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RESEARCH PAPER

Military Expenditures and World Economic Growth under Hybrid Warfare Conditions

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ABSTRACT
The article examines the impact of the dynamics of military expenditures, public debt, arms exports on the economic growth of the six countries (US, China, Russia, Israel, Ukraine, Moldova). The paper empirically tested the hypothesis of the possibility of further maintaining the positive macroeconomic effects in the process of confronting and persistent 'hybrid' military conflicts in either 'hot' or 'frozen' phases. The model characterizes the effects of factors and their change over time as well as features of the aggregate and the specificity of the development of individual objects. This allowed us to construct an object-dynamic regression model to determine the dependence of the development of national economies, namely GDP growth rates, for countries in a state of 'hybrid' war. The definition of these dependencies provides the opportunity to make recommendations on the use of adequate models of forecasting military expenditure for the country, which aims to achieve the goals of sustainable development under the increasing military threats.

KEYWORDS: *Military expenditures; Hybrid warfare; Economic growth; Defense spending.*

1. Introduction

1.1. Problem description

The increasing geopolitical and geo-economic tensions among the largest countries in the world for several years in a row are the most urgent global risks. Russia's aggression against Georgia and Ukraine in 2008 and 2014 only exacerbated the problems of maintaining the political status quo that formed in Europe after World War II. Moreover, changes to this status have already taken place following the voluntary creation of the Federal Republic of Germany by the two German states, the reunification of the Czech Republic and Slovakia, and the emergence of new states on the territory of Yugoslavia as a result of the NATO-led military conflict in the Balkans. The growing number of conflicts in the Middle East, North Africa, the aggressive provocations of the DPRK, and the terrorist threat of ISIS are signs of the systemic crisis of global security and the destruction of the established world order.

A feature of contemporary military conflicts is the additional use of a wide range of information, economic, diplomatic, and other means. Both foreign and Ukrainian researchers and politicians are distinguishing the Ukrainian front of the global 'hybrid' war, which is the newest kind of global confrontation in today's unstable security environment [1], [2], [3], [4].

Numerous local military 'hybrid' conflicts are taking place against the backdrop of a new escalation of global confrontation between the US, China, and the Russian Federation, which significantly actualizes the issue of counteracting the existing threats, ensuring the national defense capability of any country. These conflicts and wars are becoming more expensive as the cost of military equipment and high-tech weapons is increasing, which, in turn, requires a rise in military expenditures and their share in general government spending. Thus, according to a report by the Stockholm International Peace Research Institute (SIPRI) in 2019, global military

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expenditures have risen by 3,6% since 2018 to $ 1.9 trillion, or 2,2% of the global GDP [5], [6], [7].

Undoubtedly, at different stages of development and under different historical conditions, depending on the international situation, military expenditures can be both excessive and insufficient. Thus, a study of the dynamics of military expenditure in the United Kingdom, covering the period from 1692 to 2014 showed that their percentage in GDP fluctuated from 3,5% in peacetime and reached 45% during World War I and up to 60% during World War II [8]. Excessive military expenditure during the wars led to deep economic crises, impoverishment, and in some countries such as the United Kingdom and the USSR, even to a severe shortage of food and hunger.

First and foremost, the size of military expenditures must bear in mind the security and its sufficiency to protect national borders and interests. However, this level should not violate the macroeconomic stability of the state, reduce economic growth, worsen the welfare of the population, cause inflation and so on. During the Cold War, the military expenditures of the countries increased, which significantly influenced their economic development. In the USSR excessive military expenditure led to its net economic loss to Western countries followed by its disintegration into 15 states.

The situation on the European continent changed dramatically after the fall of the Berlin Wall. It is worth noting that back in 2013, scholars and political elite of the West were actively discussing the recognition of military expenditure as a burden on the country's economy, motivating the possibility of their reduction by the end of the arms race between the West and the USSR [9]. The facts mentioned above led to a reduction in defense budgets in most European countries, including the North Atlantic Treaty Organization (NATO).

Similar studies were carried out in Ukraine, where, due to a sharp decrease in funding, the army lost its defense capability. On the contrary, since 2011 Russia has been actively modernizing its armed forces by increasing military expenditure. Thus, in 2012 it amounted to more than $90 billion, or 4,4% of the country's GDP. Such military expenditure allowed the country to start military aggression against Ukraine, annexing the Crimea and part of the Donetsk and Luhansk oblasts in 2014. Whereas a sharp increase in military expenditure in the United States following armed conflicts in Afghanistan and Iraq helped the country easily overcome the 'new' economy crisis.

