

# The Probability of the Military Potential Increase: Financial and Economic Factors

## Ймовірність підвищення рейтингу військового потенціалу: фінансові та економічні фактори

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**Purpose:** To model financial and economic indicators and determine their real impact on Ukraine's military power (military potential).

**Method:** Non-linear modelling.

**Findings:** The results of the preliminary exploratory data analysis indicate that it is advisable to use the following variables for modelling: business environment and credit. Thus, an increase in the business environment indicator (improvement in the following parameters: stability of economic policy for doing business; economic policy and entrepreneurship culture) adds 3.64% to the probability of improving the military potential rating; an increase in the credit indicator (financing start-ups and scaling up; domestic loans to the private sector, as a percentage of GDP; loans to microfinance institutions, as a percentage of GDP) adds 2.04% to the probability of improving the military potential rating.

**Theoretical implications:** The understanding of Ukraine's economic capabilities has been expanded to include the following factors: investment; credit; business environment; general infrastructure; intangible assets; trade, diversification and market scale. Ukraine's military potential has good chances for growth if defence production, i.e. military entrepreneurship, is properly supported, which in turn requires improvement of business tools and the business climate. Meanwhile, business activities related to the production of weapons and military equipment require proper crediting—financial support from the state and local budgets.

**Value:** Classical and neoclassical theories have become a sufficient basis for an empirical study, which indicates that, given the positive dynamics of the financial and economic sector of Ukraine, the process of military building takes place in the plane of a favourable business climate and lending to entrepreneurial activities, in particular, the production of weapons and military equipment.

**Future research:** The prospect of further research is to expand the range of time series, countries, and methods of nonlinear modelling.

**Майбутні дослідження:** Перспектива подальших досліджень полягає в розширенні діапазону часових рядів, країн та методів нелінійного моделювання.

**Paper type:** empirical.

**Мета:** здійснити моделювання фінансових та економічних індикаторів для з'ясування їхнього реального впливу на військову могутність (військовий потенціал) України.

**Метод дослідження:** нелінійне моделювання

**Результати дослідження:** Результати аналізу даних свідчать про те, що для моделювання доцільно використати наступні змінні: бізнес середовище та кредитування. Так, зростання індикатора бізнес середовища (покращення показників: стабільності економічної політики для ведення бізнесу; економічної політики та культури підприємництва) додає ймовірності покращення рейтингу військового потенціалу на 3,64%; зростання індикатора кредитування (фінансування стартапів та масштабування; внутрішні кредити приватному сектору, у % від ВВП; кредити мікрофінансових організацій, у % від ВВП) додає ймовірності покращення рейтингу військового потенціалу на 2,04%.

**Теоретична цінність дослідження:** Розширено розуміння економічних спроможностей України за рахунок таких факторів: інвестування; кредитування; бізнес середовище; загальна інфраструктура; нематеріальні активи; торгівля, диверсифікація та розміри ринку. Військовий потенціал України має хороші шанси для розвитку, якщо належним чином буде забезпечено оборонно-промислове виробництво, тобто військову підприємницьку діяльність, яка своєю чергою потребує вдосконалення інструментів ведення бізнесу та безпосередньо покращення бізнес клімату. Водночас підприємницька діяльність з виробництва озброєння та військової техніки потребує належного кредитування, зокрема, фінансової підтримки з державного та місцевого бюджетів.

**Цінність дослідження:** Класичні та неокласичні теорії стали достатнім підґрунтям для проведення емпіричного дослідження, яке вказує на те, що за умови позитивної динаміки фінансово-економічного сектору України, процес військового будівництва відбувається у площині сприятливого бізнесового клімату й кредитування підприємницької діяльності, зокрема, з виробництва озброєння та військової техніки.

**Майбутні дослідження:** Перспектива подальших досліджень полягає в розширенні діапазону часових рядів, країн та методів нелінійного моделювання.

**Тип статті:** empirical.

**Key words:** probit regression, military potential, finance, economics.

**Ключові слова:** пробіт регресія, військовий потенціал, фінанси, економіка.

## Introduction

It is obvious that the economy of a country always faces an extraordinary challenge: the approval and implementation of an effective strategy for positive economic growth in the long term, which, accordingly, is supported by appropriate government decisions. Thus, it is reasonable to consider the economy as the main engine of the country, which in turn needs to be maintained and secured, and thus protected from external influences. Building up and maintaining a high level of defense sector capabilities is closely linked to the smooth functioning of the economic system at the macro, micro, and mezzo levels. And vice versa: the higher the level of security and military potential, the more guarantees there are for the economic engine. Thus, it is reasonable to talk about such concepts as “economic security”, “defense potential” and “strategy of development and interaction”.

**Table 1 — Components of Economic Capabilities: Financial and Economic Factors of Influence on Military Potential**



Source: created by the authors.

It is natural for state leaders and military commanders to strive for a degree of cooperation in which the adjustment of the state's socio-economic development leads to improved norms and standards of living, i.e. social welfare, and, in general, well-being. This raises the question of the necessary amount of resources that could satisfy an uncompromisingly favourable investment environment, which is also a significant contribution to the development of the state. The formula is simple: more accumulated resources are a key driver in ensuring economic security, defense capabilities, and the development strategy in general. At the same time, resources need to be efficiently allocated and redistributed, considering the state's long-term priorities.

