“Assessing dynamic stability of economic development of global food markets in the context of globalization”

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ASSESSING DYNAMIC STABILITY OF ECONOMIC DEVELOPMENT OF GLOBAL FOOD MARKETS IN THE CONTEXT OF GLOBALIZATION

Abstract

The global food market is in constant transformation. Cyclical fluctuations and force majeure (financial crises, epidemics, military actions) affect the volumes of production, consumption, exports and imports of food products. Therefore, the study of the dynamic stability of the growth of world food markets is especially relevant.

The purpose of the study is to assess the dynamic stability of economic growth in the world food markets: cheese, butter and sugar.

The study used general scientific and special methods: dialectical and logical to summarize the scientific foundations for ensuring the sustainable development of world food markets; regression analysis – to determine the direction of market development; variational analysis – to determine the sustainability of market development.

The advantage of the approach proposed in the paper is the assessment of the direction of development by the regression coefficients and the amplitude of fluctuations by the average percentage of deviations from the trend, which allows more correct interpretation of the results than when using only the coefficient of variation, which takes into account changes around the average value.

It is established that the world markets for cheese, butter and sugar from 2011 to 2020 are characterized by dynamically stable growth in production, consumption, exports and imports. However, the markets of individual countries have developed unevenly: cheese production is most attractive and less risky in the EU, Brazil and South Korea; butter production in the EU and India; sugar production – in the USA, India, Algeria. Forecast calculations confirm the likelihood of growth in these markets.

Keywords dynamic stability, economic growth, food market, cheese market, butter market, sugar market

JEL Classification C22, C62, L66, Q11, Q18

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INTRODUCTION

Finding solutions to the problems of measuring the sustainable development of food markets is especially relevant due to significant differences in the environment of socio-economic systems in different countries. Countries develop their own approaches to measuring sustainable development at the national level. However, to conduct such research at the international level, it is necessary to find ways to compare these problems and explore possible solutions to them.

According to FAO (2021b) Food Outlook Report, much attention is paid to the risks associated with the rising cost of food imports against the background of sharp price spikes. This is done to study the challenges of measuring the sustainable development of the global food system in the context of the COVID-19 pandemic. There are expectations that the global food trade in the near future should remain resilient, even despite the projected preservation of high international

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exchange prices for food products in uncertain supply and demand. The actual trade volumes in the global food markets during the pandemic, contrary to predictions, set new records – trade in agricultural products, especially the less perishable ones, fared better than world trade in general.

It was forecasted that the global volume of food imports in 2021 should have reached $1.72 trillion – 12% higher than the record level of 2020 ($1.53 trillion). However, rising prices raise concerns that increased food costs could further deteriorate food nutrition in vulnerable countries. In addition, the increased share of food imports in total imports can be a harbinger of crisis in some sectors. In low-income countries and countries with food deficits, food import costs are likely to rise by nearly 20% – five times faster than in the least developed countries overall. Countries whose export revenues suffered greatly during the pandemic may be particularly vulnerable (FAO, 2021a).

Sustainable development is considered a priority goal of Ukraine's national policy. However, the framework of indicators for its measurement is still being approbated. Several methodical approaches to measuring individual indicators already exist, but there are no solutions for measuring the sustainable development of food markets among them (UNECE, 2013).

1. LITERATURE REVIEW

Sustainable development is defined as a type of "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987, p. 37). In addition, it is viewed as a type of country and regional development when economic growth, material production, and consumption, as well as other activities, occur within limits determined by the ability of ecosystems to recover, absorb pollution and maintain livelihoods of present and future generations (Marushevskyi & Nyzhnyk, 2017).

The formation of the essence of sustainable development has an interdisciplinary basis. Thanks to this, several concepts and stages of its evolution are distinguished, forming a theoretical model based on the criteria of ethics, justice, natural capital, location, and global political order (Drahomyretska, 2019; Bobrovska, 2021). Based on the basic concept of sustainable development as an equilibrium and stable state of the habitat of humankind paired with economic growth, the development of scientific thought has been reflected in experimental economics, individualistic ethics, concept of social justice, and other theories (Kasych & Yakovenko, 2019).

Scientific literature considers a multitude of factors influencing the behavior of consumers in different conditions of food systems. The problem of ensuring the sustainability of food systems has been discovered. It is associated with the inconsistency between the sustainable development goals (Naylor et al., 2007; Waldron et al., 2017) – as increasing food production to end hunger is contrary to other objectives, in particular, to ensure "clean water and sanitation" (Goal 6), "responsible consumption and production" (Goal 12), and to combat "climate change" (Goal 13). The main risks and problems of sustainable food security are usually associated with food availability, price instability, purchasing power of the population, quality and environmental friendliness of food products. Studies of these relationships and the joint action of various factors are set out (Nejati et al., 2011; Ariffin et al., 2019).

The inconsistency between the sustainable development goals and food security has generated a need to strengthen the effectiveness of food policies in the EU. Particularly, it is vital to consider the migration of the population caused by problems of uneven access to food products, and ensure the quality and safety of food in the EU countries, limited by internal resources (including land suitable for organic production in individual countries). Moreover, increasing the efficiency of state financing of R&D for the agri-food complex and deregulation of technological development, usually applied to reduce possible risks, is crucial (Petrunenko et al., 2021).

In recent years, several major global driving forces have disrupted the global sustainable development

efforts toward eradicating hunger and malnutrition by 2030. The problems have been exacerbated by the COVID-19 pandemic and related containment measures. As a result, millions of people worldwide suffer from food shortages and various forms of malnutrition because they cannot afford healthy eating. Such changes in food security and nutrition were caused by factors, the frequency and intensity of which are constantly increasing. These include conflicts, weather variability, and extreme climate events, slowing and declining economic growth exacerbated by the underlying causes of poverty and an overly high and persistent level of inequality (FAO, 2021b).