Modern security realities actualize the study of the impact of military expenditure on economic growth in the context of 'hybrid' warfare occurring in the era of the Fourth industrial Revolution (Industry 4.0) [10], [11], [12], [13], [14], [15]. Digitization and virtualization, creation of cyber-physical systems, robotics, Internet of Things, etc., are radically changing the field of confrontation, which is not limited to warfare in a specific region. Such warfare not only goes beyond the globe into space but involves diplomatic and economic spheres. All these lead to changing the amount of military expenditure and their structure, which, in turn, require new approaches to forecast the required macroeconomic proportions. These tasks are different for countries aiming to achieve geopolitical leadership and the ones striving to preserve territorial integrity and national sovereignty.

1.2. Literature review

Analysis of research and publications shows that these issues are attended to a wide range of foreign and domestic scientists. Scientific discussions and theoretical justifications for defense financing have been going on since A. Smith's (1776), who considered military expenditures unproductive but recognized their growth as society developed and civilized.

This issue has rarely been addressed to researchers before the XX-XXI centuries. Today, the impact of military expenditure on macroeconomic indicators is viewed from three sides of aggregate demand, aggregate supply, and security. The demand-side effect is based on the Keynesian multiplier effect. It is believed that an increase in military expenditure while reducing aggregate demand for supply may lead to capacity utilization and, consequently, increased investment and economic growth.

Supply-side effects operate through the factors of production (labor, physical and human capital, natural resources) and technologies that jointly identify a possible additional output of goods and services, including dual use. Security-side effects are driven by the need to protect national markets and can have a positive impact on macroeconomic performance. This is an institutionalized approach [16], [17], [18]. In this respect, a group of individuals, companies or organizations combined in a military-industrial complex lobbies for increased military spending even without any need. This often leads to the

corruption component of military expenditure, which can be quite high in many countries.

The study of the macroeconomic effects of military spending in foreign countries is in most cases based on the use of econometric models within the Keynesian or neoclassical approaches. They are carried out through empirical verification of the most used models. These include R. Barro's model of endogenous growth, Feder-Ram's model, and R. Solow's model.

Thus, researchers [8], [19], [20], [21], [22], [23], [24], [25] point out the positive impact of military expenditure on economic growth. Yet, the last two researchers argue that between 1995 and 2011 in 56 countries of the world, an increase in military expenditures by 1% led to 0,35% GDP growth, i.e. the size of the positive impact was negligible.

In addition to the studies mentioned above, there are others that determine the negative impact of rising military expenditure through tax increases and the displacement of private investment. In the nineties of the XX century, those scholars were [26], [27]. In the recent years, [28] studying the impact of military spending on GDP in three North American countries (USA, Canada, Mexico) between 1963 and 2005, concluded that Canada and Mexico's increase in military expenditure led to a rise in GDP, while the USA underwent a recession. However, a lot of theoretical and empirical studies indicate the ambiguity of this influence [14], [16], [29], [30] and others. Authors emphasize that the real impact of defense spending may be indirect and depend on the cost's origin.

It is worth mentioning that the detailed analysis of theoretical approaches to the assessment of the consequences and effects of defense spending for the last 15 years has been carried out by [31], [32], [33], within the framework of the research. The above confirms the fact that the Russian Federation thoroughly prepared to increase military spending and predicted possible negative macroeconomic effects. Hence, [31] estimated the impact of military expenditure on GDP in 38 countries between 1992 and 2014 using popular econometric models (Feder-Ram, Solow, and Barro). As part of the study, he concluded that there was no uniqueness in the impact of military expenditure.

Thus, it can be argued that today there is no clear answer as to the direction of the impact of military expenditure on economic growth. It can be either positive or negative, and even neutral. Thus, it is relevant to study the macroeconomic effects of many factors that are important in the context of modern 'hybrid' wars to develop models of justification for military expenditure.

The purpose of this study is to elucidate the macroeconomic effects of the military expenditure at current prices, the share of government spending in general on the state budget, public debt, and arms exports on the economic growth of countries involved in 'hybrid' military conflicts inside and outside their territories. Identifying sustainable dependencies will provide recommendations for the use of adequate military cost forecasting models for a country that aims to achieve sustainable development goals in the face of increasing military threats.

2. Research Methodology

Both general and specific research methods were used. A comparative analysis was conducted to determine the countries' military expenditures. The hypothesis of the possibility of further maintaining the positive macroeconomic effects in the process of confronting the United States, China, and Russia has been checked. Our research focused on these three countries as they are increasing their largest military expenditures in the world in the fight for geopolitical leadership. Additionally, the same hypothesis was empirically tested on the territories with 'hybrid' military conflicts in the 'hot' phase (Ukraine and Israel) and the 'frozen' phase – Moldova.

Empirical testing of the proposed hypothesis is carried out using economic and mathematical modeling of the process of determining the macroeconomic effects on the economic development of the above six countries from 2010 to 2017. The factors of the share of government spending; military expenditure as % GDP (military expenses); expense in current prices; export of weapons, and the national debt of the country (GSD – gross state debt) have been considered. GDP has been used as the main indicator of economic development, which is traditionally a benchmark for developing economic growth strategies and selecting the political and social development vectors of the world countries.

