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Analysis and modelling of value added tax revenues on imports: Some issues of application in Ukraine

Luchko, M. [a]*, **Drozd, I.** [b], **Plutytska, K.** [c], **Ruska, R.** [d], **Vovk, I.** [e]

[a] Department of Accounting and Control in Public Administration, Ternopil National Economic University, Ternopil, Ukraine.

[b] Educational and Scientific Center for Public Administration and Financial Control, Institute of Postgraduate Education, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine.

[c] Department of Criminal Law and Justice, Zaporizhzhia National University, Zaporizhzhia, Ukraine.

[d] Department of Applied Mathematics, Ternopil National Economic University, Ternopil, 46009, Ukraine.

[e] Department of Innovation and Services Management, Ternopil Ivan Puluj National Technical University, Ternopil, Ukraine.

[a] *m_luchko@ukr.net,* [b] *drozdirina@ukr.net,* [d] *r_ruslana@ukr.net,* [e] *vovk.ira.2010@gmail.com*

Abstract: The aim of the article is to study the issues of analysis, modeling with the purpose of forecasting the payment of value added tax (VAT) on goods, works and services imported as imports into the customs territory of Ukraine. The reliability and validity of the planned VAT rate depend on the assessment of the status, forecast, seasonality and trends of economic and social development. The purpose of the work is to analyze and systematize the methodology for modeling VAT revenues from imports, justify the use of the econometric method and develop an adequate ARIMA model. It application is possible in the long term as well as smaller periods of time, which is relevant for monitoring and control of tax revenues. The study revealed the main factors influencing the application of the ARIMA model when modeling VAT revenues from imports. The resulting regression model in STATISTICA linked the variables with an accurate approximation.

Key words: Forecasting, Value Added Tax, Tax Revenue, ARIMA Modelling, Regression.

1. Introduction

As has already been pointed out, considerable attention is paid to tax forecasting and modeling of tax revenues. In our opinion, tax forecasting, tax revenue modeling, and analysis of their results should be explored with consideration of such functions as part of management, process, and category. It has to be a continuous process, some sort of a well-balanced system. Such a systematic approach means that tax revenue forecasting, modeling, has a purpose, a goal function, and consists of manageable interrelated elements.

It is accepted that the purpose of tax forecasting consists of two parts: first, to understand how the future development of certain fiscal indicators depends on the future changes in the bases of these revenue sources, to assess the «budgetary elasticity» of these indicators, taking into account the expected changes in the policy of their collection; second, to understand how the change in revenue sources will additionally indirectly affect the behavior of the tax base, including its influence on the size of macroeconomic indicators.

It is well known that Ukraine's economy is heavily dependent on imports. This is clearly evidenced by

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the data in Table 1 and Figure 1. In some years, the amount of imports reaches 50 percent of nominal GDP, which significantly complicates the functioning of the economy.

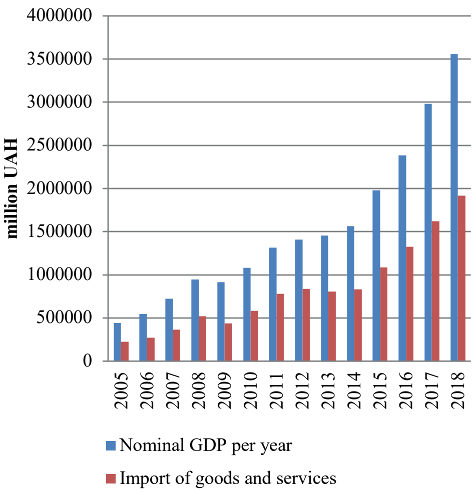

Figure 1. Ratio of nominal GDP and imports in Ukraine, million UAH (*Source*: MinFin, 2019).

VAT is one of the main sources of the state budget. Unlike many European countries, administering this tax in Ukraine is problematic. This is due to many factors and the main ones are the state of the economy, the exports-imports ratio, electronic administering and the creation of VAT debt, numerous tax exemptions, benefits and an extremely low level of business culture. These problems certainly complicate the VAT revenue forecast.

Table 1. Import of Ukraine from 2005 to 2018 (UAH million).

