

# **PRACE NAUKOWE**

Uniwersytetu Ekonomicznego we Wrocławiu

# **RESEARCH PAPERS**

of Wrocław University of Economics

Nr 434

## **Quantitative Methods in Accounting and Finance**



Publishing House of Wrocław University of Economics  
Wrocław 2016

Copy-editing: Elżbieta Macauley  
Layout: Barbara Łopusiewicz  
Proof-reading: Barbara Cibis  
Typesetting: Agata Wiszniowska  
Cover design: Beata Dębska

Information on submitting and reviewing papers is available on websites:  
[www.pracnaukowe.ue.wroc.pl](http://www.pracnaukowe.ue.wroc.pl)  
[www.wydawnictwo.ue.wroc.pl](http://www.wydawnictwo.ue.wroc.pl)

The publication is distributed under the Creative Commons Attribution 3.0  
Attribution-NonCommercial-NoDerivs CC BY-NC-ND



© Copyright by Wrocław University of Economics  
Wrocław 2016

**ISSN 1899-3192**  
**e-ISSN 2392-0041**  
**ISBN 978-83-7695-589-6**

The original version: printed

Publications may be ordered in Publishing House:  
Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu  
ul. Komandorska 118/120, 53-345 Wrocław  
tel./fax 71 36-80-602; e-mail: [econbook@ue.wroc.pl](mailto:econbook@ue.wroc.pl)  
[www.ksiegarnia.ue.wroc.pl](http://www.ksiegarnia.ue.wroc.pl)

Printing: TOTEM

## Contents

<b>Preface</b> .....	7
<b>Piotr Bednarek</b> , Evaluating the usefulness of quantitative methods as analytical auditing procedures / Ocena użyteczności metod ilościowych jako audytowych procedur analitycznych .....	9
<b>Kateryna Berezka, Vadym Masliy</b> , ARCH-building models of time series prediction for investment / Budowa arch-modeli szeregów czasowych do prognozowania inwestycji portfelowych.....	19
<b>Natalia Bielous, Valeria Sopko</b> , Implementation of the results phase of the estimation system of the economic security of enterprises / Wdrożenie wniosków z systemu oceny bezpieczeństwa ekonomicznego przedsiębiorstw .....	27
<b>Magdalena Chmielowiec-Lewczuk</b> , The impact of the implementation of Solvency II on the financial reporting of insurance companies in Poland / Wpływ wdrożenia projektu Solvency II na sprawozdawczość finansową zakładów ubezpieczeń w Polsce.....	38
<b>Elżbieta Jaworska</b> , Diversity management and reporting in selected companies / Zarządzanie różnorodnością oraz raportowanie informacji o różnorodności w wybranych przedsiębiorstwach.....	48
<b>Ganna Karmeliuk, Svitlana Plaskon</b> , Econometric modeling of the external debt of Ukraine / Ekonometryczne modelowanie długu zewnętrznego Ukrainy .....	63
<b>Joanna Koczar</b> , Responsibility for accounting of a business entity in Russian accounting law / Odpowiedzialność za rachunkowość podmiotu gospodarczego w rosyjskim prawie bilansowym.....	69
<b>Mykhailo Kuzub</b> , Ways of improvement of accounting of production stocks in agricultural enterprises / Sposoby poprawy księgowego ujęcia zapasów w księgach rachunkowych przedsiębiorstw rolnych .....	79
<b>Lesya Leshchiiy</b> , Valuation models of Investment Property / Modele oceny nieruchomości inwestycyjnych.....	92
<b>Marek Masztalerz</b> , Why narratives in accounting? / Skąd narracje w rachunkowości? .....	99
<b>Ruslan Motoryn</b> , Estimation of services in global added value chains / Ocena udziału wartości usług w globalnych łańcuchach wartości dodanej .....	108
<b>Vasyl Mukoviz, Kateryna Obertas</b> , The impact of accounting policy on formation of the valuation of assets, obligations and company's capital / Wpływ polityki rachunkowości na wartość aktywów, zobowiązań i kapitału własnego .....	116

