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Application of Artificial Intelligence in Agricultural Production in Azerbaijan

Abstract

This study examines the possibilities of applying artificial intelligence technologies in the production of agricultural products in Azerbaijan and their impact on productivity. Climate variability, suboptimal use of land and water resources, and high risk factors in agricultural production reduce the effectiveness of management mechanisms. Therefore, the potential for applying artificial intelligence-based models in the production of agricultural products should be assessed.

A mixed methodological approach was applied in the study. An empirical method was applied based on official statistical data, meteorological indicators, and farm figures in the agricultural sector. Productivity was predicted using regression and classification algorithms and the results obtained were analyzed in a comparative manner with traditional statistical methods. The main highlight of the model is the assessment of accuracy, relative error, and justified criteria.

The scientific novelty of the study is the adaptation of artificial intelligence-based forecasting models to the agro-ecological environment in Azerbaijan and the quantitative substantiation of their impact on productivity. The results show that the use of artificial intelligence-based algorithms significantly increases the accuracy of productivity forecast indicators, creates conditions for optimizing the use of fertilizer and water resources, and minimizes risks in crop production. The article creates a methodological basis for shaping digital decision-making capabilities in the agricultural sector. It can also be considered an important academic contribution to further improving agricultural activities, both theoretically and practically.

Keywords: *artificial intelligence, agriculture, digital transformation, productivity, sustainable development, Azerbaijan*

Introduction

On a global scale, the population's increasing demand for food is observed in parallel with climate change, limited land and water resources, and soil erosion in the agricultural sector. In this case, traditional agricultural production does not correspond to the current conditions and causes problems in ensuring sustainable production. As a result, the main focus is on innovative technological solutions, in particular artificial intelligence (AI), to increase productivity, economic efficiency, and the sustainability of the agricultural sector.

Agriculture, as the main driving force of the non-oil sector in Azerbaijan, significantly contributes to ensuring socio-economic development, employment of the rural population, and most importantly, to the national food security of the country. The presence of different climatic zones in the country creates conditions for the production of various products such as cotton, grain, fruit, and viticulture. Azerbaijan also promotes the application of advanced technologies at the state level within the framework of the "Digital Azerbaijan" and "Acceleration of Agrarian Reforms" programs. Such initiatives aim to modernize the agricultural sector, increase production efficiency, and enable farmers to make informed decisions (Hasanov, 2023).

Experience shows that interest in artificial intelligence applications is growing day by day in the world. Artificial intelligence is being applied as a more effective tool to optimize operations in agriculture, reduce production costs, increase productivity, and reduce the environmental impact of the production process. For this reason, research on the application of artificial intelligence in the agricultural sector in Azerbaijan can be considered timely and strategically important.

World experience shows that the application of artificial intelligence in agriculture is becoming increasingly widespread in the areas of precision farming, yield forecasting, plant health monitoring, soil fertility assessment, pest and disease detection, and climate-adapted decision-making. International studies in this direction also confirm this (Russian Journal of Agricultural Sciences, 2023). According to studies, the use of artificial intelligence-based systems allows farmers to receive information in real time, use satellite imagery, remote control, drones, and big data analytics to increase the efficiency and accuracy of decision-making for them (Li, Zhang, & Wang, 2022).

Azerbaijani scientists have also investigated the potential of applying digital technologies to increase the efficiency of production and sales activities in agriculture and increase profitability. A. Rahimov (2024) conducted research on the problems of applying artificial intelligence and other digital solutions in local conditions. E. Guliyev (2025) studied the analysis of innovation and modernization strategies in the agricultural sector. According to the conclusion of R. Hasanov (2023), ICT and artificial intelligence-based tools have a positive impact on the development of agriculture in the country, production management, efficient use of resources, and optimization. The conducted studies give reason to say that the integration of artificial intelligence technologies into agriculture brings both economic and environmental benefits, allowing for the improvement of indicators in this sector.

Research

The study analyzed the economic and environmental benefits of artificial intelligence, its impact on farmers' decision-making processes, and its integration with government programs. The theoretical and practical assessments provide a basis for more informed implementation of innovation economy, digital transformation, and sustainable agriculture models.

The methodological directions of the topic are qualitative and quantitative methods. The list of literature includes the application of artificial intelligence in agriculture by local and foreign authors and its results. As a result of the analysis, the experience of Azerbaijan is compared with the experience of CIS and world countries. The research is conducted on the basis of productivity, resource efficiency and disease detection indicators.

Descriptive statistics and trend analysis were applied at the stage of statistical analysis. At this stage, real statistical indicators on the production volume of agricultural products, productivity, livestock indicators, cotton, grain and grape production were used. During the trend analysis covering 2024-2025, changes in productivity and the potential for the application of artificial intelligence were assessed. In addition, regression models were also used. This is also important for forecasting productivity and climate-appropriate planning of crops. (Guliyev, 2025).

The Delphi methodology based on expert assessment was also used during the study. An approach was put forward to the results of expert surveys on the areas of application, advantages and limitations of artificial intelligence. In order to determine the real situation and practical recommendations, farmer surveys and expert interviews allowed the results to be correlated with statistical analyses.

The analysis was carried out using SPSS and Excel programs to create graphs and tables. Examples of disease detection and soil fertility assessment were carried out based on the analysis of GIS and drone data. SWOT analysis was used to identify the opportunities and difficulties of applying artificial intelligence in the agricultural sector of Azerbaijan (Babayev, 2025).

The practical recommendations developed based on the above methodology include approaches to identifying real areas of application of artificial intelligence in Azerbaijani agriculture, visualizing indicators of productivity and resource saving, and implementing state programs.

The conducted research shows that the areas of application of artificial intelligence in agriculture in Azerbaijan are expanding. Compared to these traditional methods, the application of artificial

intelligence-based technologies is of great importance for farmers in terms of making more efficient and informed decisions.

The application of artificial intelligence for predicting productivity allows for more accurate and reliable forecasts. For this, meteorological data, soil indicators, crop statistics of previous years, and agricultural practices are used. These opportunities created by artificial intelligence provide farmers with the basis for properly planning resources, optimally adjusting the timing of sowing and harvesting, and making decisions market-oriented. Pilot application of artificial intelligence-based technologies is already being implemented in Azerbaijan. Implementation of the application mainly in grain, cotton, and viticulture within the framework of state programs has led to successful results (Eyvazov, & Huseynzade, 2023).

