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MATHEMATICAL TOOLS AS A COMPONENT OF THE TAX CONSULTING SYSTEM: A METHODOLOGICAL PERSPECTIVE

Summary

Relevance. Problem statement. In conditions of dynamic changes in the taxation system in Ukraine, business entities need accurate calculation and legal optimization of the tax burden. Traditional qualitative approaches in consulting do not allow to fully formalize this process. This determines the relevance of the systematic application of mathematical tools in the practice of tax consulting.

The **purpose** of the article is to systematize and substantiate the methods of mathematical tools used in the tax consulting system, to develop an optimization model for choosing the optimal taxation system for an enterprise, and to empirically test a correlation-regression model for quantitative assessment of the effective tax burden. **Methodology.** The following methods were applied: correlation-regression analysis, linear programming, cluster analysis, simulation modeling.

Results. A classification of mathematical tools by five functional groups is proposed. A linear programming problem was developed and numerically tested under 2026 conditions (minimum wage 8,647 UAH; military levy mandatory for simplified tax payers from January 2025): selecting the 2nd group of unified tax yields total tax liabilities of 305.1 thousand UAH and an effective tax burden of 4.36%, compared to 769.9 thousand UAH (ETR 11.00%) under the general taxation system. The increase in absolute tax liabilities relative to earlier estimates reflects the growth of the minimum social contribution base and the introduction of the military levy. A regression model $ETR = \beta_0 + \beta_1 \cdot ROA + \beta_2 \cdot LEV + \beta_3 \cdot SIZE + \beta_4 \cdot INTAN + \varepsilon$ was tested on 60 small and medium enterprises ($R^2 = 0.612$).

Practical significance. The results confirm that profitability, leverage and intangible asset intensity are statistically significant determinants of effective taxation.

Findings can be used by consulting companies for analytical decision-support and by taxpayers for optimizing their tax liabilities under the Tax Code of Ukraine.

Keywords: mathematical tools, tax consulting, correlation-regression analysis, optimization model, linear programming, effective tax burden, alternative taxation systems, cluster analysis, mathematical modeling, Tax Code of Ukraine.

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МАТЕМАТИЧНИЙ ІНСТРУМЕНТАРІЙ ЯК СКЛАДОВА СИСТЕМИ ПОДАТКОВОГО КОНСАЛТИНГУ: МЕТОДИЧНИЙ АСПЕКТ

Анотація

В умовах динамічних змін системи оподаткування в Україні суб'єкти господарювання мають потребу в точному розрахунку та легальній оптимізації податкового навантаження. Традиційні якісні підходи в консалтингу не дозволяють повною мірою формалізувати цей процес. Це визначає актуальність систематизованого застосування математичного інструментарію в практиці податкового консалтингу.

Мета дослідження **–** систематизація та обґрунтування методів математичного інструментарію, що застосовуються в системі податкового консалтингу, розробка оптимізаційної моделі вибору системи оподаткування підприємства й емпірична апробація кореляційно-регресійного аналізу для кількісної оцінки факторів, що визначають рівень ефективного податкового навантаження.

Запропоновано класифікацію математичного інструментарію за п'ятьма функціональними групами. Розроблено та чисельно апробовано задачу лінійного програмування для вибору оптимальної системи оподаткування: за умовами 2026 р. оптимальною є 2 група єдиного податку з сукупним податковим зобов’язанням 305,1 тис. грн та ETR (Effective Tax Rate) 4,36%, тоді як на загальній системі сукупне податкове зобов’язання становить 769,9 тис. грн (ETR 11,00%). Побудовано регресійну модель ETR на вибірці 60 підприємств малого і середнього бізнесу, де статистично значущими факторами виявились рентабельність активів, фінансовий важіль та частка нематеріальних активів.

Результати дослідження можуть використовуватись консалтинговими компаніями при побудові аналітичних систем підтримки прийняття рішень та

підприємствами для оптимізації власного податкового навантаження у рамках чинного законодавства. Перспективи подальших досліджень пов'язані з розробкою програмного модуля автоматизованого розрахунку оптимальної стратегії оподаткування та адаптацією методів машинного навчання для прогнозування ефективного податкового навантаження.

Ключові слова: математичний інструментарій, податковий консалтинг, кореляційно-регресійний аналіз, оптимізаційна модель, лінійне програмування, ефективне податкове навантаження, альтернативні системи оподаткування, кластерний аналіз, математичне моделювання, Податковий кодекс України.

Кількість джерел: 14; кількість таблиць: 3.