<b>Maria Nieplowicz</b> , The use of performance-based budget to measure the efficiency of public transport in metropolises in Poland / Wykorzystanie budżetu zadaniowego do pomiaru efektywności transportu publicznego w polskich metropoliach.....	125
<b>Edward Nowak</b> , Deviation analysis as an instrument of cost control in an organization / Analiza odchyleń jako instrument kontroli kosztów przedsiębiorstwa .....	140
<b>Marta Nowak</b> , Quantitative assessment of culture and its usage in accounting / Ilościowa ocena kultury i jej zastosowanie w rachunkowości .....	148
<b>Stepan Popina, Olesia Martyniuk</b> , Some aspects of security portfolio optimization / Wybrane aspekty optymalizacji portfela papierów wartościowych.....	159
<b>Michał Poszwa</b> , Problems of determining the costs in the calculation of tax result / Problemy ustalania kosztów w rachunku wyniku podatkowego....	166
<b>Olga Sharapa</b> , Methodological approaches to determining the level of transaction costs of sales of agricultural enterprises / Metodyczne podejścia do określenia poziomu kosztów transakcyjnych gospodarstw rolnych	174
<b>Alfred Szydelko, Anna Warzybok</b> , Risk associated with research and development projects and its consequences for the financial accounting system / Ryzyko w projektach badawczo-rozwojowych i jego konsekwencje dla rachunkowości finansowej .....	181
<b>Marcin Wierziński</b> , Performance management in a water and sewerage company / Zarządzanie dokonaniem w przedsiębiorstwie wodociągowo-kanalizacyjnym.....	190

## **Preface**

This book presents the results of Polish-Ukrainian scientific cooperation. It contains the papers prepared for the 10th international conference “Quantitative Methods in Accounting and Finance”. Accounting and finance face nowadays many challenges. They require both an international and local approach, they need to be considered from the theoretical and practical point of view, and they also encourage general and specific analysis.

Support from quantitative methods is needed in order to discover, implement and verify new finance and accounting trends, methods and instruments. The research papers which are part of this book present different aspects of accounting and finance combined with a quantitative, in particular Econometric, approach.

Some of the papers focus on methodology of measurement, estimation and forecasting of financial phenomena, especially those related to investment processes. Others address specific problems of accounting such as accounting solutions for different branches, legal issues of accounting, responsibility and reporting. An alternative approach was also undertaken and the roles of a narrative and culture in accounting were presented.

The variety of papers selected for this issue ensures the complexity of the book. It provides theoretical as well as empirical material which can be used in further research and in business practice, particularly in accounting and finance. We hope that the content of the book provides a starting point for scientific discussion and practical changes.

*Marta Nowak*

**Ganna Karmeliuk, Svitlana Plaskon**

Ternopil National Economic University  
e-mail: plaskon1962@mail.ru

---

## **ECONOMETRIC MODELING OF THE EXTERNAL DEBT OF UKRAINE**

---

## **EKONOMETRYCZNE MODELOWANIE DŁUGU ZEWNĘTRZNEGO UKRAINY**

---

DOI: 10.15611/pn.2016.434.06

**Summary:** In this article the gross domestic product and the gross external debt of Ukraine are analyzed. Trends for the gross external debt, the public and publicly guaranteed external debt, the gross domestic product (GDP), the ratio of gross debt to the GDP and the ratio of external debt to the GDP of Ukraine are constructed and considered. Econometric models for linking the gross external debt and the gross domestic product of Ukraine are justified based on the analysis of its dynamics. The causation between the gross domestic product and the gross external debt of Ukraine is investigated. The mutual correlation function for the gross external debt and the GDP is calculated, which gets the highest value for two years. Therefore the model of distributed lag time is constructed with a delay of two years. Also the model with instrumental variables is grounded and constructed. According to the econometric model with instrumental variables, the growth of the gross external debt of Ukraine is confirmed by the new borrowings and the cost of servicing of current debt. It is shown that the gross external debt is growing along with the growth of the GDP. This shows on the one hand, the expenditure of a certain amount of the GDP for repayment and servicing of the external debt and on the other hand, the insufficiently effective use of the GDP for the economy of Ukraine in order to reduce its debt.

**Keywords:** gross external debt, state debt, gross domestic product, econometric model, trend, lag.

**Streszczenie:** W artykule został przeanalizowany produkt krajowy brutto oraz dług zewnętrzny Ukrainy. W artykule opracowano i przeanalizowano trendowe modele produktu krajowego brutto, długu zagranicznego, długu państwowego oraz długu zabezpieczonego przez państwo, a także stosunek długu zewnętrznego do produktu krajowego brutto Ukrainy. Na podstawie danych statystycznych opracowano ekonometryczne modele zależności publicznego długu Ukrainy od jej produktu krajowego brutto. Za pomocą modeli ekonometrycznych zbadano także związek przyczynowo-skutkowy między zadłużeniem zewnętrznym i produktem krajowym brutto. Ponadto obliczono współczynnik korelacji między długiem zagranicznym a produktem krajowym brutto. Według opracowanego modelu ekonometrycznego następuje wzrost zewnętrznych zobowiązań dłużnych Ukrainy, wynikający z nowych pożyczek oraz wydatków na obsługę bieżących zobowiązań dłużnych. Niemniej jednak dług zewnętrzny zwiększa się wraz ze wzrostem produktu krajowego brutto.