Due to the limited number of time series, and to expand the information base, space and time series were combined in the research, which made it possible to construct a model of object-periods whose input information array is 3D data. This model is one of the possible variants of the analysis of mixed static-dynamic (panel) information.

The study used open-source data, in particular, World Development Indicators (WDIs) obtained by the World Bank [34] and the Stockholm International Peace Research Institute [35]. Data on the growth rate of gross national product, government debt, and arms exports from 2010 to 2017 are taken from the open electronic database [36].

Combining the spatial and dynamic series into one information array allowed to obtain 48 (6x8) object periods. This significantly expanded the model's information base and provided with it special properties. The main property is the dependence of observations. In this case, not only the levels of the dynamic series are dependent, but also the rows (both spatial and temporal), since particular row levels are fixed. The dependence between the series of dynamics is the result of spatial variation (change of series values), which, due to the inertia of the processes, preserves some time. Spatial row dependencies reflect the synchronicity of metrics across entities, driven by common development conditions.

The peculiarities of spatial variation are taken into account in the model with the structural variables of the individual six objects (countries) u_j ($j=\overline{1,n-1}$, $n=6$). The trend of function Y inherent to all objects is filtered by the time variable t. Dynamic interaction variables for factors x_it ($i=m$, $m=5$), and objects – u_jt were used to filter out significant individual trends. The model parameters were calculated using software STATISTICA 10.

3. Results and Discussion

Military expenditures throughout the history of civilizations have always remained crucial to the budgets of most world countries. They are of importance today, against the background of the escalation of the security situation in almost all regions of the world, with the simultaneous destruction of relevant international institutions. It has been stated in the report of the Munich Security Conference "To the Brink - and Back?" the world in 2017 approached the point at which serious armed conflicts begin.

According to the American Comprehensive Peace Agreement – CPA [37], at the beginning of 2017, there was 36 warfare in 28 countries. Almost half of these countries have protracted conflicts that have lasted for more than a decade. They are Afghanistan, Colombia, the Democratic Republic of the Congo, India, Iran, Myanmar, Nigeria, Pakistan and others. For more than five years, military operations have been taking place in the center of Europe – in the east of Ukraine.

The main trend of today's conflicts is to change their form and means of management. Thus, the dominant form of conflict is the internal state with the involvement of other countries. According to experts of international organizations [6], in 1990-2004 only 4 out of 57 conflicts were interstate. However, as a rule, these conflicts were widespread in larger territories and turned into interstates with high levels of confrontation. This trend is still observed today.

Concerning the means of conducting modern military conflicts and wars, one should note the change from the classic way of waging war with the use of military forces and the transition to 'hybrid' wars with simultaneous actions in cyberspace, and the use of means of economic and diplomatic pressure on the enemy. According to experts, the share of cyberterrorism is increasing around the world, its effects on national and international security are becoming more tangible. Attacks against government sites (including the US, Canada, South Korea, Israel, Estonia, etc.), public and private companies (NASA, Delta Air, Dell, Yahoo, Amazon, E-bay, Sony), international organizations are spreading with more frequency [2].

Under these circumstances, the issue of forming a military budget becomes particularly crucial. It should be noted that many countries, defining their military budget as a goal, determine not only their defense capability but also their geopolitical status. As it has already been noted, the United States, China, and Russia are fighting in this way, resulting in a large gap between countries being ready and able to focus on security and spending on maintaining global and regional status. According to [35], in 2017 US military expenditure amounted to more than a third of all defense spending in the world. For 24 consecutive years, China has been increasing its armaments spending and ranked second in the world's military spending rankings.

The military budget, or the amount of the country's defense outlays, is intricately linked to the country's economic capabilities. On the one hand, too much defense spending can adversely affect the socio-economic security of the population due to lack of funds for medicine, education, retirement benefits, etc. On the other hand, military spending can improve the quality of human capital and increase overall productivity factors, the emergence of new technologies and their spread to other areas of the economy, generally stimulating economic growth. This is exactly what happened in the

United States when military breakthroughs such as the Internet, GPS navigation were applied in all areas of people's lives outside the country.

In turn, chronic underfunding of defense spending can have a negative impact on the growth potential of the economy, which will be difficult to tap in the face of a real military threat, regardless of the current state of the economy. This is exactly what happened in Ukraine. From 2007 to 2013, Ukraine's military expenditures made up around 2,5% of GDP annually (fig. 1).

In terms of the dollar equivalent, the largest drop in Ukraine's actual financing capacity was observed in 2009 and 2011 – the fall rate was around 10,0% (fig. 2).

