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ЕКОЛОГО-ЕКОНОМІЧНА КОНВЕРГЕНЦІЯ: ПЕРЕХІД ДО СТИЙКОЇ ЕНЕРГЕТИКИ

Сталий енергетичний розвиток є складним завданням, так що тільки комплексні рішення і підходи можливо реалізувати найбільш ефективним чином. Залишається невирішеним питання, – яким має бути оптимальний обсяг використання нових і відомих енергоресурсів для забезпечення та підтримки сталого розвитку та екологічної безпеки для будь-якої держави світу. Стаття присвячена аналізу конвергенції в аспекті більш ефективного використання аналітичного та системного підходу для моделювання еколого-економічних зовнішніх ефектів при переході до стійкої енергетики. Розглядаються економічні наслідки такого переходу. Проводиться аналіз динаміки енергоспоживання в розрізі різних типів енергоресурсів за період 1820-2030 років. Результат підтвердив необхідність комплексного аналізу зв'язку "економіка – енергетика – довкілля". Вкрай актуальним бачиться необхідність впровадження комплексних підходів для моделювання та прогнозування розвитку нових енергетичних систем. Проведено порівняльний аналіз різних типів моделей і методів аналізу економіко-енергетичних систем.

Ключові слова: споживання енергії; конвергенція; моделі; енергоресурси.

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ЕКОЛОГО-ЕКОНОМІЧЕСКАЯ КОНВЕРГЕНЦИЯ: ПЕРЕХОД К УСТОЙЧИВОЙ ЭНЕРГЕТИКЕ

Устойчивое энергетическое развитие является сложной задачей, так что только комплексные решения и подходы возможно реализовать наиболее эффективным образом. Остается нерешенным вопрос, – каким должен быть оптимальный объем использования новых и известных энергоресурсов для обеспечения и поддержки устойчивого развития и экологической безопасности для любого государства мира. Статья посвящена анализу конвергенции в аспекте более эффективного использования аналитического и системного подхода для моделирования эколого-экономических внешних эффектов при переходе к устойчивой энергетике. Рассматриваются экономические последствия такого перехода. Проводится анализ динамики энергопотребления в разрезе различных типов энергоресурсов за период 1820-2030 годов. Результат подтвердил необходимость комплексного анализа связи "экономика – энергетика – окружающая среда". Крайне актуальным видится необходимость внедрения комплексных подходов для моделирования и прогнозирования развития новых энергетических систем. Проведен сравнительный анализ различных типов моделей и методов анализа экономико-энергетических систем.

Ключевые слова: Потребление энергии; конвергенция; модели; энергоресурсы.

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COMPARATIVE ANALYSIS OF THE KEY FACTORS OF GROWTH OF STATE DEBT OF UKRAINE AND EU

Based on research results, economical-statistical model was developed aimed to exhibit the connection between the government debt and major economic factors, namely: gross capital formation, household consumption and credits granted to the residents. After the statistical data of European countries had been examined, the peculiarities of debt formation were elicited in each of them. As a result, the relation between the type of economy and factors of debt formation was outlined.

Keywords: Government debt; government borrowing; capital formation; consumption of the population; lending to the economy.

Introduction

In the world of total globalization the development of the international financial system is notable for a significant increase in external government debt in different countries that by estimations has exceeded 30 trillion dollars [1]. Government borrowing is now an integral part of the financial systems of most countries in the world, as well as an effective institution in the mechanism of macroeconomic

regulation and a tool for implementation of an economic strategy of a country. However, the use of debt instruments for the purpose of overcoming nonrecurring deficit and social issues transfers the payment of the debt to a future period without considering the state budget potential.

In this context there is a need, on the one hand, to identify factors that lead to the external debt growth in different countries, while on the other hand, to clarify the

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scale of impact a debt burden might have on macroeconomic indicators. Moreover, an important area of the external government debt analysis is a study of regularities in the formation of growth trends in the debt burden.

In this study we have set two main *objectives*. Firstly, to investigate the process of formation of the external government debt in the European countries as well as to carry out a comparative analysis of the main factors causing its growth with the purpose of identifying the specificity of the external debt accumulation in different countries and defining a model of the external government borrowing. Secondly, to describe the key trends in shaping the external government debt in each country and to develop a forecast model of external government debt.

Formation of the parameter circle for modeling external debt

Traditionally, in a study of factors of the external government debt formation the following key macroeconomic indicators are selected: the inflation rate, GDP per capita, export and import rate per capita [2-4]. However, in terms of national accounts system this parameter circle including, namely, the amount of external government debt, GDP per capita, export and import rate, can not be a basis for modeling, since all these parameters are a part of the GDP, and thus, are a priori interconnected, which makes it impossible to use them in a model. Concerning the inflation rate, due to the fact that the amount of external government debt is measured in dollars or euros, which requires appropriate assessment of the rest of the indicators, in terms of national economies, the domestic inflation rates converted into hard currency will be generally taken into account.

That is why according to the results of data mining of a possible parameter circle we have decided to select the following characteristics, which, to our mind, are the main components of a macroeconomic environment:

- the external government debt;
- fixed capital accumulation;
- volumes of the final household consumption;
- volumes of economy crediting (loans granted to financial institutions).

Capital accumulation is an indicator that describes the process of investing funds by economic units into objects of fixed capital to create new revenue in the future and to support the process of expanded reproduction. As long as foreign borrowing is an opportunity to raise additional funds for the economy, we should analyze by contrast how much money in the country is "consumed", i.e. the volume of the end consumption or expenses of households on goods and services.