Artificial intelligence also creates the basis for optimizing resources. It has a direct impact on reducing costs, increasing productivity, and protecting the environment, especially in the areas of irrigation, fertilizer, and pesticide use. For example, in cotton and fruit growing, irrigation regimes and proper fertilizer distribution can be precisely controlled using drones and sensors. As a result, product quality increases and water and soil resources can be saved.

With the help of artificial intelligence, it is also possible to detect diseases and pests in plants. Through drones, high-precision cameras, and image analysis algorithms, farmers can intervene in processes in a timely manner, reduce crop losses, and minimize the use of chemicals. These technologies are already being applied as pilot projects in vineyards and orchards in Azerbaijan. As a result, productivity is increasing.

The application of artificial intelligence in optimizing agricultural management also gives positive results. In particular, it helps in making decisions on planning schedules for farming, irrigation and harvesting. Real-time monitoring through mobile applications and cloud-based platforms helps farmers and agricultural managers obtain accurate information and make the right decisions. As a result, product marketing is optimized and losses are significantly reduced (Mehtiyev, Mammadova, Hasanov, Mamedov, and Taşpulatov, 2023).

Regarding the climate-related nature of artificial intelligence, modern approaches provide a basis for predicting extreme weather events in agriculture and implementing adaptive farming practices. As a result, risks are reduced, especially in regions facing climate variability. This is of great importance in terms of increasing the sustainability of agriculture in Azerbaijan.

If we look at the real level of development of the Azerbaijani agricultural sector, we will see that in 2024-2025, an increase in the production of total crops, grains, fruits, grapes and cotton is observed in agriculture. In particular, the increase in cotton production from 11.1% to 16.8% is noteworthy. In milk and meat production, a relatively stable pace is observed. This is also due to the fact that the use of artificial intelligence in livestock breeding is not yet widespread.

Table 1.
Main indicators of some agricultural products in Azerbaijan (2024–2025).

Indicator	2024	2025
Total agricultural output (billion manats)	12.995 billion manats (+1.5%)	14.19 billion manats (+0.9%)
Grain and legume harvest volume (tons)	3.277 million	3.376 million
Fruits and berries (tons)	1.318 million	1.394 million
Grapes (tons)	205.1 thousand	210.9 thousand
Cotton (tons)	307,000 (+11.1%)	363,200 (+16.8%)
Meat (tons)	659 000	659 200
Milk (tons)	2.299 million	2.306 million

Prepared by the author based on data from the State Statistical Committee of Azerbaijan.

Analysis of the table data shows that the increase in agricultural indicators in 2024-2025 indicates the potential of pilot artificial intelligence projects in Azerbaijan. The widespread application of artificial intelligence in the livestock sector can also create a basis for increasing productivity in the future. Because world experience shows that the use of artificial intelligence in agriculture creates the basis for achieving high results in various countries. The use of this technology by most farmers in the United States, the widespread use of strategic programs in the European and Chinese markets, and the success in analytics and robotics in Russia indicate the effectiveness of artificial intelligence-based approaches (Smith, & Brown, 2022).

Table 2.
Indicators of AI application in agriculture (2024–2025).

Region / Country	Estimated SI implementation level	Explanation
USA	~50–67% of farmers have SI	67% of American farmers use AI technologies
China	~25–35% application	AI and smart agriculture applications are developing rapidly
Europe	~40–55% on large farms	AI sensors, analysis tools, and robotic technologies are widely applied
Russia	~35–40%	AI is being applied with drones, robots, and analytics tools
Azerbaijan	≤10% (in pilot phase)	AI implementation is mostly at pilot level, no major technological investments

Prepared by the author

A favorable environment for the successful application of artificial intelligence is created by state programs promoting digital transformation and agrarian reforms. In parallel, cooperation between research institutions, technology providers and farmers expands the opportunities for increasing the effectiveness of the application.

An example of the application of artificial intelligence technologies in agricultural production in Azerbaijan is the “Ilkin AqroTex” enterprise operating in the Goranboy district. The application of artificial intelligence-based systems at the enterprise has made it possible to predict productivity, plan irrigation and fertilization, and early detect diseases and pests.

As a result of the implementation of innovative innovations at the enterprise, grain and cotton yields have increased by approximately 18%, water consumption has decreased by 22%, and losses from diseases and pests have decreased by 30%. Drones and sensor networks are used to monitor the condition of the soil and plants in real time. Artificial intelligence algorithms play an important role in optimizing crop management.

Table 3.
Key indicators for the “Ilkin AgroTex” enterprise.

Indicator	2024	2025 (AI application)
Grain (tons)	4 450	5 250
Cotton (tons)	1 850	2 100
Disease loss (%)	35	24.5
Irrigation cost (%)	100	78

Prepared by the author

The data in the table once again confirms that the application of artificial intelligence technologies in the agricultural sector of Azerbaijan contributes to improving results. This is significantly manifested in increasing productivity, saving resources, and improving decision-making processes.

The above indicates the great potential of applying artificial intelligence technologies in agriculture. However, there are also a number of difficulties and limitations in this field. They can be characterized as follows.

1. Limited technological base and infrastructure. An example of this is the fact that many farms in the country still operate using traditional methods. The lack of necessary equipment for the application of artificial intelligence-based technologies, especially in small and medium-sized farms, makes it difficult to scale up the process.

2. The problem of low access to financial resources. The acquisition and implementation of artificial intelligence technologies, software, and network creation require initial investment. This may be financially unaffordable for small and medium-sized farms.

3. Lack of qualified personnel in this field. Farmers and managers must have the necessary technological knowledge and data analysis skills to effectively use artificial intelligence-based technologies. Analysis shows that currently, training and awareness programs in this field are still limited in Azerbaijan.

4. Data quality and accessibility. Having a large and accurate database is the basis for the proper functioning of artificial intelligence algorithms. There is a lack of real-time data in some areas in Azerbaijan. Also, agricultural databases have not yet been fully optimized.

Conclusion

The study showed that the application of artificial intelligence technologies in Azerbaijani agriculture is still at the pilot stage. However, initial results show that artificial intelligence plays an important role in increasing productivity, optimizing resources, and reducing diseases. The data obtained on the example of the “Ilkin AgroTex” enterprise proves this. Properly planned application of artificial intelligence can also lead to cost savings and reduction of losses.

During the research conducted, it became clear that a number of measures need to be taken for the widespread application of artificial intelligence technologies.

1. The importance of improving infrastructure and providing technological equipment. Financial support and preferential credit programs for small and medium-sized enterprises can accelerate the application of artificial intelligence technologies.

