

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we will refer to the economy of a country or even to the global economy in terms of a system whose evolution is modeled. It is less interesting in this context if the modeling is done at macroeconomic or microeconomic level, but we accept that economic laws are defined as functions with input values (statistical data recorded at different time intervals) and output values (expressed as forecasts economic).

We also bear in mind that economic development is primarily determined by human behaviors, such as consumption, saving behavior, responses to stock market indices, immediate economic decisions to develop a business, invest in, or The influences created on the market by marketing activities, etc. All of them have a high degree of subjectivity, unpredictability, and can generate or be influenced by decisions that do not respect economic laws or are sometimes not rational.

A significant example of this is the decision to invest in luxury goods at the expense of products considered to be strictly necessary. The correlation between consumption decisions and the Pyramid of needs (defined by Maslow) is not always correct, and this decision is increasingly influenced by social trends or trends that do not always have a rational foundation.

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To clarify the notion of linearity, it should be noted that this is essentially expressed by the following phrase: the sum of the effects of the causes is equal to the effect of the sum of the causes. In other words, if a system acts on several causes, the sum of the resulting effects will be equal to the effect generated by the action of all causes. In essence, this condition of linearity includes an additive operation, through which an aggregation phenomenon (in an economic sense but not only) can occur without inducing distortions on the final result.

In mathematical language:

$$f(c_1) + f(c_2) + f(c_3) + \dots f(c_n) = f(c_1 + c_2 + c_3 + \dots c_n) \quad (1)$$

and: $f(c_1)$ - the effect of the cause 1;

$f(c_n)$ – the effect of the cause n;

$c_1 + c_2 + c_3 + \dots c_n$ = sum of cases;

The linearity property is intuitively modeled by means of the vector assembly:

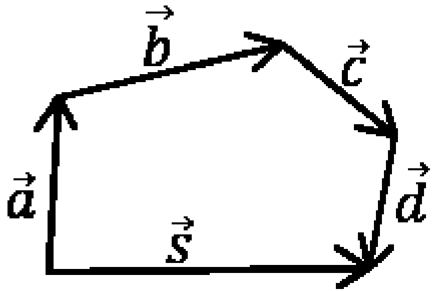

Figure 1. Vector Assembly (vector shape in two-dimensional space).

The vector may describe for example the influence of the sudden rise in price for the product "M", as the other vectors $\vec{a}$, $\vec{b}$, $\vec{c}$, $\vec{d}$, will also describe the influence of other events (economic or not). But the cumulative effect of these factors is described by the vector $\vec{s}$. Obviously, vectors defined on n-dimensional spaces can also be used, in which composition laws will be the laws of the economic system.

A necessary step for the operationalization of this approach is to be the establishment of the unit vector, which has to include a minimum number of properties so that it can describe economic processes both micro and macroeconomic. I think this is really an important challenge for applying a modeling of the economic system based on the principles of quantum mechanics, in terms of the conditions that such a vector space must satisfy.

The modeling of economic phenomena implicitly accepts this condition of linearity, with economic laws being defined as functions describing linear evolutions. An example in this respect may be that, in general, an increase in the price for the product "M" leads to a decrease in demand. Moreover, this linear dependence is accepted as immutable and independent of subjective factors. This is an intrinsic necessity of linear system modeling, because in its absence it exponentially increases the number of degrees of freedom that characterize the system and it simply becomes too complex to provide clear predictions.

The economic forecasts also contain an important doctrinal component associated with a certain economic (eg neoliberal) economic vision that has the role of significantly reducing the degrees of freedom associated with the economic system. Thus, one of the fundamental laws of macroeconomics asserts that money issuance that is not correlated with an increase in the quantity of goods and services generates inflation (Dornbusch R., Fischer S., 1993). However, American economists (including those from the EDF) or Europeans (from the European Central Bank - ECB) have not hesitated to flood the money markets in response to the economic crisis of 2008 through fiscal relaxation programs (Neguriţa A ., 2014). Moreover, the economy of the European countries and, in particular, of the Eurozone countries has experienced a deflationary period.