Year	National GDP	Import of goods, works and services	Import quota, % of GDP
2005	441452	223555	50.6
2006	544153	269200	49.5
2007	720731	364373	50.6
2008	948056	520588	54.9
2009	913345	438860	48.0
2010	1082569	580944	53.7
2011	1316600	779028	59.2
2012	1408889	835394	59.3
2013	1454931	805662	55.4
2014	1566728	834133	53.2
2015	1979458	1084016	54.8
2016	2383182	1323127	55.5
2017	2982920	1618749	54.3
2018	3558706	1914893	53.8

Import of goods, works and services into the customs territory of Ukraine is subject to VAT under the provisions of the Tax Code of Ukraine. VAT liabilities on import already exist by the time of submitting customs declaration for customs clearance. Yet VAT on import would still have to be paid before or on the day of the customs declaration submission.

Usually, the import of goods into the customs territory of Ukraine is subject to 20% VAT rate. A 7% tax rate is applied only to the import of medicine and medical devices provided that: (1) the medicine is authorized for production and use in Ukraine; is listed in the State Register of Medical Products; (2) medical devices are authorized for marketing and/or putting into service and use in Ukraine; are listed in the State Register or meet the requirements of the relevant technical regulations (confirmed by a document of conformity). Failure to meet the conditions results in an application of a 20% import tax rate. Thus, in practice, we have two tax rates, which will undoubtedly make adjustments to the VAT payment and its administration.

In order to forecast VAT on import, the most important is to develop the appropriate methodology for VAT revenues estimating for countries in transition, in particular for Ukraine. There are four basic tax revenues estimating methodologies: the actual rate method, the elasticity method, the simulation method, and the trend and auto-correlation method. It is quite difficult to determine the best methodology to be applied in Ukraine. All methods have their advantages and disadvantages.

2. Literature review

For the article goals to be achieved, they are necessary to be structured in the following areas: general questions and provisions, values of tax analysis and forecasting, methods of regression analysis models, use of ARIMA model.

Many authors have addressed the problem of VAT modeling, including impact on main indicators of well-being (Bilan et al., 2020; Danilov, 1999; Ebrill, et al., 2002; Louzis, 2019; Luchko et al., 2019; Mishchuk and Grishnova, 2015; Ngoc Huy, 2018; Shahnazarian et al., 2017). It is considered that the most widely discussed topics in the economic scientific literature on VAT include topics such as administering the tax, problems of its payment, tax evasion, VAT reimbursement in EU, VAT refunds and fraud, VAT assessment, etc. The topic of VAT revenue modeling, though extremely important, is not widely explored. According to the data, it has been little discussed in the current literature on public finances. There is reason to believe that VAT is considered as one of the most stable taxes. Accordingly, it is relatively easy to forecast based on simple methods.

The Modern VAT (Ebrill, Keen, Bodin and Summers, 2001) is one of the most interesting research papers on VAT. The content of the work shows that it thoroughly investigated the nature of VAT, analyzed the income from this tax, its rates and benefits, administration and audit of VAT and VAT refunds. The study proposes a summary of VAT efficiency through the «efficiency ratio», which is calculated as VAT revenue - GDP ratio divided by the standard VAT rate. Since errors are possible in the calculation of GDP, the more appropriate baseline is aggregate consumption, which is the ideal VAT base. The C-efficiency ratio is the VAT revenue - consumption ratio divided by the standard tax rate. If the C-efficiency ratio is 100%, then the VAT system works very well. In Ukraine, however, this ratio is low.

Jenkins, Kuo and Shukla (2000) have indicated that tax analysis and revenue forecasting are crucial in ensuring the stability of the state's tax policy and budgeting. For a timely and effective analysis of the revenue aspects of a country's fiscal policy, it is increasingly important to rely on internal tax policy forecasting rather than to rely solely on tax experts from the outside. This makes it possible to predict and analyze the impact of fiscal policy on the economy and to assess the effects of tax measures on revenues, with the ultimate aim of ensuring a healthy fiscal situation in the economy. The following broad functions are necessary to be performed: (a) monitoring of revenue collection; (b) an assessment of the economic, structural and revenue aspects of tax policy; (c) analysis of tax expenditures; (d) assessing the impact of non-tax economic policies; (e) forecasting future tax revenues.

