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## ECONOMIC AND MATHEMATICAL MODELING IN BUDGETING

### Introduction

Budgeting is an indispensable mechanism for organizations to allocate resources judiciously, set financial priorities, and achieve fiscal sustainability. The integration of economic principles and mathematical models empowers decision-makers to enhance the precision and reliability of budgetary forecasts, thereby enabling more informed and strategic financial planning.

**Analysis of recent research and publications and selection of unsolved parts of the general problem.** The integration of economic and mathematical modeling in budgeting has witnessed a surge in scholarly interest in recent years.

The analysis of scientific sources by such experts as O. Kuzmin, G. Tsehelyk, M. Yastrubskyy [1], Devajit Mohajan, Haradhan Kumar Mohajan [2], Raquel Sanchis [4; 5], Alfonso Duran-Heras and Raul Poler [4], L. Canetta, R. Poler [5] and others [6-10] allows us to state that economic and mathematical methods and models provide the following opportunities:

- accurately and compactly state the provisions of economic theory;
- formally describe the relationships between economic variables;
- solve the problems of optimization of planning and management, reflecting the specifics of production processes;
- timely respond to changes in goals, resource constraints, dependencies between parameters and adequately adjust plans and management decisions;
- to obtain information about the facility and its operation;
- to predict the object and its behavior in the future.

The current issue is to determine the possibilities of business analytics based on the use of economic and mathematical modeling tools to form an effective budgeting system. For effective budgeting, it is worth using modeling tools that allow enterprises to get a better visualization of existing processes for effective cost management and, accordingly, to identify opportunities for their optimization, as well as to provide a better understanding of the data obtained on the current situation and future forecasts, which will

help to establish cooperation between different business units and ensure more effective communication with key stakeholders (beneficiaries, business owners, etc.) in the context of providing.

A scrutiny of recent scholarly investigations and published works [1-10] has brought to light that the outstanding aspect of the overarching issue lies in examining the potentialities for establishing a robust enterprise budgeting system within Ukrainian companies through the adept utilization of economic and mathematical modeling tools.

**The purpose of the article** – analyze the possibilities of forming an effective enterprise budgeting system based on the successful implementation of economic and mathematical modeling tools for Ukrainian companies.

**Presentation of the main research material.** The convergence of economic theories and mathematical modeling within the domain of budgeting constitutes a critical nexus that demands rigorous exploration. As budgeting remains a linchpin in the financial management apparatus, the nuanced integration of economic insights and mathematical methodologies emerges as an indispensable facet in enhancing the precision and efficacy of fiscal planning. This discourse delves into the bedrock of economic and mathematical modeling in budgeting, dissecting the essential components, methodological frameworks, and implications for decision-making processes.

The effectiveness of the budgeting system at an enterprise based on the use of economic and mathematical modeling tools (Table 1) will improve resource planning, including taking into account the existing capabilities, priorities, needs and constraints of a particular enterprise and its external business environment.

During the review of modern approaches to the formation of the enterprise budget management system, a procedure for the formation of the budgeting system was proposed [11].

Within the stages of budget development and allocation of resources and monitoring of budget implementation in real time, issues of allocation of

Table 1

**Economic and mathematical modeling in budgeting: key aspects**

Key aspects	Explanation of the aspect
Economic foundations of budgeting	The economic underpinnings of budgeting involve understanding the macroeconomic environment, including factors such as inflation rates, interest rates, and overall economic growth. Economic modeling aids in predicting the impact of these variables on revenue generation, enabling organizations to make realistic projections for budgetary purposes.
Mathematical modeling techniques	Various mathematical modeling techniques contribute to the robustness of budgetary frameworks. Time series analysis, regression analysis, and optimization models are among the key tools employed in economic and mathematical modeling for budgeting. These techniques enable the identification of patterns, correlations, and optimal resource allocation strategies.
Revenue forecasting	Accurate revenue forecasting is a cornerstone of effective budgeting. Economic models, coupled with mathematical algorithms, facilitate the prediction of revenue streams based on historical data, economic indicators, and market trends. This foresight enables organizations to establish realistic revenue targets and mitigate the risk of budgetary shortfalls.
Expenditure planning and optimization	Mathematical optimization models play a crucial role in expenditure planning. By considering various constraints and objectives, these models assist in determining the optimal allocation of resources across different operational areas. This ensures that budgetary allocations align with organizational goals and priorities.
Challenges and considerations	While economic and mathematical modeling enhances the precision of budgeting, it is not without challenges. Data accuracy, model complexity, and the dynamic nature of economic variables pose significant hurdles. Addressing these challenges requires a combination of advanced modeling techniques, robust data governance, and continuous refinement of models.