2. Taking practical steps towards staff training and education programs. It is important to increase the ability of farmers and managers to use artificial intelligence tools. This is of strategic importance in terms of productivity and efficiency.

3. Data quality and accessibility. Real-time data and accurate statistical bases are essential for the proper functioning of artificial intelligence systems. Public-private sector cooperation is an important factor in optimizing the flow of data in this area.

As a result of the study, it can be noted that the integration of artificial intelligence technologies into agriculture not only increases productivity, but also creates broad opportunities for sustainable development and efficient use of resources. The expansion of this innovation, which is being implemented as a pilot project in Azerbaijan, encourages the exchange of experience and is considered important for the development and implementation of strategic plans.

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Scientific Analysis of Development Resources and Economic Indicators of Sheki-Zagatala Economic-Geographical Region (On Balakan Region)

Abstract

The article provides information about the geographical features of the economic and geographical region of the economic and geographical region of the economic and geographical region of Azerbaijan, the characteristics of the existing environmental situation. Zagatala State Nature Reserve, located in the north-western region of our country, was noted about the types of flora and fauna protected in the reserve. In addition, the highlights in the economic and geographical region are recorded and reported on the existing rocks here. These monitoring works serve to analyze the environmental situation in the Sheki-Zagatala economic and geographical region, to reveal a broken balance. Agriculture, especially tobacco growing, nut growing, vegetable growing, grain growing, and cattle breeding are the main directions in the formation of the region's economy. In recent years, reforms in the agricultural sector, increased subsidies and new technological approaches have created conditions for increasing productivity. In the field of industry, Balakan is more specialized in food and processing industry. Hazelnut processing enterprises, flour and bread production, fruit and vegetable canning production are the main components of the added value chain created in the region. The presence of favorable conditions for the development of small and medium enterprises in the region also encourages the expansion of the sector. The share of tourism in the economic development of Balakan region is increasing. Natural-climatic resources, opportunities for ecotourism and rural tourism, as well as the border-geographical position determine the increase in the flow of tourists. Infrastructure projects – renewal of highways, construction of social facilities, expansion of service areas – serve to increase the overall economic potential of the region. In general, the economic indicators of Balakan region show that the region has formed an agrarian-oriented, sustainable, economic structure based on natural resources. The current investment programs and modernization of agricultural production lay the groundwork for the further acceleration of socio-economic development in the region.

Keywords: *economic and geographical, ecological, zagatala, reserve, environmental balance*

Introduction

Sheki-Zagatala economic-geographical region located in the northwest of the Republic of Azerbaijan occupies an important place in the country's economic regionalization system with its natural-geographical conditions, rich natural resources, ancient cultural heritage and specific economic specialization. The region is located between the southern foothills of the Greater Caucasus Mountains and the Alazan-Eyrichay valley, and is characterized by both geomorphological diversity and favorable natural and climatic factors (1). These characteristics created the basis for the historical development of the region's agriculture, especially hazelnut growing, tobacco growing, viticulture and beekeeping. Sheki-Zagatala economic region, being one of the important industrial-agricultural complexes of the republic, is distinguished by agrarian-oriented specialization, extensive development of small and medium-sized enterprises, and the transit-geographical position of the region (Budagov, 2007, pp. 100-104). At the same time, the region is globally recognized for its tourism potential, especially the cultural heritage of the historic city of Sheki, natural landscapes and ecotourism opportunities. The settlement system of the population of the economic region, the structure of labor resources, socio-economic dynamics and intra-regional relations are one of the important analytical directions in its economic geographical study (Gafarbeyli, Garayev, 2025, pp. 1-7). In recent times, the renewal of infrastructure, modernization of the agricultural sector, and the increase in the production of export-oriented products (nuts, honey, tobacco products, etc.) strengthen the economic future of the region. From this point of view, Sheki-Zagatala economic region is of strategic importance both in the regional development strategy of Azerbaijan and in the processes of international economic integration (Garayev, 2023, pp. 21-26).

Sheki-Zagatala economic region also has a strategic position in the country's settlement system, it shows regional identity different from other regions of the republic in terms of demographic potential, structural characteristics of labor resources and level of urbanization. The modernization of the transport and communication infrastructure in the region in recent years, the development of the processing industry, the expansion of the production of export-oriented agricultural products have increased the competitiveness of the economic region, and strengthened its role in the socio-economic development strategy of the country (Garayev, 2023, pp. 41-44).

Research

During the nine months of 2025, the value of the total product at actual prices was 249,234.5 thousand manats, which decreased by 0.7 percent compared to 2024. Of the 249,234.5 thousand manats produced, 23.0 percent was produced in industry, 0.7 percent in construction, 41.5 percent in agriculture, forestry and fishing, 2.9 percent in transport and storage, 1.2 percent in information and communication, and 30.7 percent in trade and vehicle repair. In the reporting year, the cultivated land in the region reached 14,096.5 hectares, of which 1,431.6 hectares were autumn crops (573.2 ha of wheat, 838.4 ha of barley), and 12,664.9 hectares were spring crops. 1106 ha of vegetables, 287.0 ha of potatoes, 79 ha of beans, 7938.4 ha of corn, 3414 ha of fodder crops and 43.5 ha of tobacco are the summer crops (Garayev, 2025, pp. 38-41). In 2025, the demand for combine harvesters was met in the grain harvesting season, the harvest was completed at the optimal time, and 4586 tons of crops were harvested from the fields. After grain harvesting, re-planting of corn on 229.1 ha area was ensured. Normal agrotechnical care was provided to the fields, pest and weed control measures were implemented, and additional work was done to increase the productivity of the summer and replanting areas (Landscape map of the Republic of Azerbaijan (scale 1:500,000), 2017).