Problem statement. The dynamic updating of Ukraine's tax legislation, driven through regular amendments to Tax Code of Ukraine (2026), in particular by the On Amendments to the Tax Code of Ukraine to Improve Tax Administration, Eliminate Technical and Logical Inconsistencies in Tax Legislation (2022), significantly complicates the process of making well-grounded managerial decisions in the field of taxation. Enterprises, especially small and medium-sized businesses, are forced to continuously adapt to updated conditions and seek legal ways to minimize the tax burden.

Traditional approaches to providing tax consulting services are often based on empirical experience and qualitative analysis without sufficient use of formalized mathematical methods. This reduces the accuracy of recommendations and limits the ability to forecast the consequences of managerial decisions. There is a growing need for the systematic introduction of mathematical tools into tax consulting practice.

Analysis of recent research and publications. Methodological and instrumental support for managerial decision-making in taxation is presented in the fundamental textbook "Tax Policy: Theory, Methodology, Instruments", edited by Ivanov et al. (2020), which systematizes analytical tools of fiscal policy mainly at the macro level. The monograph "Alternative Tax Systems" by Ivanov (2003) reveals the comparative advantages and limitations of various taxation regimes, forming a necessary theoretical basis for building optimization models.

Bonucchi et al. (2015), using quantitative panel models, empirically demonstrated the significant impact of tax structure on investment decisions. Fejzaj and Gjon (2021) applied regression

analysis to assess the impact of tax system structure on the business environment and obtained statistically significant results, confirming the applicability of this method at the firm level. Revenko (2021) proposed a method of factor decomposition of the influence of tax factors on business performance; Karpova (2020) conducted a quantitative analysis of mechanisms for efficient enterprise functioning in the tax context.

Klochkovska and Klochkovskyi (2021) characterized modern features of taxation in Ukraine and identified key factors differentiating tax burden among taxpayers. Onisiforova and Sidelnikova (2019) systematized advantages and disadvantages of the simplified taxation system as an alternative regime. Krysovaty et al. (2014) studied tax transformation experiences in EU countries and demonstrated the role of quantitative methods in their analysis. An analytical report by Dragan et al. (2020) highlights the growing demand among businesses for high-quality analytical support in adapting to reforms.

Maliarchuk et al. (2024) substantiated the feasibility and potential of econometric methods as tools for supporting financial planning, forecasting, and strategic decision-making, with particular emphasis on optimizing tax burden under economic transformation.

Despite existing contributions, there is a lack of a comprehensive approach in the literature to systematizing mathematical tools specifically for micro-level tax consulting services.

Purpose of the article. The aim of the article is to: (a) systematize mathematical tools in tax consulting by functional purpose; (b) develop and numerically test an optimization problem for selecting a taxation system based on linear programming; (c) construct a correlation-regression model of effective tax burden and analyze statistical significance of its factors based on a sample of SMEs.

Presentation of the main content. Mathematical tools in tax consulting include a set of quantitative methods that ensure a formalized approach to analysis, forecasting, and optimization of taxpayers' liabilities. According to the functional assignment, the article proposes a classification into five groups (Table 1).

The key analytical method is correlation-regression analysis, which allows quantitative assessment of relationships between effective tax rate (ETR) and explanatory variables Revenko (2021).

Table 1

Classification of Mathematical Tools in the System of Tax Consulting*

Functional Group	*Methods*	*Consulting Tasks*	*Key Indicators*
Analysis and assessment	Correlation-regression analysis, factor analysis, dispersive analysis	Assessment of factors effecting tax burden, diagnostics of deviations	R^2, β-coefficient, t-statistics, p-value
Optimization	Linear programming, nonlinear optimization, integer programming	Minimization of tax liabilities, selection of the optimal taxation system	Objective function $Z \rightarrow \min$, constraints $Ax \leq b$
Forecasting	Time series, ARIMA, trend extrapolation, exponential smoothing	Forecasting tax burden and tax liabilities for future planning periods	MAE, RMSE, Theil's criterion
Classification and clustering	k-means, hierarchical clustering, discriminant analysis	Grouping taxpayers by the level of tax burden, identification of risk groups	Euclidean distance, F-criterion
Modeling scenarios	Simulation modeling, Monte Carlo method, dynamic programming	Stress testing of strategies, "what-if" analysis	E[TL], decision tree, confidence intervals

*Source: made up by the authors based on (Ivanov et al., 2020; Ivanov, 2003; Revenko, 2021; Karpova, 2020).

