

# PRACTICAL ASPECTS OF MODELING THE STABLE POLITICAL AND ECONOMIC SITUATION IN THE COUNTRY ON THE BASIS OF MULTI-CRITERIA OPTIMIZATION METHODS

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## ABSTRACT.

*The article gives practical recommendations for the modeling of static (in time  $t$ ) and dynamic (for a certain time interval) comprehensive assessment of a stable political and economic situation based on graphical interpretation - the construction of a centroid of the triangle "economic, political and social sphere"; provides calculations of the generalized characteristics of economic, social and political development as average normalized values. The article offers approaches to mathematical formalization of structural changes in the country's political and economic condition by examining the dynamics of a stable political and economic situation in a given time interval.*

**Keywords:** Stability, Political-Economic Condition, Economy Development, Semicenter.

## 1. INTRODUCTION.

In the conditions of international financial integration the relationship between domestic and international financial markets increases with the deepening of their interpenetration. Gradual disappearance of barriers between these markets on the global scale ensures the free movement of financial capital, creates the basis for the realization of investments, lending and redistribution of risks as well as interdependence of the levels of economic, social and political development in different countries. At the same time, in the process of financial integration instability of political and economic condition of each country leads to intensification of crisis phenomena. Therefore, the necessity of an early prediction, monitoring, prevention of the negative consequences of the market, political and other risks leads to the development of instruments for economic and mathematical modeling of a stable political and economic situation of the country on the basis of multi-objective optimization methods, the development of effective measures of regulation.

## 2. ANALYSIS OF THE LAST RESEARCHES AND PUBLICATIONS.

Significant contribution to the study of the general features of a stable functioning of an economic system and approaches to stabilization of crises was made by the following researchers: Andrews, D. (1993) [1], Gale D., 1962 [2], Shapley L., 1962 [2,3], M. Goldstein, 2000 [10], G. Kaminsky, 1998 [10, 11], C. Reinhart, 2000 [10, 11], S. Lizondo, 1998 [11] and others. The theoretical and practical aspects of achieving stability were highlighted in the publications of Ukrainian authors: Baldohyn A. [9], Baholdyn A. [4], Boyko A. [5], Kozmenko O. [6], Merenkova O. [7], Onishchenko Y. I. [8], Pshenychna A. A. [8], and others. However, it is necessary to further develop the formalization of a stable economic, social and political development, finding the appropriate balance between the three objectives in the "economic, political and social spheres", the simultaneous achievement of which requires the solving of the problem of multi-criteria optimization.

## 3. PURPOSE AND RESEARCH METHODS.

The purpose of the article is the development of practical recommendations for the mathematical formalization of the static and dynamic evaluations of a stable political and economic situation of the country on the basis of multi-objective optimization.

The article is based on the general scientific methods: methods of empirical and theoretical research (modeling - to develop a methodological approach to the definition of the integral assessment of a stable system by finding the appropriate balance between three objectives, the simultaneous achievement of which requires the solving of the problem of multi-criteria optimization); local (specific) methods: methods of situation analysis (methods of formalization of economic conditions, methods of multi-criteria optimization and

graphic interpretations - to determine the centroid of a triangle, the vertices of which are generalized characteristics of economic, social and political development).

#### 4. RESULTS.

The results of the study of the practical aspects in the modeling of a stable political and economic situation of the country on the basis of multi-objective optimization methods include: the proposed sequence of practical steps to determine a stable political and economic situation in time  $t$ ; research of a stable political and economic situation by using the examples of Ukraine and France from 1960 till 2012 in the context of: characteristics of the country's economy (economic and financial sector indicators), social sphere (labor market and social protection, education, health, social development), politics (public sector and external debt liabilities); analysis of the dynamics and changes in the relative position of the curves of social, political and economic components confirming the priority of the components of political and economic situation of the country, as well as the levels of variation of each of the studied characteristics; comparison of the obtained results relating to instability of political and economic situation with the global crises and depressions; determination of a compromise stable political and economic situation in Ukraine and France in time  $t$  – a centroid of the triangle built in the previous phase; calculations of the static and dynamic values for the indicator of political and economic situation – crisis (instability) indicator.

#### 4.1 Theory and practice of political and economic stability of a country.

The analysis of the systems' stability makes it possible to systematize the existing approaches and consider this category as the ability of a system to maintain stable basic characteristics during insignificant market fluctuations, to adequately counteract the influence of external factors and to maintain a long-term dynamic equilibrium [19, 2020].