We ration this measure to the consumer price index. It is impossible to do without the crediting rate of the economy that defines the amount of loans granted by financial institutions.

To identify the interdependence of external government debt and selected indicators for the period of 2003-2011 their rationing was completed in order to eliminate the impact of inflation (for Ukraine in 2007, for the rest of the world – in 2005). Adjustments were made separately for each indicator. Thus, the external government debt was deflated, capital accumulation and the amount of loans adjusted to the price index for investment, while final household consumption – to the consumer price index.

Within the study external debts in a number of European countries were analyzed. The results of the survey will be presented for Germany, Denmark, Sweden, Finland, the Netherlands, Italy, Greece, Poland and Ukraine. All the calculations were done in the Eviews and Statistica software programs. Several basic models were taken as a foundation: the model of multifactor regression, autoregression, and mixed regression based on the factor scaling.

We found similar patterns in the formation of external government debt in some countries, such as non-random coincidences in the dynamics of external government debt and certain macroeconomic indicators. This pattern is inherent in economies distinguished by sustainable development of the economy. Such countries as Denmark, Sweden, Finland, Netherlands, Germany, and France turned out to be in this group. Let us examine the details of the trends in external debt accumulation and determine the pattern of their formation on an example of Germany.

Development of the external government debt models for countries with different levels and rates of economic growth

Germany. The dynamics of government debt in Germany in the period of 2003-2011 is distinguished by rapid growth and belongs to the wavy type, which is an evidence of seasonal fluctuations (Fig. 1). But it is only at first glance. A deeper analysis of seasonal fluctuations with identification of the trend component has shown that after evaluating the distribution of balance it was found out that it significantly deviates from the normal distribution laws, which is an evidence of presence in the model (that takes into account the seasonal component) of heteroscedasticity. This, in turn, means that the seasonality, actually, does not explain the deviations from the main development trend, characterized by a gradual growth by the 3rd quarter of 2010 and a dramatic leap starting from the 4th quarter of 2010.



Figure. 1. Dynamics of the total government debt of Germany for the period of 2003-2011, in mln EURO.

Source: own calculations based on data of Eurostat

The factor analysis has proved that all the parameters belong to one factor that accounts for 67% of the total variations. After a rotation of the matrix two factors were obtained that have the following factor loading (Table 1).

Government debt and lending volumes account for 45% of the variation, while 48% of the variation is explained by the factor of fixed capital formation and household final consumption.

Table 1. Factor loading after rotation using the Varimax method

Indicators	Factor 1	Factor 2
debt – the external government debt	0,219251	0,923412*
cap_from – fixed capital accumulation	0,960983*	0,175815
credits – volumes of economy crediting	0,216249	0,925447*
house_cons – volumes of the final household consumption	0,942073*	0,250912
Expl.Var	1,905825	1,803010
Prp.Totl	0,476456	0,450752

*) reliable estimations

Source: own calculations based on data of Eurostat

Studies on existence of autocorrelation in the dynamics line have revealed a period of decay that is 6 quarters long, which is a year and a half. The results of calculations of the first order autoregressive model have shown that by 95.1%

the volume of debt of the next quarter is determined by the previous one. A check of the balance autocorrelation has given positive results, i.e. autocorrelation was removed already in the first declinations.

Table 2. Results of the autoregressive model for Germany *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2115640	744280	2,84	0,0076
AR(1)	0,971	0,0398	24,42	0,0000

*) model estimations:

R-squared 0,951 **Akaike info criterion** 24,05
F-statistic 635,1 **Hannan-Quinn criterion** 24,08
Prob(F-statistic) 0,0000 **Durbin-Watson statistic** 1,77

Source: own calculations based on data of Eurostat

For the further modeling of the government debt accumulation process with the AR-process and results of factor scaling taken into account a mixed model of factors was built, which proved to be stable and has given very good results (Table 3).

Table 3. Results of the mixed model of factors for Germany *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3,193510	5,980865	0,533955	0,5973
F_1	-0,232420	0,041992	-5,534866	0,0000
AR(1)	0,967847	0,056259	17,20342	0,0000

*) model estimations:

R-squared 0,904 **Akaike info criterion** 0,638
F-statistic 140,6 **Hannan-Quinn criterion** 0,68
Prob(F-statistic) 0,000 **Durbin-Watson statistic** 2,38

Source: own calculations based on data of Eurostat

The debt factor (F_2) is by 90.4% explained by the debt payable in the previous period, as well as by the consumption and accumulation factor (F_1) with the AR-process prevalence. A disadvantage of this model is that without a possibility of interpreting the estimates received, from the point of view of possibilities of modeling it has no practical application. That is why we have attempted to develop a mixed model based on actual data about the external government debt, crediting volumes, as well as volumes of consumption and accumulation with the seasonality factor taken into account (Table 4).

According to the results obtained, the autoregressive mixed model explains 97% of external national debt variation in Germany but the estimates of the model are unstable. All factors turned out to be substantial, except for accumulation. The dominant factors that determine the dynamics of the external government debt proved to be the AR-process and the seasonality of the first order, showing that the formation of the external government debt in Germany in the next quarter is generally due to the accumulated debt of the previous quarter, as well as to seasonal fluctuations.