As noted by Bogetic and Hassan (1993), VAT receipts usually depend on three groups of factors: the structural aspects of tax (rates, bases, thresholds, etc.), the amount of taxable activity, and tax discipline. In general, VAT revenue can be modeled as a function of $R(\iota, \alpha)$, where ι is the tax collection variables (rates, bases, thresholds, etc.) and α is the economic environment variables (which affect the tax base and compliance with the collection rules). Next, the authors distinguish between taxable and non-observable tax variables.

Researcher Stock (2001) believes that historical empirical patterns should be used to predict time series. At the same time, it is expedient to be guided by a theoretical understanding of economic processes, which provides the basis for the creation of future forecasts. Economic forecasts are used in a wide range of activities, including the definition of monetary and budgetary policies, state and local budgets, financial management and financial engineering. Key elements of economic forecasting include the choice of one or several forecasting models that are appropriate for addressing the problem, as well as estimation and reporting of uncertainty associated with the forecast, and protection against model instability.

The main purpose of the study conducted by Gamboa and Sophia (2002) is developing a tax forecasting model. Existing tax forecasting methodologies have shown that the approach to tax elasticity using the regression procedure is more efficient, and is considered to be the best forecasting methodology. Thus, a tax elasticity approach is used for the purposes of this study. Structural models for unified equation prediction have been identified and evaluated. Both linear and double logarithmic functions were applied in an attempt to use the ordinary least squares method as a regression procedure.

Giesecke and Tran (2012) point out that the modeling of payment on exported and imported goods in different countries, combined VAT compliance measures are valuable for identifying problematic areas of its payment. They are also important for meaningful cross-country comparisons and for the shortest possible time for VAT compliance. A comprehensive and general basis for calculating VAT compliance rates at both the economy and industry level is presented. This makes it possible to set multiple VAT rates, exemptions, registration rates, refund restrictions, informal activities, taxation of domestic non-residents and undeclared imports.

Andrejovska and Pulikova (2018) point out that, as a tool for assessing the macroeconomic impact of alternative tax policies in the country, taxes are often weakened by restrictions on the measurement of tax revenues. The article investigates the quantitative impact of selected macroeconomic indicators (gross domestic product, employment rate, public debt, foreign direct investment, effective tax rate, statutory tax rate) on the total amount of tax revenues taking into account the competitiveness of 28 EU Member States. The methods of three regression analysis models were used: merger models, fixed effects models, and random effects models. The hypothesis that gross domestic product has the greatest impact on tax revenues was tested. The strongest correlation was observed between tax revenues and employment rates, as well as foreign direct investment and gross domestic product, as was confirmed by the analysis.

Sabaj and Kahveci (2018) propose the introduction of new forecasting models and the use of forecast combinations for Albania, with forecasting errors exceeding the average. The results of the evaluation show that the influence of internal and external factors on the forecasting of tax revenues creates a significant improvement in the accuracy of tax revenues. The estimates and combinations of forecasts in this paper result in fewer errors than the official forecasts, suggesting that revising the tax forecasting methodology can increase the accuracy of forecasts for emerging market economies.

Rudzkis and Maciulaityte (2007) examined the forecast of budget revenues using econometric models in Lithuania. It is established that the set of applied models should be reduced to very simple models in short time series. Therefore, the regression analysis is proposed to be conducted in two stages: econometric modeling being the first stage, and the algorithms for forecasting the tax base being the second. Cross-estimation was used to evaluate the accuracy of these algorithms.

The work of Legeida and Sologoub (2003) analyzes modeling and forecasting of VAT payment in Ukraine. Unlike most VAT administering countries, it is problematic to administer this tax in Ukraine. Of paramount concern are VAT debt, numerous tax exemptions, and extremely low VAT compliance. These issues certainly complicate the forecast of VAT revenues. That is why the main purpose of the work was to test different methodologies for forecasting VAT revenues. Using an effective rate approach, the authors found out that actual VAT revenues constituted less than a half of potential VAT revenues. The econometric method establishes a strong empirical long-term relationship between VAT revenues and its base.

Soto-Ferrari et al. (2019) examined the capabilities and efficiency of ARIMA models, forecasting capabilities, and developed procedures to improve such forecasting.