It seems that European citizens have changed their consumer behavior as a result of the financial crisis and have refused to plummet at a time of consumption that would have led to a money laundering. They preferred to limit their costs and consequently there was a contraction in demand coupled with a fall in prices.

In a Newtonian approach, the result of applying the principle of linearity in economic systems results in prognoses that depart more or less from objective reality. The result of modeling is considered satisfactory when these differences are small enough to allow for decisions to be taken to trigger economic recovery and / or to maintain economic macroeconomic balances. There is a fundamental limitation in this approach. No predictions can be made about the differences between the output values offered by the model and the reality modeled after the occurrence of the events. Thus, it is necessary to produce the effects of all the cases included in the model in order to make an assessment of the quality of the approximations made in the process of linearization of the causes.

A fundamentally different approach, from this point of view, provides the modeling made in the context of quantum mechanics. It provides the tools necessary to determine the probability with which the values obtained match the modeled reality before the effects occur. In this way, the degree of determination of the output variables characterizing the system increases, and the doctrinal options are applied to "choose" one of the options considered desirable in relation to the economic doctrine.

From the perspective of economic policies, this fundamental difference reveals the existence of a large dose of doctrinal (and not only) subjectivism in substantiating decisions. Thus, the economic models that substantiated the decisions of the FED management prior to the 2008 crisis were clearly based on the deterministic principles of Newtonian mechanics, and as a result their predictive value was always validated retroactively by the absence of an economic crisis. As the crisis unfolded, the EDF chairman himself at that time declared himself powerless and admitted that the models used did not have the capacity to provide the data needed to manage major imbalances.

At present economic forecasts increasingly accept the principles of quantum mechanics and recognize the limitations generated in the process of linearization of the functions used. Thus, after the economic crisis in 2008, no definitive sentences are given on the evolution trend of an economy, but forecasts are closer to the meteorological ones (which are currently using the principles of quantum mechanics) to express even the percentage of the probability of some Negative economic developments.

For example, the FED uses an Autoregressive Integrated Moving Average (ARIMA) model to predict the growth of investment fund growth rates, calibrating it on "stacking" - assessments by economic analysts based on a long range of data history. ARIMA models use long historical data series to make predictions about the future developments of those data series. The data series are statistically interpreted, and multivariable analyzes of probability densities are performed as they are defined in quantum mechanics. However, the principles underlying the interpretation of the results are inherent to Newtonian mechanics, ie Heisenberg's principle of uncertainty (non-determination) is not accepted (essentially, this principle states that it is impossible to determine with maximum precision two independent variables.) Thus, the better the precision we determine A variable - for example, the impulse of a particle will be less precise - the other variable will be described - for example particle velocity). As such, analysts' assessments are used to choose different possible outcomes from the model.

In ARIMA models, the mathematical function (regression or, more precisely, autoregression) expresses data redundancy (it quantifies the frequency with which certain values occur within a given timeframe), while

the moving average indicates that the statistical error Is a linear combination of values of variables that occur within a given time interval (which is actually the time of analysis). Integrating the values expresses that they have been replaced by the difference between their current values and their values at a given time in the past.
The mathematical form of an ARIMA model is as follows:
$X_t - \alpha_1 X_{t-1} - \dots - \alpha_p X_{t-p} = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \dots + \theta_q \varepsilon_{t-q}$
(2)
ande: X_t - is a series of real data, in which t is an integer indexer;
α_1 – are parameters of autoregression (function);
θ_1 – are the parameters of the dynamic mean;
ε_t – are the terms of statistical error;

Therefore, the general pattern specific to linearity modeling is respected, ARIMA models being summaries of some effects. Although these models take into account a certain amount of nonlinear variation, by including statistical error, they do not capitalize on the fundamental advantage of quantum mechanics' own approach, namely the ability to make predictions in which the probability density quantitatively expresses an element of predicting developments.
In order to achieve a correct modeling of the economic system we must use the idea that the quantum states of the system are vectors in an abstract vector space (which can be two-dimensional, three-dimensional or even n-dimensional) and it is not indicated to use the wave functions that impose Limitations due to the conditions specific to each system.