Table 4. Results of the mixed model for Germany *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	573851	1171663	0,49	0,628
AR(1)	1,024	0,03	28,81	0,000
@SEAS(1)	-108830	34540	-3,15	0,004
CREDITS	0,482	0,19	2,56	0,016
HOUSE_CONS	-3,019	1,28	-2,36	0,026
CAP_FORM	-3,354	1,88	-1,77	0,085

*) model estimations:

R-squared 0,970 **Akaike info criterion** 23,85
F-statistic 172,6 **Schwarz criterion** 24,13
Prob(F-statistic) 0,000 **Durbin-Watson statistic** 1,23

Source: own calculations based on data of Eurostat

Despite the instability of the model, taking into account the reliability of the regression coefficients there are grounds for some conclusions:

1. Based on the levels of probability, the order of factors in terms of their importance is as follows: an increase in debt is accompanied, first of all, by an increase in the volume of economy crediting. The second place in terms of importance is occupied by the final household consumption, the third one – by accumulation of fixed capital.

2. An increase in external debt is accompanied by an increase in crediting volumes of the economy, as well as fixed capital accumulation. Thus, an increase in crediting by 1 million euros is accompanied by an increase in the external debt by 0.601 million euros (elasticity coefficient – 1.3, i.e. the debt accumulation process is elastic in relation to crediting), while the growth in fixed capital accumulation by 1 million euros increases the external debt by 2.858 \$1 million euros (elasticity coefficient – 0.18, i.e. the debt accumulation process is not elastic regarding the fixed capital accumulation). All this suggests that the use of external borrowings is related to provision of expanded reproduction.

3. An increase of external debt is accompanied by a decrease in consumption, suggesting the use of external

borrowings for investment programs realization rather than for final consumption. Thus, a growth in household consumption by 1 million euros is accompanied by a decrease in external debt by 2.6 million euros with the materiality level of 0.0511 (elasticity coefficient – (-0.5)).

Thus, modeling of the external government debt in Germany yielded results that indicate that the growth of the national debt in Germany is mainly connected to the increase in crediting of the economy and accumulation, as well as a decrease in the final consumption. This situation is typical of economies with expanded reproduction, where resumption of production at each new stage is accompanied by growth of both quantitative and qualitative characteristics of the social product, which, in turn, is realized in the economic growth. Such a type of reproduction is inherent in developed market economies. This suggests an exemplary model of the external government debt formation in Germany.

Italy. The dynamics of government debt in Italy in the period of 2003-2011 is characterized by a gradual increase with pronounced seasonal variations, which enables us to draw conclusions about certain cyclicity in government debt application in Italy (Fig. 2).

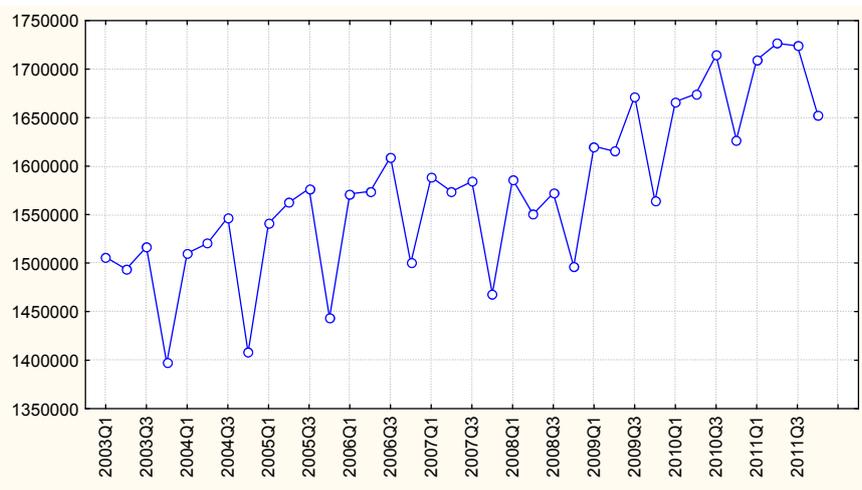


Figure 2. Dynamics of the total government debt of Italy for the period of 2003-2011, in mln. EURO
Source: own calculations based on data of Eurostat

A deeper analysis of seasonal fluctuations with identification of the trend component has shown that the distribution of balance does not deviate from the laws of normal distribution, and thus, the model of the seasonal component is homoscedastic. However, the seasonal factor is responsible for only 22% of the external debt variation, and thus, it is necessary to evaluate the autocorrelation component of the debt dynamics. Surveys on the presence of autocorrelation in the dynamics line have shown that the duration of decay amounts to 8 quarters, i.e. two years. The results of calculations of the autoregressive

model have shown that it is necessary to use the AR-process of the fourth order, explaining 86.5% of the debt formation in the next quarter at the expense of the previous four ones, which is one year.

A check of the balance autocorrelation did not produce necessary results, indicating existence of disturbances in the formation of the external debt of Italy (human factors), and hence, balance autocorrelation was not eliminated neither at the first nor at the eighth difference. This fact must be taken into account when developing models of the external national debt of Italy formation (Table 5).

Table 5. Results of the autoregressive model with respect to the seasonality factor and the MA-process for Italy *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2779538	5559930	0,500	0,6210
AR(4)	0,977	0,106	9,215	0,0000
MA(1)	0,733	0,164	4,464	0,0003
@SEAS(4)	142571	1253756	0,114	0,9103

*) model estimations:

R-squared	0,923	Akaike info criterion	23,07
F-statistic	112,5	Hannan-Quinn criterion	23,13
Prob(F-statistic)	0,000	Durbin-Watson statistic	1,65

Source: own calculations based on data of Eurostat

The autoregressive model with the seasonality factor and the MA-process taken into consideration explains the variation of government debt of Italy by 92.3%. The most substantial factors turned out to be the following: the auto-correlation function that determines its growth throughout the period under study, as well as random fluctuations – disturbances that occur in each quarter. The seasonality

factor, although not proved to be significant, but is an essential component of the model.

