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Planning and Forecasting Customs Revenues to the State Budget: A Case Study of Ukraine

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Volodymyr Martyniuk[1], Tomasz Wołowiec[2], Elena Mieszajkina[3]

Abstarct:

Purpose: *The paper aims at the studying of the planning and forecasting process, as well as the formation of a dynamic model of customs revenues to the state budget on the example of Ukraine.*

Design/Methodology/Approach: *The methodology of the regression data analysis was used to assess the receipt of customs payments to the budget. The parameters of the regression models are selected by the Least Squares Method. To assess the significance of the regression parameters, their variances and the covariance matrix, the diagonal elements of which are the variance parameters, are calculated. Along with the linear and power model, the Brandon model is considered. The adequacy of the model for forecasting customs revenues was assessed using the coefficient of determination.*

Findings: *Factor analysis by the method of main components allowed us to conclude that the size of tax revenues to the state budget is most influenced by two main components, monetary and macroeconomic. Multifactor regression analysis and multiple processing of statistical data resulted in finding that it is the volume of imports and the national currency that have the greatest impact on the amount of taxes and fees to the state budget. Inflationary processes are not significant, but still affect the amount of tax revenues to the state budget, which makes it possible to increase the accumulation of taxes and fees to the budget by raising prices.*

Practical Implications: *Experiments on forecasting the receipt of taxes and fees to the budget using a dynamic model confirmed its good predictive properties and enabled us to recommend the application of the proposed dynamic model in the practice of customs and tax authorities in their planning of tax proceeds to the state budget.*

Originality/Value: *The results of the study reflect the applicability and effectiveness of the proposed dynamic model. Consequently, the dynamic model of planning and forecasting the customs revenues to the budget may constitute an alternative to the existing models.*

Keywords: *Customs payments, regression model, factor analysis, dynamic model.*
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[1]*Corresponding author, Institute of Public Administration and Business, University of Economy and Innovation in Lublin, Poland, e-mail: volmartynyuk@gmail.com;*
[2]*Corresponding author, same as in 1, e-mail: tomasz.wolowiec@wsei.lublin.pl;*
[3]*Corresponding author, Departament of Management, Faculty of Management, Lublin University of Technology, Poland, email: e.mieszajkina@pollub.pl;*

1. Introduction

One of the main tasks of scientific research is not only to understand the essence of economic phenomena and processes, their quantitative measurement, but also to predict what may happen to them in the future. The planning and forecasting stage is quite crucial in the management process of any system, as it allows, with some probability, to predict the state of the system over a period of time, and thus prepare appropriate management decisions to neutralize the negative consequences. At the same time, planning and forecasting is the most complex management function and an active organizational tool for influencing the entire system, which faces the task of choosing the entire system development direction. Modern financial science has already developed basic research procedures and findings on planning and forecasting financial revenues.

In particular, the general problems of financial planning are analyzed in the works of leading world scientists (Amiti and Weinstein, 2011; Krugman and Obstfeld, 2003; Johnson, 1980; Schmidt-Eisenlohrt, 2013; Baker, Bloom, and Davis, 2016), as well as Ukrainian and Russian scientists (Bazylevych, Bazylevych, and Balastryk, 2007; Bakanov and Sheremet, 1999; Martyniuk, 2011; Sivelkin and Kuznetsova, 2002; Bocharnikov, Zakharov, and Laba, 2006). Their research is also aimed at studying theoretical, methodological, organizational and practical aspects of tax revenues planning and forecasting process. An attempt to theoretically determine the process of planning and forecasting in the customs service was made in the works of Zia (2008) and Taylor (2010). However, scientific research on theoretical, methodological and practical problems and opportunities for planning and forecasting revenues to the state budget from customs duties are currently not performed.

In a general sense, the forecast or prognosis (from the Greek prognosis - prediction) is a scientifically sound prediction that provides advanced information about the development of certain phenomena and processes in the future, while the plan (from the Latin planum - flat place, plane) is a predetermined order, sequence of implementation of a specific program, performance of work (Johnson, 1980).

The authors Bazylevych, Bazylevych, and Balastryk, (2007) define the forecast as a scientifically based hypothesis about the probable state of the economic system or its individual aspect in the future. Macroeconomic forecasting, in their opinion, is based on the study of patterns and trends in economic phenomena and processes, taking into account their diversity and identifying the most acceptable alternatives of their development. There are several approaches to the existing differences between the concepts of plan and forecast. Summarizing the views given in Krugman and Obstfeld (2003), Schmidt-Eisenlohrt (2013), and guided by practical expediency, it can be stated that the plan and forecast are complementary parts of the management process with one fundamental difference, the plan is short-term (usually one year) prediction of the state of the object (economic system), which contains specific tasks and their implementation terms, whereas the forecast provides long-term, and therefore more probable prediction of the state of economic phenomena and processes.

