Improvement of the mechanisms of taxation of forest resources of Ukraine to ensure sustainable forest management

Nazaket Musayeva

PhD in Economic Sciences, Associate Professor
Azerbaijan State University of Economics (UNEC)
AZ1001, 6 Istiglaliyyat Str., Baku, Azerbaijan
https://orcid.org/0000-0001-5973-981X

Nigar Atakishiyeva

PhD in Economic Sciences, Senior Lecturer
Azerbaijan State University of Economics (UNEC)
AZ1001, 6 Istiglaliyyat Str., Baku, Azerbaijan
https://orcid.org/0000-0002-7668-8193

Ulkar Mammadova

PhD in Economic Sciences, Senior Lecturer
Azerbaijan State University of Economics (UNEC)
AZ1001, 6 Istiglaliyyat Str., Baku, Azerbaijan
https://orcid.org/0000-0001-7341-7737

Nahid Almasov

PhD in Economic Sciences, Deputy Dean of the Faculty of Business and Economics
Azerbaijan University
AZ1007, 71 Jeyhun Hajibeyli Str., Baku, Azerbaijan
https://orcid.org/0009-0001-1140-2115

Maksym Shevchenko[*]

PhD Student
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine
https://orcid.org/0009-0003-5302-2772

Abstract. The purpose of the study was to substantiate ways to optimise fiscal mechanisms in the forest sector to increase its economic efficiency and sustainability. A quantitative analysis was carried out based on the reporting data of six enterprises of various forms of ownership (state, municipal, and private), which allowed identifying imbalances in tax pressure. In the public sector, this figure was 31.1%, and in the municipal sector – 26.5%. In the private sector, the tax burden reached 40.1% in the Forest enterprise and 35.2% in the Karpatlis enterprise, which significantly exceeded the indicators of the public sector – 29.3% in Chernihivlishosp, 32.9% in Sumylishosp, and 40.4% in the Forests of Ukraine enterprise. In the municipal enterprise Kharkivlis,

*Corresponding author

the tax burden was 26.5%. The level of profitability in private enterprises was 4.7% in the Forest and 6.0% in Karpatlis, while state-owned enterprises showed stable indicators: 9.1% in Chernihivlishosp, 7.4% in Sumylishosp, and 5.0% in the Forests of Ukraine. Municipal enterprise Kharkivlis showed the highest profitability – 9.7%. The structure of indirect fiscal expenditures was analysed separately, among which the main ones were expenditures on environmental monitoring, forest protection, certification, and reporting. It was established that the share of indirect expenses in the total expenses of enterprises ranged from 5.4% to 11.8%. The risk assessment of tax reforms was carried out on a point scale (from 1 to 10) according to five criteria: legal framework, personnel readiness, business resistance, digitalisation, and fiscal losses. The highest risk profile was recorded in the private sector (average level – 7.4 points), the lowest – in the public sector (4.8 points). The projected effects of the introduction of the adaptive tax model included a reduction in the tax burden by 5.5%, an increase in profitability by 3.2%, investment in reforestation – by 18%, and a decrease in the level of shading by 12.5%. The results of the study can be used to develop a tax policy and support sustainable forest management at the state and enterprise levels

INTRODUCTION

The relevance is conditioned by the need to reform the tax policy in the field of forestry in Ukraine, which is conditioned by the strategic role of forests in ensuring ecological balance, economic stability, and social employment in the regions. The forest sector is a source of public revenue, but in the current context of global changes, increased environmental requirements and integration with European standards, there is a need to create a fair, stimulating, and environmentally oriented tax model. Fiscal instruments should ensure both efficient use of resources and their recovery. The problem is caused by the fact that the current system of taxation of forest users is outdated, undifferentiated and does not consider the environmental responsibility of enterprises. The high tax burden, duplication of obligations, lack of incentives to invest in reforestation, and inconsistency of interdepartmental mechanisms cause economic losses and reduce the transparency of the industry, which requires an urgent reconsideration of the fiscal approach (Destek *et al.*, 2024; Shahini & Shahini, 2025).

As established by N. Tsehelnyk (2021), the level of tax burden without considering environmental specifics negatively affects the financial stability of forestry enterprises. It was noted that the fiscal system hinders the renewal of forest infrastructure. According to N. Pravdiuk (2024), information support in terms of taxation remains fragmented. It was emphasised that duplication of reporting leads to an increase in administrative costs. As noted by S.O. Proyava (2024), investors avoid investing in the forest industry due to non-transparent tax policies. It was also emphasised that the instability of fiscal conditions reduces interest in long-term environmental projects. Based on the conclusions of L. Sofitri (2025), a possible combination of a carbon tax with quota trading mechanisms in the forest sector. It was noted that the tax system can become an effective tool for climate policy. According to research by J. Stubenrauch *et al.* (2022), in the European Union (EU), fiscal mechanisms are being integrated into the climate strategy. It was noted that tax instruments support the sustainable forest development goals.