The multi-vector impact of military expenditures on countries' macroeconomic indicators forces governments to approach the military budget thoroughly and base it on many macroeconomic estimates and forecasts to reduce error risk. One such approach is to assess the macroeconomic effects of military expenditure, which not only ensure the country's defense capability but also maintain a sufficient level of socio-economic development.

In line with this goal, the paper presents the results of an empirical study to determine the impact of military expenditure, the size of the national debt (GSD), government spending as a whole (SDS), and the export of weapons on GDP growth rates of the above six countries from 2010 to 2017. The output is given in table 1.

According to table 1, the GDP growth rate in 2017 compared to the base one in 2010 increased in China (from 2,8 to 6,9%) and in Israel (from 2,8 to 3,3%), remained relatively stable in the USA (from 2,5 to 2,3%), and worsened sharply in Ukraine (from 4,2 to 2,5), Russia (from 4,4 to 1,3) and Moldova (from 7,1 to 4,5). A similar heterogeneity is observed in other indicators. The inhomogeneities of the individual parameters of the population are detected by the variables of dynamic interaction.

Considering these features, we will use a panel regression model for the entire set of object periods to solve the given problems [38]:

$$Y = a_0 + \sum_{i=1}^{m} b_i x_i + \sum_{i=1}^{m} c_i x_{i,t} + \sum_{j=1}^{n-1} a_j u_{jt} + \sum_{j=1}^{n-1} d_j u_{jt} + f_t \quad (1)$$

where Y – dependent variable – GDP growth rate;
x_i (i = 1,5) – independent variable models: Share of Govt. spending; Expense in current prices; Export of weapons; Military Expenses; Gross State Debt;
a_o – free equation member;
b_i – net eliminated from the equations within the model, the effect of the factor x_i;
c_i – change of effects within time, where

$$c_i = \frac{\sum_{t=2}^{8} \Delta_{i,t}}{8-1} = \frac{\sum_{t=2}^{8} \left(b_{i,t} - b_{i,t-1}\right)}{7}, \quad i = \overline{1,5} \quad (2)$$

a_j – difference between function values on j – object and in the aggregate;
d_j – these differences change over time, where

$$d_j = \frac{\sum_{t=2}^{8} \Delta_{j,t}}{8-1} = \frac{\sum_{t=2}^{8} \left(a_{j,t} - a_{j,t-1}\right)}{7}, \quad j = \overline{1,6}$$
$$a_j = Y_j - Y \quad j = \overline{1,6} \quad (3)$$

f_t – a common trend across all entities – the impact of factors that are not considered in the model.

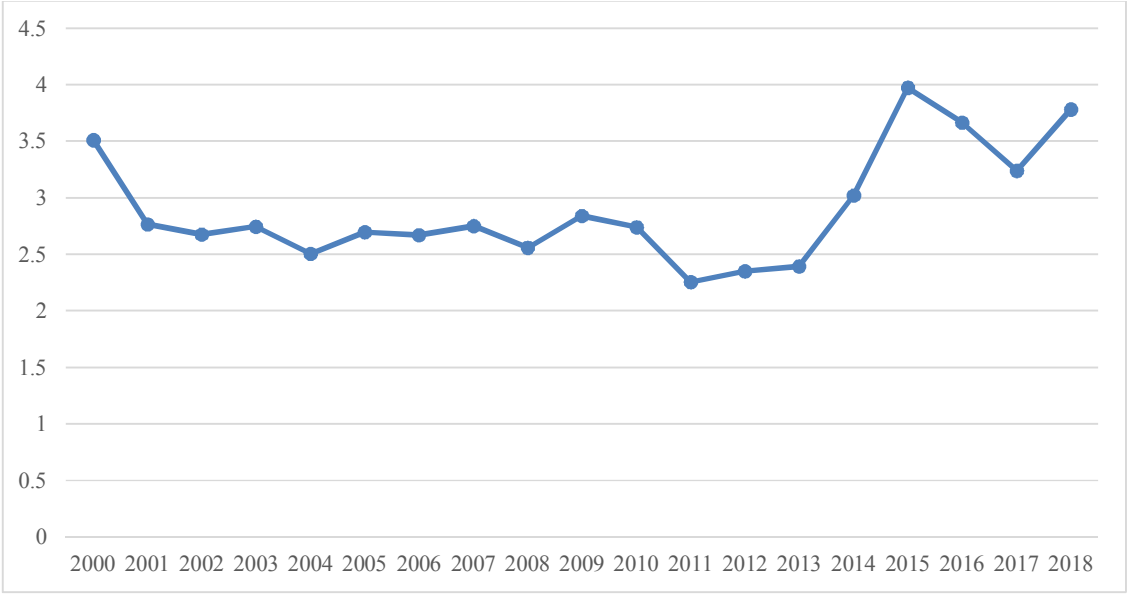

Fig. 1. Military expenditures of Ukraine as % GDP [39]