The factor analysis revealed the presence of two factors that generally explain 89% of the variation (Table 6). Thus, the government debt, loans and accumulations account for 52.2% of the variation while 36.8% of the variation is explained by the factor of the final household consumption.

Table 6. Factor loading after rotation using the Varimax method

Indicators	Factor 1	Factor 2
debt	0,838957*	0,367674
cap_form	-0,91416*	0,261781
credits	0,742447*	0,573640
house_cons	0,009174	0,968581*
Expl.Var	2,090864	1,470926
Prp.Totl	0,522716	0,367731

*) reliable estimations

Source: own calculations based on data of Eurostat

For further modeling of the process of national debt accumulation with the AR-process of the fourth order, MA-process of the first order, seasonal factors and the results of factor scaling taken into account, a mixed model of factors that explains almost 98% of the variation of the debt of Italy was built, but it turned out unstable, which means the model can be used for getting an understanding of regulari-

ties in debt formation. What about the application of its estimates in further calculations, it should be done carefully, taking into account actual circumstances (Table 7). Thus, the factor of debt, accumulation and crediting (F_{-1}) is basically by 98% due to the debt of the previous year, the consumption factor (F_{-1}) and disturbances that occur in each quarter.

Table 7. Results of the mixed model of factors for Italy *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	66,11	904,15	0,0731	0,9423
@SEAS(4)	27,96	382,32	0,0731	0,9422
F_2	-0,5967	0,0783	-7,62	0,0000
AR(4)	0,9968	0,0433	23,00	0,0000
MA(1)	1,3686	0,2337	5,86	0,0000

*) model estimations:

R-squared	0,9798	Akaike info criterion	-0,722
F-statistic	327,85	Hannan-Quinn criterion	-0,646
Prob(F-statistic)	0,0000	Durbin-Watson statistic	1,256

Source: own calculations based on data of Eurostat

The development of a mixed model based on actual data on external government debt, lending volumes, consumption and accumulation with seasonal factors taken into account, as well as on the MA- and AR-processes

(Table 8) has shown that it is stable. All the factors, except for the AR-process, proved to be substantial, while the model itself adequately describes by 92.9% the regularities in the formation of government debt in Italy.

Table 8. Results of the mixed model for Italy *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	827143	452941	1,8262	0,0798
CAP_FORM	-7,53	1,38	-5,44	0,0000
MA(4)	0,9239	0,0604	15,30	0,0000
@SEAS(4)	-95752	20502	-4,6704	0,0001
CREDITS	0,0898	0,0341	2,6313	0,0144
HOUSE_CONS	5,50	2,45	2,2454	0,0338
AR(4)	0,1304	0,2106	0,6191	0,5415

*) model estimations:

R-squared	0,929	Akaike info criterion	23,18
F-statistic	54,3	Hannan-Quinn criterion	23,29
Prob(F-statistic)	0,000	Durbin-Watson statistic	1,28

Source: own calculations based on data of Eurostat

The dominant factors that determine the dynamics of the external debt turned out to be the MA-process, seasonality of the fourth order, and fixed capital formation showing that the formation of the external government debt of Italy in the next quarter is mainly due to random and seasonal fluctuations, as well as to the fixed capital accumulation.

Given the model stability and the high reliability level of the regression coefficients there are grounds for the following findings:

1. Based on the levels of probability, the order of factors in terms of importance is as follows: the increase in debt is accompanied primarily by subjective processes that occur in manually managed economies, which does not allow it to be attributed to the stable economy type. In the

second place is the increase of economy crediting volumes, and in the third – the final household consumption.

2. An increase in foreign debt is accompanied by an increase in the economy crediting, as well as final consumption volumes. Thus, an increase in crediting volumes by 1 million euros is accompanied by an increase in external debt by 0.09 million euros (elasticity coefficient is 0.01, i.e. the processes of debt accumulation and crediting are not adequate) and an increase in the final consumption by 5.5 million euros (elasticity coefficient – 0.74), suggesting the use of foreign loans not for the purpose of accumulation but for consumption purposes, which cannot be considered an evidence of expanded reproduction.

3. The growth of external debt is associated with lower fixed capital accumulation, suggesting that the investment process inhibits the growth of the external debt in Italy, but taking into account that the elasticity coefficient amounts to only (-0.35), accumulation is unable to cover the rapid growth of debt.

Thus, modeling of the external national debt of Italy yielded results that indicate that the increase in the external government debt of the country is mainly connected to the subjective processes, seasonality, growth of final consumption and reduced savings. This situation is typical of unstable economies where there is a high possibility of recession, accompanied by deterioration of not only quantitative but also qualitative characteristics of social manufacture, which, in turn, can lead to a recession. Such a situation in Italy is explained by the country's inclination to crisis phe-

nomena. Indeed, in recent years Italy often turns to IMF loans to avoid a default and stabilize the economy. While the lack of correlation of macroeconomic indices and government debt volumes is a proof of ineffective and unjustified loans. This type of reproduction is characteristic of market economies with a high level of uncertainty. This enables us to draw a conclusion about the unpredictability of the model of external government debt formation in Italy.

Poland. The dynamics of external government debt in Poland was characterized by a gradual increase until the end of 2008. Starting from 2009 the external debt has been rapidly growing over the recent years, accompanied by seasonal fluctuations. This allows us to assume about the existence of certain cyclicity in borrowings of the government of Poland during the period under study (Fig. 3).