resources, operational improvements, optimization of activities, etc. arose.

Economic and mathematical modeling enhance the precision and effectiveness of these stages of budgeting by providing tools to analyze, forecast, and optimize

financial decisions based on a thorough understanding of economic and financial processes (Table 2).

Taking into account the possibility of improving the efficiency of the budgeting process at enterprises, the authors suggest developing a model of the future state of the process.

Table 2

**Direction of application of economic and mathematical models in the process of budgeting (the stages of budget development and allocation of resources and monitoring of budget implementation in real time)**

Direction of application of economic and mathematical models	Purpose and procedure of application
1	2
Forecasting Economic Variables	Economic models help forecast key variables such as inflation rates, interest rates, and economic growth. These forecasts are essential for estimating future costs, revenues, and overall financial conditions that can impact budget planning
Revenue Projection	Mathematical modeling is used to project future revenues based on historical data, market trends, and economic indicators. Regression analysis and time series analysis are common techniques to predict revenue patterns
Cost Estimation	Mathematical models assist in estimating costs associated with various activities, projects, or programs. Cost functions are developed to understand how costs vary with changes in different factors. This helps in setting realistic budgetary targets
Sensitivity Analysis	Mathematical models are used to perform sensitivity analysis, assessing how changes in specific variables impact budget outcomes. This helps in identifying potential risks and uncertainties in the budgeting process
Optimization	Mathematical optimization models are employed to find the best allocation of resources to maximize desired outcomes while adhering to budget constraints. This is particularly useful when there are limited resources and competing priorities
Scenario Planning	Economic and mathematical models enable organizations to create different scenarios to assess the potential impact of various economic and financial conditions on the budget. This helps in developing contingency plans and risk mitigation strategies
Resource Allocation	Mathematical models aid in optimizing the allocation of resources across different departments or projects, ensuring that the budget is distributed efficiently to achieve organizational objectives

1	2
Decision Support	Economic models provide a framework for decision-making by evaluating the financial implications of alternative courses of action. This helps in making well-informed decisions that align with the organization's strategic goals
Budgetary Control	Mathematical models are used in monitoring and controlling budgets by comparing actual financial performance against budgeted figures. Deviations from the budget can be analyzed to understand the reasons and take corrective actions
Risk Assessment	Economic and mathematical models assist in assessing financial risks associated with budgeting decisions. This includes identifying potential market risks, operational risks, and external economic factors that may impact the budget

Systematized by the authors based on the results of the study [12-16].

In this case, the AS IS model is considered to be the model provided in [11].

The TO BE model involves the integration of economic and mathematical modeling tools at stages A2 and A3 (see figure). New elements (improvements) are marked in red.

It should be noted that the use of economic-mathematical modeling tools in budgeting will require

the involvement of specialists with appropriate qualifications. The issue of involving relevant specialists, detailing the models and determining the responsible persons who make decisions based on the results of modeling will be the subject of the authors' subsequent research.