## Theoretical Foundations of Research

Whatever the priorities, the mechanisms of filling the state budget remain an important characteristic of the effective functioning of the economy, among which the key role should be given to exports of goods and attraction of foreign investment in production, as opposed to excessive imports, despite the implementation of protectionist policies and loan repayment. Hence, it is advisable to identify the first important economic factor that could affect the defense sector: investment.

The second and no less important factor is lending. It is worth noting that any system is relatively stable if it has sufficient reserves. Potential problems with foreign currency outflows, in particular because of a negative trade balance, worsen stability. It is fair to say that such problems are already real for Ukraine, at least given the phenomenal volumes of imported weapons and other goods and services, the production of which has significantly decreased in Ukraine since the beginning of the full-scale war. In turn, the weaker ability to meet the needs of the domestic market increases the need for imports, through the instruments of internal and external obligations. Obviously, in such a scenario, an additional burden for the state's economy would be the

introduction of effective credit mechanisms that would provide financing for startups and forward-looking enterprises by providing domestic loans to the private sector (at the expense of state funding) and obtaining loans by enterprises from microfinance organizations.

**Table 2 — Market development: investment indicator and relevant indicators in Ukraine for 2024**

Market sophistication (25,7)			
Investment (2,6)			
Market capitalization, % GDP (4,3)	Venture capital (VC) investors, deals/bn PPP\$ GDP (0,1)	VC recipients, deals/bn PPP\$ GDP (0,0)	VC received, value, % GDP (0,0)

\* score/value is indicated in brackets

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At the same time, the effect of such decisions would be of strategic importance for the development of Ukraine's economic and defense sectors, and the corresponding "dividends" would serve to promote sustainable development and strengthen defense capabilities. Neoclassical economists argue that the private sector is more dynamic than the public sector and thus can serve as a more efficient allocation of defense spending. The Ministry of Defense can ensure the development and modernization of weapons by conducting defense procurement from the private sector, which in turn receives grants from the state budget. At the same time, the consumption of defense products on the domestic market is strategically important for the development of the state, as it simultaneously satisfies several needs: the availability of a defense order and the increase of state reserves.

**Table 3 — Market development: lending indicator and relevant indicators in Ukraine for 2024**

Market sophistication (25,7)		
Credit (13,8)		
Finance for startups and scaleups (34,8)	Domestic credit to private sector, % GDP (23,5)	Loans from microfinance institutions, % GDP (0,1)

Created by the authors based on **source:** *Global Innovation Index...*, 2024.

Besides credit, an important role in strengthening economic capacity belongs to the creation and maintenance of a proper business climate, which results in the production of goods and services. Thus, the third factor influencing defense capability is the business environment. Neglecting this role, along with the outflow of foreign investment and insufficient credit, can lead to inevitable stagnation of the national economy. Instead, creating a favorable investment climate, credit, and a business environment in general can stimulate the economy, by meeting consumer needs. Thus, the implementation of Keynesian theory could have quite positive consequences for economic growth and, consequently, for the development of the defense sector. Neoclassical scholars Gupta and others argue that the multiplier effect occurs during the period of increased military expenditures and production stimulation (Gupta S., et. al., 2004). It is worth noting that the multiplier effect would work in the context of the development of the business environment, including the introduction of an effective economic policy to stabilize business development,

business policy and culture, which would have a positive impact on the development of the defense sector. This also makes sense for the development of defense production, which is a strategically important task for Ukraine.

**Table 4 — Market development: business environment indicator and relevant indicators in Ukraine for 2024**

Institutions (30,8)	
<b>Business environment (38,2)</b>	
Policy stability for doing business (46,0)	Entrepreneurship policies and culture (30,3)

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From both a theoretical and practical point of view, it may be inappropriate to explain economic growth because of increased expenditures of the Ministry of Defense under the budget program for the purchase and modernization of weapons and military equipment. Increased public spending should be accompanied by improvements in institutional development, human capital, market sophistication, creativity, and infrastructure. Earlier it was mentioned that the national economy has better chances of growth through the production of goods for export. However, such production cannot be effective without the development of the overall infrastructure through such tools as electricity generation, logistics, and gross capital formation (as a percentage of GDP). That is why the fourth important factor is the development of *general infrastructure*.

**Table 5 — Market development: general infrastructure indicator and relevant indicators in Ukraine for 2024**

Infrastructure (35,5)		
<b>General infrastructure (13,8)</b>		
Electricity output, GWh/mn pop. (3605,8)	Logistics performance (27,3)	Gross capital formation, % GDP (14,1)

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Finally, the private sector, based on democratic principles, functions using innovation, which is also the engine of economic progress. The authoritative opinions of prominent figures of the productive capacity school, Adam Smith and David Ricardo, as well as the neoclassical theories of Paul Krugman, suggest that market efficiency is achieved through the exploitation of natural and human resources. However, Joseph Schumpeter aptly noted that the basis of any production is the involvement of innovation. In general, market efficiency is based on the following postulate: the productive capacity of various economic activities provides a so-called “window of opportunity” for achieving a high level of social welfare. At the same time, policymakers tend to forget that technology is the “invisible hand” of production progress.

