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Bazhenova O.
Doctor of Economics, Associate Professor of Economic Cybernetics Department,
Taras Shevchenko National University of Kyiv, Ukraine;
e-mail: bazhenova.olena25@gmail.com; ORCID ID: 0000-0003-3197-8426
Chornodid I.
Doctor of Economics, Professor,
Head of Department of Enterprise Economics and Management,
Academy of Labour, Social Relations and Tourism, Kyiv, Ukraine;
e-mail: chornodid@ukr.net; ORCID ID: 0000-0002-4464-2641
Yarmolenko Y.
Doctor of Economics, Professor of Department of Marketing,
Academy of Labour, Social Relations and Tourism, Kyiv, Ukraine;
e-mail: yarmolenko_y@ukr.net; ORCID ID: 0000-0002-1814-5828
Golubev O.
Ph. D. student,
Academy of Labour, Social Relations and Tourism, Kyiv, Ukraine;
e-mail: ordnadi@ukr.net

EARLY WARNING SYSTEM OF EXTERNAL SUSTAINABILITY OF AN ECONOMY: CASE OF UKRAINE

Abstract. The paper deals with the early warning system that allows monitoring the external sustainability of an economy due to external economic shocks. For this purpose, the analysis of the external sustainability indicators system of an economy (example of Ukraine) was implemented. It consisted of statistical analysis of the system of indicators of external sustainability of an economy, probabilistic assessment of their dynamics due to external economic shocks. The analysis of external sustainability indicators includes verifying their volatility, stability and variability relative to GDP. It means calculation of standard deviation for testing the volatility, autocorrelation to check the stability of the indicator and correlation between its value and GDP growth rate to measure the variability relative to the economy's performance. The calculations of threshold percentiles for indicators of external sustainability of Ukraine's economy, noise-signal ratios and probabilities of the occurrence of unsustainable external perturbationsare based on signal approach. The analysis of indicators of external sustainability of Ukraine's economy shows that most indicators are volatile relative to their average values. It is shown that most indicators of the external sustainability of Ukraine's economy are acyclic as they are weakly correlated with the growth rate of GDP, although their turning points coincide in many cases. Procyclical indicators are the ratio of reserve assets to «broad money», the ratio of net foreign assets to GDP, the average interest rate on external government liabilities, countercyclical indicators are the ratio of reserve assets to short-term external debt, the share of external public debt denominated in foreign currency to the total amount of external government obligations (except for SDR).

Keywords: external sustainability, early warning system of external sustainability, external economic shocks, commodity prices, debt sustainability, social and market efficiency.

JEL Classification F30, F40, F62

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Баженова О. В.
доктор економічних наук, доцент,
доцент кафедри економічної кібернетики,
Київський національний університет імені Тараса Шевченка, Україна;
e-mail: bazhenova.olena25@gmail.com; ORCID ID: 0000-0003-3197-8426

Чорнодід І. С.
доктор економічних наук, професор,
завідувач кафедри економіки підприємства та менеджменту,
Академія праці, соціальних відносин і туризму, Київ, Україна;
e-mail: chornodid@ukr.net; ORCID ID: 0000-0002-4464-2641
Ярмоленко Ю. О.
доктор економічних наук, професор кафедри маркетингу,
Академія праці, соціальних відносин і туризму, Київ, Україна;
e-mail:yarmolenko_y@ukr.net; ORCID ID: 0000-0002-1814-5828
Голубєв О. В.
аспірант,
Академія праці, соціальних відносин і туризму, Київ, Україна;
e-mail: ordnadi@ukr.net

СИСТЕМА РАННЬОГО ПОПЕРЕДЖЕННЯ ЩОДО ЗОВНІШНЬОЇ СТІЙКОСТІ ЕКОНОМІКИ (НА ПРИКЛАДІ УКРАЇНИ)