2. Forecasting of Customs Revenues

Speaking about the customs duty, it should be noted that despite the fact that in Ukraine the duty is a regular national indirect tax, and in the process of planning and forecasting its revenues would thus call for regular methods that work for other taxes, the more detailed study of this issue however shows that a number of other factors do influence customs revenues planning and forecasting process. In addition to assessing the dynamics of GDP and inflation, it is necessary to take into account the economic activity of foreign economic entities, international trade, exchange rate changes, the political situation in the country, the country's prospects for integration, and other non-price factors affecting change in the tax base. The influence of these factors must be taken into account in the process of planning (forecasting) budget revenues from VAT and excise tax, levied from export-import operations. All this transforms the problem of planning and forecasting revenues to the state budget from customs duties into a separate area of research and emphasizes the relevance, timeliness and necessity of its implementation.

Planning and forecasting of customs revenues should be considered as a process of determining the amount of future budget revenues, as well as identifying and mobilizing reserves and justifying priorities in accomplishing tasks aimed at increasing the level of profitability of the state treasury. This is a management activity of the state aimed at establishing the order of formation of the state budget revenues from customs duties, VAT and excise tax.

It should also be noted that recently foresight methods of constructing long-term forecasts are gaining particular popularity (Ellison, 2020). One of the definitions considers this concept as a system of methods for expert assessment of strategic areas of socio-economic and innovative development, identification of technological breakthroughs that can affect the economy and society in the medium and long term prospect (Becker, Chen, and Greenberg, 2013). However, a significant disadvantage of their use is the need to involve a significant number of experts. In addition, as noted by Ellison (2020), the foresight method is most effective primarily for technological predictions, although this view does not preclude attempts to use it in making long-term economic forecasts.

3. Choice of Forecasting Method

The most difficult stage in the process of planning and forecasting customs revenues is the choice of forecasting method. Out of more than 200 forecasting methods, according to various estimates, only 30 are used in practice today (Becker, Chen, and Greenberg, 2013). In our work (Martyniuk, 2011), we have already explored the need and feasibility of elimination and correlation analysis to identify the density of relationships between individual factors and the amount of budget revenues in the planning and forecasting of budget revenues by tax and customs authorities.

Based on logical comprehension and analysis of the process and features of planning and forecasting budget revenues on the example of Ukraine, we have selected ten indicators for evaluation, which, in our opinion, affect the amount of revenues to the state budget from customs payments. These include, GDP at actual prices, exports, imports, the official UAH-USD exchange rate, the official UAH-EUR exchange rate, loans to the economy of Ukraine in national currency, loans to the economy of Ukraine in foreign currency, weighted average banks' interest rates on loans in national currency, the weighted average interest rates of banks on loans in foreign currency and, of course, the weighted average rate of import duty. It is known that the use of quantitative methods requires sample statistics. In this case, to reproduce the real relationships, i.e., to build adequate economic and mathematical models, it is necessary to use data obtained at the same time. Otherwise, the dynamics inherent in economic phenomena and processes will distort the real relationship between the studied factors and the size of budget revenues. In our opinion, to avoid this distortion, it is advisable to use as detailed a statistical sample as possible, in particular the monthly values of the studied indicators. To build models of the relationship between indicators and factors influencing them, regression data analysis is used in most cases (Bakanov and Sheremet 1999). The development of regression models is to approximate the statistical material with the dependent:

$$y = f(x) \tag{1}$$

Typically, this uses the Least Squares Method (Johnson 1980; Draper and Smith, 1986), in which the requirement for the best agreement between the theoretical dependence (1) and statistics is to ensure that the sum of the squares of the deviations of the statistics from the smoothing curve is converted to a minimum. Let us present the dependent variable *y* (indicator of cash receipts to the State Budget of Ukraine) as a function of the vector of arguments $\vec{x}$ (selected macroeconomic indicators, which, in our opinion, affect the performance indicator and parameters

a, b, c: $y = f(\vec{x}; a, b, c, \dots)$.

The a, b, c parameters have to be selected so that the condition is met:

$$\sum_{i=1}^{n\Sigma} [y_i - f(\vec{x}_i; a, b, c, \dots)]^2 \xrightarrow{a,b,c,\dots} min, \tag{2}$$

where i (i=1,2,…,n) is the observation number, which in our case specifies the corresponding month and year; y_i – the actual value of the indicator of cash receipts to the state budget for the given values of the vector of influential factors $\vec{x}_i$;