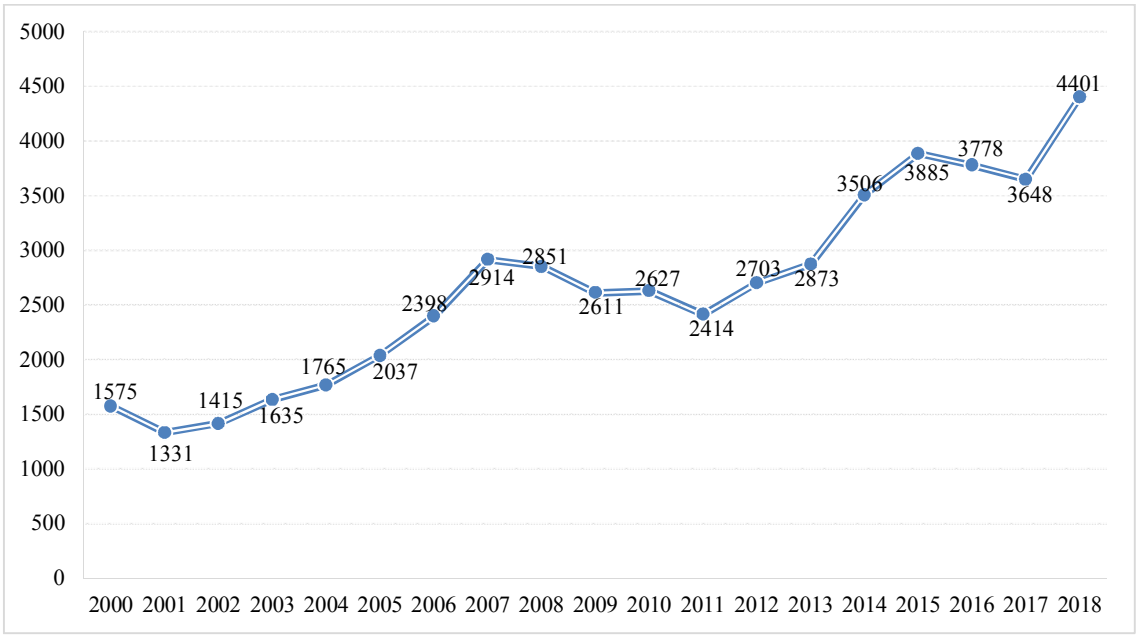

Fig. 2. Military expenditures of Ukraine, million $ [40]

Tab. 1. Output Model

	Countries	GDP growth, %	Government spending	Gross State Debt	Military expenses	Expenses	Export weapons
USA	2010	2,5	11,7	95,5	4,7	698180	8063
	2011	1,6	11,8	99,9	4,6	711338	9087
	2012	2,2	11.4	103,3	4,2	684780	9122
	2013	1,7	10,6	104,9	3,8	639704	7660
	2014	2,6	9,9	104,6	3,5	609914	9656
	2015	2,9	9,4	104,8	3,3	596105	10048
	2016	1,5	9,8	106,0	3,2	600106	10304
	2017	2,3	8,8	103,4	3,1	509758	12394
Israel	2010	2,8	15,4	70,7	6,2	14573	655
	2011	4,7	15,7	68,8	6,2	16319	541
	2012	1,9	14,8	68,4	6,0	15446	461
	2013	4,1	14,6	67,1	5,9	17302	426

	2014	3,4	15,0	66,1	6,0	18481	399
	2015	3,0	14,3	54,1	5,7	15953	727
	2016	4.1	11,0	52,3	4,7	14783	1433
	2017	3,3	11,5	60,9	4,7	16489	1263
	2010	4,2	5,5	40.5	2,7	3730	479
	2011	5,5	4,9	35,9	2,3	3585	559
	2012	0,2	4,8	37,5	2,4	4137	1187
Ukraine	2013	0,0	5,0	40,5	2,4	4385	555
	2014	-6,6	6,7	70,3	3,0	4033	657
	2015	-9,8	9,2	79,3	4,0	3617	400
	2016	2,3	9,0	81,2	3,7	3423	535
	2017	2,5	7,8	71,0	3,4	3548	240
	2010	4,5	10,1	10,9	3,8	58720	5091
	2011	5,3	10,3	11,2	3,5	70238	8558
	2012	3,7	10,8	11,9	3,8	81459	8283
	2013	1,8	11,1	13,1	3,9	88353	7805
Russia	2014	0,4	11,8	15,0	4,1	84597	5224
	2015	-2,8	13,8	16,3	4,9	66419	5608
	2016	-0,2	14,8	15,1	5,5	59245	5937
	2017	1,3	12,0	15,5	4,3	55335	5148
	2010	2,8	7,6	33,7	1,9	115712	1479
	2011	2,0	6,8	33,6	1,8	137967	1253
	2012	1,2	6,5	34,3	1,8	157390	1509
	2013	3,5	6,5	37,0	1,9	179880	2006
China	2014	3,1	6,6	39,9	1,9	200772	1152
	2015	4,0	6,0	41,9	1,9	214093	1832
	2016	4,8	6,1	44,2	1,9	216031	2192
	2017	6,9	7,8	47,0	1,9	228231	1131
	2010	7,1	0,8	21,0	0,3	1830	2,0
	2011	5,8	0,8	23,0	0,3	2300	11,0
	2012	-0,7	0,8	24,0	0,3	2390	42,0
	2013	9,4	0,9	25,0	0,3	2570	50,0
Moldova	2014	4,6	0,9	29,0	0,3	2760	10,0
	2015	-0,5	0,9	30,0	0,4	2310	18,0
	2016	2,0	1,2	32,0	0,4	2970	19,0
	2017	4,5	1,0	33,0	0,4	2970	11,0