Анотація. Розроблено систему раннього попередження, яка дозволяє здійснювати моніторинг зовнішньої стійкості економіки внаслідок впливу зовнішніх економічних шоків. З цією метою було проведено аналіз запропонованої системи показників зовнішньої стійкості економіки на прикладі України. Він включає статистичний аналіз системи показників зовнішньої стійкості економіки, імовірнісну оцінку їхньої динаміки внаслідок впливу зовнішньоекономічних шоків. Крім того, аналіз показників зовнішньої стійкості економіки охоплює перевірку їхньої волатильності, стабільності та мінливості відносно ВВП, що полягає в розрахунку середньоквадратичного відхилення для тестування волатильності, автокореляції — для перевірки стабільності показника та кореляції між його величиною і темпами зростання ВВП для вимірювання мінливості щодо результатів функціонування економіки. Розрахунки порогових процентилів для показників зовнішньої стійкості економіки України, відношень «шум — сигнал» та ймовірностей виникнення нестійких зовнішніх збурень базуються на сигнальному підході. Аналіз показників зовнішньої стійкості економіки України засвідчив, що більшість показників є мінливими щодо своїх середніх значень. Показано, що більшість показників зовнішньої стійкості економіки України є ациклічними, оскільки вони слабко корелюють із темпами зростання ВВП, хоча їхні поворотні точки в багатьох випадках збігаються. Проциклічними показниками є відношення резервних активів до «широких грошей», відношення чистих іноземних активів до ВВП, середня процентна ставка за зовнішніми державними зобов'язаннями, антициклічними показниками виявилися такі індикатори, як відношення резервних активів до короткострокового зовнішнього боргу, частка зовнішнього державного боргу, деномінованого в іноземній валюті, до загальної суми зовнішніх державних зобов'язань (крім СПЗ).

Ключові слова: зовнішня стійкість економіки, система раннього попередження зовнішньої стійкості, зовнішньоекономічні шоки, стійкість боргу, соціальна та ринкова ефективність.

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Introduction. According to the statements of a number of economists, unexpected changes in the external environment seem to be a main trigger of instability in emerging and developing economies. These economies frequently are vulnerable to dissemination of destabilization processes due to such factors as excessive openness, low level of investment activity and savings, underdeveloped domestic markets etc. Besides this, direct investments in the commodity sector are dominating that ultimately leads to a decline in the share of industrial production, lack of protective buffer during crises in the form of «mighty» industrial exports and basis for sustainable long-term growth. In addition, there is a significant threat of the Dutch disease, which mostly affects poor countries.

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Moreover, excessive focus on commodities leads to the dependence of economic development of the country on the dynamics of commodity prices. Not with standing that, the average price of commodities remains unchanged along with the average income of the population in the long run. As to [20], rise of commodity prices have been going on for one decade, followed by two decades of decline. In addition, subject to the financial integration of commodity economies, commodity prices volatility is combined with the problem of macro-financial stability [15].

Export-oriented model of economic growth with a significant share of commodity exports dominates in Ukraine. It contributes to its dependence on external competitiveness and increase of volatility because of foreign economic shocks. As a result, the dynamics of economic growth in systemically important economies worldwide is urgent for Ukraine. Mainly, it concerns China, which has a significant impact on setting thecommodity prices worldwide.

Therefore, the problems of estimationand prediction of the effects of external shocks and, subsequently, ensuring its external sustainability are relevant in the conditions of external vulnerability of national economy.

Thus, the aim of this research is to form a system of external sustainability indicators and develop an early warning system that allows monitoring the external sustainability of an economy due to external economic shocks.

The paper has the following structure. Section 2 provides an overview of the literature on external sustainability and some aspects of its estimation. Section 3 deals with the description of the early warning system of external sustainability (in case of Ukraine). The fourth section provides an analysis of the indicators of external sustainability of Ukraine's economy. The conclusions show the results of the study.

Literature review. A number of economic papersembrace the study of the external sustainability of an economy, main aspects of which seem to be «current account balance and external debt sustainability» [21].

The emergence of the concept of external sustainability is due to [7]. Horne alleged the external sustainability is a result of intertemporal decisions on savings and investment by government and private sector subject to market clearing and full employment.As to him, the stability of permanent deficit or surplus of current account depends on the duration of these phenomena. Moreover, the main reason of instability in an economy is unpredictable changes in the external environment inherent to developing countries that require the adjustment of economic policy and / or private sector behaviour to support intertemporal budget constraints. Salop and Spitaller associate external sustainability exclusively with the stability of the current account, which will take place even in the presence of a current account deficit in case of financial solvency of the country and borrowing abroad to finance investment demand [19]. If borrowings on international capital markets are made to finance current consumption, the current account deficit becomes volatile. The rate of adjustment of the current account balance is defined mainly by internal factors. Milesi-Ferretti and Razin define the external sustainability of the economy in the context of current account imbalances, primarily imbalances of investments and savings [16]. According to Roubini and Wachtel, the dynamics of current account balance is unstable in case of external debt-to-GDP ratio growth, and, in turn, the criterion of economic stability is the «non-growth» of external debt-to-GDP ratio [18].