$f(\vec{x}_i, a, b, c\ldots)$ the estimated value of the indicator for the i-th period. Find the values $\boldsymbol{a}, \boldsymbol{b}, \boldsymbol{c}$, that convert the left side of expression (2) to a minimum. To do this, differentiate it by a, b, c and equate the derivatives to zero:

$$\sum_{i=1}^{n}[y - f(\vec{x}_i; a, b, c, \ldots)](\frac{\partial f}{\partial a})_i = 0 \quad (3)$$

where $(\frac{\partial f}{\partial a})_i$ is the value of the partial derivative of the function f on the parameter *a* for the given values of the influencing factors in the *i*-th period. The number of equations in system (3) is equal to the number of unknowns a, b, c. To solve this system, it is necessary to set a specific type of function *f*. In economic and mathematical research, the following types of single-factor models are most often used for one influential factor (Eck, Engemann, and Schnitzer, 2015):

$$y = ax + b; \quad (4)$$

$$y = a_0 + a_1 x + a_2 x^2 + \ldots + a_k x^k; \quad (5)$$

$$y = a \cdot b^x. \quad (6)$$

Approximation of one or another set of statistics of a function is possible not only by the method of least squares, but also by other methods, such as the method of exponential smoothing (Eichenbaum, Rebelo, and Trabandt, 2020b). Quite often the time *t* is chosen as the argument of function (1): (Huang and Temple 2005):

$$y = f(t). \quad (7)$$

The dependence (7), built on retrospective data by the method of least squares, can (under certain conditions) be extrapolated to the future, which according to a certain hypothesis is understood as a continuation of the present while maintaining the stability of existing trends. The forecasting error can be estimated using the standard deviation S_i. However, it is difficult to track the dynamics of the relationship between all macroeconomic indicators and the amount of cash receipts in the State Budget of Ukraine, as the impact of a large number of uncontrolled factors will distort the real relationship and destabilize the trends reflected in the model.

Therefore, we selected ten macro indicators that, in our opinion, have the greatest impact on the studied indicator. Under such conditions, multifactor regression models are more suitable, which allow to estimate the existing complex relationships and the degree of influence of each of the factors introduced into the model on the studied performance indicator. Mathematically, the task is to find an analytical expression that would best reflect the relationship of factor traits with the resultant (Johnson, 1980):

$$y = a_0 + \sum_{j=1}^{n} a_j\, x_j, \tag{8}$$

and $y = a_0 \prod_{j=1}^{n} x_j^{a_j}$. (9)

The parameters of these models are selected by the method of least squares (Krugman and Obstfeld, 2003). To convert model (9) to a linear form, its logarithm has to be found in advance: $\ln y = \ln a_0 + \sum_{j=1}^{n} a_j \ln x_j$. Along with the linear (8) and power model (9), Brandon's model is increasingly used in various studies: (Lee, Milesi-Ferretti, Ostry, Prati, and Ricci, 2008):

$$y = k f_1(x_1) \cdot f_2(x_2) \cdot \ldots \cdot f_n(x_n), \tag{10}$$

where k is the average statistical value of the dependent variable; $f_j(x_j)$ – some function that depends on the factor $x_j (j = 1,2,\ldots,n)$.

Considering formula (2) for a multifactor model (8) or a linearized model (9), we obtain a system of linear algebraic equations (3), the solution of which is written in matrix form as follows: (Krugman and Obstfeld, 2003):

$$\vec{a} = (X^T \cdot X)^{-1} \cdot X^T \cdot \vec{Y}, \tag{11}$$

where $\vec{a} = (a_1,\ldots,a_n)^T$ is the vector of parameters of the model of the indicator of the amount of cash receipts to the State Budget of Ukraine; X– matrix of values of influential macroeconomic indicators $x_{ji}, i = 1,\ldots,N, j = 1,\ldots,n$, each strip of which specifies the value of a separate macroeconomic indicator in different periods; $\vec{Y}$– vector of values of the indicator in different periods of time.

To assess the significance of regression parameters, for example by Student's test, it is necessary to calculate their variances, or covariance matrix, the diagonal elements of which are the variances of the parameters $\vec{a}$. The covariance matrix is calculated as follows (Krugman and Obstfeld, 2003):

$$D(\vec{a}) = s^2 \cdot (X^T \cdot X)^{-1}, \tag{12}$$

where $s^2 = \frac{1}{N-n} \cdot \sum_{i=1}^{N} (y_i - a_0 + \sum_{j=1}^{n} a_j x_{ji})^2$ (13)

is the variance of regression deviations. The diagonal elements of the matrix are denoted as follows: $s^2(a_j)$. The calculated value of the Student's test is based on the formula:

$$t(a_j) = \frac{|a_j|}{s(a_j)} \qquad (14)$$

(Lee, Milesi-Ferretti, Ostry, Prati, and Ricci, 2008), and is compared with the tabular value for a given confidence probability i α and degree of freedom $N - n$.