In the light of the aforementioned, the state of food security in the context of SDGs remains a noticeable concern. It has four aspects: availability, accessibility, use, and stability. Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for active and healthy life (FAO, 1996). Conversely, obstacles to providing any of these elements can threaten food security at all levels, from individual to global (Gunaratne et al., 2021).

The development of global food markets during the first two decades of the 21st century has generally improved. However, the growth rate began to decline in the last few years. The main driver of this dangerous trend is the heavy burden of climate change and forcible conflict in areas already deprived of food security. In addition, the recent COVID-19 crisis has reinforced this trajectory (Queiroz et al., 2021). The complexity of ensuring food security to achieve global climate change goals and sustainable development goals calls for a radical modernization of the global food system (WFP, n.d.).

At the same time, along with the problem of ensuring sustainable development, the question of food sovereignty arises. Namely, the right of people to healthy and nationally acceptable food produced by environmentally safe and stable methods and their right to determine their own food systems is vital. Food sovereignty at the heart of food systems and policies sees the interests of food producers, distributors, and consumers, not the market interests of corporations. It protects people's interests, including those of the next generation. It also ensures that the rights to use and dispose of "land, territory, water, biodiversity will remain in the hands of those who produce food products" (Declaration of Nyeleni, 2007, p. 1). Food sovereignty is based on six approaches (pillars): activities in the natural environment; focus on providing food to the population; responsibility of food suppliers; localization of food systems; ensuring local control and the development of food sovereignty science and practice to ensure sustainable development (Declaration of Nyeleni, 2007; European Coordination Via Campesina, 2018).

Quantitative and qualitative assessment of the complex processes associated with the implementation of sustainable development requires a system of indicators that will adequately characterize the three main components of sustainable development. Numerous international and domestic scientists are working on this problem. However, an unambiguous position on forming an optimal measurement system has not yet been achieved.

Thus, the Institute for Applied Systems Analysis of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" assesses the level of sustainable development using the *Isd* index. It is calculated as the sum of indices for three dimensions: economic (*Iecd*), environmental (*Ied*) and social (*Isd*) with appropriate weightings. Each of these indices is calculated using internationally used indices and indicators. All indicators are brought to a normalized form so that their changes, as well as changes in the indices themselves, are in the range from 0 to 1. In this case, the worst values of these indicators correspond to numerical values close to 0, and the best ones bring these values closer to 1. This rationing calculates each of the indices – *Iecd, Ied, Isv*, and *Isd* – in the form of an average amount of its components with the corresponding weightings (Zghurovskyi, 2006).

The complexity of sustainable development processes, their dependence on a multitude of factors, and the difficulties of objective assessment bring this issue to the level of a rather complex scientific and methodological problem, especially from the point of view of forming a holistic methodology (Kasych & Marek, 2018). In economic research, the choice of a methodological approach usually

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depends on quantitative characteristics. In addition, it determines the algorithm for analyzing the sustainability of the development of economic systems and subjects. In particular, indicators of the stability of dynamic economic growth constitute the orienting economic indicators. This kind of measurement allows assuming in what direction or what dynamic trend in the development of the studied economic processes should be expected (Iudina, 2020).

Today, monitoring and evaluating dynamic stability of economic systems is a prerequisite for controlling the influence of objective economic factors operating at the global level that the population faces in everyday life. Moreover, while the need for transformational changes in the global food system is already universally recognized, how they will occur in vulnerable contexts has not been studied enough.

These problems are of particular relevance due to the importance of achieving global sustainable development goals, particularly regarding food security, which necessitates improving the existing methodology for assessing the dynamic stability of economic growth of food systems.

In theoretical and methodological terms, the issue of choosing correct models and methods for assessing the stability of socio-economic systems in the context of the dynamics of their development is especially relevant.

Any system influenced by externalities and internalities changes its state over time. A dynamic system can be defined as a set of interacting components. Here the processes that occur are determined by the initial states of these components, the relationships between them, and the influences added to the system.

Economy can be characterized by constant fluctuations in the volume of production, trade in goods, prices – all around the trends set by the progressive movement of the economy, the growth of real output, that is, economic growth, which can be considered as a long-term aspect of the dynamics of aggregate supply. Among the most commonly used and substantiated models for economic growth is the Solow model. It identifies and explores the reasons behind temporary, constant, and stable economic growth, and emphasizes that output can change over time only with changes in production factors.

Stability is the ability of the system to return to an equilibrium state if it is withdrawn from it. In this case, the state of equilibrium is stable. Another option corresponds to the instability of the state and system. The concept of "*dynamic stability*" determines the property to slightly deviate from the given trajectory of the system under minor perturbation influences of the external environment. Such a justification for the "dynamic stability of economic growth" does not contradict, but reveals an additional aspect of the "sustainable development" category, complements and specifies the system's state.

2. AIM AND HYPOTHESES

The aim of the study is to assess the dynamic stability of the economic growth of world food markets using the example of cheese, butter, and sugar markets. Therefore, the following hypotheses were developed:

H1: It may not be effective to assess the dynamic stability of the economic growth of food markets using only the coefficient of variation since it does not consider the direction of market development and makes it impossible to formulate reliable conclusions.

H2: An improved methodological approach that accounts for trend changes (their presence or absence) to assess the dynamic stability of economic growth of food markets would improve the quality of economic development assessments, in particular, in determining their directions, as well as the amplitude of fluctuations in the main indicators relative to the trends.

3. METHODOLOGY

A widely accepted indicator that characterizes the stability of time series in economic analysis is considered the coefficient of variation, calculated

as the ratio of the standard deviation to the average value of the indicator as a percentage. With its help, it is possible to estimate the amplitude of fluctuations relative to the average value of the indicator, which characterizes the level of uncertainty and riskiness of the activity. It is generally believed that if the value of the coefficient of variation is less than 10%, the amplitude of oscillations is insignificant, which indicates a low level of uncertainty and riskiness of activities. Next, if the coefficient ranges from 10% to 20%, the amplitude of fluctuations is average (the average level of uncertainty and riskiness of activities). Finally, if its value exceeds 20%, the amplitude of fluctuations is significant (high level of uncertainty and riskiness of activity).