In addition, external sustainability is treated in the context of external debt sustainability.According to a study of the International Monetary Fund, debt sustainability is the ability of a borrowing country to service its obligations without significant adjustments to income and expenditure, covering such concepts as solvency and liquidity [9].

Thus, the country's solvency characterizes a situation that does not lead to excessive accumulation of external borrowing and corresponds to the allowable level of current account deficit [17]. In turn, liquidity is the adequacy of liquid assets and available funds to service and repay debt [9].

Crockett and Goldstein correspond the external sustainability of the economy withan ability to finance debt without foreign currency earnings, provided full employement and keeping up the savings-investment ratios of other countries [5]. In their opinion, the criterion of external sustainability should reflect the characteristics of a country and evolve over time.

Approaches to estimating the sustainability in the context of debt obligations are systematized by Wyplosh [23]. They are solvency and liquidity of the economy; not exceeding the ratio of debt to GDP of its threshold level; solvency without the need for certain adjustments [9]; falling present value of debt over time; non-reduction in the present value of primary balances excluding debt obligations over time [1]; stationary debt obligations.

Standard indicators for identifying debt sustainability (the main of which is external debt-to-GDP ratio) are not accurate enough, primarily due to disregard for the country's sources of income in foreign currency [23]. This also applies to external debt-to-exports ratio due to the possible insufficiency of the accumulated funds in foreign currency.

The International Monetary Fund distinguishes two groups of external sustainability indicators (indicators based on the amount of external debt and those based on reserve assets) [8]. The first group includes the ratio of reserve assets to short-term external debt, imports and «broad money» (the first indicator characterizes the adequacy of reserve assets in countries with significant, but uncertain access to capital markets, the second indicator is used in countries with limited access to capital markets); the second group of indicators covers the ratio of external debt to exports and GDP, the average interest rate on external liabilities, the average maturity of external liabilities, the share of external debt denominated in foreign currency to the total amount of external liabilities.

In addition, to verify the state of external sustainability of the economy, it is important to compare the current valuesof indicators with threshold levels. However, it is recommended to calculate individual threshold levels for countries due to their dependence on a number of factors (the level of country's development, the availability of capital markets, etc.). For this purpose, the technique described by Karmarkar and Vani [14] could be used.

Indicative system of external sustainability of Ukraine's economy. Based on the analysis of approaches to the estimation of the external sustainability, the basis of the early warning system of external sustainability seems to be a system of indicators proposed by the International Monetary Fund.

However, given the structure of the economy, the level of its debt and sources of its financing, this system have to be supplemented by additional indicators such as current account balance to GDP ratio, external debt to GDP and exports ratios, public and publicly guaranteed external debt to public budget revenues ratio, etc.

Thus, to analyze the external sustainability of Ukraine's economy we used a system of 40 indicators proposed in [3]. The system includes five groups of indicators:

I. Macroeconomic indicators (GDP growth rate, in %; GDP per capita, in constant dollars 2010; gross national expenditure, in % to GDP; final consumption expenditure, in % to GDP; government final consumption expenditure, in % to GDP;publicbudget deficit, in % to GDP; GDP deflator (2010 = 100).

Most of these indicators, such as final consumption expenditure, government final consumption expenditure, publicbudget deficit, GDP per capita, constitute the subgroup of socio-economic factors as they to some extent contribute to the level of social and market efficiency in the national economy.

II. Indicators that characterize current account position (current account balance, in % to GDP; total investment, in % to GDP; gross national savings, in % to GDP; real effective exchange rate (2010=100); exports of goods and services, in % to GDP; imports of goods and services, in % to GDP; trade balance, in % to GDP; changes in terms of trade, national currency; share of high-technologygoods in total exports, %; net foreign assets to GDP ratio, in %).