In turn, technology is not born by itself. Of course, there can be a positive relationship between technology development and the four factors listed above: investment, credit, general infrastructure, and the business environment. Technology, which is so important for building military capabilities, is a derivative of intangible assets. That is why we tend to assume that intangible assets are the fifth factor influencing military potential. At the same time, the intangible assets indicator is expressed in the following indicators: intensity of intangible assets use; trademarks by origin; global value of brands; industrial designs by origin.

The problem of the printing press (an invention that was negatively perceived in some Eastern cultures) can explain the existence of barriers to development, the most obvious of which is the government's refusal to abandon archaism and allow innovation to influence state-building processes, including economic growth and military potential through improved weapons and military equipment production technologies. However, even when allowing innovation in the economic and security sector, governments can exercise undemocratic control over the use of modern technologies, thus demonstrating the absolutism and extractivity of a rentier economy that functions mainly on revenues from the extraction and sale of natural resources and monopolies among elites close to a strong authoritarian leader. According to Solow, products generate products, so innovations generate innovations.

**Table 6 — Market development: creative development indicator and relevant indicators in Ukraine for 2024**

Creative outputs (23,7)			
<b>Intangible assets (25,8)</b>			
Intangible asset intensity, top 15, % (n/a)	Trademarks by origin/bn PPP\$ GDP (52,3)	Global brand value, top 5,000, % GDP (0,4)	Industrial designs by origin/bn PPP\$ GDP(4,0)

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Obviously, the production of goods by the Ukrainian defence industry has a high chance of positively affecting Ukraine's economic growth, at least due to the democratic policy of using war-born innovations. According to Abramovitz, the expansion of innovation capabilities, compared to capital accumulation, is a better explanation of economic growth (Abramovitz, 1986). Meeting the demand of the Ministry of Defence of Ukraine 'here and now' is exactly the progressive niche that the Government has been meeting since 2021 mainly through imports. Economically developed countries of the world 'earn' from the war by lifting restrictions on the export of military and dual-use goods to recipient countries. Meeting the supply and demand for military goods and services under martial law through domestic production to guarantee sovereignty, territorial integrity and inviolability requires new ideas.

First, it is worth noting that the neoclassical theory of economic capability development cannot be applied to the economic growth of developing countries. Richard Nelson, who studied the issues related to the constant inflow of innovations in various spheres of economic activity, believed the use of modern technologies in production gives rise to the possibility of 'doing things in a new way' (Malerba, 2011). If we link this idea to the property of self-reproduction in the context of the Solow model, according to which part of the manufactured products is returned to the production system, we can achieve significant results in the development of defence capability in the context of defence production. Ensuring such a production philosophy requires a symbiosis with the main determinant of avoiding monopoly—market competition. In the presence of competition, each producer resorts to innovations in the production process to differentiate goods and services.

In response to a rather controversial question, it is essential to note that the benefits of innovation in industrial production are more economically favourable to inclusive public or private institutions, and this strategy implies a steady and uncompromising development of trade, diversification and market size. When it comes to the development of market relations, it is assumed that such an institution is formed mainly through inclusive state institutional support. In this context, inclusiveness should be understood as the quintessence of the rights and freedoms of entrepreneurs, free interaction between stakeholders in the relevant production, and democratic

principles of regulatory and controlling state functions. In general, entrepreneurs tend to choose the perspective of capital accumulation. That is why the development of the state's economic capacity through international trade in goods and services, including military and dual-use goods, primarily involves the introduction and use of effective mechanisms of competitiveness in the domestic market—through government encouragement of the development of private defence enterprises that are able to structure the production of goods in accordance with the principles of adaptability, flexibility and openness.

**Table 7 — Market sophistication: an indicator of trade, diversification, market size and relevant indicators in Ukraine for 2024**

Market sophistication (25,7)		
Trade, diversification and market scale (60,7)		
Applied tariff rate, weighted avg., % (1,6)	Domestic industry diversification (85,6)	Domestic market scale, bn PPP\$ (474,8)

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Before competing in the global market, which in turn will create a favourable interest of potential importers, it is necessary to take care of the ability to freely move and sell goods in the national economy. The form of sale of military and dual-use goods, which form the basis of military potential—*the military power of the state*—in a democratic manner is generated by the demand for such goods from the guarantors of defence capability, which has become especially relevant for Ukraine. In this way, supply and value added will guarantee national and economic security and maintain a high level of defence capability.

Porter identifies four steps to sustainable economic growth based on industrial production, which implies market competitiveness and is focused on investment, innovation and social welfare (Porter, 1990). Public and private companies that have access to leading technologies—for example, *in the fields of artificial intelligence and aerospace construction*—gain a significant advantage over other economies that grow mainly through low-cost textile production or the assembly of electronic components. In this way, the advanced technological potential of economically developed countries will serve as a kind of boost to the rapid introduction of innovations when creating a new product, even if this product is not related to the scope of available innovations. In this way, the production of military and dual-use goods will be competitive and guarantee a high level of defence capability.

### **Problem Statement**

Despite the advantages of protectionist policies, there are still open issues related to the direct maintenance of a high level of functioning of national production capacities. The main difficulty may lie in insufficient investment, financial support, poorly developed business environment, etc. Thus, there is every reason to believe that there may be a threat to national producers of armaments and military equipment and thus risks to the development and maintenance of the appropriate level of Ukraine's military potential.