A deeper analysis of seasonal fluctuations with identification of the trend component has shown that the allocation of balance virtually does not deviate from the laws of normal distribution, but the seasonal factor does not explain the variation of the external debt. Studies about the presence of autocorrelation in the dynamics have demonstrated that the period of decay lasts 7 quarters, which is almost two years. The results of calculations of the autoregressive model have shown that it is necessary to apply the AR-process of the first order that explains 96% of the debt formation of the next quarter with respect to the previous one. A check of the balance for autocorrelation has shown its absence in the process of Poland's foreign debt formation.

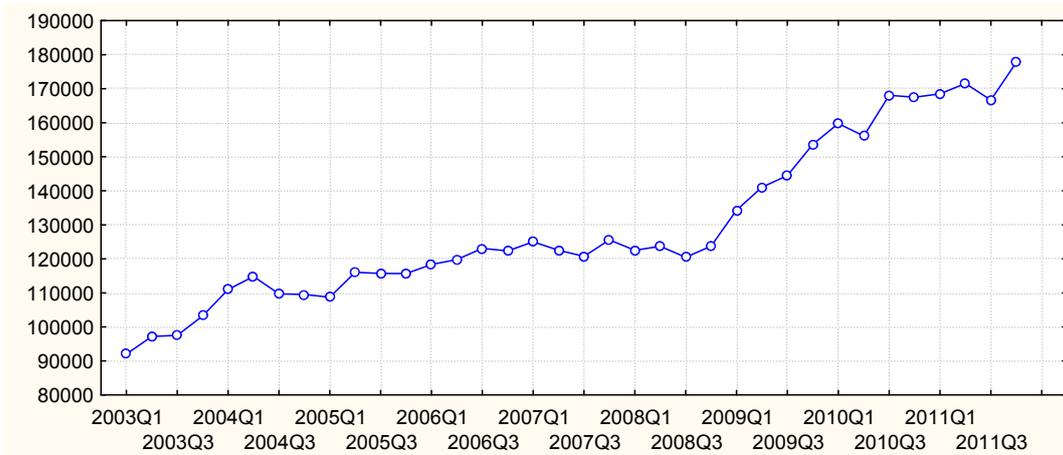


Figure 3. Dynamics of total government debt in Poland for the period of 2003-2011, mln EURO

Source: own calculations based on data of Eurostat

The autoregressive model with the seasonality factor and MA-process taken into account explains the variation of the national debt in Poland by 97.1% (Table 9). The most significant factors turned out to be the following: the first-order autocorrelation function that determines its growth throughout the whole period under study, as well as

random fluctuations – disturbances that occur every 5 quarters. The seasonality factor, although it did not prove to be significant, but given the results of the previous analysis, is an important factor that determines the amount payable in each quarter.

Table 9. Results of the autoregressive model with seasonality factor and MA-process taken into account for Poland *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	178411	65973	2,704	0,0110
AR(1)	0,962	0,048	20,19	0,0000
MA(5)	0,881	0,044	20,22	0,0000
@SEAS(4)	479	656	0,731	0,4705

*) model estimations:

R-squared 0,971 **Akaike info criterion** 19,60
F-statistic 344 **Hannan-Quinn criterion** 19,66
Prob(F-statistic) 0,000 **Durbin-Watson statistic** 1,50

Source: own calculations based on data of Eurostat

The development of a mixed model based on actual data on the external government debt, consumption and accumulation volumes with seasonality, as well as the MA- and AR-processes taken into consideration (Table 10) has

shown that it is stable and contains only reliable estimates. All factors turned out to be significant, while the level of adequacy of the model comprises 96.2%.

Table 10. Results of the mixed model for Poland *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-46905	45861	-1,023	0,3149
MA(2)	0,898	0,052	17,209	0,0000
AR(1)	0,772	0,148	5,223	0,0000
HOUSE_CONS	4,090	0,936	4,369	0,0001
@SEAS(4)	-3504	1625	-2,156	0,0395
CAP_FORM	0,771	0,259	2,977	0,0058

*) model estimations:

R-squared	0,9620	Akaike info criterion	19,98
F-statistic	147	Hannan-Quinn criterion	20,07
Prob(F-statistic)	0,0000	Durbin-Watson statistic	1,88

Source: own calculations based on data of Eurostat

The dominant factors that determine the dynamics of the external government debt in Poland turned out to be the AR-process of the first order and MA-process of the second order, as well as consumption, showing that the formation of the external government debt in Poland in the next quarter, is mainly due to the already accumulated debt and random fluctuations, as well as the final household consumption. Taking into account the model stability and the high reliability level of the regression coefficients there are grounds for certain conclusions:

1. Based on the levels of probability, the order of factors in terms of importance is as follows: an increase in debt is accompanied primarily by subjective processes that occur in manually managed economies, which does not allow to attribute it to the stable economy type. In the second place there is the accumulated debt and in the third – the final household consumption.

2. The growth of external debt is accompanied by growth in final consumption and accumulation. Thus, the growth of final consumption volumes by 1 million euros is accompanied by an increase of external debt by 4.09 million euros (elasticity coefficient – 1.33, i.e. the process of debt accumulation is elastic in relation to the increase of final consumption), an increase in fixed capital accumulation by 1 million euros corresponds to the growth of debt by 0.771 million euros (elasticity coefficient – 0.08.) All these facts indicate the allocation of foreign borrowings mainly on consumption rather than on expanded reproduction, which

is an example of an unstable economy, the development of which is entirely dependent on foreign investments.