III. Indicators that characterize capital flows (net direct investment to GDP ratio, in %; portfolio investment to GDP ratio, in %; interest rate differential, in %; reserve assets to imports ratio, months of imports; reserve assets to total external debt ratio, in %; reserve assets to short-term external debt ratio, in %; the ratio of reserve assets to «broad money», in %, net foreign assets to GDP ratio, %).

IV. Debt indicators (gross external debt to GDP ratio, in%; gross external debt to exports ratio, in %; public and publicly guaranteed external debt to public budget revenues ratio, in %; share of external public debt denominated in foreign currency, in total external government liabilities

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(excluding SDRs), the average maturity of external liabilities, the average interest rate on external public liabilities, the ratio of payments to external debt to GDP,%, the ratio of payments to external debt to exports, %).

V. Indicators that characterize the impact of external sector (world GDP growth rate, in %; total investment, in % of GDP; gross savings, in % to GDP; GDP deflator, in %; world commodity price index (2005 = 100); world price index on metal (2005 = 100), world price index for agricultural products (2005 = 100); world price index for energy products (2005 = 100)).

The first group of external sustainability indicators covers the main macroeconomic indicators that directly affect the external sustainability of Ukraine's economy.

The group of indicators that characterize the position of the current account includes 10 indicators such as current account balance, gross investment and savings, imbalance between which directly affects the stability of the current account [4].

In Ukraine, the dynamics of the current account balance during 1992—2017 was characterized by relative stability: two periods of current account deficits (1992—1998, 2006—2017, except for 2015) and one period characterized by its surplus (1999—2005).However, there have never been current account deficits of more than 5% of GDP (some economists consider the threshold level at 3%), which lasted for 5 consecutive years.

Fig. 1. illustrates the dynamics of gross investment, savings and current account balance during 2005—2019 in Ukraine and confirms the relationship between the gap between investment and savings and the current account balance. The corresponding correlation coefficient of gap between investments and savings and current account balance is -0.91.

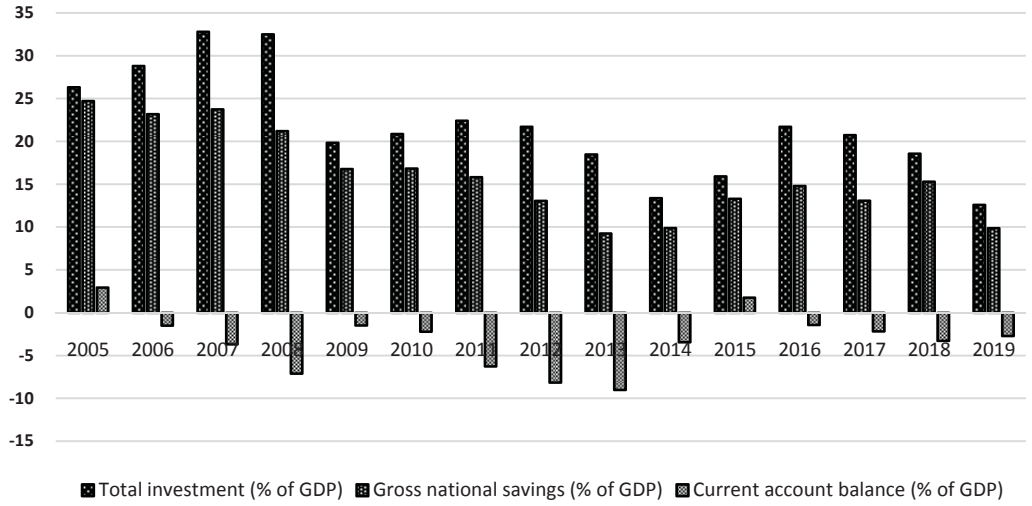

Fig. 1. **Dynamics of total investment, gross national savings and current account balance in Ukraine in 2005—2019,**% of GDP

Source: World Bank.

Thus, the reduction of the gap between investments and savings in Ukraine has always corresponded to a decrease in current account deficit, and vice versa.

Exports and imports of goods and services in relation to the country's GDP determine its openness and, as a consequence, vulnerability as a result of the perturbations of the world economy. Thus, in Ukraine in 2017 the amount of exports and imports of goods and services in relation to GDP amounted to 103.6% (for comparison, in 1992 this figure was 46%).