The development of Ukraine's military potential through the introduction of effective mechanisms and the use of efficient financial and economic instruments requires, first, an analysis of the prevailing circumstances and modelling the impact of economic and financial factors on Ukraine's military power. The main challenges include the relevance of classical and neoclassical economic doctrines to the selection of indicators required for modelling. In addition, some of the indicators used in the modelling may not follow normal or lognormal distributions, which in turn creates risks for the least biased interpretation of the results.

## Research Methodology

The use of probit and logit models is a common method for calculating the probability of a certain event occurring. For example, Ismawati Isti Yuli and Faturohma Taufik used logistic regression for a credit scoring model to determine the probability of default in a financial institution (Ismawati, I. Y., & Faturohma, T, 2023). The study identified nine variables that were used as predictors of default probability, namely: job type, work experience, net financial value, term, car brand, asset price, down payment percentage, interest, and income. All nine variables meet the goodness of fit criteria, which consist of WOE, IV, and p-value.

Durango-Gutiérrez, María Patricia and Lara-Rubio, Juan and Navarro-Galera, Andrés applied logistic regression to analyse the risk of default in financial organisations (micro level) (Durango-Gutiérrez et al, 2023). The results obtained were clear and convincing both for the use of logistic and probit models in statistical analysis and calculation of the probability of an event that is somehow related to the financial and economic sector of activity.

Despite the widespread use of the probit model, most applied researchers misinterpret the interaction term in nonlinear models. Ai, C. R. and Norton, E. C. conducted a review of economic journals to determine whether researchers use interaction terms in nonlinear models (Ai, C. R., & Norton, E. C., 2003). The authors pointed out that none of the studies interpreted the coefficient on the interaction terms correctly. Thus, it is important to focus on the correct interpretation of the modelling results, considering the recommendations of the researchers.

Thus, we can see that logistic and probit regression are widely used in studies related to calculating the probability of a certain event. It is also noticeable that the authors of these studies use different software—R, Python, Excel, Stata. The STATISTICA software product is somewhat less commonly used.

Meanwhile, the main condition for using probit models is that they follow a standard normal or lognormal distribution. The probit model can also be applied not only to continuous variables that follow a normal distribution, but also to categorical values that have a binomial distribution and can be approximated to a standard normal distribution, which is why the capabilities of probit models are much wider than those of logit models.

Before moving on to the model, it is necessary to explain the choice of nonlinear modelling, namely the probit model. It is well known that in applied research, scientists often estimate interaction coefficients to draw conclusions about the impact of one independent variable on other dependent variables and the impact of time series (indicators). For example, whether the level of investment in the domestic defence industry affects the overall level of development of production capabilities. To find out, it is advisable to use linear regression in terms of its two functions, namely:

observing the linear relationship of past periods. If the coefficient is statistically significant, there is a difference between state-owned and private enterprises in terms of sources of funding;

make forecasts. The disadvantage of forecasting is that the input parameters can take on values ranging from the minimum and maximum values of past observations, which, in turn, makes it impossible to study any other cases and deviations in the forecasted future.

Interaction terms are also very often used in nonlinear models, such as logit and probit models. Unfortunately, the logic of linear regression models does not apply to nonlinear models. In addition, the sign may be different for different observations. Statistical significance cannot be determined based on the z-statistic reported in the regression results. The odds ratio interpretation for logit coefficients cannot be used for interaction terms. However, unlike linear regression, nonlinear probabilistic regression allows the results to be interpreted in terms of the probability of a particular event occurring, which can be either true or false (1 or 0).

In general, the range of possible values can be from 0 to 1. Meanwhile, the results allow us to calculate the chances of a specific event characterised by a dichotomous variable. Since the

scientific interest is in fulfilling the goal of increasing military potential, it is also expedient to determine the chances of increasing the military potential rating based on the observations of indicators characterised by explanatory variables.

