Understanding Economic Processes Through the Lens of Econometric Methods

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Abstract. In this study, the authors highlight the importance of studying the impact of export transactions on changes in gross domestic product as the main indicator of the state of the national economy. To substantiate the feasibility of using the method for estimating multiple dependence equations, the authors compare the capabilities of some econometric approaches, and indicate the feasibility of using each of them. The emphasis has been placed on the importance of examining the state of export-import transactions as an inseparable part of the country's balance of payments – the information obtained is an integral part of the system for understanding the dynamics of the constituent economic processes. To verify the interdependence of changes in economic phenomena, it is proposed to use the method of statistical equations of dependencies, which made it possible to model changes in the volume of export transactions and gross domestic product by 2025, using Ukraine as an example. By comparing the results obtained by the authors and official forecast data (on the example of some statistical data of Ukraine), certain recommendations are made regarding the possible improvement of the effectiveness of forecasting macroeconomic indicators of the state of the national economy. The results presented in this study can be used to increase the efficiency (improvement) of methodological apparatuses for forecasting economic processes in states with developed market economies.

Keywords: Indicators of the State of the Economy, Correlation and Regression, Export-Import Transactions, Econometric Methods, Univariate and Multivariate Dependence.
JEL Codes: D23, O10.

1. INTRODUCTION

The transition to a market economy is carried out with a significant degree of uncertainty due to the fact that economic phenomena are not subject to accurate assessment. Among the many reasons for this, the following can be mentioned: the goals set are multi-valued; alternative actions do not lead to achieving the intended goals; methods and indicators that characterise effectiveness do not provide a true measurement of the degree of its achievement; predictions and forecasts are incomplete, or do not correspond to the actual development of economic phenomena or processes. Transformation of production and social relations in the absence of adequate economic laws changes the situation and strategic directions of development, sometimes contrary to the plans of managers and common sense. At the same time, the processed information is not always informative, and therefore it is difficult to identify indicators that can actually influence the dynamics of economic processes in the state (Chekas, 2020).

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Notably, incorrect use of information evaluation methods leads to erroneous conclusions since even using the same method (depending on its correct or incorrect application) for using the same information can lead to conclusions that are opposite to each other. There are many methods and approaches for evaluating information, and they show different degrees of effectiveness in econometric calculations. A prerequisite for correct econometric calculations is an understanding of the essence of economic processes in a state, the specifics of their interrelations and the rules of their interaction. Statistical and mathematical methods are also used to comprehensively characterise economic processes, determine successes and shortcomings, and choose ways and measures to eliminate undesirable trends (Garín *et al.,* 2016). These include: summary and grouping of information, analysis of variance, regression and correlation analysis, statistical dependency equations, statistical indices, and others.

Based on the purpose of calculations, at the stage of their preparation, it is necessary to establish the order of summarising and processing information and determine the indicators to be used for appropriate calculations, choose approaches and methods of data processing. In the current cir-

cumstances, it is especially important to improve the methodological apparatus for the formation, use and assessment of the number of monetary resources to meet the needs of the state, which are limited by its financial capabilities. When analysing groupings, it is advisable to provide for identifying and describing relationships and trends and draw better conclusions about the nature and structure of the phenomena under study by integrating the various results on interrelationships and trends.

Not all statistical methods can be used for the assessment of the interrelationship of performance indicators with various factors of economic phenomena. Let's look at the possibilities of their application, starting with such an important method as grouping. When grouping, the set is divided into groups, highlighting the main types and forms of phenomena. Considering changes of indicators in different groups, the dependence of the performance indicator on the factor underlying the grouping is studied (Anghelache and Anghel, 2015).

When grouping, it is necessary to remember that the same initial data at different combinations of factors and approaches to the choice of intervals of groups give different results – from incorrect (random) to correct (regular) conclusions. The ordering of economic information makes it possible to characterise the complex interrelationship of the population units (Kulinich, 2017). When constructing grouping intervals, the following aspects must be taken into account: the degree to which the intervals are filled with set units; the use of unequal intervals if an inhomogeneous population is being studied.

2. MATERIALS AND METHODS

Given the fact that most economic phenomena are heterogeneous in their structure, the establishment of a link (stable, unstable) between the factor and the effective feature can lead to incorrect conclusions. Of course, before constructing analytical groupings, first of all, they put forward a hypothesis about the dependence of effective and factor features in order to confirm or reject it. However, even confirmation of the hypothesis does not allow using the obtained values of the dependency between the performance feature and one of the factors in forecast calculations, especially since analytical groupings require the presence of one factor, and the transition to a combinational grouping to characterise economic phenomena may lead to even more inaccurate conclusions, as it is known that the normal distribution of the population is almost not non-existent here.