The main disadvantage of this indicator is the inability to consider the development trends (growth or decline, which is extremely important in the studies of the sustainable development of food systems), since the average value used in calculating the coefficient of variation is constant. Therefore, if there is a statistically significant trend in the study, it is possible to misinterpret the deviations of the amplitude of fluctuations in the indicators studied and the formulation of incorrect conclusions, in particular regarding the risks of exporting certain types of food to individual countries or the investment attractiveness of the production of certain products, etc.

The importance of taking into account the direction of the indicator's trend in assessing the dynamic stability of food markets' growth is based on the structure of the time series. Each series consists of a trend, a cyclical (per year), a seasonal (per month or quarter), and a random component. Cyclical and random components exhibit fluctuations relative to the trend or average and complement each other in the research framework.

The choice of an indicator for assessing the amplitude of fluctuations relative to the trend is also a problem. Since the average value of deviations from the trend is close to zero, the use of coefficient of variation would be incorrect. The results of experimental calculations proved the possibility of using the trend's value of "average percentage of deviations", which is calculated by:

$$\overline{BB}_{TP} = \frac{\sum_{i}^{n} \frac{\left|X_i - X_{TP_i}\right| \cdot 100\%}{X_{TP_i}}}{n}, \quad (1)$$

where X_i – the actual value of the indicator, X_{TPi} – the relevant trend value, n – the amount of time periods, years.

In economic and statistical analysis, the main indicators for assessing the dynamic stability of the growth of sectoral food markets are the volumes of production, consumption of food products, exports, and imports that characterize market demand and supply. The amplitude of fluctuations and the direction of growth of these indicators determine the stability of the system development.

Thus, for an objective assessment of the dynamic stability of growth and transformation of sectoral food markets in the global market, the study proposed an approach based on the direction of development and the amplitude of fluctuations. The direction of development is determined using regression coefficients by constructing a trend equation. And the amplitude of fluctuations is based on the average percentage of deviation from the trend and, in the absence of a trend, a coefficient of variation. At the same time, trend equations make it possible to build forecasts for the indicators studied.

If the regression coefficient obtained is positive and statistically significant ($p < 0.05$), the trend direction will increase. Next, if the regression coefficient is negative and statistically significant ($p < 0.05$), the trend direction will fall. And if the regression coefficient is statistically insignificant ($p > 0.05$), the trend direction is considered unchanged. Deviations in the amplitude of fluctuations are segregated into three levels: insignificant (less than 10%), medium (from 10% to 20%), and significant (more than 20%). The level of dynamic growth stability is determined based on the level of deviation of the fluctuations' amplitude: a low amplitude corresponds to a high level of dynamic stability, a medium – to, obviously, medium, significant – to a low one.

The calculations result in 9 variants of indicators' combinations, characterizing the dynamic stability of the food market: by the trend direction –

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Source: Authors' elaboration.

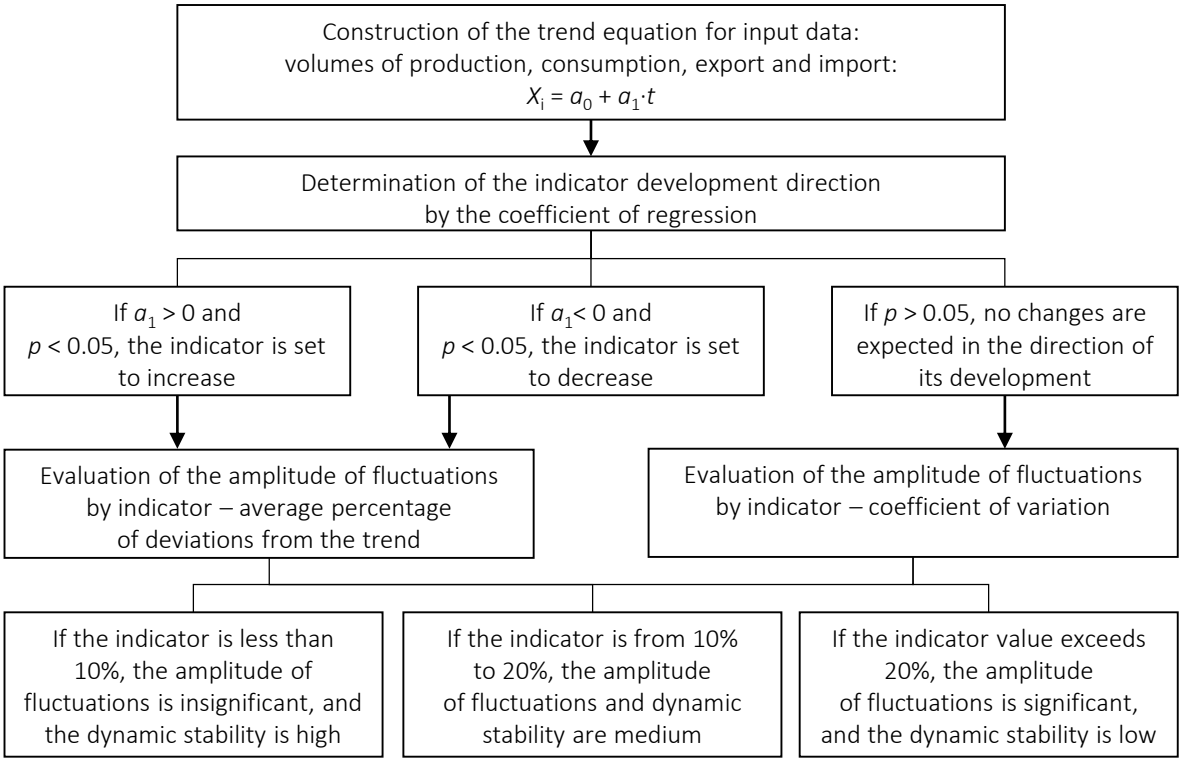

Figure 1. Algorithm for assessing the dynamic stability of sectoral food markets' growth

growing, decreasing, or zero, and by the level of deviations of the amplitude of fluctuations – insignificant, medium, and significant.