**Słowa kluczowe:** dług zewnętrzny, produkt krajowy brutto, model ekonometryczny, trend.

## 1. Introduction

An important characteristic of public finances of a country is the level of external debt. The creation of the load on the state budget and economic development in general are the long-term effects of public debt. The purpose of this article is to analyze the gross domestic product and gross external debt of Ukraine. Trends for gross external debt, public and publicly guaranteed external debt, gross domestic product, ratio of gross debt to GDP and ratio of external debt to GDP of Ukraine are constructed. In this article the establishment of a causal link between the external debt and gross domestic product is investigated.

## 2. Problems of the analysis of external public debt

Calculation of solvency ratios of the state and its liquidity position is very important in the management of external debt. In international practice, to analyze the state security debt the World Bank proposes to use a minimum standard model and according to it to determine the principal indicators [Seliverstova 2010]. Among others, these include: the ratio of gross debt to GDP (EDT / GNP), which shows the overall level of the debt component of the economy; ratio of total debt service payments to exports of goods and services (TDS / XGS) – debt service ratio, which shows how much foreign exchange earnings directed to debt repayment.

A particular obstacle to research is that the results of the statistical evaluation of the dynamics of public debt in Ukraine have no common statistical or analytical research base through the whole period of Ukraine's independence until now. By 1999, the debt is calculated according to the methodology of the World Bank [State Statistics Service 1995; 1999; 2007], since 1999 – according to IMF methodology [Bulletin of the National Bank Ukraine 2007, 2012; *Public and publicly guaranteed...; The external debt...*].

The amount of the total external debt of Ukraine increased annually during 1993-1999. In 1993 it amounted to 3.8 billion USD, then in 1999 year – 13.5 billion USD [State Statistics Service 1995; 1999; 2007]. The total external debt of Ukraine decreased by 12% in 2000 and totaled 11.9 billion USD. Since 2001 to 2007 the positive dynamics of its growth is observed in total, down only by 3% in 2005 [State Statistics Service 2007]. In 1999 the debt totaled 20.5 billion USD. The positive dynamics of its growth is observed throughout 1999-2013 [Bulletin of the National Bank of Ukraine 2007, 2012; *The external debt...*]. At the beginning of 2014 the debt was equal to 142.5 billion USD. During 2013 the debt increased by 7.4 billion USD [*The external debt...*].

On the dynamics of debt [Bulletin of the National Bank of Ukraine 2007, 2012; *The external debt...*] two temporary branches clearly reveal: I – from 1999 to 2008, and II – from 2009 to 2013. The gradual increase of the debt is observed from 19.1 to 30.647 billion USD from 2000 to 2004 on the first branch. But 2005 is a turning point. Since 2005, a steep, almost linear increase in debt in 2.6 times begins from 39.619 to 101.659 billion USD in 2008.

The appearance of the second branch in 2009 is related to the beginning of the global economic crisis in 2008 and the rise of the dollar from 5.05 to 7.7 UAH per USD. In 2009 the gross external debt amounted to 103.396 billion USD, growing annually by 10.4 billion USD to 135.049 billion USD in 2012 to almost linear dependence. The same dynamic holds for gross domestic product. From 1999 to 2004 GDP grew cyclically with the turning point in 2005. The rapid growth of GDP by almost linear dependence is observed since 2005 to 2008 with an annual increase of 31.42 billion USD. In 2009, a significant decline in production GDP took place by 35% compared to 2008, due to the economic crisis. Since 2010 GDP began to rise to 2012 by almost linear dependence by 20.63 billion USD annually.

### 3. Several researches results review

Given the above, we have built the trends for gross external debt, public and publicly guaranteed external debt, gross domestic product, ratio of gross debt to GDP and ratio of external debt to GDP of Ukraine for each time branch separately. Some models are shown in Table 1 ( $t$  – the time factor).