A logical continuation of the grouping method is the analysis of variance of the interrelationships between performance and factor features. General dispersion characterises the variation of a feature in a statistical population, as a result, it determines the influence of the factor underlying the grouping (Stepanov, 2020). Intra-group (residual) dispersion characterises the variation of a feature in the middle of each statistical grouping. The presence or absence of a connection is also determined by building parallel series and graphs. Here it can be achieved by comparison of two or more parallel series. However, if they are too long, then to identify the correlation, the units of the population are grouped by factor attribute, and then the values of the average indicators of effective attributes are calculated in groups. Consequently, defining the form, character, direction, and analytical expression (Mallikarjuna, 2019).

Graphical methods also have got the characterisation on interrelationships. If we place the data under study in a coordinate system, postpone the value of the cause on the abscissa axis, and the value of the effect on the ordinate axis, we get an ellipse of scattering. The direction of connection is determined by the position of points in the coordinate system. Index analysis occupies an important place in the system of methods for econometric assessment of the influence of factors on changes in economic processes (Dumitrescu *et al.*, 2015). Statistical indexes can be used as a measure of changes in quantity, regardless of changes in the qualitative feature (price, cost, labour productivity, etc.), as well as to characterise the qualitative feature regardless of changes in quantity (volume of products in physical terms, number of employees, etc.), which is not enough to use the identified interrelationships if it is necessary to predict them.

The method of complex statistical coefficients can be successfully applied to assess the results of economic activity, the implementation of production plans for the product range, the uniformity of its supply, assessing the stability of the exchange rate of currencies, shares, securities and the effectiveness of their purchase and sale. Mathematical methods of studying dependencies include classical methods of elementary mathematics, regression and correlation analysis, operations and queuing theory research, economic cybernetics, experiment planning, cluster analysis, and others. It should be noted that the use of certain methods in econometric calculations depends on the purpose, objectives and specifics of considering certain aspects of economic activity in the future. The method of regression and correlation analysis is most widely used in the practice of econometrics (Kushnarev *et al.*, 2022). However, long-term practice of using this method has shown that it was used without sufficient consideration of statistical criteria for processing input information (the presence of a large set of data, the randomness of economic and economic processes, the same units of measurement of factors and performance indicators, the normal distribution of variables; the lack of a functional connection between factors and performance indicators, etc.).

3. RESULTS AND DISCUSSION

If these criteria are fully considered, the application of the least square method allows obtaining fairly accurate theoretical values of the one-factor regression line and, accordingly, its graphical representation. Multiple regression equations allow calculating the theoretical values of the effective feature, but without graphical representation of it by a single theoretical line, depending on all the factors included in the multiple equation. Notably, the parameters of multivariate regression for each of the factors act as abstract calculated values to ensure the determination of theoretical values of the regression line (Anghel *et al.*, 2016). Therefore, the effectiveness of this method is insufficient to quantify the degree of influence of each factor included in the multiple regression equation on the effective feature and, accordingly, to diagnose the state and justify trends in economic development.

The method of statistical dependence equations is informative and does not require the presence of a large set of repeatability of economic phenomena. The use of statistical dependency equations in econometric calculations involves determining standards based on factor actions, as well as assessing the potential of action of factors. Statistical equations of dependencies also make it possible to justify the rate of changes in economic processes for the future period, calculate their forecast levels, assess the degree of influence of individual factors on the effective, set the levels of factors when the effective feature changes, and also assess the intensity of using factors to achieve the average value of the performance indicator.

But the only thing we know about the future is that there is uncertainty in it (The impact…, 2021). However, we must not forget that in a market economy, assessing uncertainty does not involve "playing with nature". Therefore, by assessing the external manifestations of economic phenomena (inflation, prices, profit, exchange activity, etc.), econometric methods can improve forecasting capabilities and reduce uncertainty. It is necessary to select such statistical and mathematical methods for econometric calculations that can be used to obtain results that optimally reflect the dynamics of the economic process. Only then can be found the best logical path for making decisions related to the search for optimal economic solutions. An important requirement for the application of these methods is the study of a small set of data that would make it possible to ensure the representativeness of the conclusions obtained. This requirement is also met by the method of statistical dependency equations, which makes it possible to obtain fairly reliable conclusions for small amounts (up to 20 units). Here it is also worth noting that some statistical methods (grouping, regression, variance, correlation analysis, etc.) require the presence of numerous populations, which makes it possible to determine the interrelationships, patterns and trends in the development of economic phenomena and processes (Mel′nyk, 2011; Chuku *et al.*, 2019).

