

Економіко-математичні методи та моделі фінансового розвитку

Economic and mathematical methods and models of financial development

DOI: [10.26565/2786-4995-2023-4-05](https://doi.org/10.26565/2786-4995-2023-4-05)

UDC 330.5:338.2:336.7 (043.5)

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Econometric forecasting of academic management in the face of uncertainty regarding hostilities

Abstract: This article addresses the interrelations between economic factors and military conflicts, examining the role of econometric forecasting in academic management during periods of uncertainty surrounding hostilities. It delves into the two principal theories of classical macroeconomics—neutrality and dichotomy—and explores their applicability to the complex interplay between economic forces and military dynamics. In doing so, it challenges the conventional binary view of conflicts as either war or peace, emphasizing the nuanced gradations that emerge over time.

The study highlights the significance of economic advantages in shaping decisions related to military conflicts and underscores the role of econometric forecasting as a critical factor in academic institutions navigating the indirect repercussions of hostilities. The article also presents a comprehensive examination of strategic interactions, introducing distinctions between moves, rounds, and plays in conflict scenarios.

Drawing on recent research and publications, the article underscores the importance of understanding the economic principles governing the preservation of peace and forecasting the consequences of such decisions. It references seminal work by economists P. Romer, R. Lucas, R. Barro, I. Salla y Martin, and R. Levine, who laid the foundation for the study of endogenous economic development.

The theories of trade and military conflict are two distinct branches in economic analysis and prediction. Trade theory is founded on contractual agreements and mutual benefits, while military conflict theory centers on competition for dominance. It's important to recognize that various analytical methods exist for modeling equilibrium in such situations, whether they involve active hostilities or the coexistence of armed forces during economic stagnation due to anticipated conflicts.

It becomes evident that the decision to initiate or de-escalate a military conflict is primarily driven by economic advantages, even in the domain of academic management. In this context, econometric forecasting techniques play a role in the economic activities of academic institutions, which may experience direct or indirect consequences of hostilities. This is because various sectors must compete for their survival amidst these dynamics.

Purpose: The study's objectives include assessing the impact of military budgeting productivity on economic growth using economic and mathematical modeling techniques, with a focus on countries facing uncertainties related to hostilities, evolving budget and tax regulations, and inflation. The article adapts the models of J. Battis and T. Koeli to facilitate this analysis.

Methods: Macroeconomic Analyses, Econometric Analyses, Trend Analyses

Results: Determining the optimal level of taxation to obtain the necessary income for the budgets of academic institutions in conditions of uncertainty in the conduct of hostilities.

Conclusion: In conclusion, the study challenges classical economic doctrines by establishing a strong connection between military budget allocation and the real sectors of the economy. It underscores that a nation's economic growth is contingent upon the productivity and effectiveness of its military budgeting, even in a globalized world economic system. This study opens the door to further research in this interdisciplinary field.



Keywords: *econometric forecasting, academic management, uncertainty, hostilities, economic modeling, endogenous economic development, academic institutions, budgeting, military conflicts, financial impact, economic growth, strategic decision-making, budget optimization, risk assessment, financial efficiency, methods: macroeconomic analyses, econometric analyses, trend analyses*

JEL Classification: C81, C82, C58, C52, C43, C33, B41, B26, B27, B17, G11, G14, G15, G23, G29, G32, O16, O50
Fig .0 ; Tab .0 ; bibl .: 9.

For citation: Suntsova O. Econometric forecasting of academic management in the face of uncertainty regarding hostilities. Financial and credit systems: prospects for development. №4(11) 2023. P. 41-47. DOI: <https://doi.org/10.26565/2786-4995-2023-4-05> [in Ukraine]

Introduction: The theories of exchange and military conflict represent parallel branches within economic analysis and prediction. The theory of exchange is grounded in contractual agreements and mutual gains, while the theory of military conflict revolves around competition for supremacy. It is worth noting that there are various analytical approaches for modeling equilibrium in such scenarios, whether it pertains to active hostilities or armed peaceful coexistence amid economic stagnation triggered by the anticipation of conflict.