According to the methodology developed by Revenko (2021), Fejzaj and Gjon (2021), the basic regression model takes the following form:

$$ETR = \beta^0 + \beta^1 * ROA + \beta^2 * LEV + \beta^3 * SIZE + \beta^4 * INtAN + \varepsilon, \quad (1)$$

where ETR –Effective Tax Rate;

ROA – Return on Assets;

LEV – financial leverage;

SIZE – natural logarithm of total assets;

INTAN – share of intangible assets in total assets;

$\beta_0 \ldots \beta_4$ – regression coefficients;

ε – random error.

The optimization level of consulting involves solving the problem

of selecting a taxation system from a set of admissible alternatives $S = \{s_1, s_2, ..., s_n\}$ in accordance with the Tax Code of Ukraine (2026) and the monograph by Ivanov (2003). We introduce the objective function for minimizing total annual tax liabilities:

$$Z = \min \Sigma_i (T_i * x_i),\ i = 1, 2, ..., n, \quad (2)$$

where T_i – total tax liability when choosing the i-th taxation system;

$x_i \in \{0, 1\}$ – binary selection variable.

The system of constraints includes: (a) conditions of legislative access to each system (limits on annual income and the number of hired employees) (Tax Code of Ukraine, 2026; On Amendments to the Tax Code of Ukraine to Improve Tax Administration, Eliminate Technical and Logical Inconsistencies in Tax Legislation, 2022); (b) uniqueness constraint: $\Sigma_i x_i = 1$; (c) non-negativity condition $x_i \geq 0$.

For numerical testing, we consider a manufacturing enterprise: annual income – 7,000 thousand UAH, number of hired employees – 12 persons, declared expenses – 5,800 thousand UAH. Calculations are carried out in accordance with the regulations in force in 2026: the minimum wage – 8,647 UAH On the State Budget of Ukraine for 2026 (2025), the unified social contribution (USC) – 22% of the minimum wage, i.e., 1,902.34 UAH per month per employee; the military levy for single tax payers of Group 2 – 864.70 UAH per month (fixed), and for Group 3 – 1% of income (introduced from 01.01.2025). The results of comparative calculations are presented in Table 2.

Thus, according to the Z minimization criterion, the optimal choice is the simplified taxation system of Group 2: total tax liabilities amount to 305.1 thousand UAH, while the effective tax rate (ETR) decreases from 11.00% (general system) to 4.36%, which is consistent with the conclusions of Onisiforova and Sidelnikova (2019) regarding the advantages of simplified systems for small enterprises. A significant role in the structure of tax liabilities is played by the unified social contribution (USC) – 273.9 thousand UAH, which equally applies to all four alternatives, as it is determined solely by the number of hired employees and the level of the minimum wage (8,647 UAH in 2026 according to the Law of Ukraine On the State Budget of Ukraine for 2026 (2025)). Starting

from 2025, an additional mandatory component of tax liabilities for single tax payers is the military levy: for Group 2 – a fixed 10.4 thousand UAH per year (864.70 UAH per month), and for Group 3 – 70.0 thousand UAH (1% of income). The inclusion of nonlinear constraints (in particular, restrictions on the range of counterparties for Group 2 transforms the problem into an integer nonlinear programming problem.

Table 2

Numerical Testing of the Linear Programming Problem: Comparison of Taxation Systems, Thousand UAH*

Indicator	*General System (CIT 18%)*	*ST Group 3 (5%, without VAT)*	*ST Group 3 (3%+VAT)*	*ST Group 2 (fixed)*
Income	7 000,0	7 000,0	7 000,0	7 000,0
Declared Expenses	5 800,0	—	—	—
Tax Base	1 200,0	7 000,0	7 000,0	fixed
Corporate Income Tax / Single Tax	216,0	350,0	210,0	20,8
Value Added Tax	280,0	—	175,0	—
Military Levy***	—	70,0	70,0	10,4
USC(12 employees, 22% × minimum wage × 12 months)	273,9	273,9	273,9	273,9
Total Tax Liability (T_i)	**769,9**	**693,9**	**728,9**	**305,1**
Effective Tax Rate – ETR, %	11,00	9,91	10,41	4,36
x_i (optimal choice)	0	0	0	1**

*Source: calculated by the authors in accordance with the provisions of the Tax Code of Ukraine (2026), the Law of Ukraine On Amendments to the Tax Code of Ukraine to Improve Tax Administration, Eliminate Technical and Logical Inconsistencies in Tax Legislation (2022), and the Law of Ukraine On the State Budget of Ukraine for 2026 (2025).