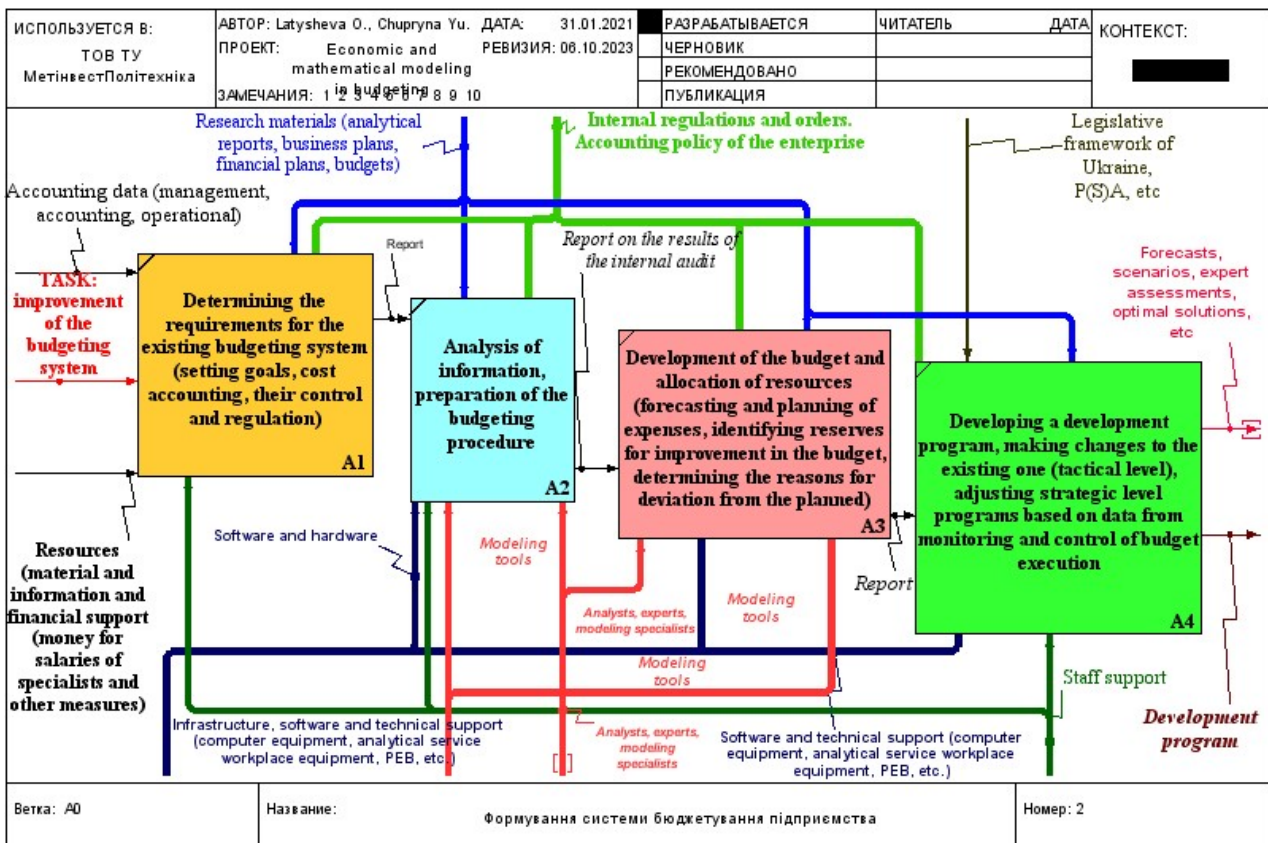


Figure. Stages of budgeting system formation (TO BE model. Integration of economic and mathematical modeling tools at stages A2 and A3) on the Ramus business process modeling platform in IDFO notation

**Conclusion**

Economic and mathematical modeling in budgeting represents a sophisticated approach to navigating the complexities of financial management. As organizations strive for greater precision and

foresight in resource allocation, the integration of economic principles and advanced mathematical techniques offers a powerful toolkit. The continuous refinement of these models, coupled with advancements in technology, promises a future where budgeting

becomes not only a strategic necessity but also a dynamic and adaptive process in the face of evolving economic landscapes.

The evolving landscape of technology and data analytics presents opportunities for further refinement

of economic and mathematical models in budgeting. Machine learning algorithms, artificial intelligence, and big data analytics hold the potential to revolutionize the accuracy and efficiency of budgetary forecasting and decision-making processes.