In addition, one of the most important indicators of external economic sustainability is the share of high-technologygoods in total exports, given that sustainable long-term growth is possible only in industrialized countries. At the same time, the trigger for accelerated economic growth seems to be the growth of exports of manufactured goods [24]. For instance, according to the World Bank during 2011—2018, the share of high-technology goods in total exports of manufactured goods in Ukraine averaged 6.85%.

The third group of indicators covers capital flows indicators. Firstly, they are net direct and portfolio investment to GDP ratios.

The analysis of dynamics of net direct and portfolio investments in Ukraine in 2005—2017 showed a net outflow of direct investments from Ukraine. During 2005—2007, 2010—2012, and 2015—2017 it exceeded the outflow of portfolio investments from Ukraine. The exception is 2013, when the outflow of portfolio investment amounted to 8.787 billion US dollars and more than doubled the outflow of direct investment.

To comment on the dynamics of gross external debt during 2009—2019, it is necessary to note the growth of gross external debt from 2009 to 2013 and its decline in 2014—2019.At the same time, in 2016 and 2017, GDP growth rate exceeded the external debt growth rate, which indicates a certain strengthening of external sustainability. Thus, there was a decrease in external debt from 114.71 billion US dollars to 113.28 billion US dollars compared to the positive rates of economic growth at 2.4 and 2.5%, respectively.In addition, since 2015, the ratio of gross external debt to exports and gross national income has fallen significantly.

Finally, the fifth group of indicators of external sustainability includes ones that outline the world economy development and the situation in export markets (primarily, price indices for metals and agricultural products). In this context, it should be noted that periods of accelerating economic growth in Ukraine correspond to periods of rising world prices for commodities (in particular, metal). In addition, according to [2], the economic development of Ukraine is significantly influenced by the rate of economic growth in China due to the setting the price in majority of commodity markets.

Results. To assess the system of indicators of external sustainability of Ukraine we used the approach, which includes statistical analysis of these indicators, and a probabilistic assessment of their dynamics as a result of disturbances. In addition, for the analysis of indicators of external sustainability, their volatility, stability and variability relative to GDP were verified. Verifying the volatility of the indicatorsmeans the calculation of the standard deviation, stability — autocorrelation coefficient, variability relative to GDP — the correlation coefficient with the GDP growth rate.The calculation of threshold percentiles for indicators of external sustainability of Ukraine's economy, noise-signal ratios and probabilities of the occurrence of unsustainable external perturbations based on signal approach [10—14] implemented in [3].

Thus, the analysis of indicators of external sustainability of Ukraine's economy includes the calculation of such statistical characteristics as: mean, standard deviation, 25% and 75% percentiles, probabilities of being in intervals $(\mu-\sigma, \mu+\sigma)$ and $(\mu-2\sigma, \mu+2\sigma)$, autocorrelation coefficient and correlation coefficient with GDP growth rate.

To calculate probabilities we applied Chebyschev's inequality, which implies that the probability of a shock more than k standard deviations from the mean is less than $1/k^2$ [9].

For the analysis, we used the World Bank and the IMF data of the indicators for 2005—2019.

Thus, according to the results obtained, almost all of the indicators of external sustainability of Ukraine's economy are volatile relative to their average values, except for the current account balance (in% to GDP), portfolio investment to GDP ratio (in% to GDP) and net external assets to GDP ratio (in% to GDP). In particular, portfolio investment to GDP ratio, in%, is less volatile compared to other indicators of external sustainability due to relative stability as the main channel of inflow/outflow of investment in Ukraine is foreign direct investment.

Due to the shock of ± σ only 56% of the values of the share of external public debt denominated in foreign currency to the total amount of external government liabilities (except SDRs) will be in the interval $(\mu-\sigma, \mu+\sigma)$, and in turnbecause of a shock of ±2σ 100% of values are in the interval $(\mu-2\sigma, \mu+2\sigma)$. Compared to the fluctuations of the GDP growth rate, we note the contrary trend in the dynamics of this indicator with the coinsidance of turning points in 2010 and 2012. However, this trend has changed since 2014.