**Results and Discussion**

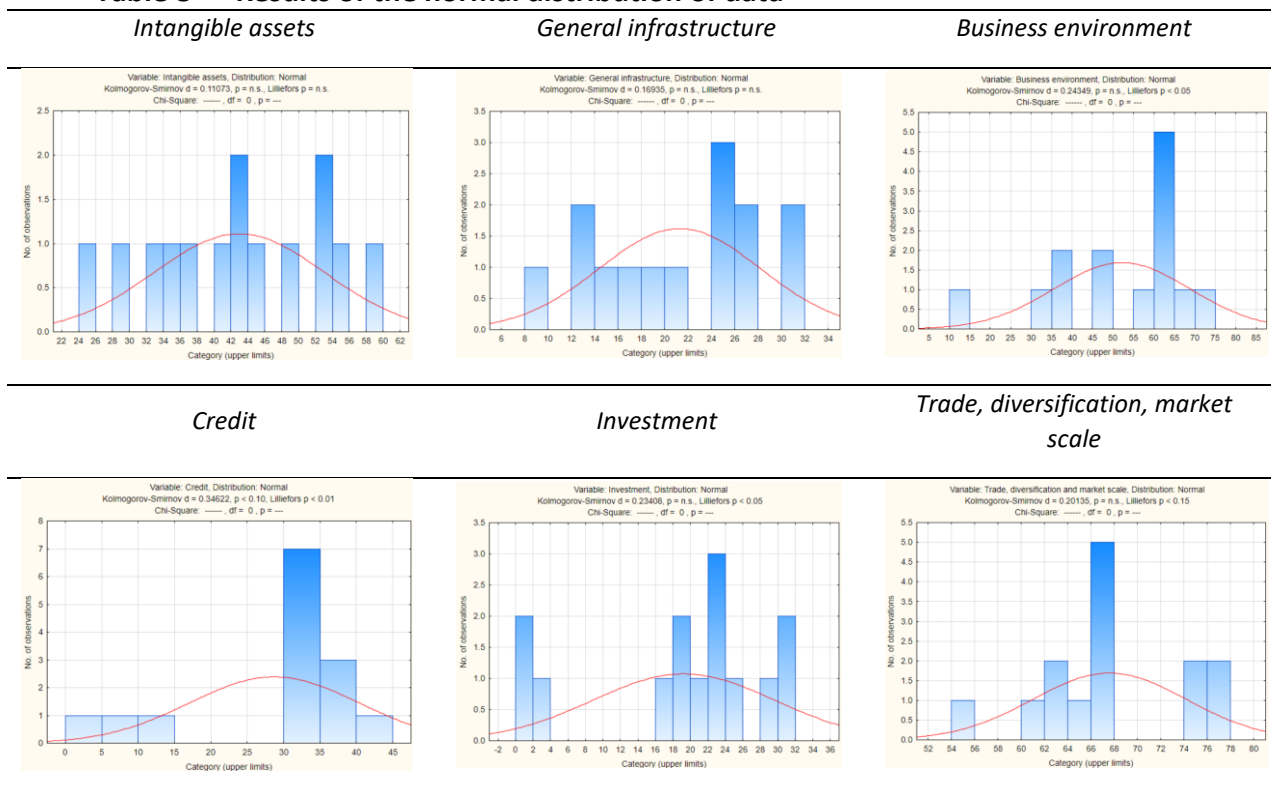
Given the relevance of conducting an empirical study to calculate the probability of increasing the rating of Ukraine’s military potential, it is necessary to use explanatory variables and a dichotomous (dependent) variable. The explanatory variables were defined earlier, namely: *intangible assets* (1), *general infrastructure* (2), *business environment* (3), *credit* (4), *investment* (5), *trade, diversification, market scale* (6). A dichotomous variable is the fact that Ukraine is included in the ranking of the top 25 countries in terms of military power development—Global Firepower Index (Global Firepower, 2025). This will make it possible to determine the level of interrelationships between the explanatory variables, as well as to directly calculate the probability of increasing the rating of Ukraine’s military potential through economic capabilities—the explanatory variables.

First, it is necessary to conduct an exploratory analysis of the data: a test for normal distribution is performed. The Kolmogorov-Smirnov method is preliminarily applied. Although the interpretation of the results of this method can be ambiguous, the results are clearly structured and understandable.

The normal distribution allows only numerical values, i.e. all explanatory variables can be used, except for the military power variable (which is categorical and thus dichotomous). It is important to note that an additional test for lognormality is performed, since the dependent variable contains categorical data, namely, whether a country is in the top 25 countries in terms of military power or not. As noted earlier, the advantage of probit models is the ability to analyse and model non-numerical, i.e. categorical, variables.

Tables 8 and 9 show the results of the normal distribution of the data. Based on the results of the analysis, decisions are made regarding further modelling.

**Table 8 — Results of the normal distribution of data**



Source: created by the authors

**Table 9 — Results of the normal distribution of data**

Variable	Observed mean	Observed variance	Kolmogorov-Smirnov test	Lilliefors p	p-value	Most expected value	Percent Expected
Business environment	52,21	275,25	0,24	<0,05	n.s.	65	35,71
General infrastructure	21,28	47,56	0,17	n.s.	n.s.	26	21,43
Credit	28,72	136,46	0,35	<0,01	<0,1	35	50
Investment	19,25	108,20	0,23	<0,05	n.s.	24	21,43
Trade, diversification, and market scale	67,59	43,63	0,20	<0,15	n.s.	68	35,71
Intangible assets	42,99	101,30	0,11	n.s.	n.s.	54	14,29