It becomes evident that the decision to engage in or de-escalate a military conflict is predominantly influenced by economic advantages, even within the realm of academic management. In this context, econometric forecasting techniques can be viewed as contributing factors to the economic activities of academic institutions, which may bear the direct or indirect consequences of hostilities. This is because productive forces in all spheres vie for their sustenance in the face of such dynamics.

The initiation and resolution of hostilities are commonly viewed as a binary concept, where states are perceived to be either at war or at peace. However, this dichotomy can exhibit a multitude of nuances and subtle gradations. What may seem dichotomous in the short term often reveals a continuous spectrum when observed over the long term. The unresolved aspect of the overarching issue lies in understanding the economic principles governing the preservation of peace and forecasting the repercussions of such decisions.

In such binary models, the conventional challenge arises in determining the subsequent course of action following the commencement of hostilities, whether they persist or conclude. However, conflicts, including wars, conform to continuous models wherein ongoing events manifest through typical interactions between parties involving a delicate balance of cooperative and confrontational activities. In strategic interactions, it is crucial to differentiate between moves, rounds, and plays.

During these interactions, each participant is afforded the opportunity to make an offer in each bidding phase. A move in the auction signifies an individual player's decision to participate or abstain from the bid, essentially choosing to engage or pass. Since outcomes materialize after each bidding round is completed, engaging in multiple rounds implies a series of winnings distributions. Successive rounds can exhibit the same outcome pattern, akin to a recurring prisoner's dilemma scenario [8-9]. Within a given round, there may be a sequence of bidding moves or negotiations among players. However, it's essential to note that these moves and rounds do not yield outcomes until the conclusion of the round [9].

Literature Review and Problem Statement: The late 1980s witnessed significant attention given to the exploration of the new theory of endogenous economic development, which serves as the foundation for all assumptions in this study. Notably, economists P. Romer and R. Lucas [9] were pivotal in this regard, as they not only identified but also empirically substantiated the primary factors driving a nation's economic growth. These pioneering studies can be considered as early theories of long-term endogenous economic growth, outlining the following key determinants: investments in physical and human capital, taxation policies, and technological advancement. In the

1990s, American researchers R. Barro, I. Salla y Martin, and R. Levine further expanded this body of work by introducing another element crucial to a nation's economic growth – financial development [1, 3, 5-8].

For the first time, we endeavor to assess the specific impact of each segment of a nation's military budget on the productive efficiency of economic processes, building upon the previously mentioned theory of endogenous economic development. While F. Norzad made an attempt at a similar assessment in his work, he did not fully account for the unique characteristics of countries with military-based economies. Therefore, our study aims to enhance the applicability of the Batts and Koeli model in such contexts.

Formulation of the Article's Objectives (Task Setting): This study aims to investigate the influence of military budget productivity on economic growth through the application of economic and mathematical modeling techniques. In this context, we will adapt the models of J. Batts and T. Koeli [2, 4] to transform the stochastic productivity model for usage in nations facing uncertainties related to hostilities, ongoing changes in budget and tax legislation, and inflationary dynamics. These factors are particularly pertinent for countries experiencing active conflicts within their territories.

Research Results: Since military actions tend to be largely ineffective in achieving Pareto improvements, pursuing a peaceful resolution to a military conflict remains a preferable option. However, the effectiveness of settlement agreements hinges on the presence of mechanisms to ensure their enforcement. Typically, these arrangements necessitate the involvement of a third party, often referred to as an enforcer, to oversee their implementation.

The potential for establishing a long-term mutually beneficial relationship among all involved parties serves as a motivating factor for complying with such agreements, making them binding in nature. Nonetheless, mutual commitments, whether in marital relationships or other contexts, are often vulnerable to well-known challenges, including the so-called "last-period problem" and other issues. In situations where there is no third party available (e.g., in territorial disputes among animals or in the international rivalry among powerful states), the likelihood of achieving and maintaining peace diminishes significantly.

It's important to note that the mere existence of binding agreements doesn't eliminate the possibility of conflict entirely. Despite having a legal framework in place to enforce agreed-upon settlements, legal disputes and proceedings remain a substantial aspect of human activity. In a military conflict, the stakes can range from life and death to the pursuit of specific gains [1], and the objectives may involve either the destruction of the enemy or territorial adjustments.