The main purpose of studying the dependency is to identify relationships, patterns, and trends in development. The dependency expresses the relationship between a function and an argument in the form of an increase or decrease in one variable to an increase or decrease in another. There are usually two main forms of causal causation: correlation and functional. In a correlation, each value of an argument corresponds to not one, but several values of the function and there is no close relationship between them, and in a functional causation a certain value of the function corresponds to a certain value of the argument.

To identify the dependence, it is necessary to identify the most important features of the statistical population. Changing levels of factors have different effects on economic stability. However, the effective application of econometric methods for assessing the relationships between socio-economic phenomena and the development of predictions and economic hypotheses based on them depends on knowledge of the essence of the method and its capabilities in evaluating information. For practical purposes, an important point is the so-called correspondence of the average theoretical values of the feature to empirical values, that is, to the environment according to which the parameters of regression equations are calculated (Pinto, 2011). However, as practice shows, the use of the least square method does not always meet this requirement. In many cases, when calculating the theoretical regression line, individual parameter values go beyond the minimum or maximum values of the effective feature.

In econometric calculations, it is also necessary to take into account that the values of parameters for factors differ not only between univariate and multiple regression equations, but also when the number of selected factors increases or decreases. The parameters of univariate and multiple regression equations characterising the degree of influence of factors on the dynamics of economic phenomena calculated by the least square method can have different signs (plus or minus), that is, characterising direct or inverse relationship, which largely leads to contradictory conclusions (Chuku *et al.*, 2019). It is important to take into account the presence of such discrepancies and prevent making incorrect management decisions and forecasts.

The criterion for the correct application of regression and correlation analysis in the study of interrelationships between socio-economic phenomena is the presence of a normal distribution of the population, which exists only if this interrelationship is affected by many random, independent, or weakly dependent factors, and there are no factors that play a predominant role in the overall result (Ahmadi *et al.*, 2019). Worth noting that when studying socio-economic phenomena, a population with a normal distribution (even for one feature) is infrequent, and when combining features, it is almost non-existent.

The criterion for using the method of regression and correlation analysis when constructing multiple regression equations is the absence of a high linear relationship between factors, i.e., multicollinearity. But even if the correlation coefficient is zero, this does not mean that there is a hyperbolic, parabolic, or other types of curved relationship between the factors. In addition, it should be mentioned that even in the case of multicollinearity, the theory of regression analysis does not answer the question of which specific factor to exclude from the calculations of the parameters of the multiple regression equation.

The least squares method is applicable in those cases when not only factor indicators but also factor and performance indicators are functionally dependent on each other, which does not allow building functional theoretical multi-factor models of the development of economic phenomena. The method of statistical dependence equations can be used to examine the relationships between factors and the results of economic processes. In contrast to the least square method, the parameters of dependence equations are calculated in tabular form, and calculations indicate the following positive differences compared to regression analysis:

1. the initial term of the dependence equation has a real economic meaning since it is the minimum or maximum value of the performance indicator. It can also be argued that on its basis it is possible to

calculate the size of the increase (decrease) of individual theoretical values of the performance indicator due to the action of the studied factor (with a one-factor relationship), as well as with a multifactor relationship;

2. the parameter values for individual factors and their signs for uni- and multivariate equations are the same. The relationship between two or more factor indicators is shown only when calculating dependency coefficients that justify the influence of factor indicator on the performance indicator;
3. the sum of linear deviations of the theoretical values of the performance indicator from its actual values should be minimal. A comparison of these sums will show which type of equation is more appropriate to characterise the phenomenon under study. A graphical representation of the relationships of economic activity indicators does not provide for the characterisation of the square of deviations of theoretical values of the performance indicators. Such a characteristic does not make economic sense (De Michelis and Monfort, 2008).

For the choice of effective methods of econometric calculations of indicators of economic processes, the very fact of distinguishing a significant or insignificant influence of a factor on the results is insufficient. Substantiation of econometric calculations of factor levels and performance indicators in the future period is determined by the calculated values of the parameters of regression equations and their signs (plus or minus). We believe that this criterion can mainly be used to determine the effectiveness of the method used in econometric calculations. This is especially true for calculations based on small amounts of data at the regional level (homogeneous enterprises, organisations, firms in administrative districts or regions).

As already noted, the least squares method does not always provide reliable results when studying the relationships between phenomena and determining their essence, taking into account a small population. In this regard, the application of the least squares method to determining the parameters of the regression equation and the theoretical line of dependence of socio-economic phenomena, which in most cases are asymmetric, and can lead to misleading results.