To sum up, the probabilities of being in the interval $(\mu-\sigma, \mu+\sigma)$ for indicators of external sustainability of Ukraine are quite high exceeding 0.5. The lowest values of probability are

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observed for final consumption expenditure and current account balance and equal 0.58 and 0.59 respectively. The highest value of probability is for reserve assets to total external debt ratio at 0,84. As for the current account balance, the probability of being in the interval $(\mu-\sigma, \mu+\sigma)$ is 0.59, in the interval $(\mu-2\sigma, \mu+2\sigma)-$ 0.95. That is, 5% of the values will even go beyond the interval $(\mu-2\sigma, \mu+2\sigma)$ (this is, in particular, the peak value of 10.65%, which took place in 2004). Moreover, the fluctuations of this indicator are ahead of the fluctuations of GDP, and the correlation coefficient with the latter is only 0.37.

Checking the persistence or stability of indicators based on the calculation of the autocorrelation coefficient showed that the following indicators are unstable: the ratio of reserve assets to imports in months of imports, the ratio of portfolio investment to GDP, the ratio of net external assets to GDP, the average interest rate on external liabilities average maturity of external liabilities, public budget deficit, in% to GDP, real effective exchange rate, share of high-tech products in total exports, in%, world GDP growth rate, in% (value of first-order autocorrelation coefficient for these indicators is less than 0.5).

Analysis of the volatility relative to GDP has shown thatthe majority of indicators are procyclical (ratio of reserve assets to «broad money», ratio of net external assets to GDP, average interest rate on external government liabilities, exports of goods and services, imports of goods and services). The countercyclical indicators are the ratio of reserve assets to short-term external debt, the share of external public debt, and the share of external public debt in foreign currency to total external public liabilities (excluding SDR), interest rate differential. Other indicators of the external sustainability of Ukraine's economy are acyclical.

The analysis of indicators tendencies outlined that during periods of economic recovery there was an increase in short-term external debt relative to reserve assets, which may be explained by growth in both consumer and investment demand and, therefore, attraction of financial resources, including short-term. The downturn is observed for reserve assets to gross external debt ratio (the correlation coefficient with the GDP growth rate is only 0.44).

Most of the indicators of external sustainability are characterized by long-term fluctuations, indicating high valuesof autocorrelation coefficients. Short-term fluctuations are observed only in such indicators as the ratio of reserve assets to imports, the ratio of portfolio investment to GDP, the ratio of net external assets to GDP, the average interest rate on external government liabilities, and the average maturity of external liabilities.

Conclusion. The paperexplores the early warning system of external sustainability of the economy on the basis of approach, which includes statistical analysis of indicators and probabilistic assessment of their dynamics due to external economic shocks. The analysis of external sustainability indicators includes verifying their volatility, stability and variability relative to GDP that lead to the calculation of standard deviation for testing volatility indicators, autocorrelation coefficient to check the stability of the indicator and the correlation coefficient between its value and GDP growth rate to determine the variability relative to this indicator of the effectiveness of the economy.The calculation of threshold percentiles for indicators of external sustainability of Ukraine's economy, noise-signal ratios and probabilities of the occurrence of unsustainable external perturbationsis based on signal approach.

Analysis of indicators of external sustainability of Ukraine's economy showed that most of them are volatile relative to their average values (exceptions are the current account balance, the ratio of portfolio investment to GDP and the ratio of net foreign assets to GDP). The overwhelming majority of indicators are stable, except for the ratio of reserve assets to imports, the ratio of portfolio investment to GDP, the ratio of net external assets to GDP, the average interest rate on external government liabilities and the average maturity of external liabilities.

The probabilities of being in the interval $(\mu-\sigma, \mu+\sigma)$ are greater than 0.5 for indicators of external sustainability of Ukraine. At the same time, for some indicators the probability of being in the interval $(\mu-2\sigma, \mu+2\sigma)$ is equal to one.

It is shown that most indicators of the external sustainability of Ukraine's economy are acyclic as they are weakly correlated with the growth rate of GDP, although their turning points coincide in many cases. Procyclical indicators are the ratio of reserve assets to «broad money», the ratio of net foreign assets to GDP, the average interest rate on external government liabilities, countercyclical indicators are the ratio of reserve assets to short-term external debt, the share of external public debt denominated in foreign currency to the total amount of external government obligations (except for SDR).

The early warning system indicators of external sustainability will allow to monitor the external sustainability of an economy in order to respond in advance to the emergence of unstable situations due to foreign economic shocks.

The main directions of perspective research can be, firstly, the expansion of the system of indicators in response to new challenges, and secondly, the development of approach to their forecasting and, therefore, prediction of indicators values.

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