Thus, according to the results of Poland's external government debt modeling, certain conclusions were made, suggesting that the level of external government debt of the country and its growth are mainly due to subjective processes, accumulated debt, significant increase in final consumption and a slight increase in accumulation. This situation is typical for an unstable economy, the welfare of which depends on the amount of external funding. Such economies are susceptible to external factors, i.e. to the macroeconomic situation in the world, a deterioration of which will be accompanied by reduced rates of economic growth, which eventually will lead to a recession. This allows us to assume the subjectivity of the model of external government debt formation in Poland.

Greece. Another country with unstable economy is Greece. The dynamics of the government debt of Greece for the period of 2003-2011 is defined by constant growth (Fig. 4). An analysis of existence of seasonal fluctuations with identification of the trend component has revealed that the seasonal factor does not explain the variation of the external debt. Surveys on occurrence of autocorrelation in dynamics have shown that the period of decay amounts to 8 quarters, it means two years, which is the same as in Italy. The results of calculations of the autoregressive model showed that it is necessary to apply the AR-process of the first order that explains almost 98% of the formation of debt in the next quarter due to the previous one.

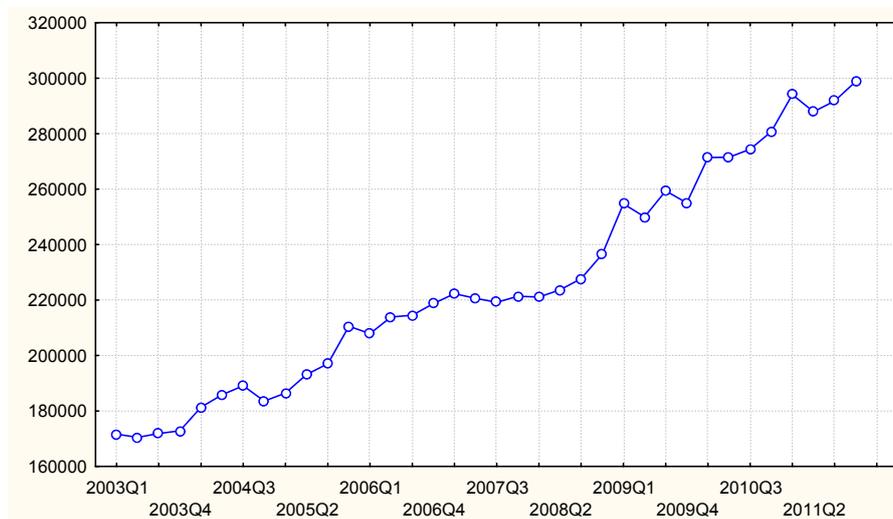


Figure 4. Dynamics of the total government debt of Greece for the period of 2003-2011, mln EURO

Source: own calculations based on data of Eurostat

A check for balance autocorrelation did not produce necessary results, indicating the existence of disturbances in the external debt formation of Greece (subjective factors), and hence, balance autocorrelation was not eliminated – neither on the first, nor on the eighth differences. The autoregressive model based on the MA-process explained the variance in national debt of Greece by 98%. The most significant turned out to be: the autocorrelation function that determines its growth throughout the whole period, as well as random fluctuations – disturbances that occur in each quarter. Seasonality factors are not significant, and therefore, will not be taken into account in further modeling.

The factor analysis has shown presence of two factors that generally explain 94% of variation. Thus, the government debt and loans account for 63.5% of variation and 30.5% of it is explained by the second factor that includes accumulation and final consumption.

For the further modeling of the government debt accumulation process with the AR-process, first-order MA-process and the results of factor scaling taken into account, a mixed model of factors was built that explains almost 98% of the government debt variation of Greece, but the second factor did not prove to be significant. Thus, the factor of debts and loans (F_1) is mainly explained by debts in the previous year and by disturbances that occur in each quarter.

Development of a mixed model based on actual data about the external government debt, lending volumes, consumption and accumulation with the MA- and AR-processes taken into account (Table 11) has shown that it is stable. All the factors, except for consumption and accumulation, proved to be significant, while the model itself adequately describes the regularities of the government debt formation in Greece by 99%.

Table 11. Results of the mixed model for Greece *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	395047	54892	7,20	0,0000
AR(1)	0,9110	0,0418	21,79	0,0000
MA(8)	0,8981	0,0314	28,65	0,0000
CAP_FORM	-4,1366	1,2820	-3,23	0,0031
HOUSE_CONS	-1,0547	0,8277	-1,27	0,2127
CREDITS	-0,0999	0,0987	-1,01	0,3201

*) model estimations:

R-squared	0,988	Akaike info criteri	19,87
F-statistic	471,0	Hannan-Quinn criterion	19,96
Prob(F-statistic)	0,000	Durbin-Watson statistic	2,17

Source: own calculations based on data of Eurostat

The dominant factors that determine the dynamics of the external government debt turned out to be the AR-process of the first order, the MA-process of the eighth order and fixed capital accumulation, proving that the formation of the external government debt of Greece is mainly due to the amount of accumulated debt, random fluctuations, as well as fixed capital accumulation. Taking into account the model stability and the high reliability level of the regression coefficients there are grounds for the following conclusions:

1. Based on the levels of probability, the order of factors in terms of their importance is as follows: an increase in debt is accompanied first of all by the gross debt burden and subjective processes that occur in a manually managed economy, and characterize the instability of the economic system. In the second place is a decline in accumulation volumes.