According to Büyükşahin and Ertekin (2019), there are different methods for predicting time series that use linear and nonlinear models separately or a combination of both. Studies show that combining linear and nonlinear models can be effective for improving forecasting efficiency. A new hybrid method of autoregressive integrated moving average (ARIMA), an artificial neural network (ANN), which operates in a more general framework, is proposed. It is stated that the experimental results showed that the strategies of decomposition of the initial data and the combination of linear and nonlinear models in the process of hybridization are key factors for predicting the efficiency of the methods.

Tiao (2001) indicates that time series data in business, economics, environment, medicine, and other scientific fields tend to exhibit patterns such as trends, seasonal fluctuations, irregular cycles, and periodic level or variability shifts. The task of analyzing such series is often to extrapolate the dynamic picture to predict future observations, as well as to evaluate the effect of known exogenous interventions and to detect unexpected interventions.

The IMF (2001) outlines four main revenue forecasting approaches. The first approach is based on the actual rate. To calculate tax revenue, we first calculate the actual rate by dividing the tax amount by the estimated tax base. Usually, the actual tax rate is below the statutory rate. The difference between the two may be explained by tax exemptions and taxpayer discipline problems. Next, we estimate tax revenue by multiplying the estimated tax base for the next period by the actual tax rate for the current period. The second approach is based on flexibility. It is based on establishing a stable empirical relationship between the growth of tax revenues and the corresponding increase in the tax base, known as "elasticity". The increase in tax revenues is obtained as a product of the projected increase in the tax base for elasticity. It also takes into account the estimated value of the impact of changes in the tax structure, its administration and tax discipline. The third one is an econometric approach. It can be used to calculate revenue forecasts based on general equilibrium model or micro modeling based on sample tax amounts.

The fourth is a trend-based and autocorrelation approach. Past trends can be used to forecast, along with specific information about each source of revenue. Empirical approaches often use ARIMA models, in particular for forecasting.

The objective of the article is to investigate the possibilities of building a model of the dynamics of monthly import VAT revenues and its analysis. Standard white noise errors are analyzed and the relative error of the model is determined. The significance of the parameters by the Student's t-test was checked. In our opinion, this will enable us to check the equality of the averages in the two samples.

To develop the main idea of our study, we propose the following hypothetic assumptions that we will experimentally test for a possible solution to the problem. The first assumption is whether VAT on imports can act as a tool for macroeconomic impact on the formation of budget revenues. The second one is to find out if parameter importance is confirmed when using the ARIMA model to forecast VAT on imports.

3. Research methods

Let us check the assumptions made. The results of the study confirm that the import quota is expressed as a percentage of the volume of imports to GDP, which characterizes the country's dependence on world markets for goods and services. According to Table 1 in Ukraine, it is about 50%, which indicates the dependence of the country's economy on imports. In this respect, it should be borne in mind that VAT on imports is a tool for macroeconomic impact on state budget revenues. It is safe to say that on the one hand, imports of goods have a negative impact on the development of domestic economy and on the other hand, they stimulate it and significantly improve the budget.

Imports VAT payment statistical data is presented in Table 2.

According to Table 2, we will analyze the analytical model of calculating VAT revenues from imported goods to Ukraine. Specification of the model (analytical form of econometric model) is written in Equation (1).

$$y_t=b_0+b_1t+u \tag{1}$$

where y_t – the level of a series of dynamics at time t=1,2,...,55.

Consider the dynamics of actual monthly VAT revenues from imported goods, works and services into the territory of Ukraine as a time series (Figure 2). There is reason to believe that it represents fluctuations around some level. Let us check the assumption made. It seems likely to use regression and moving average methods. Essentially, the regression method is based on the construction of a line that "on average" deviates the least from the array of values that specify the behavior of the baseline. Mathematically it is described by the Equation (2):

$$y_t=\varphi_1y_{t-1}+\varphi_2y_{t-2}+\cdots+\varphi_py_p+\varepsilon_t \tag{2}$$

where y_t – the value of y at time t; φ_i – equation coefficients (i=1,2…p); p – autoregression order; ε_t – random variable.