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## Латішева О. В., Чуприна, Ю. В. Економіко-математичне моделювання в бюджетуванні

Стаття присвячена огляду сучасних підходів моделювання для ефективного управління бюджетами підприємства. У статті досліджено інструментарій економіко-математичного моделювання, який може застосовуватися в системі бюджетування. Запропоновано підвищити ефективність процесу бюджетування шляхом застосування інструментарію економіко-математичного моделювання на стадіях розробки бюджету та розподілу ресурсів, а також у процесі бюджетного контролю та моніторингу. Для підвищення наочності процедури та результатів моделювання представлена візуалізація моделі TO BE в нотації (мові моделювання) IDF0 на платформі «Ramus».

Зазначено, що ефективність системи бюджетування на підставі використання інструментарію економіко-математичного моделювання дозволить покращити планування витрат ресурсів з урахуванням можливостей, пріоритетів, потреб та обмежень конкретного підприємства та його зовнішнього бізнес - середовища. Обґрунтовано необхідність впроваджувати інструментарій діджиталізації та економіко-математичного моделювання в системі бюджетування.

Метою статті є аналіз можливостей формування дійової системи бюджетування підприємств на підставі успішної імплементації інструментарію економіко-математичного моделювання.

Автори орієнтуються на потенціал використання бізнес-аналітики як результату використання інструментарію економіко-математичного моделювання для формування ефективної системи бюджетування.

У статті аргументовано можливості ефективного використовувати інструментарію моделювання у процесі бюджетування, що дозволяє підприємствам приймати якісні управлінські рішення на підставі прогнозів, сценаріїв, рекомендацій оптимізації, візуалізації поточних проблемних ситуацій тощо.

*Наукова новизна даної статті полягає в тому, що рекомендації та висновки, надані авторами, можуть стати корисними для вітчизняних підприємств в існуючих умовах жорстких обмежень наявних ресурсів, нестачі вільних коштів, існуючих та потенційних ризиків. Загалом, ця стаття є корисною для тих, хто бажає більш детально ознайомитися з можливостями використання інструментарію економіко-математичного моделювання в системі бюджетування.*

*Ключові слова:* бюджетування, інструментарій моделювання, економіко-математичне моделювання, метод моделювання, управління витратами.

### **Latysheva O., Chupryna, Yu. Economic and Mathematical Modeling in Budgeting**

The article is devoted to an overview of modern modeling approaches for effective management of enterprise budgets. The article examines the toolkit of economic and mathematical modeling that can be used in the budgeting system. It is proposed to increase the efficiency of the budgeting process by applying the tools of economic and mathematical modeling at the stages of budget development and resource allocation, as well as in the process of budget control and monitoring. To increase the clarity of the simulation procedure and results, a visualization of the TO BE model is presented in IDFO notation (simulation language) on the Ramus platform.

It is noted that the effectiveness of the budgeting system based on the use of economic-mathematical modeling tools will allow to improve resource expenditure planning taking into account the opportunities, priorities, needs and limitations of a specific enterprise and its external business environment. The need to implement digitalization tools and economic-mathematical modeling in the budgeting system is substantiated.

The purpose of the article is to analyze the possibilities of forming an effective enterprise budgeting system based on the successful implementation of economic and mathematical modeling tools. The authors focus on the potential of using business analytics as a result of using economic and mathematical modeling tools to form an effective budgeting system.

The article argues for the possibility of effectively using modeling tools in the budgeting process, which allows enterprises to make high-quality management decisions based on forecasts, scenarios, optimization recommendations, visualization of current problem situations, etc.

The scientific novelty of this article lies in the fact that the recommendations and conclusions provided by the authors can be useful for domestic enterprises in the current conditions of severe restrictions on available resources, lack of free funds, existing and potential risks. In general, this article is useful for those who want to learn more about the possibilities of using economic-mathematical modeling tools in the budgeting system.

*Keywords:* budgeting, modeling toolkit, economic-mathematical modeling, modeling method, cost management.

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