**Table 1.** Trends of the volume of external debt and gross domestic product

Years	Trend	Coefficient of determination $R^2$
I – Trends of the gross external debt		
1999-2008	a) $Y_t = 8.4105t - 5.073$ ;	0.7799
	b) $Y_t = 1.7217t^2 - 10.528t + 32.804$ ;	0.9891
	c) $Y_t = 8.623t - 6.633$	0.8011
2009-2013	a) $Y_t = 9.591t + 96.132$ ;	0.9849
II – Trends of the public and publicly guaranteed external debt		
1999-2007	a) $Y_t = 0.0871t^2 - 0.2071t + 10.199$ ;	0.9451
	b) $Y_t = 0.6636t + 8.6029$	0.8684
2008-2013	a) $Y_t = -1.1008t^2 + 11.443t + 8.3745$ ;	0.9715
	b) $Y_t = 3.7379t + 18.648$	0.8198
III – Trends of the GDP		
1999-2008	a) $Y_t = 6.134t^2 - 11.894$ ;	0.8884
	b) $Y_t = 2.2038t - 8.1084t + 36.59$ ;	0.9945
2009-2013	a) $Y_t = 16.964t + 104.54$ ;	0.9385
IV – Trend of the ratio of gross debt to GDP		
1999-2008	a) $Y_t = 0.7303t^2 - 8.9988t + 74.887$	0.9467
V – Trend of the ratio of external debt to GDP		
2010-2013	a) $Y_t = -2.563t + 28.12$	0.9687

$t$  – time factor.

Source: own study based on State Statistics Service of Ukraine, basic economic and social indicators, public and publicly guaranteed debt, external debt of Ukraine [*The external debt...; Public and publicly guaranteed...*].



Given that the share of GDP is used for the repayment and servicing of external debt, it would build econometric models depending on the gross external debt of gross domestic product in two time intervals from 1999 to 2008 and from 2009 to 2013 ( $Y$  – the value of gross external debt, billion USD;  $X$  – the value of GDP, billion USD). The result of the investigation is presented in Table 2. The ability to test the validity of this analysis and the establishment of a clear correlation between debt and GDP is presented in the next issue [Kucher, Kalytchuk 2007].

**Table 2.** Econometric models depending gross external debt to gross domestic product

Years	Model	Coefficient of determination $R^2$
I – econometric model without displacement		
1999-2008	a) $Y = 0.5498 X - 1.06223$ ;	0.977
	б) $Y = 0.0018 X^2 + 0.2053 X + 10.843$ ;	0.994
	в) $Y = 13.923e^{0.0117x}$	0.984
2009-2013	a) $Y = 0.5414 X + 40.764$ ;	0.962
	б) $Y = 0.0017 X^2 + 0.0382 X + 77.387$ ;	0.964
	в) $Y = 62.109e^{0.0045x}$	0.966
II – model with displacement lag		
1999-2008	$Y_t = -16.80232 + 1.07 X_{t-2}$	0.890
III – model with instrumental variables		
1999-2008	$Y_t = -8.04342 + 1.24 Y_{t-1} + 0.16 X_t$	0.970

$Y$  – gross external debt,  $X$  – gross domestic product,  $t$  – time factor.

Source: own study.

Since 2000, the volume of GDP begins to grow along with further increasing of debt, which is reflected in the models. This suggests that there is a time lag between debt growth and GDP growth. T. Vakhnenko suggested that there is a time lag to five years between debt growth and GDP growth in Ukraine [Vakhnenko 2007, pp. 14-24]. For the mathematical justification of the lag we calculated mutual correlation function  $r(\tau)$  for different values  $\tau$  (Table 3), which gets the highest value at  $\tau = 2$ .

Therefore the next dynamic model of distributed lag is considered and calculated ( $Y_t$  – the value of foreign debt in  $t$  period, billion USD;  $X_{t-2}$  – the value of GDP in  $t - 2$  period, billion USD):

$$Y_t = -16.80232 + 1.07 X_{t-2} (R^2 = 0.890).$$

**Table 3.** Mutual correlation function  $\tau$  for the gross external debt and GDP

$\tau$	0	1	2	3	4	5	6	7	8
$r(\tau)$	0.94	0.94	0.95	0.91	0.84	0.84	0.88	0.90	0.95

$\tau$  – lag of the time,  $r(\tau)$  – coefficient of mutual correlation.

Source: own study.