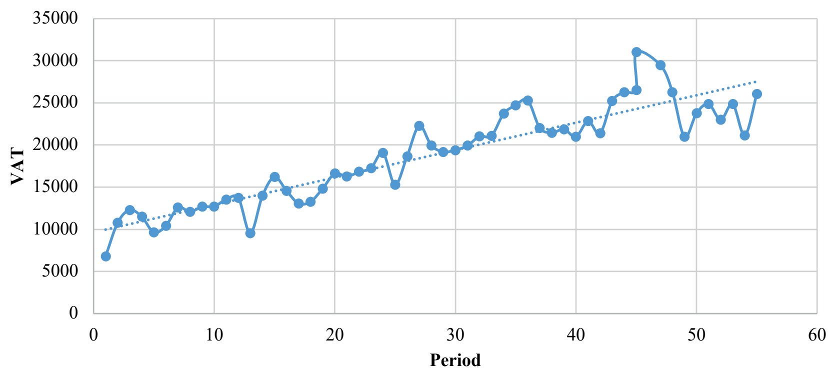

Figure 2. Dynamics of monthly actual VAT revenues from imported goods, works and services to Ukraine according to the Table 2.

Table 2. Dynamics of monthly VAT receipts from imports, mln UAH.

Years	2015	2016	2017	2018	2019
Months	VAT	VAT	VAT	VAT	VAT
1	6814,2	9531,0	15291,5	22033,0	20972,4
2	10779,1	13969,9	18674,6	21459,9	23778,4
3	12294,6	16203,0	22280,0	21865,3	24863,4
4	11482,4	14565,3	19961,5	20995,9	22992,7
5	9637,7	13064,3	19190,7	22828,4	24847,0
6	10429,7	13284,8	19394,6	21387,5	21155,2
7	12578,9	14836,5	19924,9	25215,5	26056,7
8	12071,9	16622,4	21022,3	26251,1	
9	12673,6	16247,0	21111,7	26534,9	
10	12715,3	16818,8	23712,4	31038,1	
11	13545,7	17257,4	24722,0	29474,9	
12	13741,2	19052,9	25303,9	26292,8	

Source: State Tax Service of Ukraine (2020).

At the same time, the moving average method is that each element of the series is prone to the total effect of previous errors:

$$y_t=\omega_1\varepsilon_{t-1}+\omega_2\varepsilon_{t-2}+\cdots+\omega_q\varepsilon_{t-q}+\varepsilon_t \qquad (3)$$

where y_t – the value of y at time t; ω_i – equation coefficients (j=1,2…q); q – moving average order; ε_t – random variable.

For further study, we use the ARIMA model, which combines the two methods and looks like:

$$y_t=\sum_{i=1}^{p}\varphi_i y_{t-1}+\sum_{j=0}^{q}\omega_j\varepsilon_{t-1}+const \qquad (4)$$

Testing the input data of the monthly VAT receipts from the imported goods, works and services into the territory of Ukraine, we transformed the time series

Table 3. Simulation results in STATISTICA.

	Parameter	Parameter	Asymptote. Stat. f.	Asymptote. t(52)	p
Model: (0,0,1)(0,0,1) Conversions: ln(x) Seasonal lag: 12 Approxim. number.: 55 Initial SS=5275.1 final SS=2.3758 (0.0450%) MS=0.04569 Parameters (p/Ps-autoregression, q/Qs-moving aver.); selection: p<0.05	Const.	9.684210	0.075863	127.6533	0.000000
	q(1)	-0.639558	0.093089	-6.8704	0.000000
	Qs(1)	-0.579764	0.119670	-4.8447	0.000012
Model: (0,0,2)(0,0,1) Conversions: ln(x) Seasonal lag: 12 Approxim. number.: 55 Initial SS=5275.1 Final SS=1.8078 (0.0343%) MS=0.03545 Parameters (p/Ps-auto-regression, q/Qs- moving aver.); selection: p<0.05	Const.	9.591779	0.113452	84.54483	0.000000
	q(1)	-0.863142	0.144147	-5.98791	0.000000
	q(2)	-0.511931	0.127891	-4.00286	0.000203
	Qs(1)	-0.600854	0.124562	-4.82373	0.000013
Model: (1,1,1)(0,2,1) Conversations: D(1),2*D(1) Seasonal lag: 12 Approxim. number.: 55 Initial SS=1723E6 Final SS=4112E5 (23.86%) MS=8567E3 Parameters (p/Ps-auto-regression, q/Qs- moving aver.); selection: p<0.05	Const.	41.06193	38.31173	1.07178	0.289176
	p(1)	-0.32089	0.16237	-1.97627	0.053886
	q(1)	0.94344	0.08058	11.70816	0.000000
	Qs(1)	-0.68889	0.13429	-5.12980	0.000005
Model: (1,1,1)(0,1,1) Conversations: D(1),D(1) Seasonal lag: 12 Approxim. Number. 55 Initial SS=1612E6 Final SS=4279E5 (26.54%) MS=7377E3 Parameters (p/Ps-auto-regression, q/Qs- moving aver.); selection: p<0.05	Const.	19.32306	19.50255	0.99080	0.325900
	p(1)	-0.45805	0.12184	-3.75936	0.000398
	q(1)	0.95106	0.04868	19.53620	0.000000
	Qs(1)	-0.19042	0.13032	-1.46121	0.149355