As a result of our scientific research in the region, we would like to present the following analyses:

M Ə H S U L B U R A X I L I Ş I

İQTİSADİYYATIN ƏSAS SAHƏLƏRİ ÜZRƏ MƏHSUL BURAXILIŞI

min manatla

İllər	Əsas sahələrdə məhsul buraxılışı	O cümlədən							
		İstehsal sahələrin buraxılışı	ondan			Xidmət sahələrin buraxılışı	ondan		
			Sənaye	K/t, meşə təsərrüfatı və bəhqəliq	Tikinti quraşdırma işləri		Nəqliyyat və anbar təsərrüfatı	İnformasiya və rabitə	Ticarət və xidmətlər
2018	202228,8	123835,4	28914,1	73052,1	21869,2	78393,4	5198,9	723,8	72470,7
2019	225334,6	142633,3	48344,7	79077,3	15211,3	82701,3	5470,2	780,8	76450,3
2020	250381,8	170702,3	53865,3	83197,9	33639,1	79679,5	2947,4	838,6	75893,5
2021	244344,5	158597,8	58333,6	91820,0	8444,2	85746,7	4406,8	987,6	80352,3
2022	297811,3	198465,5	60944,2	115805,7	21715,6	99345,8	5946,9	1061,8	92337,1
2023	317616,4	209306,5	77919,2	128757,8	2629,5	108309,9	6184,3	1331,9	100793,7

HƏR NƏFƏRƏ DÜŞƏN MƏHSUL BURAXILIŞI
cari qiymətlərlə, manatla

2018	2019	2020	2021	2022	2023
2065,0	2312,1	2546,5	2466,2	2984,1	3162,1

Figure 1. Statistical data of some economic indicators of Balakan region are given

Dynamics of product release in Sheki-Zagatala economic-geographic region (2018-2023):
Scientific Analysis

Statistical indicators for the years 2018-2023 demonstrate that the economic activity of the Sheki-Zagatala economic-geographical region is moving along the trajectory of sustainable development both in terms of scale and structure. The total volume of product release in six years is 20.2 billion. 31.7 billion manats. Increased to AZN, forming a significant 56-58% increase in the production potential of the economic region. This growth can be assessed as a result of parallel development of industry, agriculture, service sector and trade-infrastructure complex in the region (Mammadov, Imrani, Aghabalayev, Zeynalov, 2025, pp. 581-590).

1. Growth trend of total output

According to the data, the total volume of production in the region has shown a consistent increase for all years:

2018: 20,223.8 million manats

2020: 25,031.8 million manats

2023: 31,761.6 million manats (Mustafabayli, Latifov, Rahimov, Aghabalayev, Suleymanov. 2020, pp. 167-168).

This dynamic shows that economic activity has stabilized, investment attractiveness has increased, and structural renewal has taken place in the regional economy (Mustafabayli, Latifov, 2019, pp. 22-28). Acceleration of growth, especially during 2021-2023, can be associated with the

recovery of economic activity in the region in the post-pandemic period (Mustafabayli, Latifov, Rahimov, Aghabalayev, & Suleymanov, 2019).

2. Development of industry and production areas

While the industrial output was 28,914.1 million manats in 2018, it increased to 77,919.2 million manats in 2023.

This means an increase of approximately 2.7 times, which indicates extremely dynamic industrial development for the region (Mustafabayli, Latifov, Rahimov, Aghabalayev, & Suleymanov, 2020).

This increase can be explained by the following factors:

- ❖ Expansion of the activity of processing enterprises in the food industry;
- ❖ Industrialization of the processing of nuts, honey, tobacco and other agricultural products;

Improvement of production infrastructure and logistics capabilities (On improving the activities of libraries in Azerbaijan: Decree of the President of the Republic of Azerbaijan, 2007).

3. The role of the agriculture, forestry and fishing sector The agricultural sector remains one of the leading functional areas of the economic region.

In 2018, the output of this field was 7,305.2 million manats, and in 2023 it was 12,875.7 million manats .

This increase:

The expansion of hazelnut farming as an export-oriented field, the increase in the number of beekeeping farms,

It is related to the increase of productivity in seed production and crop production. The region's natural and climatic conditions, land resources and settlement system create a favorable basis for the sustainable development of agriculture. Expansion of service areas and trade. While the volume of products released in service areas was 7,839.4 million manats in 2018, it reached 10,830.9 million manats in 2023. This is in the region:

Revitalization of tourism activity, development of public catering and hotel sector,

Related to the expansion of transport and logistics services. The trade and services sector has also shown consistent growth: 7,247.0 million manats in 2018, and 10,079.3 million manats in 2023 (Regional geographical problems of the Republic of Azerbaijan: Balaken district, 1999). Transport, storage and information-communication sectors. In the years 2018-2023, the production output in transport and storage industry increased from 518.9 million manats to 618.4 million manats, and in information and communication from 723.8 million manats to 1331.9 million manats. If the growth in these areas is related to the increase in economic activity on the one hand, it is explained by the digitalization processes and the application of information technologies on the other hand (Yusifova, Aghabalayev, Babayeva, Vysotskyi, 2025, pp. 3-11).

4. Output per capita

In 2018, the output per person was 2065.9 manats, In 2023, this indicator reached 3162.1 manats. This indicator reflects that the economic well-being of the region's population has increased, production efficiency has increased, and the economy has entered the expansion phase (State Program on socio-economic development of the regions of the Republic of Azerbaijan (2004–2008), 2004).



Figure 2. Employees of the Azerbaijan National Academy of Sciences, Sheki Regional Scientific Center, Department of Ecological Geography collecting economic and statistical data in Balakan region (Oktyabr 2025).



Figure 3. Employees of the Azerbaijan National Academy of Sciences, Sheki Regional Scientific Center, Department of Ecological Geography collecting economic and statistical data in Balakan region (Oktyabr 2025).

Conclusion

This study reveals the following results based on the analysis of the socio-economic indicators of Balakan region. The economy of the district is mainly agrarian, based on crop (especially nuts,

tobacco, dates/persimmons, corn) and animal husbandry sectors; The share and structure of agricultural products has been increasing in recent years. The importance of the agricultural sector in the total output of the district is high, and the volume of production has increased in recent years — local executive authorities and statistical sources have recorded an increase in the volume of agriculture and total output in the district (for example, reports on increases in total output and agricultural output). This shows that the natural resource potential of the region (fertile lands, forest resources, water resources) is used to a certain extent. The industrial sector in the region mainly serves the processing of agricultural products — there are hazelnut and other fruit and vegetable processing, canning, tobacco fermentation and small industrial enterprises. However, the industry's value chain is not yet fully verticalized: high value-added processing and export-oriented production volumes are limited, so expansion of processing areas is important to increase both employment and regional profitability potential. As a result of infrastructure and investment policies, socio-economic indicators have improved in recent years; the development of local infrastructure (transportation, irrigation, processing facilities) and state programs of the regions can strengthen the investment flow. However, for sustainable economic development, it is important to target infrastructure projects, improve the investment climate and support small/medium enterprises. Social indicators — population structure and regional employment — play an important role in directing economic sectors. The fact that the majority of the population in Balakand lives in rural areas and the relatively high share of the young generation creates an opportunity for the modernization of agricultural fields, vocational training and increasing business awareness. In this regard, investment in human capital (training, agro-consultation, technical knowledge) should be a priority.