The calculated values of Durbin-Watson coefficient  $DW = 0.70$  showed that autocorrelation exists at the 95% confidence level. Since the lag explanatory variable  $X_{t-2}$  is included in above econometric model and there is no complete picture of the object and its inertia, we used the method of instrumental variable [Novak 2004, p. 248] and received the next econometric model:

$$Y_t = -8.04342 + 1.24 Y_{t-1} + 0.16 X_t (R^2 = 0.970).$$

The calculated empirical value of Durbin-Watson coefficient  $DW = 1.71$  showed that autocorrelation does not exist; study test showed the reliability research model parameters on the confidence level  $P = 0.95$ . Accordingly to the model increasing GDP by 1 billion USD leads to an increasing in gross external debt by 0.16 billion USD. Analyzing the resulting model, designed according to statistics from 1999-2008, we can conclude that the increase in gross external debt by 1 billion USD in the previous year leads to an increase in gross external debt in the current year to 1.24 billion USD.

#### 4. Conclusions

Main conclusions of research presented in this paper are:

- Trends of foreign debt and GDP of Ukraine are presented based on the analysis of its dynamics.
- Econometrical models depending on gross external debt to gross domestic product of Ukraine are constructed (gross domestic product is an argument and gross external debt (public external debt) is output indicator).
- The model distributed lag with a delay in two years and the model with instrumental variables are grounded and constructed.

It is assumed that the growth of GDP has caused the external debt of Ukraine. The model of distributed lag time is constructed with a delay of two years. According to the econometric model with instrumental variables, the growth of the gross external debt of Ukraine is confirmed by the new borrowings and the cost of servicing of current debt. It is visible that the gross external debt is growing along with the growth of GDP. This shows, on the one hand, about the expenditure of a certain amount of GDP for repayment and servicing of external debt, on the other hand, the insufficiently effective use of GDP for the economy of Ukraine in order to reduce its debt. In order to eliminate the existing problems and negative aspects of the existence of public debt, there should be carried out not only a balanced debt policy but also multilateral economic policy which must be implemented aiming at reduction or complete elimination of the budget deficit.

The results of the investigation, dynamic development of the global world of finance and lack of effectiveness of modern management tools sovereign debt are causes for further research of this issue.

## References

- Bulletin of the National Bank of Ukraine, 2007, 2012, *Basic economic and social indicators of Ukraine's situation in 1991–2001 and 2002–2007*, no. 9, pp. 68-75.
- Karmeliuk G., Plaskon S., 2016, *Econometric analysis dependence of the external debt of Ukraine from import, export and net export*, Quantitative Methods In Accounting And Finance, Ternopil, pp. 66-75.
- Kucher G., Kalytchuk V., 2007, *Impact of public debt on economic situation in Ukraine*, Bulletin of Kyiv National Economic University, no. 1, pp. 45-47.
- Main economic indicators*, 2012, National Bank of Ukraine, Bulletin of the NBU, no. 10, pp. 46-47.
- Novak E. 2004, *Introduction to the econometrical methods: The collection of problems*, Finances and Statistics, p. 248.
- Public and publicly guaranteed debt of Ukraine on 31.12.2013*, Ministry of Finance of Ukraine, [www.minfin.gov.ua/file/link/383889/file/debt\\_31.12.2013.pdf](http://www.minfin.gov.ua/file/link/383889/file/debt_31.12.2013.pdf).
- Rozhko A., 2013, *The management of the sovereign debt as an instrument of the macroeconomic stabilization*, Banking Management, no. 11-12, pp. 46-59.
- Seliverstova O.I., 2010, *Debt security as an element of the state financial security*/ I.O. Seliverstova, O.Y. Laschenko, S. I. Shaposhnikova, *Problems of systematic approach in the economy*, [http://archive.nbuv.gov.ua/e.journals/pspe/2010\\_3/Laschenko\\_310.htm](http://archive.nbuv.gov.ua/e.journals/pspe/2010_3/Laschenko_310.htm).
- State Statistics Service, 1995.
- State Statistics Service, 1999.
- State Statistics Service, 2007.
- The external debt of Ukraine by the end of 2013*, National Bank of Ukraine, [www.bank.gov.ua/doccatalog/document?id==71174](http://www.bank.gov.ua/doccatalog/document?id==71174).
- Vakhnenko T., 2007, *Conceptual foundations of management of external national debt of Ukraine*, Economics of Ukraine, no. 1, pp. 14-24.