In the context of mathematical formalization it is proposed to interpret a stable political and economic situation in time  $t$  as a centroid of the triangle whose vertices are the generalized characteristics of economic, social and political situation. A stable state of the system requires a compromise between the three objectives, the simultaneous achievement of which requires the solving of the multi-objective optimization problem.

Let's consider the sequence of phases in determining a stable political and economic situation in time  $t$ :

1) The formation of the information research base – indicators of characteristics of the country's economy (economic and financial sector indicators), social sphere (labor market and social protection, education, health, social development), politics (public sector and external debt liabilities). At this stage the collection of statistical information about the component of political characteristics (column A of Table 1), economic component (column B of Table 1) and social component (column C of Table 1) of the system is carried out.

The implementation of this phase involves informational support for further research of a stable political and economic situation of the country (the examples of Ukraine and France), which includes the period of 53 years (from 1960 to 2012) in the context of these three components. The economic component is represented by 13 indicators (data time series), the political component – by 14 indicators and the social component - by 12 time series. Therefore, the input data set of the study of stable political and economic situation of these countries is represented by three asymmetric matrices with sizes of 14 by 53, 13 by 53 and 12 by 53.

**TABLE 1 – INFORMATION BASE OF THE RESEARCH OF A STABLE POLITICAL AND ECONOMIC CONDITION OF A COUNTRY**

Political component	Economic component	Social component
A	B	C
Central government debt, total (% of GDP)	Charges for the use of intellectual property, receipts (BoP, current US\$)	Children out of school, primary, female
Proportion of seats held by women in national parliaments (%)	Current account balance (BoP, current US\$)	Children out of school, primary, male
External debt stocks, private nonguaranteed (PNG) (DOD, current US\$)	Exports of goods and services (% of GDP)	Expenditure per student, primary (% of GDP per capita)
External debt stocks, public and publicly guaranteed (PPG) (DOD,	Foreign direct investment, net inflows (BoP, current US\$)	Expenditure per student, secondary (% of GDP per

current US\$)		capita)
External debt stocks, short-term (DOD, current US\$)	GDP (current US\$)	Expenditure per student, tertiary (% of GDP per capita)
Portfolio equity, net inflows (BoP, current US\$)	GDP growth (annual %)	Labor force, total
Total reserves (includes gold, current US\$)	GDP per capita (current US\$)	Population ages 0-14 (% of total)
Use of IMF credit (DOD, current US\$)	Gross savings (% of GDP)	Population ages 15-64 (% of total)
Cash surplus/deficit (% of GDP)	Imports of goods and services (% of GDP)	Public spending on education, total (% of GDP)
Central government debt, total (% of GDP)	Industry, value added (% of GDP)	Unemployment, total (% of total labor force)
Military expenditure (% of central government expenditure)	Inflation, consumer prices (annual %)	Birth rate, crude (per 1,000 people)
Revenue, excluding grants (% of GDP)	Services, etc., value added (% of GDP)	Death rate, crude (per 1,000 people)
Tax payments (number)	Trade in services (% of GDP)	
Tax revenue (% of GDP)		

Source: Author calculations on the base [12,13,14,15,16,17]

2) Normalization of indicators of political and economic situation of the country as indicators of stimulators on the basis of natural normalization (for stimulating indicators) and Savage normalization (for destimulating indicators). The use of the proposed approach to normalization of the database indicators relating to the research of political and economic situation of the country makes it possible to bring the indicators into comparable form, to bring all values to the interval from zero to one, to consider the impact of each indicator's variations on the result indicator, and to weigh the deviation of each indicator from its optimal level (maximum or minimum) in the range of 53 observations.

3) Determination of generalized characteristics of the three aspects of research by aggregating the normalized indicators on the basis of the mean arithmetic value. The general characteristics of the development level of the economy, social sphere and political situation are offered to be presented as sides of the triangle of the political and economic situation of the country in time t.

Let us consider the results of calculations based on formulas (1) and (2)