Offers (short and priority directions)

1. Verticalization of agro-processing and strengthening of the value chain: supporting processing enterprises, packaging and branding activities for nuts, dates and other local products.

2. Targeted infrastructure development: reducing crop losses and improving market access through roads, irrigation systems and cold chains.

3. Financial and technical support of small and medium enterprises — formation of cooperatives, credit and insurance mechanisms, agricultural training programs.

4. Integration of tourism and ecotourism opportunities: creation of additional sources of income through mountain-forest resources, festivals and cultural events.

As a result, the economic potential of Balakan region—rich natural resources, traditional specialization in agriculture, and demographic structure—can be translated into higher growth rates through strategic investment and policy measures. The main priorities should be strengthening of agricultural processing, targeted modernization of infrastructure and investments in human capital; these directions will increase the sustainable development of the region and regional competitiveness.

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Climate Risk, Financial Stability, and Green Investment in Emerging Markets: Evidence, Mechanisms, and Policy Imperatives

Abstract

The growing materialization of climate-related financial risks has placed emerging market economies in an increasingly precarious position, caught between the imperatives of sustainable development and the structural vulnerabilities inherent in their financial systems. This article offers a comprehensive, evidence-based synthesis of recent Scopus-indexed research spanning the period 2010–2026, examining how physical and transition climate risks destabilize banking systems, equity markets, and shadow financial intermediaries in developing economies. The paper evaluates the mitigating capacity of macroprudential policy frameworks and green finance instruments—principally green bonds and ESG (Environmental, Social, and Governance) assets—while systematically mapping the institutional and regulatory barriers that constrain the broader adoption of sustainable finance. A distinguishing feature of this synthesis is its integration of the education–technology–economy nexus (Mammadov et al., 2026) and geopolitical risk–green finance interactions (Dilanchiev et al., 2023) as foundational preconditions for effective sustainable investment. Seven testable research hypotheses are advanced and evaluated through the synthesized evidence. The findings carry substantive implications for financial regulators, central banks, government policymakers, and the international development community.

Keywords: *climate risk, financial stability, green investment, green bonds, ESG performance, macroprudential policy, emerging markets, education–technology nexus, sustainable finance*

Introduction

The past decade has witnessed a fundamental reorientation in how economists, financial regulators, and policymakers understand the relationship between environmental change and systemic financial risk. Climate change is no longer treated as an externality remote from the concerns of finance; it has become a first-order determinant of credit quality, asset valuations, liquidity conditions, and macroprudential stability.

This transformation is especially consequential for emerging market economies, which face a distinctive combination of exposures: high physical climate vulnerability, limited institutional capacity to absorb transition shocks, structural dependence on carbon-intensive industries, and financial systems that remain shallow relative to the scale of investment required for a sustainable transition.

The convergence of these vulnerabilities has been compounded by rapid urbanization, the digitalization of financial services, and mounting fiscal pressures—particularly in the aftermath of the COVID-19 pandemic, which simultaneously depleted sovereign fiscal space and accelerated awareness of systemic risk. The growing body of empirical literature emerging in the post-Paris Accord period has begun to map these linkages with increasing precision, yet the field remains fragmented across disciplines and geographies, and comprehensive syntheses that bridge macroprudential finance, green investment theory, and development economics are comparatively rare.

Research

This article responds to that gap by drawing exclusively on Scopus-indexed empirical research published between 2010 and 2026. The synthesis spans three interlocking domains: the destabilizing effects of climate risk on emerging market financial systems; the role of macroprudential policies and green investments in mitigating these effects; and the institutional, regulatory, and human capital barriers that condition the effectiveness of sustainable finance interventions. The paper further integrates recent work on the education–technology–economy nexus (Mammadov et al., 2026) and on geopolitical risk and green finance interactions (Dilanchiev et al., 2023)—contributions that speak to foundational preconditions for effective green finance adoption that are often neglected in the mainstream finance literature.

The paper proceeds as follows. Section 2 presents the theoretical background and advances seven research hypotheses. Section 3 reviews empirical evidence on climate risk and financial stability. Section 4 examines green investment as a mechanism for climate risk mitigation. Section 5 addresses the financial stability implications of green finance. Section 6 explores the human capital and technological preconditions for sustainable finance. Section 7 identifies research gaps. Section 8 presents policy implications, and Section 9 concludes.

2. Theoretical Background and Research Hypotheses

2.1 Conceptual Framework

The analytical framework adopted in this paper rests on three foundational concepts. Climate risk denotes the financial and economic risks arising from climate change, encompassing physical risks (extreme weather, chronic temperature changes, sea-level rise) and transition risks (policy shifts, technological disruption, market repricing of carbon-intensive assets) (Shaik et al., 2026; Liu et al., 2024). Financial stability refers to the resilience of financial systems to withstand shocks while continuing to perform core intermediation functions (Varadi et al., 2026). Green investment denotes capital allocation to projects and assets that support environmental sustainability—renewable energy infrastructure, green bonds, and ESG-screened portfolios (Rabbani et al., 2025).

The transmission channels between these concepts are multiple and interacting. Physical climate shocks impair collateral values, increase default probabilities among exposed borrowers, and generate correlated losses across financial portfolios. Transition risks introduce uncertainty about future carbon costs and regulatory environments, affecting asset pricing and investment horizons. Green finance instruments, by redirecting capital toward lower-risk, climate-resilient activities, can interrupt these transmission channels—but their effectiveness is conditioned by institutional quality, governance frameworks, and the human capital endowments of the economies in question.

This last point connects the green finance literature to the development economics literature on education and technological capacity. Mammadov et al. (2026), examining the education–technology–economy nexus across developing countries, demonstrate that human capital and digital infrastructure are primary determinants of macroeconomic performance—a finding that implies important spillover effects on the institutional capacity required for sophisticated green finance

market operation. Countries investing in their educational systems and digital transformation are, we argue, simultaneously building the analytical and regulatory infrastructure required to implement complex sustainable finance instruments effectively.

The geopolitical dimension adds a further layer of complexity. Dilanchiev et al. (2023) demonstrate that geopolitical risk significantly disrupts green finance flows and crowds out sustainable investment in natural resource-dependent economies—a finding with obvious relevance for the many emerging markets whose developmental trajectory remains anchored in fossil fuel extraction. The interaction between geopolitical risk, resource dependence, and green finance development represents an underexplored but policy-critical nexus that subsequent research must address.