If the calculated value is less than the tabular one, then with probability 1-α we can say that the corresponding parameter in the regression is close to zero and can be removed. The adequacy of the model for forecasting customs receipts can be assessed using a coefficient of determination or functionality r^2. The closer it is to 1, the more the selected dependence corresponds to the statistics. Its calculation is based on the formula (Lee, Milesi-Ferretti, Ostry, Prati, and Ricci, 2008)

$$r^2 = 1 - \frac{s^2}{s_y^2}, \qquad (15)$$

where $s_y^2 = \frac{\sum_{i=1}^{N}(y_i - \frac{1}{N} \cdot \sum_{i=1}^{N} y_i)^2}{N-1}$ – the variance of random values of the amount of cash receipts in the state budget. To date, there is a large number of application packages for these calculations. Let us briefly consider their features.

The MISR program can be used to implement models (4) and (6) on a computer (Borovikov and Ivchenko, 2000). In this case, the logarithm of the model (6) must be found in advance to reduce it to linear. Model (5) can be constructed using the POLRG (polynomial regression) application (Borovikov and Ivchenko, 2000). MISR and POLRG can be used in the analysis of time series of the form (7). The parameters of these models are selected by the method of least squares using the REGRE and STEPR programs (Borovikov and Ivchenko 2000). Reporting forms of REGRE and STEPR programs contain, in addition to regression parameters, the values of the main numerical characteristics of the dependent and independent variables, the value of Student's test, which can assess the significance of a factor, the coefficient of determination that sets the degree of linear dependence between dependent and independent variables, a table of residuals, which characterizes the deviation of the actual values of the dependent variable from the calculated, and other characteristics. The STEPR program also ranks factors according to their importance. Insignificant factors can, at the request of the user, be automatically excluded from the model. There are other programs for processing statistical data, implemented, for example, in GPSS modeling language (Borovikov and Ivchenko, 2000).

However, all the considered programs are designed for a completely obsolete series of computers such as EC and CM and are not suitable for implementation on new generation computers. The software application packages such as MS EXCEL, MATHCAD, STATAN, MATLAB and STATISTICS are worth mentioning among the more up-to-date programs. These application packages have a well-developed universal software interface together with well implemented modern and classical methods of statistical data processing. Typically, a detailed study of the statistical characteristics of samples using these packages. Analysis of existing application packages shows that under these conditions, the priority is given to Excel spreadsheets, where the simplest software interface is implemented with enough resources to build regression models under conditions of limited sampling.

Let us introduce the following notation:

x_{1i} – gross domestic product of Ukraine in actual prices (UAH million) for the i-th period;
x_{2i} – volumes of exports (million USD) in the i-th period;
x_{3i} – volumes of imports (million USD) in the i-th period;
x_{4i} – the official UAH-USD exchange rate (average for the period) in the i-th period;
x_{5i} – the official UAH-EUR exchange rate (average for the period) in the i-th period;
x_{6i} – loans to the economy of Ukraine in national currency (UAH million) for the i-th period;
x_{7i} – loans to the economy of Ukraine in foreign currency (UAH million) for the i-th period;
x_{8i} – weighted average interest rates of banks on national currency loans (%) in the i-th period;
x_{9i} – weighted average interest rates of banks on foreign currency loans (%) in the i-th period;
x_{10i} – weighted average import duty rates (%) in the i-th period;
y_i – cash receipts to the State Budget of Ukraine in the i-th period of time.

$a_1 a_2 a_3 a_4 a_5 a_6 a_7 a_8 a_9 a_{10}$ – regression coefficients of factors influencing the amount of budget revenues, which indicate the degree of influence of the relevant factor on the performance indicator at a fixed position of the other factors;

$S_{a_1} S_{a_2} S_{a_3} S_{a_4} S_{a_5} S_{a_6} S_{a_7} S_{a_8} S_{a_9} S_{a_{10}}$ – variances of regression coefficients for factors influencing the size of budget revenues;

S – variance of the regression of macroeconomic indicators affecting the size of budget revenues;
SY – variance of random values of macroeconomic indicators affecting the size of budget revenues;
N – number of months;
n – the number of regression coefficients;
r^2 – coefficient of determination of regression of macroeconomic indicators that affect the size of budget revenues;
$T_{a_0}, T_{a_1}, T_{a_2}, T_{a_3}, T_{a_4}, T_{a_5}, T_{a_6}, T_{a_7}, T_{a_8}, T_{a_9}, T_{a_{10}}$ – the value of the Student's test for the regression coefficients of macroeconomic indicators that affect the size of budget revenues.