As highlighted in the study by D. Heine *et al.* (2021), it is advisable to set tax rates that vary depending on the sustainability of production. It has been proven that such a model can encourage environmentally responsible forest users and simultaneously ensure tax fairness. According to X. Shen *et al.* (2023), the effectiveness of market instruments in the forest sector depends on the quality of the institutional environment. It was clarified that it is stable legal mechanisms that strengthen the role of fiscal policy in ensuring sustainable forest management. As noted by S. Anane *et al.* (2023), small and medium-sized forest enterprises are essential to support the local economy, but they face tax pressures that do not consider the scale of their activities. It was found that it is necessary to introduce simplified fiscal models for small producers. C. Besacier *et al.* (2021) highlighted the importance of local financial mechanisms for forest restoration. The researchers concluded that local tools, in particular tax incentives, can activate environmental initiatives at the community level. As shown in the study by D. Deng *et al.* (2023), the assessment of sustainable forest management requires an integrated approach using multi-criteria models. It was determined that the integration of financial and environmental indicators should be part of tax analysis. According to S. Aggarwal *et al.* (2020), reforms in the area of forest use rights remain incomplete, which affects the effectiveness of tax administration. It was noted that without securing property rights, it is difficult to implement effective fiscal strategies. The impact of tax incentives on reforestation, differentiation of rates depending on the form of ownership, and the effectiveness of digital tools in the tax administration of the forest sector remain insufficiently investigated.

The purpose of the study was to substantiate the areas of improving the tax policy in the field of forestry in Ukraine to ensure its efficiency, fairness, and promotion of sustainable forest management.

MATERIALS AND METHODS

The time limits of the study covered the period from 2020 to 2024, which allowed assessing the transformation processes in the forest taxation system against the background of legislative, economic, and environmental changes. The research methodology combined quantitative and qualitative analysis methods, including comparative statistics, structural analysis, expert evaluation, and predictive modelling of tax policy scenarios. Data processing was performed using the Python programming language (Pandas library, Matplotlib, Seaborn), the Microsoft Excel table editor, and IBM SPSS Statistics statistical analysis software. The main sources of data were financial reports of enterprises, official statistics of the State Statistics Service of Ukraine (2024), materials of the State Agency of Forest Resources (2024).

To analyse the economic indicators of the tax burden, six enterprises were selected that represent different organisational and legal forms, business scale, and regional affiliation. The selection included three state-owned enterprises (State Enterprise Chernihivlishosp (2022), State Enterprise Sumylishosp (n.d.), State Enterprise Forests of Ukraine (2024)), one utility company (Public Limited Liability Company Kharkivlis (n.d.)) and two private limited liability companies (LLC Karpatlis (n.d.), LLC Forest (n.d.)). This approach provided a typical, non-random sample based on different forms of ownership, availability of complete financial statements, and ongoing forestry activities. The sample included enterprises that carry out forestry activities on a permanent basis, have a registered legal address in different administrative regions of Ukraine and cover standard organisational management models. Enterprises with bankruptcy status, incomplete or unreliable reporting data, and those with a special tax regime (for example, experimental farms) were excluded. This sample composition made it possible to ensure comparability of indicators and adequacy of modelling the consequences of tax reform in the context of different types of property, which, according to Law of Ukraine No. 185-V (2006), directly affects the structure of tax liabilities and financial discipline. The tax burden was calculated using the equation (1):

$$\text{Tax}_{exp} = \left(\frac{\text{Total taxes paid}}{\text{Total operating expenses}}\right) \times 100, \qquad (1)$$

where Tax_{exp} – tax burden.

In addition, taxes were considered as a share of income (2):

$$\text{Tax}_{rev} = \left(\frac{\text{Total taxes paid}}{\text{Revenue}}\right) \times 100, \qquad (2)$$

where Tax_{rev} – revenue tax.

The structure of indirect fiscal expenditures was determined by collecting information on five groups of expenditures: forest protection, environmental monitoring, certification according to international standards of the Forest Stewardship Council (2024) and the Programme for the Endorsement of Forest Certification (2024)), administrative reporting (tax, environmental and forest reporting), and other mandatory payments related to obtaining permits, conducting examinations and audits. The volume of such expenses was recorded either in the structure of operating expenses of enterprises, or in separate environmental safety budgets. Total indirect fiscal expenses were calculated using the equation (3):

$$\text{Total indirect expenses} = \sum_{i=1}^{n} C_i, \qquad (3)$$

where C_i – expenses for each category: forest protection, certification, monitoring, reporting, permits, i – cost group, $\sum$ – total of all expenses, n – total number of expense groups included in the calculation.

The assessment of the risks of tax reform was carried out on a multi-factor point scale, which included five main risk groups: business resistance, legal barriers, personnel and technical readiness, fiscal budget losses, and interdepartmental coordination (Ministry of Finance of Ukraine, 2022). The risk assessment of tax reform was carried out in the range from 1 to 10 points based on a combination of quantitative models, scenario analysis, data extrapolation, and simulation modelling. An individual risk profile was formed for each enterprise, considering five key factors: business resistance, legal barriers, personnel and technical readiness, fiscal budget losses, and interdepartmental coordination. Conditional assessment scales were unified: scores of 8-10 corresponded to a high level of risk, 5-7 – moderate, and 1-4 – low. Final scores were calculated as the average values of forecast estimates for each factor, considering the weight coefficients determined based on the influence of the factor on the effectiveness of the reform.

In the block of forecasting the effects of the implementation of the tax reform, an alternative scenario was modelled, which provided for the introduction of such elements as a differentiated tax rate depending on the level of profitability of enterprises, an environmental tax discount of up to 10% subject to investment in reforestation, tax benefits for enterprises implementing electronic declaration, and setting the maximum level of tax burden at a level not higher than 32% of total expenses. Special attention was paid to the creation of a centralised digital tax reporting system that would simplify accounting and control the fulfilment of obligations. Based on this scenario, the projected changes in such key financial and economic indicators as the level of tax burden reduction, profitability growth, dynamics of investment in reforestation, reduction in the volume of shadowing of the sector and the amount of administrative savings due to process automation were calculated. These indicators were calculated for each

enterprise separately using basic relative growth equations (4):

$$\Delta P = \left(\frac{P_{\text{after}} - P_{\text{before}}}{P_{\text{before}}}\right) \times 100, \qquad (4)$$

where ΔP – relative change in the indicator, P_{after} – projected value after the implementation of the reform, P_{before} – current value.