The use of the method of statistical dependence equations for econometric calculations in the context of small populations makes it possible to distinguish between stable and unstable relationships between factors and results. It is the presence of a stable dependence that will make it possible to conduct objective regulatory and forecast calculations and thereby obtain reliable conclusions about the development of economic phenomena and processes.

That is to say, for a comprehensive understanding of economic processes, and especially the type of relationships that combines the components (indicators) of the state economy, it is advisable to study the interdependence of axiomatic relationships. For example, relationships were studied taking into account the following statements (axioms):

1. export and import transactions have an impact on changes in GDP;
2. for the sustainable development of economic processes, the volume of exports must be greater than the volume of imports (the presence of a positive trade balance).
3. GDP = Consumption (C) + Investment (I) + Government Spending (G) + (Export – Import) (Ministry of Economic…, 2021).

Consequently, foreign trade significantly affects the country's GDP growth as the main source of income generation for financial relations entities. Export-import activities of the state have a positive impact on the country's GDP growth, especially in conditions of high productivity and competitiveness of domestic products. To study the relationships between export, import operations and GDP volumes, the corresponding functions were determined by estimating the dependence equations (Anghelache and Anghel, 2015). They can be used to predict the future dynamics of economic processes. The nature and type of relationship is also determined, which is sufficiently informative for understanding the economic situation, which is a priority for conducting research in this area.

To study the corresponding relationships, data from such countries as: Great Britain, Germany, Slovakia, Czech Republic, Russia, Ukraine and France were used. Taking into account the results of using the method of estimating multiple dependency equations (as well as meeting the requirements of our axioms), the dependence of GDP changes on two factors at once (both on the volume of import and export transactions) is established (Tables **1** and **2**). This may be the indicator of:

1. meeting the requirements of axioms and corresponding implementation of dynamics in the economic processes of countries such as: Great Britain, Germany, Slovakia, Czech Republic;
2. sustainable gradual development of all three components, as well as the presence of a stress-resistant factor to external interference in the economic processes of states, and so on.

It is interesting that to describe the dynamics of import and export transactions in Ukraine, it is possible to use as many as four functional dependencies (Tables **3** and **4**). Therefore, for a more detailed analysis of the impact of export operations on GDP, it is advisable to evaluate single-factor dependency equations and compare them with existing official forecasts regarding the future dynamics of the corresponding indicators (Anghelache *et al*., 2016).

Table 1. Search results of establishing a high level of affluence between export and import transactions and the GDP of countries such as the United Kingdom, Germany, Slovakia and the Czech Republic.

Country	Characteristics of Functional Dependency	Name of the Functional Dependency and Function	Quantitative Dependency	Import Volume (X)	Export Volume (Z)
The United Kingdom	Direct relationship with the reduction of factor characteristics and indicators (MLOGDR No. 2)*	$y_{xz}=\frac{1}{\frac{1}{y_{max}\left(d\frac{1}{z_i}-\frac{1}{z_{max}\frac{1}{x_i}\frac{1}{x_{max}}}\right)}}$		+	+
Germany	Parabola (M_parabola)*	$y_{xz}=y\left[1-B\left(d_{1-\frac{(x_i\le x_0)}{x_0};\frac{(x_i>x_0)}{x_0}-1}+d_{1-\frac{(z_i\le z_0)}{z_0};\frac{(z_i>z_0)}{z_0}-1}\right)\right]_{max}$		+	+
Slovakia	Parabola (M_parabola)*	$y_{xz}=y\left[1-B\left(d_{1-\frac{(x_i\le x_0)}{x_0};\frac{(x_i>x_0)}{x_0}-1}+d_{1-\frac{(z_i\le z_0)}{z_0};\frac{(z_i>z_0)}{z_0}-1}\right)\right]_{max}$		+	+
Czech Republic	Direct relationship with the reduction of factor characteristics and indicators (MLOGDR No. 2)*	$y_{xz}=\frac{1}{\frac{1}{y_{max}\left(d\frac{1}{z_i}-\frac{1}{z_{max}\frac{1}{x_i}\frac{1}{x_{max}}}\right)}}$		+	+

Note: * – dependency function symbol; y_{min} – minimum value of the effective attribute; X_j,Z_j – value of factor attributes; X_{max},Z_{min} – maximum and minimum values of factor attributes; B – cumulative multidimensional parameter; d- deviation sign for comparing coefficients.

Source: author's own calculations.