The algorithm for assessing the dynamic stability of sectoral food markets' growth is shown in Figure 1. This approach can be applied to a similar assessment of economic, social, demographic, and other processes.

4. RESULTS AND DISCUSSION

The most dynamic sectors of the global food market with ever-increasing volumes of production and trade are now the market of dairy products (including hard cheese and butter) and sugar. For this study, these sectoral markets are taken as representative. The analysis is carried out based on the example of five regions of the world, the share of which in global production of the selected products constituted more than 50% (TOP-5).

Per the algorithm, at first, the paper applied the generally accepted approach based on the calculation of variation coefficients. The results of the calculations are presented in Tables A1-A3 (Appendix A).

Based on the values of the coefficients of variation for the dynamic set of indicators of the global cheese market (Table A1), it was found that the indicators of production and consumption volumes were relatively stable during 2011–2020. Significant fluctuations in production can be observed in Russia, and average – in Argentina. Average fluctuations in consumption show trends in Russia and Mexico. Fluctuations in global exports and imports have an average level of stability. Therefore, international trade operations in the cheese market are riskier than within individual countries.

According to the calculations presented in Table A2, it is possible to conclude the relative stability of global production growth and consumption of butter over the past 10 years. Average fluctuations in indicators can only be observed in India. Fluctuations in global exports of butter are relatively stable, while in the TOP-5 countries, the amplitude of fluctuations is too volatile (the coefficient of variation in the EU is 26.4%, in Argentina

– 50.0%, in the USA – 53.1%, in India – 75.3%). Unstable dynamics of fluctuations is also characteristic for global imports of butter (coefficient of variation – 20.8%). That is, international trade operations in this market are distinguished by uncertainty and riskiness of activity.

The structure of the global sugar market is based on two types of raw materials – sugarcane and sugar beet. The main producers of sugarcane are Brazil, India, and China. The leading regions in sugar beet production are the EU and USA. The global sugar market is characterized by generally good sustainability of growth in production, consumption, exports, and imports (Table A3). At the same time, the TOP-5 countries demonstrate average deviations of the amplitude of fluctuations in production, exports, and imports. Significant deviations in the amplitude of fluctuations are inherent to India's export and Indonesia's import.

The next step is to compare the traditional and proposed approaches to assessing the dynamic stability of food markets' growth: 1) by the coefficient of variation; 2) by the average percentage of deviations from the trend (if a trend is present), and by the coefficient of variation (in the absence of a trend). The results of calculations are provided in Tables 1-3.

Table 1. Comparison of the traditional and improved approaches to assessing dynamic stability of the growth of the global cheese market in 2011–2020

Source: Authors' elaboration.

Top-5	Characteristics of market development		Traditional approach		Improved approach		Dynamic stability, *level*
	regression coefficient (*level of* significance *p*)	direction of market development	coefficient of variation, %	deviation of the fluctuation's amplitude, *level*	average percentage of deviations from the trend*/ coefficient of variation, %	deviation of the fluctuation's amplitude, *level*	
Production volume							
EU	146.6 (0.00)	increase	4.6	insignificant	*1.1*	insignificant	high
USA	145.9 (0.00)	increase	8.2	insignificant	*1.2*	insignificant	high
Russia	67.3 (0.00)	increase	**27.1**	**significant****	***17.9***	**medium**	medium
Brazil	8.6 (0.00)	increase	4.1	insignificant	*3.1*	insignificant	high
Argentina	11.8 (0.23)	no changes	17.7	medium	17.7	medium	medium
Global	489.3 (0.00)	increase	7.7	insignificant	*1.6*	insignificant	high
Consumption volume							
EU	122.7 (0.00)	increase	4.2	insignificant	*1.5*	insignificant	high
USA	133.4 (0.00)	increase	7.8	insignificant	*2.2*	insignificant	high
Russia	52.5 (0.00)	increase	16.7	medium	*11.3*	medium	medium
Brazil	8.3 (0.00)	increase	3.8	insignificant	*2.8*	insignificant	high
Mexico	27.2 (0.00)	increase	19.9	medium	*10.6*	medium	medium
Global	458.9 (0.00)	increase	7.5	insignificant	*1.5*	insignificant	high
Exports volume							
EU	22.8 (0.00)	increase	9.9	insignificant	*7.5*	insignificant	high
USA	11.5 (0.01)	increase	14.8	medium	*14.5*	medium	medium
New Zealand	8.0 (0.02)	increase	10.6	medium	*12.6*	medium	medium
Australia	–0.3 (0.71)	no changes	4.5	insignificant	4.5	insignificant	high
Argentina	1.0 (0.30)	no changes	14.9	medium	14.9	medium	medium
Global	65.5 (0.00)	increase	**11.0**	**medium**	***4.0***	**insignificant**	high
Imports volume							
Russia	–14.0 (0.10)	no changes	25.7	significant	25.7	significant	medium
Japan	9.4 (0.00)	increase	**11.4**	**medium**	***4.5***	**insignificant**	high
South Korea	7.9 (0.00)	increase	**22.3**	**significant**	***7.0***	**insignificant**	high
USA	2.6 (0.20)	no changes	13.3	medium	13.3	medium	medium
Mexico	4.4 (0.00)	increase	14.6	medium	*13.4*	medium	medium
Global	38.9 (0.00)	increase	**10.6**	**medium**	***7.1***	**insignificant**	high

Note: *Italics mark the value of the average percentage of deviations from the trend. **Bold denotes the difference between the amplitude of fluctuations calculated using the traditional and the improved approaches.

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The assessment of the dynamic stability of the global cheese market growth carried out through the traditional approach (Table 1) indicates an overestimated amplitude of fluctuations in the development trend compared with the average percentage of deviations from the trend. Thus, it distorts the results of production, export, and import volumes in individual countries, as well as global indicators.