Elements of scenario analysis and modelling of the impact of the proposed reforms on the economic behaviour of enterprises were used to verify the validity of the results obtained.

RESULTS

Economic indicators of the tax burden on forest users in Ukraine. For state-owned enterprises, taxes in the cost structure ranged from 29.3% to 32.9%, while for private enterprises – from 35.2% to 40.4%. The utility company showed the lowest level of this indicator – 27.0%. These values were calculated based on equation (1), where the tax burden was defined as the share of the amount of taxes paid in total operating expenses. The highest absolute amounts of taxes were recorded in state-owned enterprises, but using equation (2), which reflects taxes as a share of income, it was found that it was private enterprises that experienced the greatest fiscal burden – 40.1% and 40.4%. The level of profitability also varied depending on the form of ownership. State-owned enterprises achieved profitability in the range of 7.4%-9.1%, which indicated the relative stability of their financial model. The utility showed the highest profitability among the entire sample – 9.7%, which was partly due to a lower level of tax liabilities. Private enterprises showed lower returns – from 4.7% to 6.0%, which directly correlated with an increased tax burden.

Reforestation costs, as an important element of environmental responsibility, were significantly lower in the private sector (Naumenkova *et al.*, 2023). State-owned enterprises spent an average of 12.1% of their profits for this purpose, while private enterprises spent only 6.9%. The utility company demonstrated an intermediate level of 9.4%. The estimate of the share of reforestation expenditures in total expenditures also confirmed the higher environmental orientation of the public sector: on average, 3.15%, while in the private sector this figure did not exceed 1.7%. The lowest values were recorded for enterprises with the highest tax liabilities – LLC Forest (1.3%) and State Enterprise Forests of Ukraine (1.7%). This led to the conclusion that the existing tax system did not provide adequate incentives for sustainable forest management, particularly in the private sector.

The average monthly amount of taxes paid ranged from UAH 0.47 million (Public Limited Liability Company Kharkivlis) to UAH 1.59 million (State Enterprise Chernihivlishosp), which indicated significant constant cash outflows even for enterprises with small incomes. This situation could create liquidity risks, especially for businesses with seasonal revenue. In addition, the tax burden was estimated as a share of total income. This indicator was the highest in the private sector: in LLC Forest – 40.1%, in State Enterprise Forests of Ukraine – 40.4%. This meant that more than 40 kopiykas from each hryvnia of income were sent to pay taxes. In the public sector, this figure was lower — on average 31.1%, in the municipal enterprise – 26.5% (Table 1).

Table 1. Economic indicators of the tax burden on forest users in Ukraine

Enterprise	Form of ownership	Income, mln UAH	Taxes, mln UAH	Taxes in expenses, %	Income taxes, %	Forest restoration, % of profit	Profitability, %	Reforestation in costs, %	Average monthly taxes, mln UAH
Chernihivlishosp	State	65.1	19.1	29.3	29.3	12.8	9.1	3.3	1.59
Karpatlis	Private	44.3	15.6	35.2	35.2	8.3	6.0	2.1	1.30
Forest	Private	30.7	12.6	40.1	40.1	5.9	4.7	1.3	1.05
Kharkivlis	Municipal	21.1	5.6	27.0	26.5	9.4	9.7	2.6	0.47
Sumylishosp	State	56.2	18.5	32.9	32.9	11.4	7.4	3.0	1.54
Forests of Ukraine	State	25.5	10.3	40.4	40.4	6.6	5.0	1.7	0.86

Source: *compiled by the authors*

Summarising, it can be noted that the financial efficiency of forestry enterprises in Ukraine in 2024 significantly depended on the level of tax burden. A direct relationship between the form of ownership and tax pressure was revealed, which, in turn, affected profitability and the volume of environmental expenditures. Private enterprises were in the most vulnerable position – they showed the highest share of taxes in expenses and income, the lowest profitability and insufficient investment in reforestation.

Structure of indirect fiscal expenditures for forest sector enterprises. The average amount of indirect fiscal expenses per enterprise was UAH 1.90 million. Most indirect costs were incurred SE Chernihivlishosp – UAH 2.60 million, which accounted for 4.0% of its total operating expenses. SE Sumylishosp

incurred expenses in the amount of UAH 2.40 million, or 4.5%. Private enterprises had lower absolute indicators, but their share in total expenses was higher. Thus, in LLC Forest, indirect fiscal expenses amounted to UAH 1.55 million, or 5.1%, and in SE Forests of Ukraine UAH 1.59 million, which was the highest relative indicator in the sample – 5.3%.

Forest protection costs ranged from UAH 0.60 million (PLLC Kharkivlis) up to UAH 1.20 million (SE Chernihivlishosp). The average value for the sample was UAH 0.85 million, which corresponded to 1.33% of total expenses calculated according to equation (3). The largest share of such expenditures in the structure of indirect liabilities was found in state-owned enterprises, where they accounted for 46.2% of indirect expenditures. For private enterprises, this figure did not exceed 45.5%. Certification and reporting costs averaged UAH 0.42 million per enterprise. The highest indicator was SE Chernihivlishosp – UAH 0.65 million, the lowest – PLLC Kharkivlis (UAH 0.28 million). The share of such expenses in total fiscal encumbrances was 1.3% in the sample, but for some private enterprises (for example, LLC Forest), reporting expenses reached UAH 0.30 million, or 19.4% of all indirect liabilities.