2.2 Research Hypotheses

Drawing on the conceptual framework and the synthesized empirical literature, this paper advances seven testable hypotheses:

H1: *Physical and transition climate risks significantly increase banking instability—as measured by non-performing loan ratios, reduced Z-scores, and heightened credit risk—in emerging market economies, with effects intensifying in the post-Paris Accord period.*

This hypothesis draws on the theoretical prediction that climate shocks impair borrower creditworthiness through asset devaluation and income disruption, while transition risks introduce balance sheet uncertainty through stranded asset exposures. The empirical basis is provided by Syed (2026), Lang et al. (2023), and Ben-Ammar (2025).

H2: *Liquidity-based macroprudential instruments—specifically reserve requirements and currency controls—are more effective than capital-based tools in reducing bank risk under climate uncertainty in emerging market economies.*

The differential effectiveness of macroprudential tool categories has direct policy implications. Jeon et al. (2024) provide the primary empirical foundation for this hypothesis, with implications for supervisory toolkit design in emerging Asia and beyond.

H3: *Green finance development reduces the negative impact of climate risk on banking stability, with the moderating effect being stronger in countries with lower initial financial stability.*

This hypothesis formalizes the countercyclical stabilization function of green finance articulated by Nguyen (2025) and Jadoon et al. (2021). The conditional nature of the effect—stronger where financial systems are more fragile—implies that green finance is most impactful precisely where climate vulnerability is greatest.

H4: *Green bond issuance in Southeast Asian economies generates a significant positive effect on renewable energy consumption, with wind energy exhibiting the largest response relative to other renewable technologies.*

Drawing on panel evidence from Dong et al. (2023) and Tsipas et al. (2024), this hypothesis tests the specificity of green bond transmission mechanisms, distinguishing between energy technology categories. The expected differential response reflects differences in capital intensity, investment horizon, and regulatory maturity.

H5: *Firm-level ESG performance significantly buffers against the negative effects of climate policy uncertainty on corporate financial performance, with the protective effect mediated by reduced information asymmetry and improved investor confidence.*

This hypothesis integrates the ESG-performance and climate policy uncertainty strands of the literature. Brahim and Romdhane (2025) and Xu et al. (2024) provide evidence consistent with both the direct buffering effect and the information asymmetry mechanism.

H6: *Green bonds provide significant hedging and safe-haven benefits for equity investors during acute financial crises, though the magnitude of these benefits diminishes during post-crisis normalization periods.*

The time-varying nature of green bond hedging properties, documented by Arif et al. (2022) and Ren et al. (2023), is important for understanding when climate-aligned portfolios genuinely reduce systemic risk versus when their benefits are more limited.

H7: *Countries with higher educational attainment and greater technological readiness exhibit stronger green finance market development, reflecting the complementarity between human capital, digital infrastructure, and sustainable investment capacity.*

This hypothesis extends Mammadov et al.'s (2026) finding—that education and technology jointly drive economic performance—into the sustainable finance domain. Countries that have built strong human capital and digital capacity are, we argue, better positioned to design, implement, and scale the institutional machinery required for effective green bond markets and ESG investment ecosystems. Dilanchiev et al.'s (2023) findings on geopolitical risk and green finance flows provide a complementary perspective on the structural preconditions for sustainable investment.

3. Climate Risk and Financial Stability in Emerging Markets

3.1 Banking Sector Vulnerabilities

The empirical literature on climate risk and banking stability has expanded rapidly since the Paris Accord, producing broadly consistent findings across diverse country contexts. Climate risk negatively affects bank soundness through multiple interrelated channels: non-performing loan ratios increase as borrowers in climate-exposed sectors face income disruptions; Z-scores decline as earnings volatility rises and capital buffers are eroded; and credit risk premiums widen as lenders price newly recognized exposures.

Syed (2026) provides a comprehensive pre- and post-Paris Accord comparison, documenting that banking regulation and supervisory quality significantly moderate the adverse effects of climate uncertainty on bank stability. This finding has a direct policy implication: the regulatory architecture constructed in response to the Paris Agreement has been effective in partially buffering financial systems against climate-related shocks, but further calibration is needed. Lang et al. (2023)—in a study that explicitly credits the role of Mirza and Umar in developing the emerging market banking-climate risk framework—demonstrate that both physical and transition risks exert meaningful pressure on bank liquidity, with smaller banks and institutions in low-income countries facing particularly acute challenges.

Ben-Ammar (2025) establishes that country-level institutional factors—governance quality, regulatory capacity, rule-of-law indicators—play a crucial moderating role, with stronger institutions enabling more effective absorption of climate shocks. Yu et al. (2025) decompose bank liquidity responses into precautionary hoarding and flight-to-safety components, finding that larger banks benefit disproportionately from the latter mechanism, effectively drawing liquidity away from smaller institutions during climate stress events—a redistributive dynamic that amplifies systemic vulnerability in banking systems with large institutional size disparities.

3.2 Capital Markets and Shadow Banking

Climate risk transmission extends well beyond the banking sector. In equity markets, Derbali (2026) documents that climate risk increases required returns and systematic risk (beta) in climate-sensitive industries, with fossil fuel-intensive firms exhibiting the sharpest vulnerability. The shadow banking sector presents an underexplored transmission channel: Lan et al. (2025) find that climate risk dampens shadow banking activities while simultaneously weakening corporate resilience and inducing capital structure adjustments, with implications for the significant portion of credit intermediation that occurs outside the supervised banking perimeter.

Geographically specific vulnerabilities are important. Prabheesh and Rasheed (2025) demonstrate that small island economies face unique fiscal and credit risk configurations during climate disasters,

with sovereign creditworthiness becoming intimately linked to climate event frequency and severity. In Sub-Saharan Africa, Amo-Bediako et al. (2025) find more limited direct climate-banking linkages, attributing this partly to financial system shallowness—a finding that underscores the importance of developmental context in interpreting climate-financial research.

3.3 Physical Versus Transition Risks

Physical and transition risks operate through different channels and require distinct policy responses. Physical risk research has documented that temperature shocks increase stock market risk premiums in India (Srivastav and Kannadhasan, 2026) and Brazil (Barasal Morales et al., 2025), with firm-level innovation capacity providing partial mitigation. Akshaya and Gopalakrishna (2025) show that temperature anomalies amplify short-run equity volatility while precipitation anomalies have a stabilizing long-run effect—a temporal heterogeneity that carries implications for the appropriate horizon of climate risk assessment.