The use of an improved assessment approach for the global butter market made it possible to clarify the levels of deviations in the amplitude of fluctuations in the production and consumption of these products in India, as well as similar overestimated indicators of export and import volumes (Table 2).

With the help of the proposed methodical approach, the assessment of the fluctuations' amplitude in sugar imports of Indonesia (reduced from significant to medium) and in Algeria (reduced from medium to insignificant) was clarified. Thus, under the growth trends and moderate fluctuations in import volumes, prospects for the sale of sugar in these countries increase.

Table 2. Comparison of the traditional and improved approaches to assessing dynamic stability of the growth of the global butter market in 2011–2020

Source: Authors' elaboration.

Top-5	Characteristics of market development		Traditional approach		Improved approach		Dynamic stability, *level*
	regression coefficient (*level of* significance *p*)	direction of market development	coefficient of variation, %	deviation of the fluctuation's amplitude, *level*	average percentage of deviations from the trend*/ coefficient of variation, %	deviation of the fluctuation's amplitude, *level*	
Production volume							
India	189.0 (0.00)	increase	**11.1**	**medium****	***1.4***	**insignificant**	high
EU	40.2 (0.00)	increase	5.8	insignificant	*3.7*	insignificant	high
USA	12.3 (0.00)	increase	5.4	insignificant	*4.7*	insignificant	high
New Zealand	–0.04 (0.99)	no changes	6.9	insignificant	6.9	insignificant	high
Russia	6.9 (0.00)	increase	9.3	insignificant	*6.6*	insignificant	high
Global	276.3 (0.00)	increase	8.5	insignificant	*1.2*	insignificant	high
Consumption volume							
India	186.1 (0.00)	increase	**11.0**	**medium**	***1.2***	**insignificant**	high
EU	22.6 (0.00)	increase	3.9	insignificant	*3.8*	insignificant	high
USA	23.0 (0.00)	increase	8.5	insignificant	*3.7*	insignificant	high
Russia	4.6 (0.03)	increase	5.6	insignificant	*6.6*	insignificant	high
Mexico	5.9 (0.00)	increase	8.4	insignificant	*6.8*	insignificant	high
Global	284.0 (0.00)	increase	9.2	insignificant	*0.8*	insignificant	high
Exports volume							
New Zealand	–0.4 (0.93)	no changes	7.4	insignificant	7.4	insignificant	high
EU	12.7 (0.00)	increase	26.4	significant	*20.9*	significant	low
USA	–5.1 (0.05)	decrease	53.1	significant	*63.3*	significant	low
Argentina	–1.0 (0.22)	no changes	50.0	significant	50.0	significant	low
India	2.9 (0.03)	increase	75.3	significant	*95.2*	significant	low
Global	16.3 (0.04)	increase	**8.7**	**insignificant**	***11.4***	**medium**	medium
Imports volume							
Russia	–1.9 (0.40)	no changes	16.7	medium	16.7	medium	medium
USA	7.1 (0.00)	increase	57.4	significant	*42.9*	significant	low
Australia	3.0 (0.00)	increase	**32.1**	**significant**	***15.9***	**medium**	medium
Canada	2.1 (0.00)	increase	43.4	significant	*39.3*	significant	low
Mexico	1.1 (0.38)	no changes	23.4	significant	23.4	significant	low
Global	23.3 (0.00)	increase	**20.8**	**significant**	***11.8***	**medium**	medium

Note: *Italics mark the value of the average percentage of deviations from the trend. **Bold denotes the difference between the amplitude of fluctuations calculated using the traditional and the improved approaches.

A comparison between the traditional and improved approaches to assessing the dynamic stability of the global sugar market growth has confirmed earlier assumptions. Thus, the application of the variation factor is practical when the market direction remains unchanged, that is when there is no trend (growth or decline). However, when the direction of market development demonstrates growth, the amplitude of fluctuations may be overestimated, as happened in the dynamics of imports of Indonesia and Algeria (Table 3).

The dynamic stability of the growth of different branches of food production is closely related to the indicators of investment attractiveness and riskiness of investments. The level of investment attractiveness of the reviewed global markets of cheese, butter, and sugar helps to further understand the directions of their development previously identified in this study. The constant growth of production, consumption, export, or import of relevant food products in individual countries attracts investors and determines the investment attractiveness of national sectoral food markets.

Table 3. Comparison of the traditional and improved approaches to assessing dynamic sustainability of the growth of the global sugar market in 2011–2020

Source: Authors' elaboration.

Top-5	Characteristics of market development		Traditional approach		Improved approach		Dynamic stability, *level*
	regression coefficient (*level of* significance *p*)	direction of market development	coefficient of variation, %	deviation of the fluctuation's amplitude, *level*	average percentage of deviations from the trend*/ coefficient of variation, %	deviation of the fluctuation's amplitude, *level*	
Production volume							
Brazil	–201.5 (0.67)	no changes	10.9	medium	10.9	medium	medium
India	616.5 (0.16)	no changes	13.2	medium	13.2	medium	medium
EU	–150.2 (0.46)	no changes	10.3	medium	10.3	medium	medium
China	–366.8 (0.07)	no changes	16.9	medium	16.9	medium	medium
USA	33.6 (0.40)	no changes	4.2	insignificant	4.2	insignificant	high
Global	–485.4 (0.29)	no changes	2.3	insignificant	2.3	insignificant	high
Consumption volume							
India	305.1 (0.00)	increase	4.2	insignificant	*3.9*	insignificant	high
EU	–254.0 (0.03)	decrease	6.5	insignificant	*6.1*	insignificant	high
China	18.8 (0.88)	no changes	6.5	insignificant	6.5	insignificant	high
USA	91.7 (0.00)	increase	2.9	insignificant	2.2	insignificant	high
Brazil	–133.6 (0.00)	decrease	4.1	insignificant	2.5	insignificant	high
Global	1090.4 (0.01)	increase	2.5	insignificant	2.3	insignificant	high
Exports volume							
Brazil	–43.6 (0.93)	no changes	15.7	medium	15.7	medium	medium
Thailand	107.3 (0.56)	no changes	18.9	medium	18.9	medium	medium
India	361.0 (0.03)	increase	47.0	significant	*63.7*	significant	low
Australia	68.2 (0.07)	no changes	10.0	medium	10.0	medium	medium
Guatemala	–5.5 (0.84)	no changes	11.5	medium	11.5	medium	medium
Global	622.3 (0.20)	no changes	7.3	insignificant	7.3	insignificant	high
Imports volume							
Indonesia	255.6 (0.00)	increase	**21.9**	**significant****	***17.6***	**medium**	medium
China	20.0 (0.84)	no changes	17.2	medium	17.2	medium	medium
USA	–7.7 (0.84)	no changes	10.4	medium	10.4	medium	medium
Bangladesh	98.3 (0.00)	increase	16.3	medium	*13.8*	medium	medium
Algeria	87.2 (0.00)	increase	**13.9**	**medium**	***8.8***	**insignificant**	high
Global	539.6 (0.02)	increase	4.2	insignificant	*5.0*	insignificant	high