**Source:** created by the authors

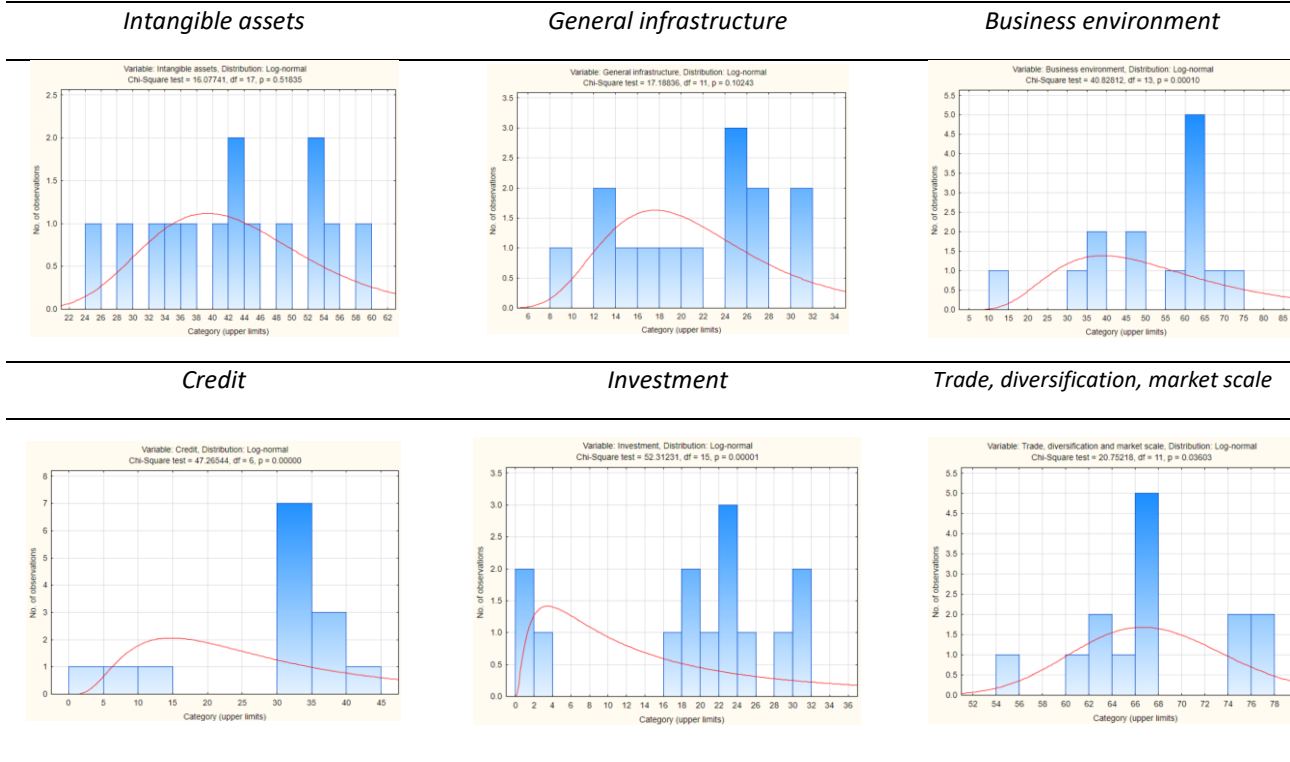
According to the results, it is noticeable that for all variables the p-value is unsatisfactory or at least unknown, except for the variable credit, which has a p-value <0.1, i.e. the distribution does not follow a normal distribution. Investigate the p-value for those variables for which it was unavailable or unsatisfactory—perhaps by testing for a lognormal distribution and changing the test parameters.

That is why the next step is to test for a lognormal distribution and to include an additional Chi-square test (*without combining the categories*, since there is no reason to expect the binary frequency to be less than or equal to 5). It is assumed that with such parameters, the test can demonstrate clearer results than the previous one.

**Table 10 — Results of the lognormal distribution of data**

Variable	Chi-square	df	p-value
Business environment	40,83	13	0,00010
General infrastructure	17,18	11	0,10243
Credit	47,27	6	0,00000
Investment	52,31	15	0,00001
Trade, diversification, and market scale	20,75	11	0,03603
Intangible assets	16,08	17	0,51835

**Source:** created by the authors

**Table 11 — Results of lognormal distribution of data in graphical representation**

**Source:** created by the authors

According to the results of the lognormal distribution, it is noticeable that:

1. Variables that follow the lognormal distribution:
  - general infrastructure (hereinafter—GI);
  - intangible assets (hereinafter—IA);
2. Variables that do not follow a lognormal distribution:
  - business environment (hereinafter—BE);
  - credit (hereinafter—CR);
  - investment (hereinafter—IN);
  - trade, diversification, and market scale (hereinafter—TDMS).

Based on the results of the lognormal distribution, it is reasonable to assume that variables that do not follow the distribution are more unstable and sensitive to any endogenous and exogenous factors of influence. At the same time, these variables can still be included in further modelling.

In turn, this may indicate the need for further identification of the factors of influence, as well as the fact that the listed variables and their unstable state may be a signal for taking measures to further stabilise them, given the state of uncertainty.

The next stage of the analysis involves finding out the correlation between the variables, i.e. how closely they are related. Since all the variables are numerical and do not contain ranks, it is not advisable to use Spearman's correlation, but rather to use contingency tables and present the results in the form of a matrix.

It should be noted that the values obtained should be compared with a p-value < 0.05. Moreover, there is a scale of correlation on which the obtained values are compared:

- $0 < r < 0.3$ —weak;
- $0.3 < r < 0.5$ —moderate;
- $0.5 < r < 0.7$ —noticeable;
- $0.7 < r < 0.9$ —high;
- $r > 0.9$ —very high (variables are highly correlated—there is a functional relationship).

Also, do not confuse p-values with  $r^2$ -value (the degree of correlation). These indicators are complementary, but not interchangeable.

For example, if the obtained correlation value is 0.5 and the p-value is  $< 0.05$ , this indicates that the obtained correlation value is not significant and, therefore, can be disregarded for modelling.

Table 12 shows the correlation indices for the identified variables.