2. The growth of external debt is accompanied by a reduction in crediting of the economy, final consumption and accumulation. Thus, the elasticity of debt against accumulation, consumption and lending is inelastic, which, given the low value of the regression coefficients, suggests the use of foreign loans to pay off the previous ones, which is evidenced by disturbances of the eighth order. Moreover, an increase in external debt is accompanied by a reduction in consumption, crediting and accumulation.

Thus, modeling of the external government debt of Greece made it possible to obtain results that indicate that an increase in external debt of the country is mainly connected to the subjective processes and accumulated debt of the previous years. This situation is typical for economies that undergo a deep financial crisis, which, in turn, may lead to a default. There is no coordination between the external debt and macroeconomic indicators in the country. By analogy with Italy, latent factors are characteristic of the formation of the external government debt of Greece. All this is an evidence of lack of a government external bor-

rowing formation strategy, and as a result there are high interest rates and inefficient loans.

In general, the developed model of the national debt in Greece describes the subjectivity of the external debt formation process, as well as contradictions in the basic economic laws operation, leading to imbalances in the economic system of the country. Continuous involvement of IMF loans for overcoming crisis phenomena has only exacerbated the problem and led to a further rise of prices, which has reduced the competitiveness of the Greek economy, increased the debt burden of the country and brought Greece into the ranks of outsider countries in Europe.

Ukraine. Ukraine can also be attributed to the countries with an unbalanced economy. The period of 2008-2011 is characterized by soaring debt and is similar to Poland in its form (Fig. 5). An analysis of the presence of seasonal fluctuations with identification of the trend component has shown that seasonal factor does not explain the variation of the external debt. Studies on presence of autocorrelation in the dynamics line have shown that the period of decay comprises 7 quarters, which is exactly the same as in Poland. The results of calculations of the autoregressive model have shown that the inclusion of the AR-process is not enough: it does not eliminate the autocorrelation, which indicates presence of latent factors in the process of Ukraine's foreign debt formation.

The autoregressive model based on the seventh order MA-process and seasonal factors has explained the variance of the national debt of Ukraine by 97.5%. Factor analysis has revealed the presence of two factors that generally explain 91% of the variation. Thus, 53% is due to the first factor that includes accumulation and final consumption.

For the further modeling of the government debt accumulation process with the AR process, MA process of the seventh order and the results of factor scaling taken into account, a mixed model of factors was built that has ex-

plained 94% of variation of the external debt of Ukraine. Thus, the debt (F_2) is explained by debts of the previous

period, disturbances that took place over these two years, seasonality and growth of accumulation and consumption.

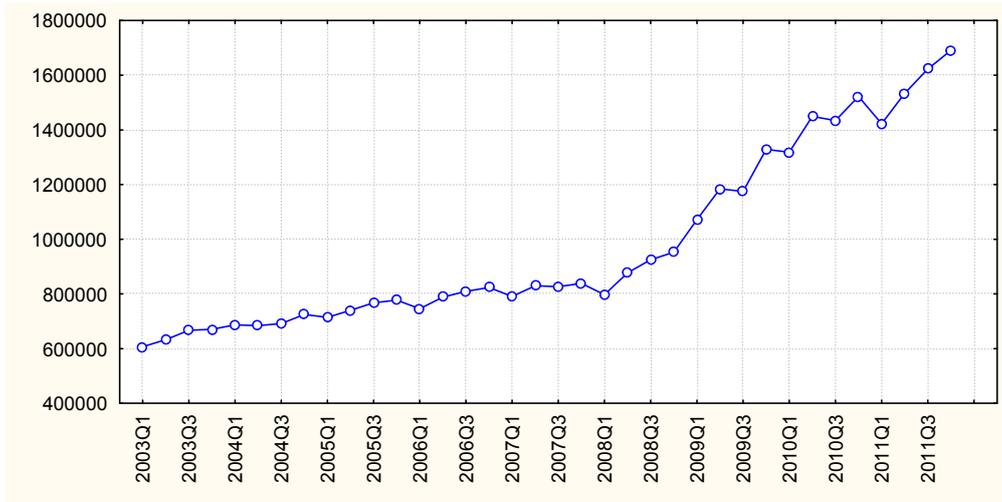


Figure 5. Dynamics of the total government debt of Ukraine for the period of 2003-2011, in mln USD

Source: own calculations based on data of Eurostat

Development of a mixed model based on actual data about the external national debt, consumption and accumulation with the MA-, AR-processes as well as seasonality taken into consideration (Table 12), has revealed its

instability. All factors except for seasonality proved to be significant, while the model itself by almost 99% adequately describes the regularities of Ukraine's national debt formation but cannot be used for the purposes of modeling.

Table 12. Results of the mixed model for Ukraine *

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-340304	587096	-0,58	0,5676
MA(4)	0,918	0,067	13,64	0,0000
AR(1)	0,976	0,099	9,84	0,0000
HOUSE_CONS	3,802	1,132	3,36	0,0026
CAP_FORM	-5,449	1,928	-2,83	0,0093
AR(6)	0,095	0,121	0,78	0,4403

*) model estimations:

R-squared	0,985	Akaike info criterion	24,36
F-statistic	316,9	Hannan-Quinn criterion	24,45
Prob(F-statistic)	0,000	Durbin-Watson statistic	2,21

Source: own calculations based on data of Eurostat

The dominant factors that determine the dynamics of the external government debt proved to be the MA process of the fourth order, the AR-process of the first order and of the sixth order, showing that the formation of the external government debt of Ukraine is mainly due to the amount of previously accumulated debt, as well as annual random fluctuations. Given the high level of reliability of the regression coefficients, there are grounds for the following conclusions:

1. Based on the levels of probability, the order of factors in terms of importance is as follows: an increase in debt is accompanied primarily by the subjective processes and gross debt burden with a review in a year and a half that occur in a manually managed economy, and characterize the uncertainty of the economic system.