In traditional economic theory, perfect competition involves a multitude of buyers and sellers in the market for military goods and services. A standard monopoly within the military-industrial complex entails a scenario where there is one seller and numerous buyers. A duopoly, on the other hand, occurs when there are two sellers and multiple buyers. It's also possible to have a situation where there is a dominant monopoly seller coexisting with several smaller sellers. Similar analogies can be drawn in the realm of military conflict theory: bilateral monopoly corresponds to one-on-one military engagements. A typical monopoly, including within the military-industrial complex, resembles the relationship between a tyrant and subjects. The decisions of the tyrant can influence the choices made by citizens, such as the decision to rebel or acquiesce, but individual citizens typically do not anticipate that their significant investments in repressive apparatus will sway the tyrant's decisions. In a conventional monopoly, buyers wield influence over prices, but in the model of pure conflict, there is no exchange between citizens and a tyrant.

Alliances can emerge when there are at least two strategic players involved [5]. One of the primary forms of alliances involves strategic players uniting against passive players. If, for some reason, one of the strategic players switches allegiance to another strategic player, an alliance may also form, often directed against a group of non-strategic players who have essentially lost their

leader. By default, alliances typically constitute coalitions of certain strategic players aligning against others. [6].

A classic illustration of a non-profit threat is the strategy known as 'mutual assured destruction' (MAD), employed to discourage the outbreak of nuclear warfare. In this strategy, if a nation faces a nuclear attack from an aggressor, it can be anticipated that retaliating will result in the aggressor suffering a nuclear counterattack, thereby incurring losses relative to the status quo.

While non-profit threats cannot be conclusively verified in terms of sequential rationality, there are certain circumstances where they can be reasonably relied upon:

1. When a party commits to an action, and this commitment is irreversible, effectively closing off any retreat (akin to 'burning all bridges').
2. When the ongoing interaction holds future opportunities, and responding to the aggressor's provocation would tarnish one's reputation and result in substantial losses.
3. When the adversary is deemed irrational or indeed demonstrates irrational behavior, leading to a retaliatory response regardless of immediate profitability considerations.

In practice, even a nonzero perceived or subjective probability of encountering such irrationality can serve as a sufficient deterrent against initiating an attack. [8].

In order to construct a model for the optimal budget structure of academic institutions in the midst of hostilities' uncertainties, it's essential to recognize that the allocation of substantial budgets, whether public or private, to academic institutions encourages states, functioning as economic entities in our globalized world, to effectively manage the additional funds they receive. This is because the expansion of production and sales of military goods has a direct impact on the overall GDP of countries engaged in the sale of such goods while concurrently diminishing the GDP of nations that allocate significant resources towards purchasing military equipment.

This underscores the importance of state governing bodies not only expending their paramilitary revenues but also utilizing them to generate returns, thereby fostering the development of their national economies to better provide services. Consequently, let's assume that academic institutions' budget revenues during times of hostilities stem from primary sources, including public funds, private contributions, and donations from international organizations or financial infusions from other countries. This assumption is designed to curtail excessive monetary transfers to academic institution budgets directly within the territory where hostilities are occurring.

Moreover, the size of these budgets will be significantly influenced by the application and enforcement of economic sanctions in accordance with decisions made by specific countries or international organizations within our globalized environment. As they form the political majority, they enact regulations or amend laws delineating the rules governing the augmentation of academic institution budget revenues. Ideally, the overarching strategic objective is to maximize the well-being of the country or safeguard it against military aggression:

$$vu(\omega + \bar{U}) + (1 - v)u(\omega + \underline{U}),$$

Where is determined taking into account the usefulness of the steps in the formation and use of academic budgets (\bar{U}, \underline{U}) , obtained in calculating the highest and lowest utility for them to improve the indicators of economic development U . Suppose that $u(\cdot)$ and grows and falls ($u'(\cdot) > 0$, $u''(\cdot) \leq 0$). w This is an index of the ratio of the level of academic budgets of IP to those collected in revenues from various sources in the military budget (the level of paramilitary, determined by the cost method). $w = \underline{w}; \bar{w}$ Accordingly, government policy, which is strategically aimed at economic participation in conditions of uncertainty in hostilities on the territory of the state and anywhere abroad, as well as participation in the application of international economic sanctions in a globalized world, and government policy, which has a strategy in any form of state participation in hostilities in conditions of uncertainty. Denote $\Delta w = \bar{w} - \underline{w} > 0$ for the degree of polarization of these strategic directions of economic development in a particular country and $w_0 =$ for the average level of distribution of spending/non-spending of financial resources on hostilities in conditions of uncertainty and globalization.