**Table 12 — Correlation matrix (correlation level)**

	BE	GI	CR	IN	TDMS	IA
BE		0,28	0,52	0,60	0,09	0,56
GI	0,28		0,21	0,47	0,28	0,27
CR	0,52	0,21		0,84	0,31	0,21
IN	0,60	0,47	0,84		0,26	0,58
TDMS	0,09	0,28	0,31	0,26		0,07
IA	0,56	0,27	0,21	0,58	0,07	

Source: created by the authors

Based on the results obtained, the  $r^2$ -values of the relationship between the variables become noticeable. For a more meaningful assessment of the results, the p-values are presented in Table 13.

**Table 13 — Correlation matrix (p-values)**

	BE	GI	CR	IN	TDMS	IA
BE		0,33	0,06	0,02	0,76	0,04
GI	0,33		0,48	0,09	0,34	0,35
CR	0,06	0,48		0,00	0,28	0,47
IN	0,02	0,09	0,00		0,37	0,03
TDMS	0,76	0,34	0,28	0,37		0,80
IA	0,04	0,35	0,47	0,03	0,80	

Source: created by the authors

It is also advisable to provide additional descriptive statistics, such as the paired N, T-statistics, and slopes and intercepts of the regression equations for each correlation variable. It is advisable to perform additional checks after the selection of variables.

Before interpreting the data, it is necessary to use the Maximax or Optimism Criterion for more objective decision-making. This criterion determines which of the variables has the highest aggregate value of the relationship with the others. Next, all p-values are summed up in terms of one variable. The results are shown in Table 14.

$$\max_{\theta_j} U(a_j; \theta_j) \quad (1)$$

When considering the results, it is worth highlighting the variables that have the highest cumulative correlation among all variables:

- business environment;
- credit;
- investment.

**Table 14 — Summing p-values**

BE	GI	CR	IN	TDMS	IA
3,0	2,5	3,0	3,7		2,6
5	1	9	6	2,01	9

Source: created by the authors

These variables were selected because the aggregate utility of each is greater than 3.0. Table 15 presents additional descriptive statistics from the exploratory data analysis.

**Table 15 — Additional statistical analysis**

	Mean	Std. Dv	r(X,Y)	r <sup>2</sup>	t	df	p	N	Const. dep: Y	Slope dep: Y	Const. dep: X	Slope dep: X
BE	52,21	16,59										
BE	52,21	16,59	1,00	1,00		9,00		14,00	0,00	1,00	0,00	1,00
BR	52,21	16,59										
CR	28,72	11,68	0,52	0,27	2,10		0,06	14,00	9,68	0,36	31,07	0,74
BE	52,21	16,59										
IN	19,25	10,40	0,60	0,36	2,60		0,02	14,00	-0,39	0,38	33,79	0,96
CR	28,72	11,68										
BE	52,21	16,59	0,52	0,27	2,10		0,06	14,00	31,07	0,74	9,68	0,36
CR	28,72	11,68										
CR	28,72	11,68	1,00	1,00		9,00		14,00	0,00	1,00	0,00	1,00
CR	28,72	11,68										
IN	19,25	10,40	0,84	0,71	5,38		0,00	14,00	-2,26	0,75	10,54	0,94
IN	19,25	10,40										
BE	52,21	16,59	0,60	0,36	2,60		0,02	14,00	33,79	0,96	-0,39	0,38
IN	19,25	10,40										
CR	28,72	11,68	0,84	0,71	5,38		0,00	14,00	10,54	0,94	-2,26	0,75
IN	19,25	10,40										
IN	19,25	10,40	1,00	1,00		9,00		14,00	0,00	1,00	0,00	1,00

Source: created by the authors

The results show that the investment variable has a moderate level of correlation with the business environment and a high level of correlation with lending. At the same time, these

relationships cannot be significant, as the p-value is below 0.05. Therefore, we accept the correlation between the business environment and lending, which, although moderate, is significant ( $p\text{-value} > 0.05$ ).

This completes the exploratory analysis of the data for the presence of a relationship between the variables. Now it is advisable to build a probit model of the probability of increasing the level of military potential due to financial and economic capability. In this case, the binary values are the data of the GFI Top 25 variable (whether Ukraine is among the top 25 most powerful countries in the world), i.e. Yes/No. According to the intelligence analysis, it is proposed to include the following independent variables in the module: business environment; credit; investment.

It should be noted that the nonlinear estimations module always estimates the parameters by maximum likelihood for probit models. Conventional least-squares estimation assumes of constant error variance (or residual variance) for different values of the independent variables. In this case (the binary dependent variable GFI Top 25), this assumption is clearly violated, so it is advisable to use the maximum likelihood criterion to estimate the parameters of the probit regression model.

To evaluate the results, it is enough to build a model using the simplex method. Additionally, the error coverage of the asymptotes is selected. The results of the preliminary descriptive statistics are presented in Table 16.

**Table 16 — Results of descriptive statistics**

	Mean	Std. Dev.	Min	Max
<b>BE</b>	52,21	16,59	12,20	74,60
<b>CR</b>	28,72	11,68	4,90	41,20
<b>IN</b>	19,25	10,40	1,20	31,60

Source: created by the authors

The test results show the mean values of the variables, as well as the standard deviations known and used in the previous calculations. Parameter estimates for probit regression are concerned with predicting the z values of a normal distribution. If the normal integral of the z values is taken, values can be obtained that will never fall outside the range of 0-1.