** Optimum: Z* = min (769.9; 693.9; 728.9; 305.1) = 305.1 thousand UAH. The income limit for Group 2 in 2026 is 7,211.6 thousand UAH (834 × 8,647 UAH); an enterprise with an income of 7,000 thousand UAH falls within this limit. Additionally, compliance of the types of activities with the requirements of subparagraph 2, paragraph 291.4, Article 291 of the Tax Code of Ukraine should be verified.

*** For the general system, the military levy on the payroll fund of hired employees (5% of accrued wages in accordance with paragraph 16-1, subsection 10, section XX of the Tax Code of Ukraine) is not included in the calculation, as it is

an enterprise expense rather than a direct tax liability on income; in a full comparison, it further increases the effective burden under the general system.

To empirically confirm the significance of ETR factors, a correlation-regression analysis was conducted on a sample of 60 small and medium-sized enterprises based on their financial statements. The results are presented in Table 3.

Table 3

Results of the Correlation-Regression Analysis of Factors of the Effective Tax Burden of SMEs (n = 60)*

Factor	*β-coefficient*	*SE*	*t-statistics*	*p-value*	*Significance*
Constant (β_0)	0,124	0,031	4,002	< 0,001	***
ROA – Return on Assets	–0,087	0,024	–3,625	0,001	***
LEV – Financial Leverage	–0,043	0,018	–2,389	0,020	**
SIZE – firm size	0,011	0,006	1,833	0,072	*
INTAN – intangible assets	–0,156	0,047	–3,319	0,002	***
R^2 = 0,612; Adj.R^2 = 0,585; F-statistics = 22,4; p(F) < 0,001					

*Source: calculated by the authors based on enterprises' financial statements; the sampling methodology was substantiated in accordance with approaches (Revenko, 2021; Karpova, 2020).

Note: *** – significance level of 1%; ** – 5%; * – 10%.

The coefficient of determination $R^2 = 0.612$ indicates that the selected factors explain 61.2% of the variance in ETR. The negative β-coefficient for ROA (–0.087, $p < 0.01$) means that more profitable enterprises manage their tax burden more effectively, which is consistent with the findings of Karpova (2020) regarding the relationship between financial performance and taxation mechanisms. A similar pattern is observed for financial leverage (–0.043, $p < 0.05$) and the share of intangible assets (–0.156, $p < 0.01$), which corresponds to the results of Fejzaj and Gjon (2021).

Clustering of the sample enterprises using the k-means method ($k = 3$) based on ETR and SIZE values identified three homogeneous groups: "low tax burden" (ETR < 5%), "medium tax burden" (5–15%), and "high tax burden" (> 15%). Each cluster is characterized

by a specific set of consulting recommendations, which confirms the appropriateness of using cluster analysis as an analytical tool in consulting practice (Krysovaty et al., 2014; Dragan et al., 2020).

Conclusions. 1. The article proposes a classification of mathematical tools in the tax consulting system into five functional groups: analysis and assessment, optimization, forecasting, classification, and scenario modeling. For each group, methods, analytical tasks, and key performance indicators are defined, which further develops the theoretical framework established in Ivanov et al. (2020) and Ivanov (2003).

2. The article has developed an integer linear programming problem for selecting the optimal taxation system. Numerical testing on a model enterprise (revenue of 7,000 thousand UAH, 12 employees) under 2026 conditions demonstrated a reduction in total tax liabilities from 769.9 to 305.1 thousand UAH, and in the effective tax rate (ETR) from 11.00% to 4.36% (Group 2 of the simplified taxation system). The increase in the absolute level of tax liabilities compared to previous studies is explained by the rise in the minimum wage to 8,647 UAH and the introduction of the military levy for simplified taxpayers starting from 2025, which fully complies with the provisions of the Tax Code of Ukraine (2026), the Law of Ukraine On Amendments to the Tax Code of Ukraine to Improve Tax Administration, Eliminate Technical and Logical Inconsistencies in Tax Legislation (2022), and the Law of Ukraine On the State Budget of Ukraine for 2026 (2025).

3. The correlation-regression model of ETR based on a sample of 60 SMEs confirmed a statistically significant impact of return on assets ($\beta = -0.087$, $p < 0.01$), financial leverage ($\beta = -0.043$, $p < 0.05$), and the share of intangible assets ($\beta = -0.156$, $p < 0.01$), with $R^2 = 0.612$. The results are consistent with the findings in (Fejzaj and Gjon, 2021; Revenko, 2021; Karpova, 2020).

Prospects for further research include the development of a software module for the automated calculation of an optimal taxation strategy taking into account current rates of the unified social contribution (USC) and the military levy, the adaptation of machine learning methods for forecasting ETR, and the formation of

industry benchmarks for effective tax burden as reference indicators in consulting practice.

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