Such parameters of allocation of levels of participation/non-participation of financial resources in military budgets of various types make it possible to determine how economic The policy in the past, which developed with the adoption of laws by certain political forces in the past, influenced the budget and tax policy in the formation of military budgets at the present stage and what is their impact on the GDP of each individual state.

The level of inconsistency of a certain government policy that influenced the formation of academic budgets in countries where hostilities take place is calculated by the function of social utility $u(\cdot)$ позначено за $r_u(x) = -u''$ - That is, such a strategic direction of state policy has led to the inefficient use of financial resources collected for military operations at all levels of X government structures. This level of inconsistency of the strategy with the use of the function of social utility should be $r_u'(\cdot) < 0$ or $r_u''(\cdot) > 0$.

It should be noted that in conditions of uncertainty in the conduct of war or tangential participation in hostilities, any tax system of the country must be completely open and transparent. Then denote by θ report of the formed and used financial resources of military budgets (their productivity in society) for a certain period. Let's denote the mechanism of openness of the authorities for their activities on and the creation and use of military and the openness of the tax system to payers for $\{\tau(\theta), y(\theta)\}$. To simplify the recording of these parameters in the model we introduce such indicators as $\{\bar{\tau}, \bar{y}\}$, which mean indicators of the share of tax revenues t a share of income from other private or international sources of income to the budgets of academic institutions with a correspondingly high and low level of productivity of business entities in a given region regarding the function of public utility for a certain period. Then limiting the level of tax payments by business entities in a given region with high productivity (to what extent agents can be considered profitable at a certain level of taxation) can be written as:

$$\bar{U} = \bar{y} - \bar{\tau} - \psi\left(\frac{\bar{y}}{\bar{\theta}}\right) \geq \underline{y} - \underline{\tau} - \psi\left(\frac{\underline{y}}{\underline{\theta}}\right) = \underline{U} + \varphi(\underline{y}) \quad (1)$$

\bar{U} - the highest level of social utility of the state body in conditions of uncertainty in the conduct of hostilities;

\bar{y}, \underline{y} - respectively, the highest and lowest GDP of the region;

ψ - expenditures of capital and labor to obtain such income;

$\bar{\theta}$ - the highest productivity of business entities in conditions of uncertainty in the conduct of hostilities;

$\bar{\tau}, \underline{\tau}$ - respectively, the largest and smallest amount of taxes paid with a intended purpose for the formation of budgets of academic institutions;

$\varphi(\underline{y})$ - це $\psi(y/\underline{\theta}) - \psi(y/\bar{\theta})$, which grows and transforms along with in while $\psi''(\cdot) > 0$, $\psi'''(\cdot) > 0$.

$$v\left(\bar{y} - \psi\left(\frac{\bar{y}}{\bar{\theta}}\right)\right) + (1-v)\left(\underline{y} - \psi\left(\frac{\underline{y}}{\underline{\theta}}\right)\right) \geq v\bar{U} + (1-v)\underline{U} + b. \quad (2)$$

Determining the optimal level of taxation to obtain the necessary income for the budgets of academic institutions in conditions of uncertainty in the conduct of hostilities

Conclusions: As commonly understood, classical macroeconomics encompasses two fundamental doctrines: neutrality and dichotomy. If we adhere to these principles, it may appear that in the long run, there exists no correlation between military budget allocation and the real sectors of the economy. Nevertheless, we have empirically confirmed that military budgeting and the real economy are interconnected, mutually influencing each other's development. Consequently, this raises the question of discerning the interdependency between the productive efficiency of processes within both the tangible and paramilitary sectors of the economy and the evolution of military budget allocation itself.

The military budgeting sector constitutes an integral part of the tangible economy. Consequently, a specific country's economic growth is also contingent upon the productivity and effectiveness of its military budgeting. Thus, for the first time, we can recognize the potential

impact of military budget allocation and its productive efficiency on the economic growth of a particular nation within the framework of a globalized world economic system.