and conducted the research using ARIMA modeling. As a result, the following models were obtained (Table 3).

To select the appropriate model, consider the simulation results in the STATISTICS program (Table 3). In the first two models, we log the time series and get: the initial sum of squares of SS residuals is the same, the finite one is smaller in the second model, and the mean square of MS residuals in the second model is also smaller. So, in terms of residuals, the second model is preferable, but in our belief we will check the significance of the parameters by the Student's t-test. To this end, we propose two hypotheses: H_0– the model parameters are zero and the alternative hypothesis H_1– not all parameters are zero. For each parameter φ_i and $\omega_j t_{defines}$ are defined as the ratio of the regression coefficient taken to the module to its standard error. Let's check the assumptions made. The calculated value is compared with with t_{crit}=2.006 the significance level α=0.01 and the number of degrees of freedom df=53. Comparing the value of t_{calcul} and t_{crit} for each of the parameters obtained, confirms the hypothesis of the significance of all parameters in both models, so we accept the alternative hypothesis.

Consider the last indicator p. The closer it is to zero, the better the result, the closer or equal to one the parameter is insignificant, so all the parameters are significant.

Models (1,1,1) (0,2,1) and (1,1,1) (0,1,1) are created using the differences of lags 2 and 1, respectively. Analyzing the sum of squared residuals by these models we can say that they are quite large and the series have not been smoothed out. As a consequence, in the Student test, in the model (1,1,1) (0,2,1), the first two parameters and in the model (1,1,1) (0,1,1), the first and fourth are not statistically significant, that is, they can be neglected in further research. This, in turn, will lead to incorrect forecasts, so we reject these models.

Since the models (0,0,1) (0,0,1) and (0,0,2) (0,0,1) according to preliminary tests are suitable for further use, we analyze the residuals (Table 4).

According to the results, the standard white noise errors in model (0,0,1) (0,0,1) have one emission, while in model (0,0,2) (0,0,1) there are two. The conducted research confirms that we should give preference to the first model, and confirms our initial assumption about the non-stationary nature of the time series, and that all the transformations made are correct. To achieve this goal, we compare the forecasting results of these models (Table 5). These forecasts are presented graphically in Figure 3.

Check the assumptions made and calculate the relative error on the models. To do this, take the actual value for July 2019 y_{55}=26056.7, the predicted value for the model ARIMA (0,0,1) (0,0,1) is 25135.49, then:

$$\theta = \frac{|26056.7 - 25135.49|}{2605.7} = 0.035$$

Table 4. Modelling results - standard errors - STATISTICA white noise estimates.

	Autocorrelation function VAT on imports: ARPSS (0,0,1) (0,0,1) balances				Autocorrelation function VAT on imports: ARPSS (0,0,2)(0,0,1) balances			
Lag	Autocorrelation	Statistical error	Ljung–Box Q	*p*	Autocorrelation	Statistical error	Ljung–Box Q	*p*
1	0.256711	0.131244	3.82590	0.050475	-0.032985	0.131244	0.06316	0.801564
2	0.591859	0.130023	24.54628	0.000005	0.188356	0.130023	2.16172	0.339317
3	0.333622	0.128790	31.25662	0.000001	0.403724	0.128790	11.98833	0.007430
4	0.485453	0.127546	45.74306	0.000000	0.210263	0.127546	14.70596	0.005358
5	0.333841	0.126289	52.73098	0.000000	0.191661	0.126289	17.00918	0.004489
6	0.269011	0.125020	57.36098	0.000000	0.134199	0.125020	18.16140	0.005851
7	0.335951	0.123738	64.73236	0.000000	0.253217	0.123738	22.34917	0.002216
8	0.193429	0.122442	67.22800	0.000000	0.077519	0.122442	22.75000	0.003709
9	0.253762	0.121132	71.61669	0.000000	0.154776	0.121132	24.38262	0.003745
10	0.125740	0.119808	72.71815	0.000000	0.106300	0.119808	25.16984	0.005045
11	0.171745	0.118470	74.81975	0.000000	0.086523	0.118470	25.70322	0.007199
12	0.043976	0.117116	74.96075	0.000000	0.054752	0.117116	25.92178	0.011034
13	0.094175	0.115746	75.62275	0.000000	0.044603	0.115746	26.07028	0.016667
14	0.005324	0.114360	75.62492	0.000000	0.028680	0.114360	26.13318	0.024938
15	0.064706	0.112956	75.95307	0.000000	0.045239	0.112956	26.29358	0.035101