Environmental monitoring required an average of UAH 0.37 million annually. The maximum expenses were in SE Chernihivlishosp (UAH 0.45 million), the minimum – in PLLC Kharkivlis (UAH 0.30 million). The share of these costs in the structure of indirect encumbrances ranged from 21.1% to 24.5%. This showed a constant nature of costs regardless of the form of ownership, but the share in relation to profit was more burdensome for the private sector. Other obligations, in particular, payment for licensing procedures, expert examinations, and internal accounting, ranged from UAH 0.18-0.35 million. The highest such expenses were recorded in State Enterprise Sumylishosp (UAH 0.35 million), which accounted for 14.6% of its indirect fiscal spending. On average, for the sample, expenses for other mandatory obligations (permits, examinations, audits) amounted to UAH 0.26 million.

Generalised data showed that indirect fiscal expenditures further increased the tax burden by another 4.65%. As a result, considering both direct and indirect obligations, the total fiscal burden on forest industry enterprises reached more than 38.8% of total expenses on average, and in some cases – exceeded 45% (in particular, in SE Forests of Ukraine – 45.7%). The imbalance also manifested itself in the disproportionate distribution of mandatory expenses between entities of various organisational and legal forms. State-owned enterprises, having a higher level of spending, provided a greater contribution to environmental protection, but did not have any advantages in fiscal regulation. However, private enterprises, despite the lower level of investment in environmental measures, experienced a comparable or even higher tax burden relative to their income (Table 2).

Table 2. Structure of indirect fiscal expenditures for forest sector enterprises

Enterprise	Forest protection expenses, mln UAH	Certification and reporting, mln UAH	Environmental monitoring, mln UAH	Other obligations (licenses, expertise in mln UAH)	Total amount of indirect expenses, mln UAH	Share in total expenses, %
Chernihivlishosp	1.20	0.65	0.45	0.30	2.60	4.0
Karpatlis	0.85	0.40	0.35	0.28	1.88	4.7
Forest	0.70	0.30	0.33	0.22	1.55	5.1
Kharkivlis	0.60	0.28	0.30	0.18	1.36	4.3
Sumylishosp	1.10	0.55	0.40	0.35	2.40	4.5
Forests of Ukraine	0.66	0.32	0.36	0.25	1.59	5.3

Source: *compiled by the authors*

Thus, the results of the study showed the presence of deep systemic inefficiencies in the tax model of forest management in Ukraine. The lack of transparency of some mandatory payments, non-recognition of environmental costs in tax accounting, the lack of incentive mechanisms for environmentally responsible behaviour, and unified approaches to taxation of enterprises with different economic and resource opportunities led to the need for a comprehensive revision of fiscal policy in the field of sustainable forest management.

Assessment of risks of tax reform implementation in forest sector enterprises. The highest level of risk was recorded in the sphere of resistance from enterprises, especially private ownership. Thus, LLC Forest and State Enterprise Forests of Ukraine, which had the highest share of tax expenditures in the cost structure (40.1% and 40.4%, respectively) and the lowest profitability (4.7% and 5.0%), declared a limited ability to adapt to changes in the tax approach without losing profitability. The overall risk score "business resistance" was estimated at 8.5 out of 10. Of the 152 regulations in force in the field of forestry, only 14 (9.2%) were directly or indirectly related to differentiated taxation or environmental benefits. SE Chernihivlishosp in its

financial report for 2024 pointed out the need to adapt the legislation to account for the costs of certification (UAH 0.55 million) and environmental monitoring (UAH 0.40 million) in the form of a tax credit, but the current legislation did not provide for such a possibility. This structural flaw was rated at 7.8 points. The next challenge was the lack of specialists in the field of tax administration and environmental audit at the level of district tax services. In particular, in the Rokytne district of the Rivne Oblast, where LLC Karpatlis is located (taxes – UAH 15.6 million, certification – UAH 0.40 million), the tax inspectorate had only two certified employees with experience in environmental management. At the end of 2024, only 42% of territorial inspections had access to training programmes on environmental tax law. According to calculations, the risk of inefficient administration of the reform was 6.9 points.

The financial risk of reduced budget revenues was estimated at 7.5 points. In the case of the introduction of an environmental tax credit (discounts of up to 10% for enterprises that invest more than 5% of profits in reforestation), revenues from the Chernihivlishosp forestry enterprise could decrease by approximately UAH 2.1 million annually according to the results of modelling the financial impact of tax incentives. This is despite the fact that the company spent 12.8% of its profit on restoring (the highest figure in the sample), which is equivalent to UAH 2.3 million. In the case of LLC Karpatlis, the tax burden of 35.2% was estimated as marginal, and according to the company's management, a further increase in rates or a change in the system of accounting for reforestation costs could lead to a revision of production plans. Technical limitations have become an additional barrier (Khan *et al.*, 2025). Thus, in SE Chernihivlishosp, the lack of an integrated electronic record-keeping system (ERP) made it impossible to automatically submit reports on reforestation costs, and to ensure compliance with the new model, up to UAH 600 thousand one-time investments in digital infrastructure were required. This created unequal starting conditions for market participants. This risk was estimated at 6.2 points. Institutional inertia, that is,

internal resistance to change at the level of state structures, was noticeable in the work of territorial branches of the state agency for forest resources of Ukraine. For example, the management of PLLC Kharkivlis, which demonstrated the highest profitability (9.7%) and the lowest tax burden (26.5%), noted the lack of centralised methodological recommendations for calculating the environmental tax credit. A request to the regional department was answered that "such tools are not yet regulated". The risk of inertial braking was estimated at 7.0 points.