On the transition risk side, Usmani et al. (2026) establish that climate policy uncertainty elevates short-term market volatility and depresses equity returns, while generating strong positive spillovers to green asset markets. Kumari et al. (2024) document that climate agreements and environmental regulations produce negative abnormal returns in oil and gas sector stocks globally—a finding with direct relevance for fossil fuel-dependent sovereign wealth funds and pension systems in emerging economies. Agrawal et al. (2025) introduce a behavioral dimension, documenting that policy uncertainty alters investor cognition in ways that may amplify market overreaction beyond what fundamental risk assessments would justify.

3.4 Macroprudential Policy Responses

Jeon et al. (2024) find that liquidity-based macroprudential instruments outperform capital-based tools in emerging Asian economies under climate uncertainty, supporting Hypothesis 2. This finding suggests that existing macroprudential toolkits may require rebalancing toward liquidity instruments in climate-stressed environments. Bartsch et al. (2025) provide a technically detailed framework for designing climate-transition-calibrated capital buffers, emphasizing the importance of granular exposure data and forward-looking stress scenarios. DeMenno (2023) argues that integrating climate scenarios into supervisory stress tests is already operationally necessary, not merely technically feasible.

Institutional quality remains a fundamental moderating variable. Ben-Ammar (2025) demonstrates that countries with stronger governance achieve better outcomes from climate-oriented macroprudential interventions, while excessive regulatory constraints can paradoxically limit adaptability—a non-linearity that demands careful calibration to the specific institutional environments of emerging market economies.

4. Green Investment as a Mechanism for Climate Risk Mitigation

4.1 Green Finance Architecture and Developmental Prerequisites

Green investment encompasses a broad spectrum of capital allocation activities oriented toward environmental sustainability. In financial markets, it most commonly refers to green bonds—fixed-income instruments whose proceeds are earmarked for environmental projects—and to ESG-screened portfolios. Both have grown rapidly in volume and sophistication, driven by regulatory initiatives, investor preferences, and the rising material costs of climate risk.

The connection between green finance capacity and broader developmental fundamentals deserves emphasis. Mammadov et al. (2026), examining the education–technology–economy nexus empirically across developing countries using multi-country panel data, demonstrate that educational attainment and technological readiness jointly drive macroeconomic performance: countries investing in human capital and digital transformation achieve higher productivity, stronger innovation capacity, and more diversified economic structures. This foundational insight translates directly into the green finance domain—Hypothesis 7 posits that countries with stronger educational and technological endowments are better positioned to develop and scale sophisticated green finance markets, from the design of bond certification frameworks to the operation of ESG rating agencies to the conduct of climate-adjusted stress tests.

The geopolitical dimension identified by Dilanchiev et al. (2023) adds a critical complication. In natural resource-dependent economies, geopolitical risk can disrupt green finance flows and crowd out sustainable investment, creating a structural tension between resource dependency and green transition that policy must explicitly address. Emerging markets that combine high fossil fuel dependence with elevated geopolitical risk face compounded barriers to green finance development that neither fiscal incentives nor regulatory mandates alone can overcome.

4.2 Green Bonds: Evidence and Mechanisms

Dong et al. (2023) confirm that green bond issuance increases renewable energy consumption across six Southeast Asian economies, with wind energy exhibiting the largest response—consistent with Hypothesis 4. Fu and Ng (2021) document how public-private partnerships in China have successfully scaled renewable energy assets through green bond issuance. Saha and Maji (2025) provide global evidence that green bonds reduce CO₂ emissions, with stronger effects in developing countries—a finding that positions green bonds as potentially most impactful precisely where they are most needed.

Political stability significantly moderates green bond effectiveness: Shah et al. (2025) establish that political stability amplifies the relationship between green bond issuance and clean energy capacity, while Frecautan and Ivashkovskaya (2024) demonstrate that governance quality directly influences green bond yield spreads. Barriers remain formidable in many contexts. Jain et al. (2024) document that Asian green bond markets are constrained by absent certification frameworks and limited private sector participation. Yamahaki et al. (2022) detail the structural barriers specific to Brazil, and De Deus et al. (2022) compare the contrasting trajectories of Brazil and China—with China's top-down regulatory commitment generating far more rapid market development, as documented by Lin and Hong (2022).

4.3 ESG Performance and Firm Resilience

ESG metrics have become central indicators of firm resilience and investor confidence. Bahadori et al. (2021) and Rahat and Nguyen (2024) document positive associations between ESG scores and firm valuation in emerging markets. Kamugisha and Sun (2025) establish that ESG ratings correlate with lower borrowing costs, enhanced creditworthiness, and greater operational efficiency. The information asymmetry mechanism is particularly well-documented: Xu et al. (2024) show that high-quality ESG disclosure reduces investor uncertainty in Chinese listed firms, improving pricing accuracy and reducing equity risk premiums—directly supporting the mediation pathway specified in Hypothesis 5.

Brahim and Romdhane (2025) confirm that strong ESG performance buffers South African firms against climate policy uncertainty, consistent with Hypothesis 5. Deb and Gurugubelli (2025) find that institutional investors mediate the ESG-performance relationship, with environmental factors receiving particular emphasis—a finding that suggests ESG preferences are not merely retail investor phenomena but are embedded in the investment mandates of major institutional capital allocators.

4.4 Green Assets as Safe Havens

The COVID-19 pandemic provided a large-scale natural experiment for the safe-haven properties of green assets. Arif et al. (2022) document meaningful hedging and diversification benefits of green bonds against equity losses during the pandemic, consistent with Hypothesis 6. Ren et al. (2023) confirm safe-haven properties during the acute pandemic phase but document their diminishment in the post-COVID normalization period—precisely as Hypothesis 6 anticipates. Imran and Ahad (2023) show that green bonds exhibited safe-haven properties across both the COVID-19 pandemic and the Global Financial Crisis, establishing that these properties are not pandemic-specific. The conditional character of ESG stock hedging documented by Rubbaniy et al. (2022)—varying with crisis type—provides an important caveat for portfolio managers seeking to exploit green asset safe-haven properties.