The value of a_o for the whole population was 4,55 (table 2).

This relatively small numerical value in this model indicates that the independent variables fully reflect the studied dependency. However, there are some variables that influence the dependent variable but are not considered in the model. The most important is the corruption schemes in the defense ministries and agencies for international military assistance, etc.

For instance, international assistance can reach significant levels, reducing the country's defense spending. International assistance to Israel in 1976 amounted to 14,2% of its GDP, and in the following years, 1985-2002 more than $30 billion were donated as US military grants. The real amount of international assistance to Ukraine in 2017 was only $0,5 billion. However, the lack of official information on these indicators for all countries and years did not allow including them in the model.

In the process of empirical model validation, the direct impact of military spending, public spending, and public debt on GDP growth rates (value b_i) have been established (table 3).

Thus, it was determined that a change in military spending by 1% for all countries of the sample would increase GDP growth by 7,86%. In turn, rising government spending also contributes to GDP growth, however, by only 5%, which is indicative of their less efficient use compared to military spending in individual countries. Additionally, as the calculations show, rising military spending at reduced prices and rising arms exports to the sample countries, have shown the opposite effect.

An empirical study also evaluated the change in the effects of the factors over time to test the stability of that influence. The results of the calculations (parameter), performed in STATISTICA 10, are also presented in table 1.

The greatest effects of the impact over time are caused by changes in military costs at current prices (cost in current prices c4 = 0,76), the smallest – military costs as a percentage of GDP (military costs c3 = 0,24). This fact can be

explained by the relatively stable value of military expenditures at the quoted prices for most objects of observation (fig. 3).

Tab. 2. Calculation of model parameters a_j, a_0

u_j	Y_j	$a_j = Y_j - Y$	a_0
USA	2,16	-0,31	43,5
Israel	3,41	0,94	-60,96
Ukraine	-0,21	-2,68	64,48
Russia	1,75	-0,72	12,23
China	3,54	1,07	-21,98
Moldova	4,15	1,68	11,64
All together	2,47		4,55

Tab. 3. Effects of the influence of independent variables on GDP growth rates across the sample countries

i	x_i	b_i	c_i	a_j	*Residual mean*
1	Govt. spending	0,05	0,55	3,5	0
2	Gross State Debt	0,0043	0,5	3,38	0
3	Military Expenses	0,0786	0,24	3,66	0
4	Expense in current prices	-0,017	0,76	2,49	0
5	Export of weapons	-0,043	0,52	2,66	0

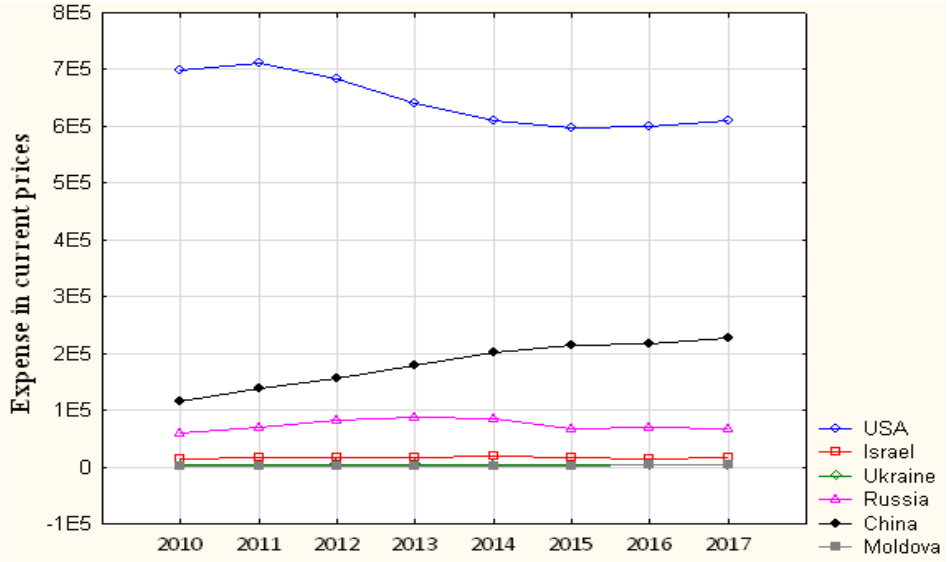

Fig. 3. Dynamics of military expenditure at the quoted prices of the six countries [39], [40]