Note: *Italics mark the value of the average percentage of deviations from the trend. **Bold denotes the difference between the amplitude of fluctuations calculated using the traditional and the improved approaches.

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In particular, production and export indicators determine the competitive positions of countries and the prospects for investing in the relevant industries. Moreover, indicators of consumption and import characterize the prospects for the development of domestic production in order to maximize self-sufficiency. For example, the growth of imports indicates an increase in unmet demand for a particular food product and the prospects for investing in the development of their own production. Dynamic growth of these indicators usually leads to a *high* level of investment attractiveness. When the dynamics of these indicators remains unchanged for a long time, investment attractiveness corresponds to the *average* level, and with a dynamic decrease in the values of indicators – the level of investment attractiveness is *low*.

The level of dynamic stability of the indicators studied characterizes the level of riskiness of investment: a high level of dynamic stability corresponds to *a low* level; the average level of dynamic stability is *an average* level; the low level of dynamic stability is *a high* level of riskiness.

The assessment of investment attractiveness and riskiness of attracting investments in the world's sectoral markets of cheese, butter, and sugar over the past 10 years in the TOP-5 countries in terms of production, consumption, export, and import are presented in Tables 4-6.

Based on Table 4, it is possible to draw general conclusions about the sufficiently high investment attractiveness of the global cheese market (in terms of production and consumption) and the low risks of investing in this industry. Only five countries on the list have an average or high level of investment attractiveness and riskiness in investing in foreign economic transactions (Russia, Argentina, Mexico, and the USA).

Table 4. Investment attractiveness and risks of investing in the global cheese market

Source: Authors' elaboration.

Top-5	Characteristics of investment attractiveness		Characteristics of investment risks	
	direction of market development	investment attractiveness, *level*	dynamic stability, *level*	investment risk, *level*
Production				
EU	increase	high	high	low
USA	increase	high	high	low
Russia	increase	high	medium	medium
Brazil	increase	high	high	low
Argentina	no changes	medium	medium	medium
Global	increase	high	high	low
Consumption				
EU	increase	high	high	low
USA	increase	high	high	low
Russia	increase	high	medium	medium
Brazil	increase	high	high	low
Mexico	increase	high	medium	medium
Global	increase	high	high	low
Exports				
EU	increase	high	high	low
USA	increase	high	medium	medium
New Zealand	increase	high	medium	medium
Australia	no changes	medium	high	low
Argentina	no changes	medium	medium	medium
Global	increase	high	high	low
Imports				
Russia	no changes	medium	significant	high
Japan	increase	high	high	low
South Korea	increase	high	high	low
USA	no changes	medium	medium	medium
Mexico	increase	high	medium	medium
Global	increase	high	high	low

Table 5. Investment attractiveness and risks of investing in the global butter market

Source: Authors' elaboration.

Top-5	Characteristics of investment attractiveness		Characteristics of investment risks	
	direction of market development	investment attractiveness, *level*	dynamic stability, *level*	investment risk, *level*
Production				
India	increase	high	high	low
EU	increase	high	high	low
USA	increase	high	high	low
New Zealand	no changes	medium	high	low
Russia	increase	high	high	low
Global	increase	high	high	low
Consumption				
India	increase	high	high	low
EU	increase	high	high	low
USA	increase	high	high	low
Russia	increase	high	high	low
Mexico	increase	high	high	low
Global	increase	high	high	low
Exports				
New Zealand	no changes	medium	high	low
EU	increase	high	low	high
USA	decrease	low	low	high
Argentina	no changes	medium	low	high
India	increase	high	low	high
Global	increase	high	medium	medium
Imports				
Russia	no changes	medium	medium	medium
USA	increase	high	low	high
Australia	increase	high	medium	medium
Canada	increase	high	low	high
Mexico	no changes	medium	low	high
Global	increase	high	medium	medium

Table 6. Investment attractiveness and risks of investing in the global sugar market

Source: Authors' elaboration.