Table 5. Modeling results — forecasting by models using STATISTICA.

No Observation	Forecasts; Model: (0,0,1) (0,0,1) Seasonal lag: 12 Initial.: VAT imported from the territory of Ukraine goods Initial: 1 Final: 55			Forecasts; Model: (0,0,2) (0,0,1) Seasonal lag: 12 (T_3) Initial.: VAT imported from the territory of Ukraine goods Initial: 1 Final: 55		
	Forecast	Lower 90%	Upper 90%	Forecast	Lower 90%	Upper 90%
56	25489.09	24048.62	30176.79	25666.46	24650.59	31321.53
57	20078.61	13083.21	30814.33	21746.53	14317.07	33031.31
58	21466.87	13987.81	32944.88	20437.28	13057.20	31988.67
59	20360.96	13267.20	31247.66	19332.74	12351.51	30259.83
60	19340.07	12601.98	29680.90	18349.16	11723.12	28720.33
61	27163.60	17699.79	41687.56	27689.91	17690.84	43340.57
62	18691.34	17179.27	28685.31	17774.05	11355.68	27820.15
63	19479.83	12693.05	29895.40	18571.21	11864.98	29067.88
64	18664.97	15162.09	28644.84	17765.61	11350.29	27806.94
65	18888.85	12307.97	28988.44	17959.61	11474.24	28110.60
66	17708.07	11538.57	27176.31	16822.19	10747.55	26330.29
67	18965.95	12358.20	29106.75	18036.79	11523.55	28231.40

According to the ARIMA model (0,0,2) (0,0,1), the forecast value is 26119.60, then

$$\theta = \frac{|26056.7 - 26119.6|}{2605.7} = 0.002$$

It is obvious that in the first case an error is approximately 4%, whereas in the second case it is only 0.2%. Since the standard errors have only one emission in the ARIMA (0,0,1) (0,0,1) model, it is safe to say that this model should be used, even though the relative error in it is greater.

Using this model, we will make a quarterly forecast for the following years (Figure 4).

It is evident that the Final seasonal factors show that the first quarters of 2020-2021 will be characterized by steady import VAT revenues, with a slight increase in 2022. At the same time, from 2023 to 2028 a steady decrease in revenues is observed. The second quarter of 2020 is characterized by the same situation, as was in 2019. In 2021 there will be a partial decrease, and starting with 2022, a partial increase is expected. A steady increase in revenues is expected starting from 2023. The third quarters of these years will be characterized by stability and slight growth. The fourth quarters from 2020 to 2023 will be shaped by steady revenues, and from 2023 to 2028 there will be a slight decline.

Final SI differences with extremes and Final SI differences without extremes characterize forecasts of surplus receipts (errors) and those without surpluses. Final SI differences without extremes have some differences from Final seasonal factors. Final SI differences with extremes characterize significant emissions, in particular in the first quarter of 2021 and 2027, a sharp decrease in revenues or their termination, which gives a rather pessimistic forecast, and in 2025 and 2028 a sharp increase, making an optimistic forecast. Such an increase is still possible in the fourth quarter of 2020, in the