Confirmation of the reliability of the model is the value of the coefficient – residual mean, which shows a slight difference between the empirical and the estimated values.

The assessment of the peculiarities and specificity of the development of GDP growth rates in the studied countries was carried out by determining the difference between the GDP growth rates of an individual country and its value in the whole population. The results of the calculations are presented in table 2.

According to the data of table 2, there was a significant decrease in the GDP growth rate in Ukraine in comparison with the whole population of the studied countries under the influence of the selected factors (the difference was -2,6). A similar decrease is also observed in Russia (a_j – 0,72). This feature is confirmed by the data in table 1, which testifies to the sharp decline in GDP growth in 2014 and 2015. The decrease has been observed since the Crimea annexation and Russia's unleashing of the war in eastern Ukraine. Warfare in the Donbas, people's displacement from these regions, declining investment, etc., has led to a sharp drop in GDP. Russia showed a similar downward trend in GDP growth in those years, but overall, it was much lower than in Ukraine.

The free term (a_o) in the performed calculations (64,48) indicates that there is a rather strong influence on the factors in the model. These include the cost structure that characterizes the

effectiveness of their use. According to international norms, the national defense budget provides for the allocation of 40% of personnel maintenance costs, the purchase of weapons and military equipment – 30%, and the financing of research and development – 30%. However, for the years of its independence, Ukraine has used up to 80% of the budget of the Ministry of Defense for the maintenance of the Armed Forces. Although with the onset of hostilities, the financing has slightly changed, both in terms of volume and distribution of military spending, given the wear and tear of equipment, the rapid development of advanced technologies in the military field, it still does not fully meet the requirements of national security and successful world experience.

The study evaluated the development of individual countries in time in comparison to their number (table 4). According to the calculations, the dynamics of development has been rather heterogeneous during the research. Thus, a positive trend was observed in most of the analyzed countries in 2012, whereas Ukraine showed a negative tendency. Overall, Ukraine, Russia, and Moldova showed a significantly lower level of GDP growth under the influence of selected factors compared to its average in the aggregate of the studied countries for the researched period.

Thus, the use of the object-period model with the inclusion of two groups of parameters allowed us to construct the following object-dynamic regression model to determine the dependence of the development of national economies, namely GDP growth rates, on countries that are in a 'hybrid' war. We used the parameters which characterize the effects of the factors and their change over time.

Additionally, population peculiarities and the specificity of the development of individual objects was exploited as well:

$$GDP = 4{,}55 + \sum_{i=1}^{m} b_i x_i + \sum_{i=1}^{m} c_i x_{i,t} + \sum_{j=1}^{n-1} a_j u_{jt} + \sum_{j=1}^{n-1} d_j u_j t - 0{,}19 \quad (4)$$

where the coefficients b_i, c_i, a_j, d_j, $i = \overline{1,5}$, $j = \overline{1,6}$ are defined in tables 1-3, respectively.

This model can be used in the process of forecasting military expenditures by countries in the state of 'hybrid' war. First and foremost, it can be applied in Ukraine, where approaches to determining the optimal size of military expenditures are only being formed.