Table 2. Results of Establishing a High Level of Prosperity Between Export and Import Transactions and the GDP of Such Countries as: Russia, Ukraine, France

Country	Characteristics of Functional Dependency	Name of the Functional Dependency and Function	Quantitative Dependency	Import Volume (X)	Export Volume (Z)
Russia	Inverse parabola M_inv. Parabola)*	$y_{xz}=y\left[1+B\left(d_{1-\frac{(x_i\le x_0)}{x_0};\frac{(x_i>x_0)}{x_0}-1}+d_{1-\frac{(z_i\le z_0)}{z_0};\frac{(z_i>z_0)}{z_0}-1}\right)\right]_{min}$	1		+
Ukraine	Direct relationship with the reduction of factor characteristics and indicators (MLDR No. 2)*	$y_{xz}=y\left[1-B\left(d_{1-\frac{(x_i\le x_0)}{x_0};\frac{(x_i>x_0)}{x_0}-1}+d_{1-\frac{(z_i\le z_0)}{z_0};\frac{(z_i>z_0)}{z_0}-1}\right)\right]_{max}$	1		+
	Parabola (M_parabola)*	$y_{xz}=y\left[1-B\left(d_{1-\frac{(x_i\le x_0)}{x_0};\frac{(x_i>x_0)}{x_0}-1}+d_{1-\frac{(z_i\le z_0)}{z_0};\frac{(z_i>z_0)}{z_0}-1}\right)\right]_{max}$	1		+
	Direct relationship with the reduction of factor characteristics and indicators (MLDR No. 2)*	$y_{xz}=y\left[1-B\left(d\frac{1}{z_i}-\frac{1}{z_{max}\frac{1}{x_i}\frac{1}{x_{max}}}\right)\right]_{max}$	1		+
	Direct relationship with increasing factor characteristics and performance indicator (MLOGDD No. 1)*	$y_{xz}=\frac{1}{\frac{1}{y_{min}\left(d\frac{1}{z_{min}\frac{1}{z_i}\frac{1}{x_{min}\frac{1}{x_i}}}\right)}}$	1		+

France	Direct relationship with increasing factor characteristics and performance indicator (MLOGDR No. 1)*	$y_{xz} = y\left[1 + B\left(d\frac{z_i}{z_{min}\frac{x_i}{x_{min}}}\right)\right]_{min}$	1		+

Note: * – symbol of the dependency function.
Source: author's own calculations.

Table 3. Search Results using the Econometric Method for Estimating one-Factor Equations of Dependences (d.) of Changes in GDP and Export Operations.

Dependencies	Indicators				
	Dependency Parameter	Communication Stability Factor	Correlation Coefficient	Correlation Index	Sum of Deviations
	(*b*)	(*k*)	(*r*)	(*R*)	($\|y_i$-$y_x\|$)
Linear (LDD No. 1)	1.118556	0.913	1	1	1614034
Linear (LDD No. 2)	1.126445	0.902	1	0.99	3356861
Linear (ILD No. 1)	5.508988	–	0.36	–	2.2E+07
Linear (ILD No. 2)	0.228716	–	0.45	–	3.6E+07
Parabolic	1.126445	0.902	1	0.99	3356861
Inverse parabolic	1.118556	0.913	1	1	1614034
Hyperbolic (HDD # 1)	1088292	–	0.91	0.91	8028723
Hyperbolic (HDD # 2)	479740.4	–	0.89	0.81	1.7E+07
Hyperbolic (IHD # 1)	2346217	–	0.19	–	2.5E+07
Hyperbolic (IHD # 2)	222527.3	–	0.69	0.63	2.3E+07
Logical (LOGDD # 1)	0.536389	0.952	1	1	3052619
Logical (LOGDD # 2)	0.520655	0.908	1	1	1968045
Logical (LOGID # 1)	1.156386	–	0.41	–	2.5E+07
Logical (LOGID # 2)	0.241505	–	0.41	0.08	2E+07

Note: "linear dependence (LDD # 1)" – one-factor linear direct dependence with an increase in the coefficient and operational characteristics; "linear dependence (LDD # 2)" – one-factor linear direct dependence with a decrease in the coefficient and effective features; "linear dependence (ILD # 1)" – one-factor inverse linear dependence with a decrease in the factor feature and an increase in efficiency; "linear dependence (ILD # 2)" – one-factor inverse linear relationship with an increase in the factor indicator and a decrease in efficiency; "hyperbolic dependence (HDD # 1)" – hyperbolic direct dependence with an increase in the factor and effective features; "hyperbolic dependence (HDD # 2)" – hyperbolic direct dependence with a decrease in the factor and effective features; "hyperbolic dependence (IHD # 1)" – hyperbolic inverse dependence with a decrease in the factor trait and an increase in efficiency; "hyperbolic dependence (IHD # 2)" – hyperbolic inverse dependence with an increase in the coefficient and a decrease in indicators; "logical dependence (LOGDD # 1)" – logical direct dependence with an increase in the coefficient and operational characteristics; "logical dependence (LOGDD # 2)" – logical inverse dependence with a decrease in the coefficient and effective features; "logical dependence (LOGID # 1)" – logical direct dependence with a decrease in the factor indicator and an increase in effective; "logical dependence (LOGID # 2)" – logical inverse dependence with an increase in the factor indicator and a decrease in efficiency.
Source: author's own calculations.