Top-5	Characteristics of investment attractiveness		Characteristics of investment risks	
	direction of market development	investment attractiveness, *level*	dynamic stability, *level*	investment risk, *level*
Production				
Brazil	no changes	medium	medium	medium
India	no changes	medium	medium	medium
EU	no changes	medium	medium	medium
China	no changes	medium	medium	medium
USA	no changes	medium	high	low
Global	no changes	medium	high	low
Consumption				
India	increase	high	high	low
EU	decrease	low	high	low
China	no changes	medium	high	low
USA	increase	high	high	low
Brazil	decrease	low	high	low
Global	increase	high	high	low

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Table 6 (cont.). Investment attractiveness and risks of investing in the global sugar market

Top-5	Characteristics of investment attractiveness		Characteristics of investment risks	
	direction of market development	investment attractiveness, *level*	dynamic stability, *level*	investment risk, *level*
Exports				
Brazil	no changes	medium	medium	medium
Thailand	no changes	medium	medium	medium
India	increase	high	low	high
Australia	no changes	medium	medium	medium
Guatemala	no changes	medium	medium	medium
Global	no changes	medium	high	low
Imports				
Indonesia	increase	high	medium	medium
China	no changes	medium	medium	medium
USA	no changes	medium	medium	medium
Bangladesh	increase	high	medium	medium
Algeria	increase	high	high	low
Global	increase	high	high	low

A study of the global butter market found that this market is generally investment attractive, while foreign economic transactions (exports, imports) have an average level of riskiness of investing. The following regions of the world have high risks of investing in the export-import segment of the market: EU, USA, Argentina, India, Canada, and Mexico.

In terms of investment attractiveness and riskiness of investing, the most heterogeneous was the global sugar market. It has an average investment attractiveness in terms of production and exports and a high level in consumption and imports. The consumption segment has a risk level. At the same time, the level of investment attractiveness in this indicator in the EU and Brazil is low, as sugar consumption in these countries has decreased over the past 10 years.

CONCLUSION

The study, using experimental calculations, substantiated the possibility of improving the methodology for assessing the dynamic stability of the development of food markets in the trajectory of achieving global sustainable development goals. The application of the proposed approach makes it possible to correctly determine the directions of development and the level of deviation of the amplitude of fluctuations in the main market indicators, as well as to substantiate conclusions about the investment attractiveness and riskiness of investing in specific segments of the food market.

The calculations improve the prospects for foreign trade in cheese, butter, and sugar. At the same time, export and import operations with these products in foreign markets are more risky and unpredictable than trade in the domestic markets of countries. Global cheese and butter markets are much more investment-attractive than the sugar market. In particular, cheese production is particularly investment attractive and the least risky in the EU countries (by production, consumption, export), Brazil (by production and consumption), South Korea (by import volumes); butter production – in the EU countries and India (by production and consumption); sugar production – in the USA and India (by consumption), and Algeria (by import volumes). In Algeria, there is a high demand for sugar that has been unsatisfied for quite a long time. It requires further development of the domestic production base, which may be facilitated by introducing government incentive measures, including increasing the industry's investment attractiveness for domestic and external investors.

The forecasts also confirm the probability of growth of these markets. Consumption and production of cheese and butter in the EU in 2025 against 2020 may increase by 8 and 14%, respectively (while maintaining previous trends), cheese exports by 7%. Next, in Brazil, there is a possibility of an increase in the consumption and production of cheese (approximately by 9%). Furthermore, South Korea should expect increased cheese imports (approximately by 24%). In India, there is a possible increase in the consumption and production of butter (approximately by 9 and 8%, respectively), as well as sugar consumption (by 5%). Finally, in the USA, there is a possibility to increase sugar consumption by 6%, and in Algeria – an increase in sugar imports (approximately by 21%).

Based on the assessment of dynamic stability and forecast calculations, for Ukrainian market operators, the prospects for exporting cheese to South Korea, butter to India, and sugar to Algeria are growing.

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APPENDIX A

Table A1. Coefficient of variation for the dynamic set of indicators of the global cheese market

Source: U. S. Department of Agriculture (2021).

Top-5	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Coefficient of variation, %
Production volume, thousand metric tons											
EU	8981	9287	9368	9560	9740	9810	10050	10160	10210	10340	4.6
USA	4806	4938	5036	5222	5367	5514	5733	5914	5959	6012	8.2
Russia	425	446	713	760	861	865	951	970	983	1035	27.1
Brazil	679	700	722	736	754	745	771	760	770	750	4.1
Argentina	339	330	556	564	548	515	514	444	523	488	17.7
Share of the Top-5 in the global volume, %	89.6	89.9	90.2	90.3	90.2	90.0	88.2	88.0	87.9	87.8	–
Global	17007	17460	18186	18659	19150	19391	20428	20740	20981	21203	7.7
Consumption volume, thousand metric tons											
EU	8374	8597	8656	8883	9087	9093	9297	9386	9394	9460	4.2
USA	4716	4786	4839	4977	5149	5369	5494	5675	5751	5750	7.8
Russia	759	789	1140	1072	1052	1076	1141	1200	1231	1319	16.7
Brazil	715	724	750	754	773	785	799	785	795	777	3.8
Mexico	344	349	368	370	391	403	511	526	551	549	19.9
Share of the Top-5 in the global volume, %	89.7	89.9	89.4	89.4	89.5	89.6	87.4	87.7	87.2	87.3	–
Global	16621	16959	17618	17958	18389	18669	19734	20030	20317	20459	7.5
Exports volume, thousand metric tons											
EU	682	768	787	721	719	800	828	833	879	943	9.9
USA	225	260	316	368	317	287	340	348	357	355	14.8
New Zealand	253	306	277	278	327	355	343	322	335	327	10.6
Australia	168	163	163	151	171	167	171	172	160	153	4.5
Argentina	60	54	51	56	43	53	44	61	61	70	14.9
Share of the Top-5 in the global volume, %	93.0	94.2	86.6	87.0	86.8	86.5	87.4	86.4	85.7	84.5	–
Global	1492	1647	1841	1809	1816	1921	1974	2010	2092	2187	11.0
Imports volume, thousand tonnes											
Russia	344	356	463	349	220	230	226	250	273	311	25.7
Japan	215	235	236	232	249	258	273	286	303	292	11.4
South Korea	76	78	85	97	112	110	125	124	131	148	22.3
USA	110	122	113	127	157	165	138	138	139	126	13.3
Mexico	78	89	103	99	116	123	122	123	121	114	14.6
Share of the Top–5 in the global volume, %	75.4	76.4	78.5	76.3	76.0	73.5	66.5	68.1	68.0	66.3	–
Global	1091	1152	1274	1185	1124	1206	1329	1353	1422	1494	10.6

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Table A2. Coefficient of variation for the dynamic set of indicators of the global butter market

Source: U. S. Department of Agriculture (2021).