There was also a low level of coordination between the State Tax Service of Ukraine, the State Environmental Inspectorate, the State Agency of Forest Resources of Ukraine and the Ministry of Environmental Protection and Natural Resources of Ukraine. Thus, LLC Forest in 2024 was forced to prepare three separate reports on the costs of environmental measures – for the tax service, the forest agency, and the state environmental inspectorate. These reports were not unified and were submitted in different formats, which increased the administrative burden on the enterprise. Total accounting and reporting costs reached UAH 0.30 million. This risk was estimated at 6.8 points. Political instability, in particular, frequent changes in the leadership of relevant ministries, created the risk of delaying reforms or changes in priorities. In 2024, three deputy ministers of environmental protection were replaced, which led to the suspension of approval of the Project "On Taxation of Rent for the Special Use of Forest Resources" (2024) for more than six months. This factor received a score of 7.9 points.

In general, according to the results of threat scaling, the average risk of implementing the reform was 7.2 points. The most vulnerable to the reforms were private enterprises, which combined high fiscal pressure, low profitability, and limited modernisation opportunities (LLC Forest, LLC Karpatlis). Public sector enterprises, despite the high level of environmental costs (SE Chernihivlishosp, SE Sumylishosp, SE Forests of Ukraine), showed greater adaptability to model changes, but faced regulatory and organisational barriers (Fig. 1).
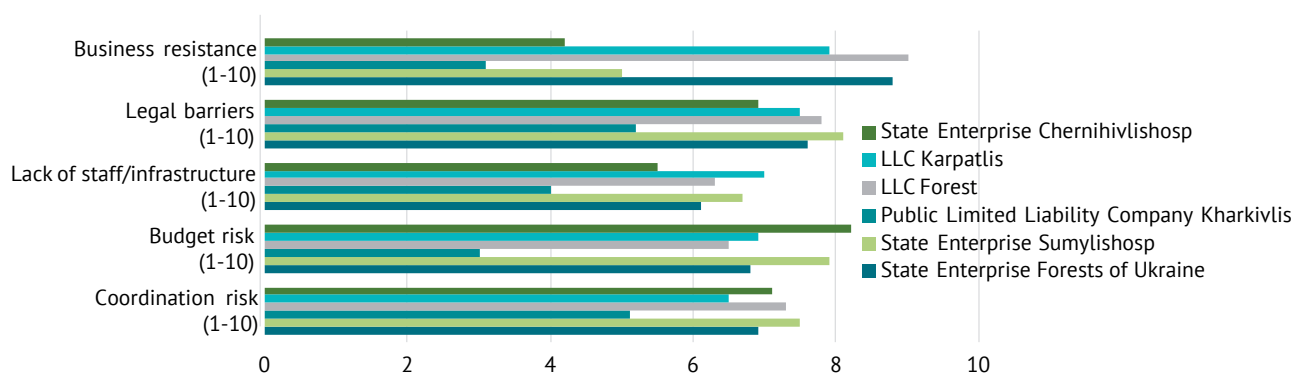

Figure 1. *Assessment of risks of tax reform implementation in forest sector enterprises*
Source: *compiled by the authors*

Thus, the practical implementation of the tax reform in the field of forest management required considering the regional, organisational and financial specifics of enterprises. The implementation strategy was to be based on an adaptive approach with step-by-step deployment, institutional support, tax compensators, and the creation of a single digital reporting platform.

Projected effects of tax reform implementation in forest sector enterprises. The basic proposal is to introduce a mechanism for differentiated tax burden depending on three key indicators: the share of investment in reforestation, the level of profitability of the enterprise, and the form of ownership. To estimate the share of investment in reforestation, equation (4) is used, which helps to determine the share of environmental costs in the company's profit. According to the simulation results, businesses that invest more than 10% of their profits in reforestation can qualify for a discount of up to 8% of their total tax liabilities. This will allow, in particular, LLC Karpatlis (which in 2024 invested 8.3% of its profit in environmental purposes) to reduce annual tax expenses from UAH 15.6 million to UAH 14.3 million, that is, by UAH 1.3 million.

It is also proposed to introduce an environmental tax credit – a mechanism for transferring part of tax liabilities to subsequent periods, subject to the targeted allocation of funds for environmental protection measures. The calculations provide that SE Chernihivlishosp, which in 2024 spent 12.8% of its profit (UAH 2.3 million) on reforestation, could receive an environmental loan in the amount of UAH 1.1 million with a two-year delay in paying taxes to the budget. This approach will reduce the burden on the company's working capital and stabilise capital expenditure planning. The next step is to introduce a unified tax reporting system that will combine fiscal, environmental and forestry components in a single digital form. It was estimated that enterprises Forest and Forests of Ukraine annually spend UAH 280-320 thousand only on the development, processing, and submission of reports to various

authorities. The introduction of a centralised portal will reduce these costs to UAH 120-140 thousand, which will reduce the administrative burden by 55-60%. Estimated savings for the industry will reach up to UAH 72 million annually.