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- The article was received by the editors 06.11.2023
The article is recommended for printing 20.12.2023

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Економетричне прогнозування управління академічною діяльністю в умовах невпевненості при військових діях

Анотація. У цій статті розглядається проблема взаємозв'язків між економічними факторами та військовими конфліктами, досліджуючи роль економетричного прогнозування в контексті академічного управління в умовах невизначеності, що оточує воєнні події. В статті глибоко аналізуються дві основні теорії класичної макроекономіки - нейтральність і дихотомія - та досліджується їх застосовність до складних взаємовідносин між економічними силами та військовою динамікою. При цьому викликається конвенційний двійковий погляд на конфлікти як війну або мир, наголошуючи на нюансах, які виникають з часом.

Дослідження підкреслює важливість економічних переваг у формуванні рішень, пов'язаних з військовими конфліктами, та підкреслює роль економетричного прогнозування як критичного чинника у навігації академічних установ у контексті опосередкованих наслідків військових подій. В статті також представлено всебічний аналіз стратегічних взаємодій, вводячи розрізнення між ходами, раундами та рухами в сценаріях конфлікту.

На основі останніх досліджень та публікацій стаття підкреслює важливість розуміння економічних принципів, які керують збереженням миру і передбаченням наслідків таких рішень. Вона посиляється на видатну роботу економістів Р. Romer, R. Lucas, R. Barro, I. Salla у Martin та R. Levine, які поклали основу для вивчення ендогенного економічного розвитку.

Теорії обміну та військового конфлікту є двома відмінними галузями в економічному аналізі та прогнозуванні. Теорія обміну ґрунтується на контрактних угодах та взаємній вигоді, тоді як теорія військового конфлікту спрямована на конкуренцію за гегемонію. Важливо враховувати, що існують різні аналітичні методи для моделювання рівноваги в таких ситуаціях, чи то це активні військові дії, чи співіснування озброєних сил в умовах економічної стагнації через очікувані конфлікти.

В статті стає очевидним, що рішення ініціювати або знеструмити військовий конфлікт визначається в першу чергу економічними перевагами, навіть у сфері академічного управління. У цьому контексті економетричні методи прогнозування відіграють роль у економічній діяльності академічних установ, які можуть зазнавати прямих або опосередкованих наслідків військових дій. Це тому, що різні сектори повинні змагатися за своє існування в умовах такої динаміки.

Мета. Основною метою дослідження є оцінка впливу продуктивності військового бюджету на економічний ріст за допомогою методів економічного та математичного моделювання, з фокусом на країни, які стикаються з невизначеністю, пов'язаною з військовими діями, змінами в бюджетних та податкових регуляціях та інфляційними процесами. Стаття адаптує моделі J. Battis та T. Koelі для полегшення такого аналізу.

Методи. Макроекономічний аналіз, економетричний аналіз, аналіз тенденцій.

Результати. Визначення оптимального рівня оподаткування для отримання необхідних доходів для бюджетів академічних установ в умовах невизначеності у проведенні військових дій.

Заключення. Дослідження викликає сумніви щодо класичних економічних доктрин, встановлюючи міцну взаємозв'язок між розподілом військового бюджету та реальними секторами економіки. Воно підкреслює, що економічний зріст країни залежить від продуктивності та ефективності розподілу її військового бюджету, навіть у системі світової економіки. Це дослідження відкриває можливості для подальших досліджень в цій міжгалузевій галузі.

Ключові слова: економетричне прогнозування, академічне управління, невизначеність, військові конфлікти, економічне моделювання, ендогенний економічний розвиток, академічні установи, бюджетування, фінансові наслідки, економічний зріст, стратегічне прийняття рішень, оптимізація бюджету, оцінка ризиків, фінансова ефективність, методи макроекономічного аналізу, економетричний аналіз, аналіз тенденцій.

Рис. 0, Табл.0, Бібл.:9

Для цитування: Suntsova O. Економетричне прогнозування управління академічною діяльністю в умовах невпевненості при військових діях. Financial and credit systems: prospects for development.. С. 41-47. DOI: <https://doi.org/10.26565/2786-4995-2023-4-05>

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Стаття надійшла до редакції 06.11.2023

Статтю рекомендовано до друку 20.12.2023