2. The growth of external debt is accompanied by the growth of final consumption and reduced accumulation, indicating the use of borrowings for end needs. Thus, debt with regards to accumulation turned out to be inelastic (-0.43): this indicates the use of external loans for repayment of previous debts, which is substantiated by fourth-order disturbances. However, the final household consumption that tends to increase with the debt turned out to be elastic regarding the external debt.

Conclusions:

Thus, modeling of the external government debt of Ukraine yielded results that indicate that the increase in external debt of the country is mainly due to the subjective processes and debts accumulated in previous years, which is accompanied by simultaneous stimulation of final consumption and narrowed reproduction. The situation that takes place in present-day Ukraine is, on the one hand, similar to that of Greece, and on the other hand, involves processes that exacerbate negative trends that can lead to an instant (unpredictable) default. In fact, the economy of Ukraine at the moment is "on the hook of IMF" and survives only due to the "snowball" of borrowings. The situation is aggravated also by the lack of expanded reproduction, decay of the real sector of the economy and use of borrowings not on investment but on consumption. Ukraine lacks any coordination between the external debt and macroeconomic indicators. By analogy with Italy and Greece, latent factors are inherent in forming the external government debt of Ukraine. This situation is typical of countries that are potentially vulnerable and are prone to an unpredictable crisis that can start any moment.

Thus, according to the results of the study, three types of models of the external debt formation were designed, namely:

- the autoregressive model based on seasonality and disturbances of different order that makes it possible to study separately the dynamics of the external government debt formation, on the basis of decomposition of the dynamics line;

- the mixed autoregressive model that includes seasonality of the MA process and results of factor scaling, based on which it is possible to study the regularities of formation of the factor of debt loading taking into account not only its decomposition, but also including the factor of accumulation, crediting and consumption;

- the mixed autoregressive model based on the actual data about the external national debt, consumption and accumulation with MA-, AR-processes as well as seasonality taken into account, which allows to determine the dominant factors that contribute to the growth of the debt burden.

Within the survey, based on a study of regularities of the dynamics of the external debt of European countries specificity of the external debt formation was revealed,

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ПОРІВНЯЛЬНИЙ АНАЛІЗ ОСНОВНИХ ЧИННИКІВ ЗРОСТАННЯ ДЕРЖАВНОГО БОРГУ УКРАЇНИ ТА КРАЇН ЄС

За результатами дослідження була розроблена економіко-статистична модель залежності державного боргу та основних макроекономічних факторів, а саме: накопичення основного капіталу, споживання населення та обсяги кредитування економіки. На основі статистичних даних європейських держав були виявлені особливості формування державного боргу. Це дозволило встановити закономірності між типом економіки і факторами формування державного боргу.

Ключові слова: державний борг; державні запозичення; нагромадження основного капіталу; споживання населення; кредитування економіки.

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ ОСНОВНЫХ ФАКТОРОВ РОСТА ГОСУДАРСТВЕННОГО ДОЛГА УКРАИНЫ И СТРАН ЕС

По результатам исследования была разработана экономико-статистическая модель зависимости государственного долга и основных макроэкономических факторов, а именно: накопление основного капитала, потребления населения и объемы кредитования экономики. На основе статистических данных европейских государств были выявлены особенности формирования государственного долга. Это позволило установить закономерности между типом экономики и факторами формирования государственного долга.

Ключевые слова: государственный долг; государственные заимствования; накопление основного капитала; потребление населения; кредитование экономики.

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MODERN APPROACHES TO ACCOUNTING AND TAXATION IN ENVIRONMENTAL ENTREPRENEURSHIP

Actual issues of accounting and taxation at enterprises of green business under the terms of realization of state environmental policy of Ukraine are investigated. Ways of improving methodology of accounting in accordance with International Financial Reporting Standards, legal regulation of calculation taxes and charges and control over its payment to the budget are defined and proved for the purpose of simplifying business activities and increasing investment prospects of green businesses enterprises in Ukraine.

Keywords: environmental entrepreneurship; accounting; taxation; liabilities; taxes; charges.

Environmental protection and preserving of climate becomes ever more relevant under modern conditions and integration of Ukraine into the world community. The most effect into the global climate changes has business activities of the entities, particularly industrial enterprises, which not always follow technical standards and neglect current restrictions on emission of repugnant substances into the atmosphere. Pollutant emissions in Ukraine were 242.9 million tons in 2011, including carbon dioxide (CO₂) – 236.0 million tons (97.2% of total emissions into the at-

mosphere). [1]. Positive tendency has been observed recently towards reducing of the pollutant emissions into environment. However, the amount of the emission remains quite large and exceeds safety standards. Relevant environmental legislative acts are being adopted to ensure environmental safety of Ukraine. Many of the acts are directed towards creating effective environmental policy which involves mechanism of payment environmental taxes, introducing a new system for exchange arrangement of the tax base, providing favorable terms for enterprises

- stable economies – Germany, France, Denmark, Sweden, Finland, the Netherlands;
- unpredictable economies – Italy;
- sensitive, unstable economies – Greece, Poland;
- Economies of instant default – Ukraine.

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