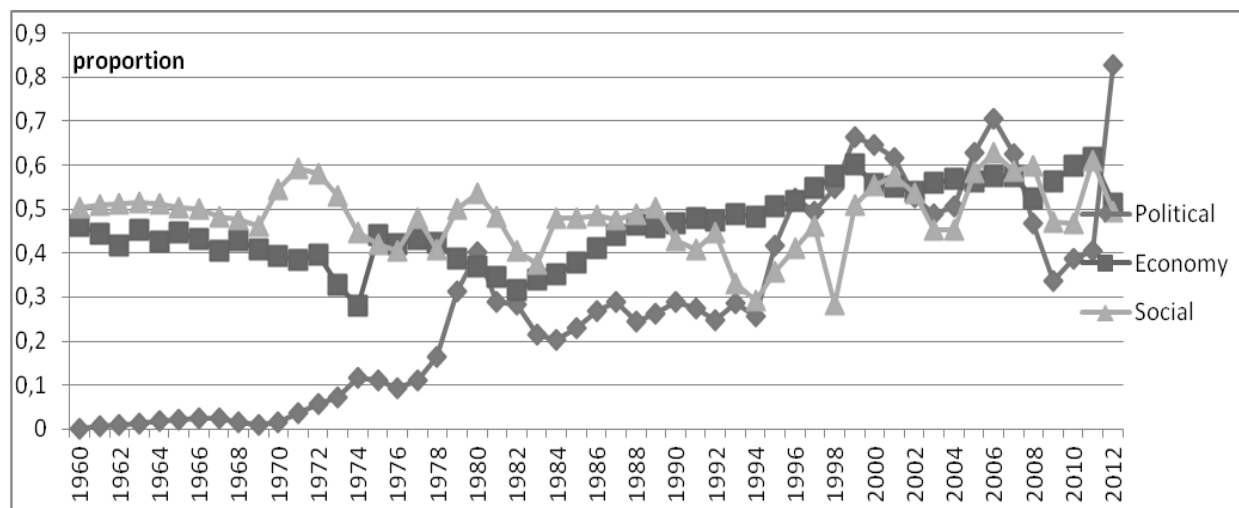


Figure 1 - Diagram of the dynamics of normalized general characteristics of economic, social and political development in France

The analysis of the dynamic of the three components of the political and economic situation in France reveals the following: the presence of approximately equal values in 2002, 2005 and 2007; during the entire period of study the curve of political component was in higher position than the curves of economic and social

components confirming the priority of political situation; the change in the mutual position of the curves of social and economic components in 1990; high level of variation of each of the considered characteristics.

Table 3 – Periodization of the international crisis phenomena over the past 50 years (from 1960 to 2012)

Name of a crisis and global depression	Period	Duration	Causes
Oil crisis	1973-1975	2 years	4 times increase in oil prices, inflation.
Crisis of 1987 Recession of 1990	1987-1991	4 years	The dollar crisis, illiquidity of real estate.
Economic bubble	2001-2003	2 years	Events of September 11, 2001, accounting scandals.
International financial crisis 2008-2010	2008 p. – beginning; 2009 p. – peak; 2010 p. – stabilization	1,5 – 3 years	Real estate, bankruptcy of banks.

Source: Author calculations

The comparison of the obtained results with the periods of crises and global depressions (Table 3): for France the crisis of 1973-1975 was characterized by the highest degree of the spreading of characteristics relating to the economic, social and political situation; a similar situation was observed in 1987, 2003 and throughout the period from 2008 to 2010 indicating a crisis and therefore instability in the political and economic situation in France as well as the adequacy of the constructed generalized characteristics that reflect the reality with a high degree of reliability.

Analyzing the dynamics of normalized characteristics of economic, social and political situation in Ukraine (Figure 2) it is necessary to indicate the availability of statistical data only for the period from 1992 to 2012, which significantly reduces the depth of the analysis. The correlation of the three components of the political and economic situation in Ukraine makes it possible to draw the following conclusion: the absence of equal values of the studied characteristics during the entire time interval; during the entire period of study the curve of political component was in higher position than the curves of economic and social components confirming the priority of political factors; the positioning of economic development between the political and social components; high level of variation of each of the characteristics, similarly to France.