Attention is also paid to the problem of shading. According to an independent assessment, approximately 28% of the turnover of unaccounted timber is accounted for by small private enterprises, which avoid taxation due to the complexity of procedures and lack of incentives for transparency. The introduction of a tax break for voluntary electronic declaration of sales volumes can reduce the shadowing of the sector by 12.5% during the first two years (Tynaliev *et al.*, 2024). Another strategic component is the introduction of a marginal fiscal coefficient, which will limit the tax burden to no more than 32% of the company's total expenses. This is especially true for enterprises with excessive pressure, such as timber (40.1%). The introduction of such a restriction will reduce tax costs by UAH 2.42 million and UAH 2.17 million, respectively, which will create an additional financial resource for modernisation and certification (which currently requires UAH 300-350 thousand). The assessment of the total effect is based on a comparison of key financial and operational indicators in the forecast scenario. It is expected that the average level of tax burden may decrease from 34.15% to 28.65% (by 5.5%), the profitability of enterprises will increase by an average of 3.2%, the volume of investment in reforestation will increase by 18%, and the level of shading will decrease by 12.5%. The total savings in administrative costs for the industry will amount to about UAH 72 million per year. Consequently, the most tangible benefits of the reform may be an increase in environmental investment (+18%), a reduction in shadow timber turnover (-12.5%), and a reduction in tax pressure (-5.5%). These results show the potential of the proposed changes both to improve the financial stability of enterprises and to meet their environmental obligations (Table 3).

Table 3. *Projected effects of tax reform implementation in forest sector enterprises (forecast for 2025-2027)*

Enterprise	Reduction in the tax burden, %	Profitability growth, %	Increased investment in reforestation, %	Reduction in shadow economy, %	Administrative savings, mln UAH
Chernihivlishosp	4.5	2.4	12	7.0	1.1.
Karpatlis	5.8	3.1	15	10.0	1.5
Forest	7.2	3.9	19	14.0	2.2
Kharkivlis	2.9	1.5	9	4.5	0.9
Sumylishosp	5.0	2.8	14	8.0	1.3
Forests of Ukraine	6.7	3.7	18	13.5	2.0

Source: *compiled by the authors*

Thus, the proposed changes to the tax policy in the field of forestry had not only a fiscal, but also an environmental effect. They allowed creating an

adaptive, socially fair tax environment that could stimulate the sustainable development of the forest sector. Their implementation required appropriate regulatory

adaptation, technical re-equipment of the accounting system and interdepartmental coordination, but the projected results exceeded the cost of implementation, which made the reform justified both from economic and managerial standpoints.

DISCUSSION

The results obtained confirm the existence of a high tax burden on forestry entities, especially in the private sector, where the share of taxes in the cost structure exceeded 40%. This burden complicates long-term planning, limits investment in reforestation, and increases the risks of shadowing activities. However, it was established that indirect fiscal expenditures related to forest protection, certification, reporting and environmental monitoring remain significant, but are not legally considered as a component of tax policy. The analysis of the risks of implementing reforms showed a high level of institutional and informational unpreparedness for changes, and the expected resistance from business in the absence of compensatory mechanisms. The projected effects of the proposed changes indicate a potential reduction in the tax burden, an increase in the profitability of enterprises and an increase in environmental investment. This indicates the feasibility of switching to a model of adaptive fiscal regulation based on environmental criteria and digital integration of accounting (Gavkalova *et al.*, 2024).

As shown in the paper by S.N. Chisika and C. Yeom (2021) and D. Huang *et al.* (2024), focused on integrating forest resources into broader environmental and economic programmes. D. Huang *et al.* emphasised the role of green investment and social factors in achieving carbon neutrality, but did not consider the tax system as a separate regulatory tool. S.N. Chisika and C. Yeom analysed public-private partnerships as the basis for sustainable management of public forests, but the issue of fiscal policy was ignored. In this context, the study supplemented existing approaches with a quantitative assessment of the tax burden, reform risks, and the effectiveness of digital solutions at the enterprise level. The use of a risk scale and scenario forecasting allowed considering both internal financial and external institutional factors that were not reflected in previous works.

As noted by E. Barbier *et al.* (2023) and S. Wang *et al.* (2024), the impact of global economic processes on forest policy was viewed through the prism of international trade and resource asset management. E. Barbier *et al.* focused on the tropical timber trade and the effects of deforestation, but did not explore domestic tax models as a regulatory mechanism. S. Wang *et al.* used the Data Envelopment Analysis toolkit to assess the effectiveness of natural resource management in China, but without detailing fiscal mechanisms at the level of individual business entities. The study allowed filling this analytical gap by highlighting indirect costs, fiscal

asymmetries between enterprises of different forms of ownership, and modelling the effects of reforms. This provided a deeper link between tax policy and the economic behaviour of forest users, which was not reflected in the above papers.

As demonstrated by P. Kadam *et al.* (2021) and J. Yan *et al.* (2024), the focus was on the structural and organisational aspects of sustainable forest management. J. Yan *et al.* proposed a model for analysing the green productivity of the Chinese forest industry, which considered technological and environmental factors, but did not include tax incentives or risks. P. Kadam *et al.* compared certification and management systems for sustainable forest management, without paying attention to the tax burden or the effectiveness of fiscal administration. The analysis supplemented these approaches with an assessment of indirect fiscal expenditures, detailed calculations of tax pressure, and forecasting the impact of reforms on profitability and investment activity. A special feature of the study was the combination of quantitative modelling with the analysis of real reporting data, which provided high applied value and analytical accuracy. As emphasised by Y. Yang *et al.* (2021), along with C.R. Franco and J. Comje (2022), policy dialogue, paradigm formation, and forest ownership regimes were recognised as key determinants of sustainable forest management. In the case of C.R. Franco and J. Comje, the historical transformation of forest policy in the United States was traced, but financial instruments, in particular tax instruments, were not singled out as the basis for regulation. Y. Yang *et al.* focused on the impact of ownership rights on the forest fund of southern China, without highlighting the relationship between taxation and the level of responsible use of resources. The conducted research differed in that it allowed to quantify the fiscal burden, correlate it with the forms of ownership, and identify structural irregularities in the taxation of forest sector enterprises, which was not presented in the mentioned studies.