The regression coefficients $a_0, a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9, a_{10}$ are calculated by formula (11), where X is the matrix $\{ x_{1i}, x_{2i}, x_{3i}, x_{4i}, x_{5i}, x_{6i}, x_{7i}, x_{8i}, x_{9i}, x_{10i},$ i=1,…,N $\}$, $\vec{Y}$ is the vector $\{ Y_i$, i=1,…,N $\}$. The matrix X and the vector $\vec{Y}$ are formed on the basis of the data of the summary table of statistical data given in Table 1. The variances $Sa_0, Sa_1, Sa_2, Sa_3, Sa_4, Sa_5 Sa_6, Sa_7, Sa_8, Sa_9, Sa_{10}$ of the regression coefficients are found from the covariance matrix by formula (12), in which the matrix:

$x = \{ x_{1i}, x_{2i}, x_{3i}, x_{4i}, x_{5i}, x_{6i}, x_{7i}, x_{8i}, x_{9i}, x_{10i},$ i=1,…,N $\}$. The value of the Student's test for the j-th regression coefficient is calculated by formula (14).

The coefficients of determination Rm are calculated by formula (15), where

$$S = \frac{1}{N-n} \cdot \sum_{k=1}^{N} (Y_i - (a_1 \cdot x_{1i} + a_2 \cdot x_{2i} + a_3 \cdot x_{3i} + a_4 \cdot x_{4i} + a_5 \cdot x_{5i} +$$

$$a_6 \cdot x_{6i} + a_7 \cdot x_{7i} + + a_8 \cdot x_{8i} + a_9 \cdot x_{9i} + a_{10} \cdot x_{10i}))^2,$$

$$\mathrm{SY} = \frac{1}{\mathrm{N}\text{-}1} \cdot \sum_{k=1}^{N} (Y_i - \frac{1}{N} \cdot \sum_{k=1}^{N} Y_i)^2.$$

Given that the amount of budget revenues at zero values of the factors of influence is zero, then in formula 13 $a_0 = 0$.

4. Empirical Results

Since the monitoring of budget revenues is carried out by several government agencies and, in addition, in the statistical data the indicator itself is presented in different versions (Table 2), at the next stage of our study we will carry out structural identification of the dynamic model by forming an adequate structure of the model and determining the connection density, thus checking the regression model for its compliance with the reality.

The study will be conducted in two planes: in the context of stable economic development, which was observed before the decline in economic activity due to the introduction of the COVID-19 pandemic-caused lockdown and after it was lifted and during the period of influence on the economy of Ukraine of adverse external and internal factors caused by the world-wide COVID-19 pandemic and political instability in the country.

The significance of this approach is that the analysis of such diverse (cyclical) intervals of macroeconomic development of the economy of the studied country will form scientifically sound conclusions and proposals for measures of customs tariff regulation in conditions of economic stability and cyclical fluctuations in the economy, aimed at maximizing customs revenues to the budget.

Table 1. *Statistical values of the factors influencing the amount of customs revenues*

Month/ year	GDP in actual prices, UAH million	Volumes of international trade, USD million	Official exchange rate of UAH against foreign currencies (average for the period)	Loans to the economy of Ukraine (at the end of the period, UAH million)	Weighted average interest rates of banks on loans,%	GDP in actual prices, UAH million	Volumes of international trade, USD million	Official exchange rate of UAH against foreign currencies (average for the period)	Loans to the economy of Ukraine (at the end of the period, UAH million)	Weighted average tariff rate on imports%
		Export	Import	100 USD	100 EUR	In national currency	In foreign currency	In national currency	In foreign currency	
09/2019	1066150	4199	5351,0	2476,51	2728	377499	289660	19	5,0	5,8
10/2019	1089465	4241	5841,4	24,80,7	2740	384700	296745	19	4,9	5,7
11/2019	1101432	4114	5240,2	2436,75	2696	398755	304879	19	5,0	5,6
12/2019	1113133	4071	5426,3	2360,94	2621	413798	313065	20	5,2	5,5
01/2020	837612	4155	4087,5	2487,92	2643	450 206	322894	21	5,2	5,4
02/2020	841740	3958	3551,4	2516,07	2744	450 484	302655	19	5,7	5,3
03/2020	850153	3136	3725,4	2586,35	2781	453347	310607	19	6,2	5,2
04/2020	854051	3839	3403,2	2681,15	2896	456494	302480	19	5,4	5,1
05/2020	860021	3438	3397,2	2637,88	2976	437599	297951	20	5,3	5,0
06/2020	875340	3382	3053,3	2650,01	2954	444295	287411	20	5,5	4,9
07/2020	889132	3721	3531,4	2575,14	2965	445288	273831	20	5,3	4,8
08/2020	897340	3221	3501,3	2524,70	2929	444766	270898	21	5,4	4,7

09/2020	1163172	4190	3711,6	2676,97	3012	441773	256210	21	5,5	4,6
10/2020	1201746	4625	3979,9	2680,82	3145	442104	265454	20	5,4	4,5
11/2020	1271263	4734	4318,8	2736,75	3133	445687	262154	20	5,4	4,4
12/2020	1301539	3881	4830,6	2760,94	3155	440128	259432	20	5,5	4,3
01/2021	839375	4190	5026,8	2769,43	3298	440027	268465	20	5,4	4,2
02/2021	849640	4199	5089,1	2770,45	3309	456387	246309	20	5,4	4,1
03/2021	856750	4241	5123,3	2777,76	3331	450003	235124	20	5,5	4,0
04/2021	861863	4114	4874,9	2779,01	3341	438265	250463	20	5,5	3,4