Tab. 4. Model parameters calculation d_i

Year	2010	2011	2012	2013	2014	2015	2016	2017	d_i
t	1	2	3	4	5	6	7	8	
Y	3,98	4,32	1,42	3,43	1,26	-0,53	2,42	3,47	
				USA (j = 1)					
$Y_{1,t}$	2,44	1,73	2,01	1,78	2,82	2,68	1,46	2,36	
$a_{1,t}$	-1,54	-2,59	0,59	-1,65	1,56	3,21	-0,96	-1,11	
$\Delta_{1,t}$		-1,05	3,18	-2,24	3,21	1,65	-4,17	-0,15	0,54
				Israel (j = 2)					
$Y_{2,t}$	3,54	3,78	2,1	3,4	4,08	2,96	3,69	3,74	
$a_{2,t}$	-0,44	-0,54	0,68	-0,03	2,82	3,49	1,27	0,27	
$\Delta_{2,t}$		-0,1	1,22	-0,71	2,85	0,67	-2,22	-1	0,10
				Ukraine (j = 3)					
$Y_{3,t}$	2,76	8,62	-1,38	0,13	-5,21	-6,71	1,23	-1,14	
$a_{3,t}$	-1,22	4,3	-2,8	-3,3	-6,47	-6,18	-1,19	-4,61	
$\Delta_{3,t}$		5,52	-7,1	-0,5	-3,17	0,29	4,99	-3,42	-0,48
				Russia (j = 4)					
$Y_{4,t}$	4,52	4,63	3,79	2,75	-0,56	-1,91	-0,89	1,66	
$a_{4,t}$	0,54	0,31	2,37	-0,68	-1,82	-1,38	-3,31	-1,81	
$\Delta_{4,t}$		-0,23	2,06	-3,05	-1,14	0,44	-1,93	1,5	-0,34
				China (j = 5)					
$Y_{5,t}$	2,95	1,51	1,69	3,26	3,28	3,81	4,45	6,85	
$a_{5,t}$	-1,03	-2,81	0,27	-0,17	2,02	4,34	2,03	3,38	
$\Delta_{5,t}$		-1,78	3,08	-0,44	2,19	2,32	-2,31	1,35	0,63
				Moldova (j = 6)					
$Y_{6,t}$	5,3	6,1	4,93	5,17	5,7	-0,05	3,79	2,29	
$a_{6,t}$	1,32	1,78	3,51	1,74	4,44	0,48	1,37	-1,18	
$\Delta_{6,t}$		0,46	1,73	-1,77	2,7	-3,96	0,89	-2,55	-0,36

4. Conclusion

Current deterioration of the security situation, exacerbation of the military tension is pushing the countries to increase military expenditures. In determining their size, governments must be guided by both a sufficiency criterion that will protect their borders and a reasonableness criterion that will preserve economic growth and foster macroeconomic stability.

The article presents the results of an empirical study of the impact of military expenditure as a percentage of GDP, military expenditures at quoted prices ($), government spending in general, public debt, and arms exports on GDP growth rates. To account for the heterogeneity of the parameters included in the model, we used panel data for the United States, China, and Russia between 2010 and 2017. These three states are currently leading an irreconcilable struggle for geopolitical recognition. Additionally, we exploited Israel, Ukraine and Moldova, whose territories have military conflicts in 'hot' or 'frozen' phases. The United States is increasing its military spending significantly in order not to lose the benefits of its one-on-one leadership because of winning the Cold War. Furthermore, China and Russia are significantly increasing their military capabilities. The first of these countries have achieved benefits through economic growth and innovative development, the second through natural resources, in particular, oil and gas, which have also become instruments of 'hybrid' warfare against Ukraine, and across Europe as a whole. China does not advertise its military strategy; instead, Russia does not hide its desire to restore the empire, at least within the borders of the former USSR. Israel's choice is explained by the positive practice of successful economic development during the ongoing 'hybrid' war with its all neighboring countries. Moldova's choice is also not accidental, as it demonstrates all the negative effects of the 'freezing' of the military conflict with Russia's participation and the continued existence of unrecognized Transnistria.

The findings showed the positive impact of selected factors on economic growth. A comparative analysis of the impact of military and public expenditures as a whole showed a higher correlation of military expenditures with GDP growth rates in the researched countries than did public expenditures as a whole.

This points to the need to increase the efficiency of public spending, in particular, in socially significant areas, such as education, science, health care, and poverty alleviation. Hence, public debt has little impact on GDP growth compared to other factors. However, among other countries in this context, it is worth noting Ukraine, which has had peak debt payments in 2019-2021. Nonetheless, it still has a positive impact on economic growth.

Among the researched countries, military expenditure has the least impact in Ukraine (the difference between the numerical values in the whole population of the countries and Ukraine – 2,68). This is explained by the sharp fall in Ukraine's GDP with the onset of hostilities in the East, as well as the irrational structure of military spending in general. Particularly, a lack of funds is seen for Industry 4.0 innovative research and technology. Although research and technology promote the production of high-precision modern weapons and save the lives of the military through the introduction of robots and alike.

Further research should focus on the selection of military expenditure models that optimize macroeconomic proportions. The study should involve all the countries mentioned in the research. In the US, China and Russia, modeling methods are used to plan military expenditures, but not all of these costs are currently justified, including the costs of military conflicts outside these countries. In general, forecasting should be based on the economic growth, its energy supply, the transition to new circular business models sustainable for the environment, periods of so-called 'shocks' or sharp changes in GDP, inflation, consumption patterns, social indicators, etc. It is also important for Ukraine to significantly change approaches to the structure of military expenditure. As we can see, some new technologies such as neural networks, artificial intelligence, virtual simulation, etc., should be applied in modeling. This requires the involvement of appropriate specialists, i.e. a multidisciplinary approach is required to solve complex multilevel problems.

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