Since, usually, official forecast data are aggregated nominal values and indices calculated as the median of the corresponding indicators provided by all forecasting organisations – participants (experts) of the survey in order to reduce the impact of indicators that are outside the largest set of forecast estimates, despite the fact that due to the rapid change of events in the economy and uncertainty and threats to its further development, when interviewing experts, significant variations / ranges of forecast estimates provided by all forecasting organisations were formed. Generalised values predicted as a percentage of GDP (in particular, external sector and budget indicators) are calculated as the ratio of the median of the nominal value of the indicator to the corresponding value of GDP calculated, also by the median (Strielkowski *et al.*, 2022). Indicators projected in US dollars are calculated as a percentage of GDP using the median exchange rate. The consensus value of the budget deficit/surplus is calculated as the difference between the median of income and expenditure indicators.

Therefore, a fairly high level of uncertainty can be somewhat ignored if you have an idea of the axiomatic processes that have a predominant impact on the development of the economy of a particular country. The lack of the opportunity to construct the function indicates a very high uncertainty, in

Table 4. Comparison of Modelling Results using the Inverse Hyperbola Equation and Official Forecast Data.

Year	Official Forecast Data		Modelling Results Using the Inverse Hyperbola Equation		Comparison	
	Export of Goods and Services (m. UAH)	Nominal GDP (m. UAH)	Export of Goods and Services (m. UAH)	Nominal GDP (m. UAH)	Rate * (%)	Rate * (%)
2005	227,252	441,452	227,252	441,452	0.00	0.00
2006	253,707	544,153	274,517	498,935	8.20	-8.31
2007	323,205	720,731	355,782	649,945	10.08	-9.82
2008	444,859	948,056	460,401	914,283	3.49	-3.56
2009	423,564	913,345	444,427	868,012	4.93	-4.96
2010	549,365	1,082,569	522,307	1,141,361	-4.93	5.43
2011	707,953	1,316,600	630,013	1,485,952	-11.01	12.86
2012	717,347	1,408,889	672,486	1,506,364	-6.25	6.92
2013	681,899	1,454,931	693,676	1,429,340	1.73	-1.76
2014	770,121	1,566,728	745,127	1,621,035	-3.25	3.47
2015	1,044,541	1,979,458	935,074	2,217,314	-10.48	12.02
2016	1,174,625	2,383,182	1,120,876	2,499,969	-4.58	4.90
2017	1,430,230	2,982,920	1,396,888	3,055,365	-2.33	2.43
2018	1,608,890	3,558,706	1,661,877	3,443,570	3.29	-3.24
2019	1,636,416	3,974,564	1,853,264	3,503,381	13.25	-11.85
2020	1,554,595	3,736,090	1,743,513	3,325,594	12.15	-10.99
2021	1,599,678*	3,907,950 **	1,822,607	3,423,554	13.94	-12.40
2022	1,702,057* *	4,075,992 **	1,899,943	3,646,010	11.63	-10.55
2023	1,863,712*	4,300,473**	2,003,254	3,997,266	6.49	-5.28
2024	1,961,353*	4,536,802**	2,112,017	4,209,426	6.94	-5.66
2025	2,058,993*	4,773,130**	2,220,781	4,421,586	7.39	-6.05

Note: – – official forecast data; * * – author's own calculations.

which it is irrational to model the future dynamics of changes in real GDP and the volume of export operations (Mel′nyk, 2011). On the example of changes in the volume of export operations and GDP (on the example of Ukraine) using the method of single-factor dependency equations, a functional dependence is established. Using the inverse parabola function (Table **1**), the modelling of their future dynamics is carried out, in our case, up to 2025 (Table **2**, **3**).

The results of the modelling, as well as a comparison of the results obtained and official forecast data, are shown in Table **4**.