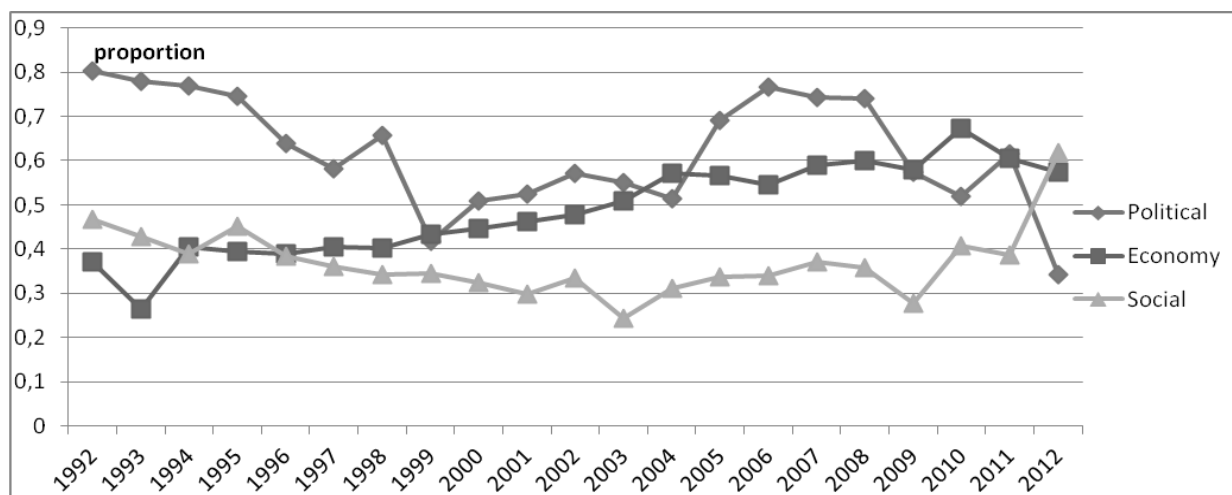


Figure 2 - Diagram of the dynamics of normalized general characteristics of economic, social and political development in Ukraine

Identification of crisis phenomena in the political and economic situation in Ukraine in comparison with the global depression periods confirms the presence of the factors of instability in the periods 2000 - 2002 and 2005 - 2009 resulting from the impact of the crisis of "bubbles" and the global financial crisis.

4) Determination of a stable political and economic situation of the country in time t – the centroid of the triangle built during the previous phase (the points of the medians' intersection).

The implementation of this phase should be carried out by defining the radius of the circle around the triangle of the country's political and economic situation in time t, which serves as a segment between the centroid and each side of the triangle under consideration. In order to achieve the clarity of the obtained results

relating to the political and economic crisis in the country based on the radius of the circle around the triangle of "economic, political and social components" we will consider the graphical interpretation of the indicator's dynamics in France and Ukraine from 1975 to 2012 (Fig. 3).

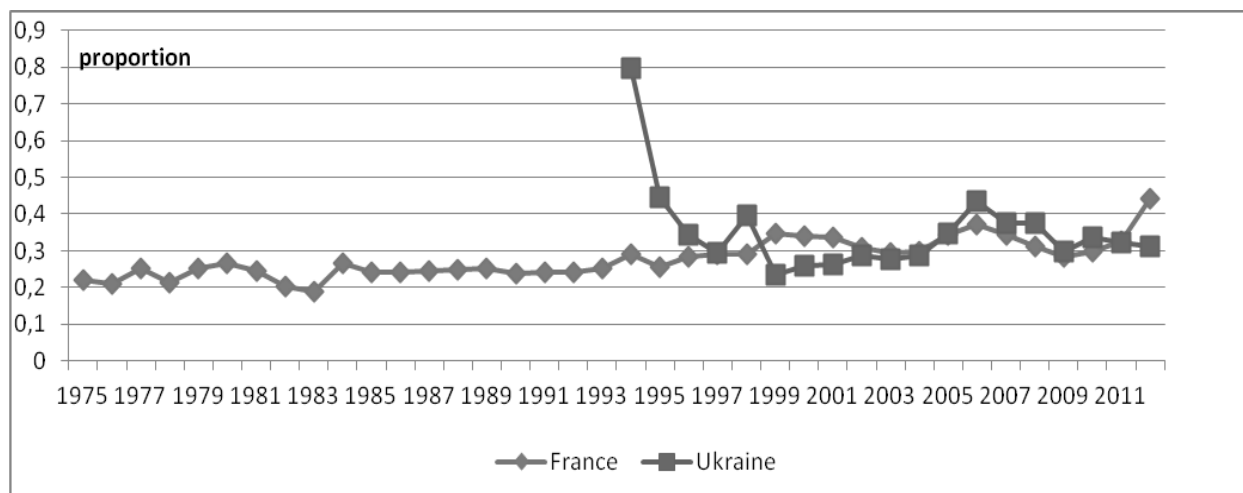


Figure 3 - Diagram of dynamics for the values of the radius of the circle around the triangle of political and economic situation in France and the Ukraine from 1975 to 2012

The analysis of Figure 3 leads to the following conclusions: the political and economic situation in France is more stable compared to Ukraine as evidenced by the location of the curve of the dynamics values for the radius of a circle around the triangle of "economic, political and social components", which is lower for France than for Ukraine, as well as the lower levels of variation relative to the average level; the presence of fluctuations (increasing) in the levels of both curves during the crisis "bubbles" and the global financial crisis. At the same time, along with these peculiarities this characteristic has a significant drawback: in case of an obtuse-angled triangle of the "economic, political and social components" the centroid will be located outside of the triangle indicating unstable political and economic situation in the country, which does not allow to identify the radius of the circle around the triangle. That is why it is proposed to consider a crisis indicator as an indicator of political and economic crisis (instability). We will study a sequence of mathematical transformations that need to be carried out to calculate this indicator.