Source: *Compiled by the Authors based on (State Statistics Service of Ukraine, 2021; Ministry of Economy of Ukraine, 2021; Ministry of Finance of Ukraine, 2021; National Bank of Ukraine, 2021; Institute Budget and Social and Economic Research, 2021).*

Let's start with the analysis and forecasting of customs revenues to the budget in the conditions of stable ecnomic development. To do this, we selected statistics from the homogeneous statistical information in the pre-crisis period (including January 2020). Using MS EXCEL spreadsheets, we perform a multifactor regression analysis of selected macroeconomic indicators (Table 1) and the amount of budget revenues in terms of completeness and sources of monitoring (Table 2). The results of this analysis are presented in Table 3.

Table 2. *The value of performance indicators of the amount of budget revenues*

Month / year	Actual cash receipts to the general fund of the State Budget of Ukraine, UAH million	Execution of the State Budget of Ukraine, UAH million		
		Total income	Tax payments	Customs payments
	Option A	Option B	Option C	Option D
09/2019	7580,40	9648,80	7019,60	3468,45
10/2019	9130,30	11467,50	8214,10	3841,60
11/2019	9434,80	12423,80	8294,80	4532,41
12/2019	9217,10	12149,90	7921,60	4594,92
01/2020	11489,30	13960,20	10743,20	1122,29
02/2020	9300,20	11691,30	8516,20	4590,94
03/2020	9388,00	40938,00	32046,70	4340,72
04/2020	12852,10	-12410,00	-11354,00	4513,46
05/2020	8433,90	13855,80	7921,30	3931,20
06/2020	10704,00	13711,00	9812,50	5220,67
07/2020	14340,40	19989,70	14133,20	5323,36
08/2020	14230,70	18516,60	13401,60	5339,50
09/2020	11210,5	13949,8	9473,7	5031,99
10/2020	14166,3	17328,5	13588,9	7608,41
11/2020	12117,1	15451,6	11405	8458,07
12/2020	14005,3	19545,2	13519,4	10510,92
01/2021	19544,7	23088,1	18436,9	9098,84
02/2021	12375	15469,9	11298,2	7831,99
03/2021	14788,6	22172,75	16966,3	9264,22
04/2021	21406,8	22172,75	16966,3	8676,49

Source*: Grouped by the Authors based on (State Treasury Service of Ukraine, 2021; Ministry of Finance of Ukraine, 2021).*

***Table 3**. The results of regression analysis of the studied indicators*

Regression analysis of the relationship between factors and performance indicator A		Regression analysis of the relationship between factors and performance indicator B		Regression analysis of the relationship between factors and performance indicator C		Regression analysis of the relationship between factors and performance indicator D	
$a_1 =$	0,0485	$a_1 =$	0,22851	$a_1 =$	0,1576	$a_1 =$	-0,03412
$a_2 =$	2,5578	$a_2 =$	-2,7195	$a_2 =$	-1,2845	$a_2 =$	-1,9502
$a_3 =$	-0,7596	$a_3 =$	0,20911	$a_3 =$	0,2185	$a_3 =$	1,9837
$a_4 =$	307,07	$a_4 =$	-223,92	$a_4 =$	-110,26	$a_4 =$	-35,23
$a_5 =$	15,68	$a_5 =$	339,591	$a_5 =$	243,27	$a_5 =$	-19,03
$a_6 =$	0,0409	$a_6 =$	-0,3452	$a_6 =$	-0,2308	$a_6 =$	-0,0318
$a_7 =$	-0,3089	$a_7 =$	-0,1977	$a_7 =$	-0,2128	$a_7 =$	0,0988
$a_8 =$	89,0411	$a_8 =$	1657,81	$a_8 =$	1470,60	$a_8 =$	1599,56
$a_9 =$	-393,63	$a_9 =$	5470,86	$a_9 =$	3464,30	$a_9 =$	-1770,66
$a_{10} =$	-22230,1	$a_{10} =$	-20815,1	$a_{10} =$	-18314,4	$a_{10} =$	3943,93
$Sa_1 =$	0,07303	$Sa_1 =$	0,4117	$Sa_1 =$	0,3391	$Sa_1 =$	0,032884
$Sa_2 =$	2,9234	$Sa_2 =$	16,4827	$Sa_2 =$	13,5745	$Sa_2 =$	1,316344
$Sa_3 =$	1,8442	$Sa_3 =$	10,3978	$Sa_3 =$	8,5632	$Sa_3 =$	0,830392
$Sa_4 =$	143,91	$Sa_4 =$	811,37	$Sa_4 =$	668,21	$Sa_4 =$	64,79763
$Sa_5 =$	64,9511	$Sa_5 =$	366,208	$Sa_5 =$	301,59	$Sa_5 =$	29,2461
$Sa_6 =$	0,1269	$Sa_6 =$	0,7155	$Sa_6 =$	0,5893	$Sa_6 =$	0,057145
$Sa_7 =$	0,1827	$Sa_7 =$	1,0302	$Sa_7 =$	0,8485	$Sa_7 =$	0,082279
$Sa_8 =$	1277,6	$Sa_8 =$	7203,16	$Sa_8 =$	5932,22	$Sa_8 =$	575,2592
$Sa_9 =$	2444,9	$Sa_9 =$	13785,3	$Sa_9 =$	11352,9	$Sa_9 =$	1100,920
$Sa_{10} =$	8530,3	$Sa_{10} =$	48095,9	$Sa_{10} =$	39609,7	$Sa_{10} =$	3841,038
$r^2 =$	0,98730663	$r^2 =$	0,803013249	$r^2 =$	0,76264095	$r^2 =$	0,98950671