Thus, the use of vector spaces provides the ability to operate with functions in defining function spaces, in which the properties of addition and multiplication with a scalar are also preserved. $(f+g)(x) = f(x) + g(x)$
(3)
$f(ax) = a f(x)$ (4)

For example, Okun's Law (an empirically discovered law but validated by economic practice) asserts that the real GDP growth rate is negatively influenced by the decline in occupancy and even gives a quantitative expression of this dependence:
$\Delta GDP = -\beta * \Delta U$ (5)
and: $\Delta GDP = (Y^*-Y)/Y^*$

ΔGDP - is the real GDP change compared to the calculated GDP;
Y – real (measured)GDP;
Y* - potential GDP;
β – rate of GDP dependency on the unemployment rate;
ΔU – the variation of unemployment ($U_{effective} - U_{natural}$)

By vectoring, the real growth rate can be defined as an Euclidean vector as well as the rate of increase of unemployment, while β is a scalar (which takes values between 2% and 3% or 0.02-0.03).
Since GDP is in turn defined as a linear expression, it includes the linearity condition and is therefore subject to its limitations. If we look at GDP as a linear function it will have the following expression:

$$GDP = C_p + C_s + I + (E_x - I_m) \qquad (6)$$

Unde:
C_p = Private consumption;
C_s = Consumption of the state;
I = investment;
E_x = export
I_m = import

Each of these indicators has in this case values given as a result of aggregation, respectively, represents a real number resulting from the application of aggregation formulas. As a result, GDP will in turn be a real number resulting from a linear function.
If a vector space is used, an aggregation step is eliminated, or series of matrix-type gross series that will define private consumption vectors (eg consumption of the main consumer goods expressed in units Currency type), state consumption vectors, etc.

In the quantum mechanics wave function, in the probabilistic interpretation of Max Born, the square of the wave amplitude represents the probability density of the particle position. Also, this wave function will provide real-number values.

$$\int |\Psi(x)|^2 dx = 1 \qquad (7)$$

In this case it is important to interpret the wave function, which must respect the principles of quantum. Thus, the position of the particle has to be interpreted as a relevant parameter for the macroeconomic macroeconomic state. In this context, I appreciate that the wave function (quantum mechanics) can be a useful tool for analyzing macroeconomic equilibrium at the level of a state's economy, especially in the case of open economies based on capitalist principles. Following the process of modeling the variations in output values, probability densities will be obtained indicating the risk of macroeconomic imbalances (crises) occurring. A necessary initial condition is to define the equilibrium parameters, an aspect that involves an empirical calibration of the macroeconomic equilibrium condition and it can be different from one economic system to another.

Also, the non-determination condition imposed by the Heisenberg principle should not be ruled out, and therefore the economic system will be interpreted as an approximation of quantum states that are vectors in an abstract (n dimensional) vector space. Thus, there will always be an inverse correlation between the precision with which we can determine the evolution of the inflation rate and the evolution of GDP for the same economic system. Similarly, there will be many other economic indicators that respect the principle of uncertainty and they are not always in the form of pairs, although this is the simplest form of correlation. Thus, we can assume that, under a certain minimum threshold of economic indicators, we will be unable to maintain the correlation between measurement precisions of several economic variables.

Conclusion:

In conclusion, we can say that the review of economic models based on the quantum mechanics principles offers the opportunity to carry out quantitative assessments on the possible evolutions of an economic system before their validation by producing the effects. Even though Heisenberg's uncertainty principle (non-determination) does not allow us to formulate a single possible trajectory for the evolution of the economic system, yet the quantum approach of modeling economic systems allows for early adjustments based on forecasting scenarios depending on their likelihood of manifestation .

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