First of all, within the triangle of the "economic, political and social components" we will write the correlation that connects the radius of the circle, the sides of the triangle (normalized levels of the three levels of research) and the angles. We will express the angles of the triangle of political and economic condition of the country. If an angle is bigger than 90 degrees, the calculated value is presented as 180 degrees minus the value of an obtuse angle. We consider the sum of angles, on the basis of which it is proposed to construct an indicator of crisis (instability) of political and economic situation of the country. The indicator of crisis (instability) in the country's political and economic condition in time  $t$  should be interpreted as follows: if the sum of angles equals 180 degrees, then the triangle of "economic, political and social components" is acute-angled and the centroid lies inside the triangle - this indicates a stable condition; if the sum of angles is less than 180 degrees, then the triangle of "economic, political and social components" is acute-angled and the centroid lies outside the triangle - this indicates unstable (crisis) condition of the political and economic situation.

We will conduct the economic interpretation of the obtained values of the dynamics of crisis indicator for the political and economic situation in France and Ukraine for the period from 1975 to 2012 (Fig. 4).

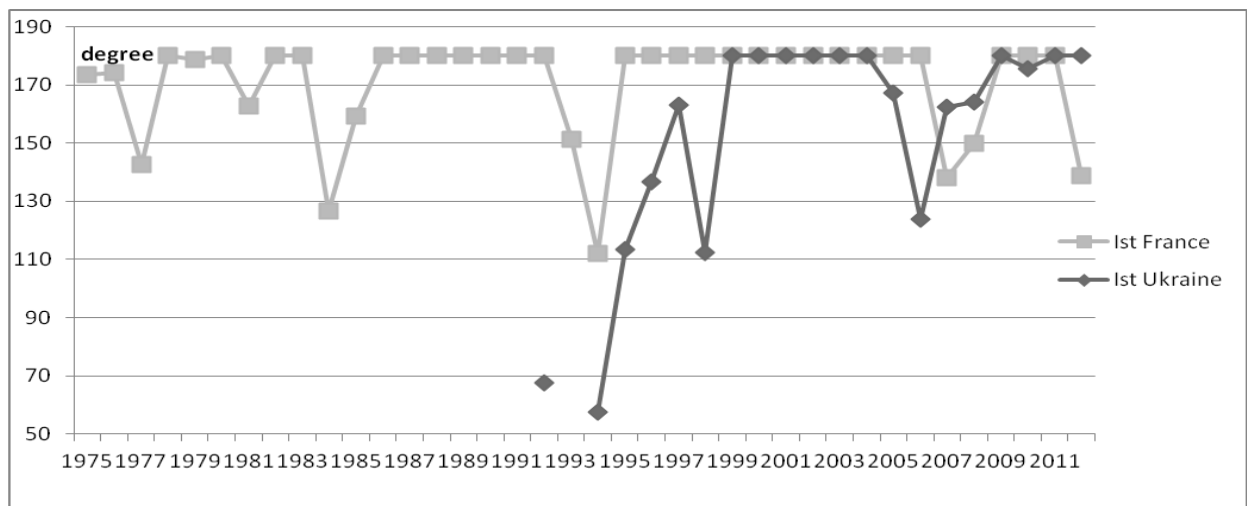


Figure 4 - Diagram of the dynamics of crisis indicator for the political and economic situation in France and Ukraine in the period from 1975 to 2012

Thus, the impact of the "bubble" crisis and the global financial crisis on the political and economic situation in France and Ukraine has a negative effect as evidenced by the corresponding values of the crisis (instability) indicator, which is less than 180 degrees. Moreover, in the context of France's the oil crisis of 1973 -1975 manifested itself in 1976, 1977, and during the period 1984-1985 the pressures were building up for the crisis of 1987 (low values of the indicator).

## 5. CONCLUSION.

The practical aspects of modeling a stable political and economic situation of a country on the basis of its mathematical formalization make it possible to develop recommendations regarding: the building of static (in time  $t$ ) and dynamic (for a certain time interval) comprehensive assessment of a stable political and economic situation; calculate the generalized characteristics of the economic, social and political situation as average normalized values; provide a graphical interpretation of a centroid of the triangle of "economic, political and social components" - a compromise between the three differing objectives; on the basis of mathematical instruments to formalize structural changes in the political and economic situation of the country through the study of a stable political and economic situation in the dynamics during a given time interval.

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