Such a discrepancy may be the result of neglect in the implementation of forecasting taking into account multiple dependencies between the components of the system under study, in our case – indicators of the state of the national economy. That is, if the national economy functions under normal conditions, namely: there are no "stress" factors, then the formation of GDP volumes is carried out under normal conditions of the economic process. It is possible to use a one-factor dependence between indicators of the state of the national economy to model their future dynamics, or to verify the interdependence of economic processes. The use of statistical trend equations for forecasting calculations based on the aggregate levels of a series of dynamics allows including the direction of economic phenomena built according to levels of a series of dynamics located in front of the forecast period, and the absence of squares, and other degree values of time periods reduce the error of forecast data (Wong *et al.*, 2020).

If after using the method of dependency equations it was not possible to select a function, then an assumption can be made about a decrease in the level of relationship between indicators of the state of the national economy, which may indicate the presence of a hidden economic crisis, the consequences of which may be: a critical decline in production, lack of demand for goods within the country, an increase in the number of unemployed, a gradual depreciation of the national currency, and so on. Thus, by comparing the results obtained and official forecast data, the authors provide the following recommendations for a possible increase in the effec-

tiveness of forecasting macroeconomic indicators of the state of the national economy: first, it is advisable to take into account the strength of the relationships between the components of the subsystem during forecasting, or the dynamics of indicators of the national economy; secondly, on the basis of certain relationships (multiple and single-factor dependency equations) to develop scientifically based "maps-schemes", taking into account the results of which can improve the quality of forecasting the state of indicators of the national economy, the authors of this study are convinced that the use of "maps-schemes" relationships data in methodically-predictive devices of state forecasting will significantly improve the efficiency of distribution and use of financial resources (Can *et al.,* 2022).

The impact of exports on GDP is no different from the impact of consumption, gross investment and government spending. Despite the fact that a certain share of goods and services produced in the country are sold abroad, the cost of their production is the cost of foreigners on domestic GDP. The higher the exports, the greater the costs incurred by foreigners in producing national GDP. Therefore, an increase in exports increases the country's total spending and GDP. Imports, by contrast, mean that a certain share of our spending on consumer and investment goods is spent on producing foreign GDP. Thus, to determine the cost of a product produced domestically, it is necessary to subtract from the total amount of expenses the share that goes to imported goods and services.

The trade balance can be positive or negative. Accordingly, it affects the economic indicators in the country. A positive trade difference means that in monetary terms, the number of goods sent for sale abroad exceeded the volume of imports. As practice shows, this indicator is quite a positive sign for the country. This means that the state produces more products than it consumes, making money from it. The higher this indicator is, the more money comes to the state from other countries. However, the positive indicator also has a downside: if this number is too high and stays relatively unchanged over a long period of time, then the useful product leaves the country, while the population accumulates free finances, and the inflation rate increases.

Acute respiratory disease pandemic COVID-19 caused by the SARS-CoV-2 coronavirus has become a factor that has forced the whole world to reconsider not only its development forecasts, its short-term economic and social policies, but also a different approach to forming its own priorities for the long term. Since, usually, official forecast data are aggregated nominal values and indices calculated as the median of the corresponding indicators provided by all forecasting organisations – participants (experts) of the survey in order to reduce the impact of indicators that are outside the largest set of forecast estimates, despite the fact that due to the rapid change of events in the economy and uncertainty and threats to its further development, when interviewing experts, significant variations / ranges of forecast estimates provided by all forecasting organisations were formed. Generalised values predicted as a percentage of GDP (in particular, external sector and budget indicators) are calculated as the ratio of the median of the nominal value of the indicator to the corresponding value of GDP calculated, also by the median. Indicators projected in US dollars are calculated as a percentage of GDP using the median exchange rate. The consensus value of the budget deficit/surplus is calculated as the difference between the median of income and expenditure indicators. Therefore, a fairly high level of uncertainty can be somewhat ignored if you have an idea of the axiomatic processes that have a predominant impact on the development of the economy of a particular country (Kim, 2016).

When conducting forecasting while studying the relationships between the main indicators of the state of economic processes, regression-correlation methods are often used, but according to the authors, the method of dependent equations has its advantages, namely:

1. the criteria for using regression analysis to assess the relationships of economic phenomena are as follows: qualitative analysis of factor and performance indicator; uniformity of the population; normal distribution of variables; lack of multicollinearity between variables; selection of the regression equation (univariate, multiple) and ensuring the calculation of its parameters by empirical data; evaluation of the parameters of the regression equation (Student's t-test, Fisher's F-test, etc.);
2. prerequisites for using statistical dependency equations to assess the interrelationships of economic phenomena (a small and large population; functional and correlation dependence; the same values of dependence parameters for individual factors in equations of single-and multiple dependence and signs in them; construction of theoretical functional economic models) (Kushnarev *et al.,* 2022);
3. criteria for using statistical dependency equations to assess the interrelationships of economic phenomena: qualitative analysis of factor and performance characteristics; uniformity of the population; selection of the dependence equation (single, multiple) and ensuring the calculation of its parameters by empirical data; assessment of the stability of the relationship between factors and the performance indicator (Anghelache *et al.,* 2015; Bilovodska et al., 2021);
4. performing econometric calculations using regression analysis: determining the size of the change in the effective feature when the factor (factors) changes on the unit if the values of other factors are assumed to be unchanged; calculating the level of the performance indicator for known values of the factor (factors);
5. performing the method of statistical equations of dependencies of econometric calculations: determining the level and size of changes in the effective feature when changing the factor (factors) by one or any value (planned, standard or predicted); calculating the level and size of changes in the effective feature at known values of the factor (factors); determining the level of factor (factors) and the size of its changes when changing the performance indicator by the unit for any value (planned, standard or predicted); determining the degree of intensity of

using factors to ensure the formation of the average level of the performance indicator; calculating the degree (specific weight) of the influence of factors on the performance indicator; construction of functional theoretical models of the development of economic phenomena;

6. modelling the dynamics and forecasting of economic phenomena by regression analysis: determining the size of changes in the level of an economic phenomenon when changing periods of a number of dynamics per unit; modelling the dynamics of economic phenomena and processes; substantiating the forecast levels of economic phenomena; identifying development trends;
7. modelling the dynamics and forecasting of economic phenomena by the method of statistical equations of dependencies: determining the size of changes in the level of an economic phenomenon when changing periods of a number of dynamics by unit; establishing the average rate of changes in an economic phenomenon as a result of the action of a factor (factors) for each period (year, quarter, month); modelling the dynamics of economic phenomena and processes; substantiating the forecast levels of economic phenomena; identifying development trends; assessing the intensity of using factors that form the development of an economic phenomenon for each period (year, quarter, month, etc.) of a number of dynamics; estimating the size of changes in the levels of various factors to ensure a given (standard or planned) level of an economic phenomenon or, conversely, the level of an performance indicator for given periods (known) values of factors and determining the necessary resource costs for each factor in monetary terms; calculating the degree (specific weight) of the influence of factors on the effective feature;
8. confirmation of the relationship of economic processes due to single-factor dependency equations is quite informative, especially when determining the cooperation of those indicators of the state of the national economy, which a priori should have interdependence for the positive dynamics of economic development of states (Ministry of Finance…, 2020).

The lack of the possibility of constructing a single-factor dependence function may indicate a relatively high uncertainty, in which it is irrational to model the future dynamics of changes in real GDP and export operations. Using the inverse parabola function (on the example of Ukraine), the presented data on modelling the dynamics of GDP and import-export processes by 2025 (Table 4) made it possible to calculate and compare the annual rate of change in the studied indicators and to detect a substantial downward deviation of the forecast data (taking into account the above-mentioned axioms). This may be grounds for challenging the reality of the official forecast provided. In other words, this approach can be used to improve the understanding of relationships in the economic processes of any country with a developed market economy, by analogy. The results of this approach can be implemented in improving the effectiveness of economic forecasting methods.

4. CONCLUSIONS

When establishing relationships between the constituent elements of economic phenomena/processes, it is advisable to follow a certain constant or statement/axiom to compare the results obtained. In this study, as an example, the statement regarding export and import transactions as important components of gross domestic product was used, as well as the causal link between them. The importance of maintaining a positive trade balance for the normal development of the economy is examined. Taking into account the results of using the method of estimating multiple dependency equations (as well as meeting the requirements of our axioms), the dependence of GDP changes on two factors at once (both on the volume of import and export transactions) in such countries as: Great Britain, Germany, Slovakia, and the Czech Republic is established. This may be evidence of full satisfaction of the requirements of axioms and the corresponding implementation of dynamics in economic processes; stable gradual development of all three components, as well as the presence of a stress-resistant factor to external interference in the economic processes of states, and so on.

Using the result of applying the econometric method (estimation of dependence equations) to understand economic processes, using Ukraine as an example, made it possible to visually compare the results obtained by the authors and the officially published predicted data. The presence of a significant error, as one of the results of comparing modelling data using the inverse hyperbola equation and official predicted data until 2025, contains a negative meaning. This situation can be evidence of both the unrealistic achievement of forecast data by the economy, and the result of the receipt of unsecured GDP credit resources of the International Fund, which have introduced an imbalance in the economic market processes of the state, and so on. Thus, the use of econometric methods for better comprehension of economic processes is quite informative, but this approach can only be used when the boundaries or axiomatic principles with which the results obtained will be compared are clearly defined.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

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