***Source:** Own elaboration.*

According to the results of the analysis of the relationship between selected economic indicators and the amount of budget revenues (Table 3), the highest coefficients of determination were obtained when determining the relationship between factors and the actual cash flow to the general fund of the State Budget of Ukraine (option A, r^2= 0.987306624) and the indicator of implementation of the State Budget of Ukraine on customs payments (option D, r^2= 0.98950671). The obtained results mathematically confirm the assumption that the factors we have chosen for the study have a major impact on the amount of budget revenues. In other words, 98.7% of the variation in budget revenues is due to the variation of selected factors, and the coefficient of residual determination (1-0.987306624) indicates that only 1.3% of the variation in budget revenues is explained by the influence of other factors. All this allows us to conclude about the adequate and objective structure of our chosen model for planning the customs revenues.

Since the subject of our study is the customs system, for further calculations we will retain the indicator of implementation of the State Budget of Ukraine on customs payments, the coefficient of determination of which is greater than option A. With regard to the other two options, the obtained relatively low coefficients of determination (option B, r^2 = 0.803013249; option C, r^2 = 0.76264095) can be explained by the shortcomings in the reporting statistics submitted by domestic government agencies. The careful analysis of the statistics (Table 2) is bound to draw investigator's attention to the period March-April 2020. In March, the state budget implementation level is relatively high (UAH 40938.00 million and UAH 32046.70 million, respectively), whereas in April the budget execution is negative. This is due to certain practical peculiarities of the fiscal authorities' performance in filling the state treasury and it often happens that in previous periods, business entities pay taxes and make mandatory payments in advance to the account of subsequent periods. As a result, we get statistical information that contradicts the objective reality. Our calculations result in the following regression model:

$$\hat{Y}(x_1, x_2, \ldots x_{10}) = -\ 0{,}03417x_1 - 1{,}95023x_2 + 1{,}983705x_3 - 35{,}231x_4 - 19{,}0282\ x_5 - 0{,}0318x_6 + 0{,}09877x_7 + 1599{,}6x_8 - 1770{,}7x_9 + 3943{,}9x_{10},$$

where $\hat{Y}$ – the projected value of budget revenues from customs payments; $x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}$ – set or projected values of selected economic indicators, respectively, GDP at actual prices, export volumes, import volumes, the official exchange rate of the Ukrainian hryvnia against the US dollar, the official exchange rate of the hryvnia against the euro, loans granted to the economy of Ukraine in the national currency, loans granted to the economy of Ukraine in foreign currency, weighted average interest rates of banks on loans in national currency; weighted average interest rates of banks on foreign currency loans; the weighted average rate of import duty.

In the next stage of our study, we decided to reject less significant factors that affect the amount of budget revenues from customs duties. To do this, we were gradually removing some economic indicators from the model. From a mathematical point of view, a factor is considered insignificant if the value of its regression coefficient is less than twice the value of the variance. The results of the calculations show that at constantly high coefficients of determination all the efforts to obtain a result that would clearly show the main and insignificant factors were unsuccessful. Then we tried to graphically analyze the existing relationships between the studied indicators in order to establish the form of relationship.

The lack of a positive result may be influenced by different units of economic indicators that affect the amount of budget revenues from customs duties. In particular, some indicators are presented in monetary units (GDP at actual prices, export and import, the official exchange rate of the national currency, lending to the national economy), while others are given as a percentage (weighted average interest rates of banks on loans, weighted average import duty). In this case, it is advisable to reduce the values of all factors to commensurate values, i.e. normalize to values from 0 to 1 by the formula (Johnson, 1980; Draper and Smith, 1986):

$$\tilde{x} = \frac{x_i - x_i^{min}}{x_i^{max} - x_i^{min}} \tag{16}$$

where $\tilde{x}$ — the normalized value of x;

x_i^{min} — the minimum value of x;

x_i^{max} — the maximum value of x.