According to the findings of A. Raihan *et al.* (2022) and S.N. Chisika and C. Yeom (2024), special attention was paid to institutional restructuring of management models and econometric analysis of climate factors. S.N. Chisika and C. Yeom described a shift in forest management paradigms in Kenya, but specific tools for fiscal impact on sustainable enterprise behaviour remained out of the field of research. A. Raihan *et al.* proposed an econometric analysis of the potential for reducing emissions in Indonesia, without considering the direct impact of the tax system. In contrast to these approaches, the analysis included both an assessment of tax expenditures of enterprises and scenario forecasting of the effects of reforms, considering the form of ownership, the level of investment, and the scale of activities. W. Yang *et al.* (2022) and V. Imbrenda *et al.* (2023) showed that socio-economic and climate factors significantly influence the rate of adaptation of the forest

sector to the requirements of sustainable development. W. Yang *et al.* analysed the challenges in the context of carbon neutrality, paying considerable attention to the regulatory framework, but without the financial aspect. V. Imbrenda *et al.* highlighted the relationship between employment, environmental efficiency, and economic stability in the European forest sector, but without a specific analysis of tax mechanisms. But in the current study, the tax burden was considered as an integral indicator that affects investment behaviour, the level of shadow economy, and the sustainable financial viability of enterprises, which allowed combining fiscal and environmental dimensions.

As revealed in studies by A. Saxena *et al.* (2022) and P.K.R. Chowdhury and D.G. Brown (2023), forest policies are increasingly combined with financial incentive and strategic planning mechanisms in the regional dimension. P.K.R. Chowdhury and D.G. Brown modelled the impact of carbon payments and cooperative management on carbon storage and income of forest owners in the United States, without considering the classical tax system as an integrated factor. A. Saxena *et al.* explored the barriers and potential of wooden infrastructure in the Himalayas, focusing on political and environmental contexts, without detailing the fiscal environment. In contrast to these approaches, the study covered not only general incentives or strategic frameworks, but also provided a complete structural analysis of fiscal pressures on forest users, considering tax indicators, the form of ownership of enterprises, the level of profitability, and the amount of indirect costs. This provided the applied value of the study for the development of specific tax decisions at the level of legislative initiative.

As demonstrated by L. Liagre *et al.* (2020) and A. Raihan *et al.* (2024), key attention is paid to the impact of specialised financial mechanisms and macroeconomic factors on ecosystem services and emissions. L. Liagre *et al.* analysed the role of national forest funds in Costa Rica, Vietnam, and Morocco, highlighting the effectiveness of funds as catalysts, but did not consider standard tax models as a source of funding. A. Raihan *et al.* applied a macroeconomic approach to investigating the impact of energy consumption, forest area, and globalisation on climate indicators in Poland, but without a detailed analysis of the relationship with tax systems in the forest industry. The study was distinguished by the fact that it was based on real data of forest sector enterprises, including an assessment of administrative costs, indirect fiscal obligations, imbalances between public and private structures, which allowed identifying the systemic limitations of the current tax model and substantiating the areas for its improvement.

As stated by B. Danley *et al.* (2021) and A. Blanton *et al.* (2024), the focus was on carbon markets and private owners' involvement in improving biodiversity. A. Blanton *et al.* investigated the state of the carbon certificate market in Latin America, where tax policies were mentioned only indirectly through regulatory conditions for trading. B. Danley *et al.* analysed the limits of voluntary participation of family forest owners in Sweden in biodiversity conservation, but fiscal instruments were presented as a general policy background without quantitative details. The analysis significantly expanded the existing problem, since for the first time a comparative tax diagnosis of various types of enterprises was carried out with modelling the effects of reforms and quantitative assessment of the potential impact on sustainable development, which significantly increases the practical suitability of the obtained conclusions for the development of a national tax policy in the field of forest management. As a result, the study differed from previous research in its practical direction, detailed tax analysis, and modelling of the effects of reforms, which helped to identify systemic problems and form applied recommendations for sustainable development of the forest sector.

CONCLUSIONS

As part of the study, a comprehensive assessment of the tax policy in the field of forestry of Ukraine was carried out to form fiscal mechanisms that will contribute to sustainable forest management. The analysis covered key aspects of the tax burden, the structure of indirect fiscal expenditures, the risks of implementing reforms, and the projected effects of changes in the fiscal model at the enterprise level. At the first stage, the tax burden was calculated at six enterprises of different forms of ownership: SE Chernihivlishosp, SE Sumylishosp, SE Forests of Ukraine (state-owned), PLLC Kharkivlis (municipal), LLC Forest and LLC Karpatlis (private). It was found that the average level of taxes in the structure of total expenditures was 34.15%. The highest values of this indicator were recorded in private enterprises: 40.1% in LLC Forest and 40.4% in SE Forests of Ukraine, while the average value in the public sector was 31.1%, and in the municipal sector – 26.5%. A similar trend was observed in calculating the tax burden on income: 40.1% and 40.4% in the private sector, compared to 31.1% in the public sector and 26.5% in the municipal sector. This indicated an asymmetric fiscal burden and a lack of incentive mechanisms for private property entities. At the second stage of the study, the structure of indirect fiscal costs was analysed – expenses that are not classified as taxes, but are mandatory and include forest protection, certification, environmental monitoring, reporting and licensing costs. Their share in total expenses ranged from 4.3% to 5.3%, and in individual enterprises – exceeded 5% (in particular, in SE Forests of Ukraine – 5.3%, in LLC Forest – 5.1%). Such a hidden fiscal burden is not reflected in tax statistics, but it significantly affects the financial stability of enterprises. At the third stage of the study, the risks of tax reform implementation were assessed on