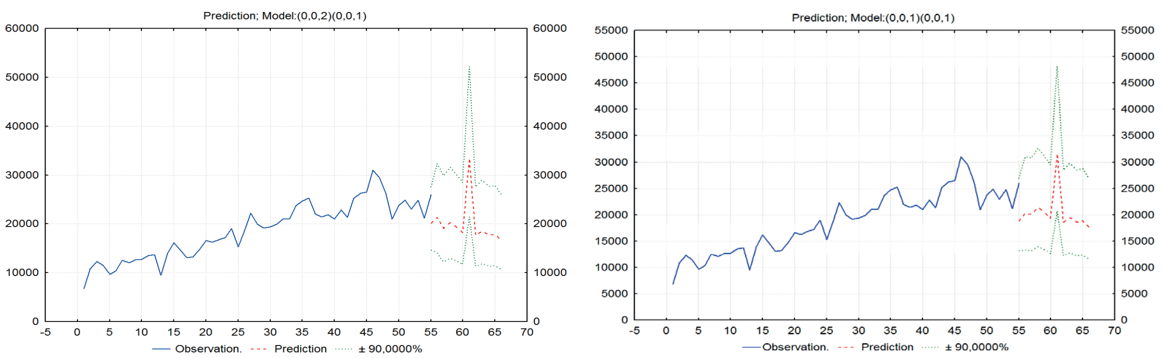

Figure 3. VAT import forecast, mln.

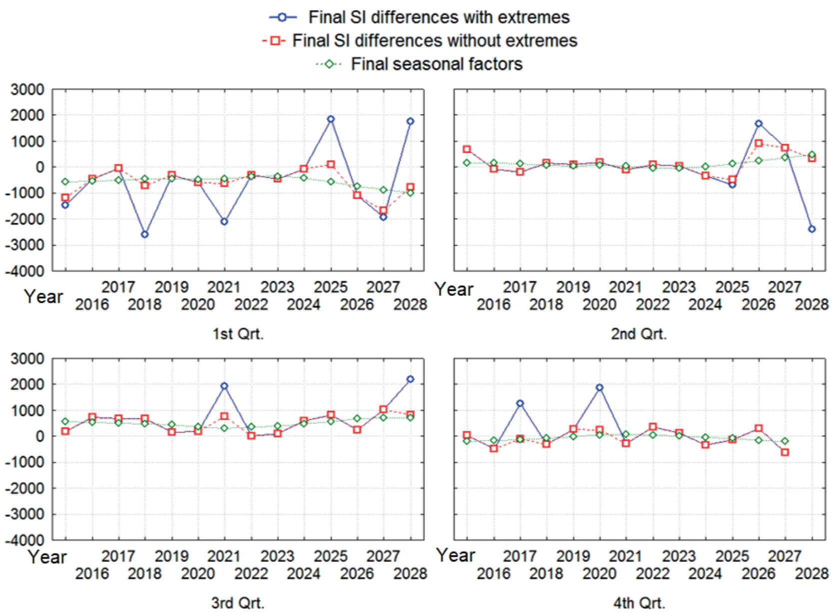

Figure 4. Quarterly VAT Import Forecast Chart, mln.

third quarter of 2021 and in the second quarter of 2026.

In general, it should be noted that VAT receipts from imports will not be spasmodic, but rather uniform.

4. Conclusion and discussion of the results

We do not claim the absolute scientific exclusivity of our thoughts. The study revealed the main factors of influence on the application of the ARIMA model when modeling VAT revenues from imports in the short and long term. The resulting regression model in STATISTICA software linked the variables with a fairly accurate approximation.

In answer to the questions and hypotheses suggested, we would like to point out that the study has shown that VAT on import has a significant impact on budget revenues, and therefore, choosing the best methodology for VAT modeling for a transition country will have a significant impact on budget and GDP indicators as a whole. We believe it expedient to use the ARIMA model.

A generalized economic and mathematical model makes it possible to minimize losses and to forecast budget revenues in terms of VAT on imports. The model can be adapted to forecast revenues from other taxes and fees.

In addition, it should be noted that, in our opinion, the performed research has enabled us to set new scientific problems that are of great theoretical and practical importance and may be the subject of further scientific research. First of all, they should include:

- optimization of tax administration;
- application of the possibilities of block-chain and artificial intelligence technologies in conditions of uncertain tax payment.

Possible direction for further research on this problem is also taking into account in the given model the future value of money and its impact on the inflationary effect due to its depreciation. In our opinion, this requires additional justifications and changes to the individual components of the calculations made.

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