Having normalized the data of Table 1 we recalculate our model (16), gradually rejecting insignificant factors. As a result, we obtain the desired result, which is presented in Table 4.

Table 4. *Regression analysis final results*

Design values	Factors Export	Import	Loans in foreign currency	interest rate of banks on loans in national currency	banks' interest rate on foreign currency loans	Import duty rate
$a_1, a_2 .. a_{10}$	-5877,8	6962,4	3215,8	5501,6	-1655,8	3647,2
$Sq_1 Sq_2 .. Sq_{10}$	3186,3	2827,7	1521,03	1574,8	1084,2	645,6

r^2 = 0,9877267

Source: *Own elaboration.*

As can be seen from Table 4, of the ten selected economic indicators, the following ones have a significant impact on the amount of cash receipts to the State Budget of Ukraine from customs payments for the analyzed period of time:

1. export volumes - inversely proportional relationship between this indicator and the amount of budget revenues from customs duties, at first glance, seems absurd, but a more careful study of this relationship shows that mathematical calculations reveal quite logical practical features, where a

zero VAT rate on export transactions leads to a decrease in revenues to the state treasury from customs duties;

2. volumes of imports;
3. loans to the economy of Ukraine in foreign currency - according to the results, the access of foreign economic entities to credit resources allows them to develop their business and, consequently, increase the size of imports. It is no coincidence that the amount of budget revenues is influenced by the size of loans in foreign currency, as it is known that in recent years lending in national currency has been less popular;
4. weighted average interest rates of banks on loans in national currency;
5. weighted average interest rates of banks on loans in foreign currency - note the inversely proportional relationship between the bank rates on loans in foreign currency and the size of budget revenues. This once again suggests that lending in the national currency mainly concerned the consumer sector. And the small weight of this indicator once again proves the need for business access to credit resources, as the interest paid by businesses to banks does not significantly affect the amount of budget revenues;
6. weighted average tariff rate on imports - despite the fact that in recent years the value of this indicator has been systematically decreasing, yet, as the results of the analysis showed, the duty rate is crucial in the formation of government revenues (Martyniuk 2011; Zhuravka, Filatova, Šuleř, and Wołowiec 2021).

Eventually the regression equation will look like:

$$\hat{Y}(\tilde{x}_1, \tilde{x}_2, \ldots \tilde{x}_6) = -\,5877{,}881\,\tilde{x}_1 + 6962{,}378\,\tilde{x}_2 + 3215{,}812\,\tilde{x}_3 + 5501{,}659\,\tilde{x}_4 - 1655{,}821\,\tilde{x}_5 + 3647{,}176\,\tilde{x}_6. \tag{17}$$

The obtained regression equation 17 is exactly the empirical formula that allows not only to approximate the set of statistics, but also to extrapolate the found dependence to future time intervals. In other words, the obtained interdependence, established by the results of repeated processing of statistical data, creates the necessary basis for further multifactor modeling and forecasting the receipt of customs payments to the state budget. To do this, it was decided to act in two ways, first, try to predict the value of each economic factor and, by substituting it in the resulting regression equation, to compare the values of state budget revenues from customs duties with the actual values in those periods. Second, to substitute the actual values of economic factors in future periods into the obtained regression dependence and, thus, to check the efficiency and adequacy of the obtained model.

5. Conclusions

The first and one of the most important and least scientifically developed functions of management of the state customs system is planning the work of customs authorities and forecasting the state budget revenues from customs payments. The importance of this stage is the need to predict with some probability the state of individual elements of the customs system in the future, and therefore prepare appropriate management decisions to neutralize the negative consequences.

Factor analysis by the method of main components allowed us to conclude that the size of tax revenues to the state budget is most influenced by two main components (groups of factors): monetary (national currency exchange rate to euro and US dollar, the size of loans in national and foreign currencies, interest rates of banks on foreign currency loans) and macroeconomic (GDP, export volumes, import duty rates, inflation rate). Moreover, monetary factors to a greater extent (48.48%) affect the receipt of taxes and fees to the state treasury than the macroeconomic ones (35.02%).

Deepening the results of factor analysis by measuring the main components for selected monetary and macroeconomic factors allowed us to identify the impact of the COVID-19 pandemic on the economy of Ukraine, which later resulted in an internal financial and economic crisis. In particular, it was found that from September 2019 to January 2020 the macroeconomic factor was growing steadily, which was reflected in a steady increase in GDP, exports and imports, with low inflation. In contrast to this trend, the monetary factor, which has a more significant impact on the national economy, is steadily declining. Its most rapid decline was observed in the period from February to September 2020. This together with an internal negative political trend and adverse external factors caused by the COVID-19 pandemic has led to severe economic consequences in Ukraine.

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