a scale from 1 to 10 points, based on five groups of criteria: regulatory uncertainty, staffing, institutional readiness of business, the level of digitalisation, and fiscal losses. Private enterprises were the most vulnerable – the average risk level was 7.4 points, which is conditioned by the lack of centralised digital solutions and limited ability to adapt. In the public sector, the risk was assessed at 4.8 points, in the municipal sector – 5.6 points. At the final stage, the projected effects of implementing an adaptive tax model for the period 2025-2027 were modelled. It is expected that the tax burden can be reduced by an average of 5.5%, profitability will increase by 3.2%, investment in reforestation will increase by 18%, and the level of shading will decrease by 12.5%. In addition, the implementation of a digital reporting system and simplified accounting will reduce the administrative burden on enterprises, which will provide projected cost savings of UAH 72 million per year across the industry. In general, the results of the study proved the feasibility of switching to a differentiated, environmentally oriented tax policy that considers the economic viability of enterprises, their form of ownership, and contribution to the preservation of forest ecosystems. Further research should be aimed at developing models of tax incentives for reforestation and evaluating the effectiveness of their implementation in the regional context.

CONFLICT OF INTEREST

None.

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Удосконалення механізмів оподаткування лісових ресурсів України для забезпечення сталого лісокористування

Назакет Мусаєва

Кандидат економічних наук, доцент
Азербайджанський державний економічний університет (UNEC)
AZ1001, вул. Істиглаліят, 6, м. Баку, Азербайджан
https://orcid.org/0000-0001-5973-981X

Нігяр Атакішієва

Кандидат економічних наук, старший викладач
Азербайджанський державний економічний університет (UNEC)
AZ1001, вул. Істиглаліят, 6, м. Баку, Азербайджан
https://orcid.org/0000-0002-7668-8193

Улкар Мамедова

Кандидат економічних наук, старший викладач
Азербайджанський державний економічний університет (UNEC)
AZ1001, вул. Істиглаліят, 6, м. Баку, Азербайджан
https://orcid.org/0000-0001-7341-7737

Нахід Алмасов

Кандидат економічних наук, заступник декана факультету бізнесу та економіки
Азербайджанський університет
AZ1007, вул. Джейхуна Гаджибейлі, 71, м. Баку, Азербайджан
https://orcid.org/0009-0001-1140-2115

Максим Шевченко

Аспірант
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
https://orcid.org/0009-0003-5302-2772

Анотація. Метою дослідження було обґрунтування шляхів оптимізації фіскальних механізмів у лісовому секторі для підвищення його економічної ефективності та сталості. Проведено кількісний аналіз на основі звітних даних шести підприємств різних форм власності (державних, комунальних і приватних), що дозволило виявити диспропорції в податковому тиску. У державному секторі цей показник становив 31,1 %, а в комунальному – 26,5 %. У приватному секторі податкове навантаження сягало 40,1 % у підприємстві «Ліс» та 35,2 % у підприємстві «Карпатліс», що значно перевищувало показники державного сектору – 29,3 % у «Чернігівлісгоспі», 32,9 % у «Сумилісгоспі» та 40,4 % у «Лісах України». У комунальному підприємстві «Харківліс» податкове навантаження становило 26,5 %. Рівень рентабельності у приватних підприємствах становив 4,7 % у «Ліс» і 6,0 % у «Карпатліс», тоді як державні демонстрували стабільні показники: 9,1 % у «Чернігівлісгоспі», 7,4 % у «Сумилісгоспі» та 5,0 % у «Лісах України». Комунальне підприємство «Харківліс» показало найвищу рентабельність – 9,7 %. Окремо проаналізовано структуру непрямих фіскальних витрат, серед яких основними були витрати на екологічний моніторинг, охорону лісу, сертифікацію та звітність. Встановлено, що частка непрямих витрат у загальних витратах підприємств коливалась у межах від 5,4 % до 11,8 %. Оцінка ризиків реалізації податкових реформ проводилась за бальною шкалою (від 1 до 10) за п'ятьма критеріями: правова база, кадрова готовність, бізнес-опір, цифровізація та фіскальні втрати. Найвищий ризиковий профіль зафіксовано у приватному секторі (середній рівень – 7,4 бала), найнижчий – у державному (4,8 бала). Прогнозовані ефекти від впровадження адаптивної податкової моделі включають зниження податкового навантаження на 5,5 %, зростання рентабельності на 3,2 %, інвестицій у лісовідновлення – на 18 % і зменшення рівня тінізації на 12,5 %. Результати дослідження можуть бути використані для формування податкової політики та підтримки сталого лісокористування на рівні держави і підприємств

Ключові слова: економічна ефективність; непрямі витрати; цифровізація звітності; фіскальне регулювання; ризики реформ