Top-5	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Coefficient of variation, %
Production volume, thousand metric tons											
India	4330	4525	4745	4887	5035	5200	5400	5600	5850	6100	11.1
EU	2055	2100	2100	2250	2335	2345	2340	2345	2375	2410	5.8
USA	821	843	845	842	839	834	838	893	905	973	5.4
New Zealand	487	527	535	580	604	584	525	550	525	500	6.9
Russia	217	216	219	252	260	246	270	256	268	278	9.3
Share of the Top-5 in the global volume, %	92.1	92.1	91.3	91.4	91.7	91.9	90.9	91.1	91.7	91.8	–
Global	8584	8914	9249	9636	9893	10020	10309	10588	10825	11180	8.5
Consumption volume, thousand metric tons											
India	4320	4525	4735	4876	5032	5196	5387	5577	5803	6081	11.0
EU	1982	2027	2031	2162	2150	2176	2207	2207	2174	2167	3.9
USA	757	792	782	794	831	853	849	898	940	979	8.5
Russia	334	340	357	376	350	347	357	346	384	396	5.6
Mexico	223	226	234	221	228	255	264	250	277	266	8.4
Share of the Top-5 in the global volume, %	94.0	93.8	93.4	93.4	93.6	93.5	91.9	91.9	92.2	92.3	–
Global	8105	8431	8716	9023	9183	9443	9864	10100	10388	10711	9.2
Exports volume, thousand metric tons											
New Zealand	449	506	508	560	552	554	476	501	509	471	7.4
EU	124	121	122	142	183	218	174	160	217	247	26.4
USA	65	47	93	74	23	26	29	49	26	27	53.1
Argentina	27	21	19	14	9	6	4	11	15	21	50.0
India	11	8	10	10	9	9	15	33	47	20	75.3
Share of the Top-5 in the global volume, %	93.4	92.3	86.6	86.6	85.6	85.8	84.2	84.2	87.0	87.4	–
Global	724	762	868	924	907	948	829	896	936	899	8.7
Imports volume, thousand metric tons											
Russia	120	124	140	137	90	100	99	88	117	131	16.7
USA	12	17	12	22	38	50	41	59	66	70	57.4
Australia	19	21	21	23	23	30	35	42	40	43	32.1
Canada	11	8	7	11	17	27	22	22	25	24	43.4
Mexico	36	37	50	37	43	65	49	33	59	42	23.4
Share of the Top-5 in the global volume, %	70.0	66.1	72.1	69.7	73.0	78.2	61.2	56.2	64.9	63.0	–
Global	283	313	319	330	289	348	402	434	473	492	20.8

Table A3. Coefficient of variation for the dynamic set of indicators of the global sugar market

Source: U. S. Department of Agriculture (2021).

Top-5	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Coefficient of variation, %
Production volume, thousand metric tons											
Brazil	36150	38600	37800	35950	34650	39150	38870	29500	30300	42050	10.9
India	28620	27337	26605	30460	27700	22200	34309	34300	28900	33760	13.2
EU	18320	16655	16020	18449	14000	15505	19508	16750	16556	14717	10.3
China	12341	14001	14263	11000	8430	9300	10300	10760	10400	10500	16.9
USA	7700	8148	7676	7853	8104	8137	8430	8164	7392	8436	4.2
Share of the Top-5 in the global volume, %	59.8	58.9	58.1	58.5	56.3	55.8	64.3	57.6	54.8	63.7	–
Global	172349	177958	176101	177224	164923	168990	173185	172646	170837	171802	2.3
Consumption volume, thousand metric tons											
India	24180	25588	26023	26500	26800	25500	26500	27500	27000	28000	4.2
EU	18200	18250	18500	18700	18800	15441	17000	17000	16600	16600	6.5
China	14200	15100	16445	17558	17500	15600	15700	15800	15400	15500	6.5
USA	10106	10421	10722	10785	10887	10979	10930	10982	11173	11000	2.9
Brazil	11500	11200	11260	11400	10900	10550	10600	10600	10650	10150	4.1
Share of the Top-5 in the global volume, %	49.0	48.6	49.7	49.8	49.4	46.2	46.6	47.4	47.3	47.3	–
Global	159597	165662	166961	170439	171799	168990	173185	172646	170837	171802	2.5
Exports volume, thousand metric tons											
Brazil	24650	27650	26200	23950	24350	28500	28200	19600	19280	32150	15.7
Thailand	7898	6693	7200	8252	8800	7016	10907	10612	6672	7300	18.9
India	3764	1261	2806	2580	2900	2125	2236	4700	5800	6000	47.0
Australia	2800	3100	3242	3561	3650	4000	3600	3735	3600	3335	10.0
Guatemala	1619	1911	2100	2340	2255	1978	1881	2125	1858	1729	11.5
Share of the Top-5 in the global volume, %	74.1	72.9	71.8	73.9	76.5	72.6	71.2	70.5	70.1	78.6	–
Global	54994	55690	57876	55032	54871	60047	65795	57855	53077	64284	7.3
Imports volume, thousand metric tons											
Indonesia	3027	3570	3570	3050	3270	4781	4325	5362	4758	5200	21.9
China	4430	3802	4275	5058	6700	4600	4350	4086	4408	4900	17.2
USA	3294	2925	3395	3223	2931	2943	2972	2785	3842	2860	10.4
Bangladesh	1700	1547	2080	1980	2350	2097	2654	2429	2397	2450	16.3
Algeria	1594	2014	1854	1844	1850	2135	2261	2328	2469	2405	13.9
Share of the Top-5 in the global volume, %	28.9	26.7	29.5	29.8	31.4	30.0	29.7	31.8	33.1	33.0	–
Global	48563	51879	51354	50883	54437	55278	55741	53414	53952	53986	4.2

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