The predicted values can be viewed as probabilities. The probit model is built with each variable separately, i.e., it checks how each individual indicator affects the country's ability to be among the top 25 countries in terms of military potential. Thus, when building the probit model, the values shown in Table 17 are obtained:

**Table 17 — Probability modelling results**

	Const.B0	BE	Const.B0	CR	Const.B0*	IN*
<b>Estimate</b>	<b>-4,43</b>	<b>0,07</b>	<b>-1,78</b>	<b>0,05</b>	<b>-19,52</b>	<b>0,82</b>
Std. Err.	2,57	0,04	1,45	0,04		
t(12)	-1,72	1,70	-1,23	1,05		
-95%CL	-10,03	-0,02	-4,93	0,05		
+95%CL	1,17	0,16	1,37	0,14		
<u>p-value</u>	<u>0,11</u>	<u>0,12</u>	<u>0,24</u>	<u>0,31</u>		

\* the matrix is poorly conditioned; standard errors cannot be calculated

Source: created by the authors

For the investment variable, the matrix is ill-conditioned, and thus standard errors cannot be calculated (since the maximum number of specified iterations was exceeded during the modelling). This is probably due to a lack of information for the model. It is possible that the model is simply identified (it has 0 df), or the model may be empirically unidentified (Bollen, K. A, 1989). In this case, the result of the likelihood calculation may not be adequate. Another reason is likely to be the requirement for a minimum number of observations to build both logit and probit models.

Given the above calculations, it is advisable to model the probability of increasing the military potential rating using business environment and credit indicators. The data obtained can be used to calculate the value of  $z$ , the function of  $z$ , and the marginal effect. The results are presented in Table 19.

$$f(Z) = (1/\sqrt{2\pi}) * e^{\frac{1}{2} * z^2} \quad (2)$$

**Table 18 — Standard calculations**

Index	Value
$\sqrt{2\pi}$	2.51
$\pi$	3.14
$e$	2.72
$1/\sqrt{2\pi}$	0.39

Source: created by the authors

**Table 19 — Results of calculations of Z, f(Z) and  $\beta$**

	Z	f(Z)	$\beta$
BE	-0,699081	0,509	0,036409849
CR	-0,445515	0,441	0,020436968

Source: created by the authors

The results of the calculations indicate that:

an increase in the business environment indicator (improvement of the following indicators: stability of economic policy for doing business; economic policy and entrepreneurship culture) adds to the probability of improving the military potential rating by 3.64%;

an increase in the credit score (financing of start-ups and scaling up; domestic loans to the private sector, as a percentage of GDP; loans to microfinance institutions, as a percentage of GDP) increases the likelihood of improving the rating of military potential by 2.04%.

The results can be interpreted as follows: financial and economic factors imply a well-developed system of economic policy and financial institutions, which in turn have a positive impact on improving the rating of Ukraine's military potential.

## Conclusion

Thus, an exploratory analysis of the data was carried out and the probability of improving Ukraine's military potential rating was calculated when economic capabilities are the factors (explanatory variables). Six factors of Ukraine's economic capability were identified, which, according to classical and neoclassical economic doctrines, can best influence both economic growth and the improvement of Ukraine's military potential rating.

The explanatory variables were selected based on the annual Global Innovation Index report, which contains the necessary statistical data for the calculations. This report contains many indicators that can be used in the most concise and understandable way to model the improvement

of Ukraine's military potential rating, considering financial and economic factors of influence, namely *intangible assets* (1), *general infrastructure* (2), *business environment* (3), *credit* (4), *investment* (5), *trade, diversification, market scale* (6).

It is worth noting that the probit model was used for modelling from among the nonlinear modelling methods, as the scientific interest was in calculating the probability, which, in turn, is assumed to be nonlinear. The study of the trends of the last decade has confirmed the rationality and significance of research based on logistic and probit regression using differentiated software. Thus, the software STASTICA 10.0 with the built-in module Advanced Models/Nonlinear Estimations was used. It is worth noting that the modelling results fully satisfy the objectives, and therefore the aim of the study has been achieved.

The classical and neoclassical doctrines, which were referred to in the text of the article, proved to be useful, as the modelling results confirmed the positive impact of some financial and economic factors on the fundamental factor of state-building: military potential. Thus, improving the business environment and credit increases the probability of improving Ukraine's military potential rating by 3.64% and 2.04%, respectively. In turn, this indicates that Ukraine's military potential has good chances for development if defence production, i.e. military entrepreneurship, is properly supported, which in turn requires improving business tools and directly improving the business climate. At the same time, business activities in the production of weapons and military equipment require proper lending, i.e. financial support from the state and local budgets.

This suggests that over the period under study (the statistical data used for modelling was collected from 2011 to 2024), the improvement of the business environment, in particular, business lending, improved Ukraine's military potential. Thus, this indicates a positive trend that the Government of Ukraine should continue to pursue, particularly given the current geopolitical and economic challenges facing the country (the context of the Russian-Ukrainian war, Ukraine's Euro-Atlantic integration, and further development prospects). At the same time, the question of calculating the probability of raising the military potential rating for the European Union and key geopolitical players who are somehow related to the situation in modern Ukraine remains open. It is also interesting to conduct the study over a longer period.

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The authors declare that they have no competing interests.

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