5. Green Finance, Financial Stability, and Governance

5.1 Green Finance as Financial Stabilizer

Nguyen (2025) provides the most direct evidence for Hypothesis 3, demonstrating through ASEAN+4 panel data that green finance development reduces bank vulnerability to climate shocks, with the stabilizing effect most pronounced in countries with lower initial financial stability. Gabr and ElBannan (2025) add firm-level evidence that lower carbon emissions associate with higher profitability and greater crisis resilience—creating a direct market incentive for environmental stewardship. Yadav et al. (2026) map dynamic risk transmission among green, energy, and carbon markets in emerging economies, with implications for cross-asset portfolio diversification.

Solangi et al. (2025) extend the analysis to human development outcomes, finding that green finance and social investment jointly reduce poverty in emerging market economies. This result positions green finance not merely as a financial stability instrument but as a contributor to the sustainable development agenda—a connection relevant for multilateral development bank strategy design.

5.2 Central Banks and Government Policy

Ibrahiem et al. (2025) survey the expanding role of central banks in green finance standard-setting and sustainable investment incentivization. Tekdogan (2023) theorizes this development as a new green central banking paradigm. Gupta et al. (2024) provide empirical support: countries facing higher climate risks adopt green financial policies more intensively—suggesting that policy responses are being calibrated to actual vulnerabilities. The Central Bank of Azerbaijan's introduction of a Sustainable Finance Roadmap (2023–2026) and its 2024 green taxonomy—adopted despite the country's fossil fuel dependence—illustrates how institutional reform can advance even in challenging developmental contexts.

China's experimental governance model remains the benchmark case. Cheng and Drahos (2022) document how pilot zones and adaptive governance mechanisms produced the world's largest green credit and bond markets within five years. Hua et al. (2024) and Li et al. (2024) confirm that green finance reforms enhanced corporate green innovation and carbon performance. Ma et al. (2025) add the digital finance dimension, documenting how market-oriented digital governance mechanisms have supported corporate green transition in China.

5.3 Climate Policy Uncertainty and Investment Flows

Climate policy uncertainty (CPU) is an underappreciated but empirically significant risk factor. Usmani et al. (2026) document that CPU elevates short-term market volatility while generating positive spillovers to green assets. Ren et al. (2025) find that CPU's long-run positive influence on green bond investment outweighs negative short-term effects, suggesting green bond market resilience over investment horizons. Wan et al. (2025) show that emerging markets experience stronger CPU volatility spillovers and longer recovery periods than advanced economies—a finding that demands robust, predictable climate regulatory frameworks in developing country contexts. Raza et al. (2024) establish CPU as a significant predictor of volatility in green and sustainable financial indices, with implications for derivatives pricing and risk management.

6. Human Capital, Technology, and the Prerequisites for Green Finance

A dimension of the green finance literature that deserves far greater attention concerns the foundational preconditions for effective sustainable investment. Green bonds, ESG frameworks, and climate-adjusted risk models are complex institutional technologies that require substantial human capital, analytical expertise, and digital infrastructure to design, implement, and credibly monitor. The assumption that these instruments can simply be transplanted from advanced economy contexts into emerging markets—absent the developmental investments required to operate them—is empirically questionable.

Mammadov et al. (2026) provide the most direct evidence for Hypothesis 7, demonstrating through multi-country panel analysis that educational attainment and technological readiness jointly and significantly predict macroeconomic performance in developing countries, with digital transformation amplifying the returns to educational investment through skill complementarities.

Translating this finding into the green finance domain: countries with strong human capital endowments and digital infrastructure are better positioned to train the financial analysts, sustainability officers, regulatory specialists, and ESG auditors that sophisticated green finance market operation requires. They are also better equipped to evaluate complex green finance instruments, detect greenwashing, and design climate-adjusted regulatory stress tests.

Digital finance capabilities deserve particular attention. Ma et al. (2025) document how digital finance mechanisms in China reduce information asymmetries and enable granular monitoring of sustainability performance, supporting corporate green transition. Krykhivska and Romashko (2025) propose blockchain-based verification architectures for green financial products—addressing the credibility problem that remains one of the most persistent obstacles to green bond market development. Both contributions underscore that technological capacity is not merely a background condition for green finance but an active ingredient in its effectiveness, reinforcing the developmental prerequisites identified in Hypothesis 7.

Dilanchiev et al.'s (2023) findings on geopolitical risk and green finance flows add a further dimension: the political economy context shapes whether the technological and human capital investments in green finance infrastructure can actually be mobilized. In highly geopolitically exposed emerging markets, even well-designed institutional frameworks may be disrupted by political instability—a constraint that points toward the need for internationally diversified green finance governance architectures that are more resilient to single-country political shocks.

7. Research Gaps and Future Directions

7.1 Geographical and Sectoral Gaps

The synthesis reveals a striking underrepresentation of African and fossil-fuel-dependent economies. Peprah et al. (2026) document structural challenges in financing green growth across African emerging economies, while Neumann (2023) notes the long distance many developing countries must still travel toward Paris Agreement climate alignment. The overwhelming concentration of empirical studies on Asian and Latin American contexts limits the generalizability of existing findings and leaves policymakers in African economies without a robust empirical basis for regulatory design.

7.2 Micro-Macro Linkages and Dynamic Risk Transmission

The micro-macro linkage problem remains largely unresolved. Arian et al. (2025) call for studies connecting firm-level climate risk exposures to systemic financial outcomes—an aggregation challenge that is shaped by network effects, correlation structures, and the distribution of exposures. Yadav et al. (2026) identify limited understanding of dynamic risk transmission mechanisms between green, energy, and carbon markets as a key empirical gap. Yang and Geng (2025) document the need for more granular disaggregation of climate risk financial impacts by firm type and sector. Big data and machine learning approaches offer promising methodological pathways for mapping these dynamics in real time (Suciati, 2025).

7.3 The Education–Technology–Green Finance Nexus

Hypothesis 7 identifies a research gap that has not yet been directly addressed in the empirical literature: the systematic relationship between human capital, technological capacity, and green finance market development. The parallel literatures on education-driven economic development (Mammadov et al., 2026) and sustainable finance have not yet been integrated into a unified empirical framework. This integration would enrich both literatures and would provide actionable guidance for development aid allocation and capacity-building program design.

8. Policy Implications

8.1 For Financial Regulators

Macroprudential frameworks should be recalibrated to integrate climate risk scenarios into regular stress testing, prioritize liquidity-based instruments over capital tools in climate-stressed environments (Jeon et al., 2024; Bartsch et al., 2025), and develop differentiated regulatory strategies for smaller banks and low-income country institutions (Yu et al., 2025). ESG disclosure standards

should be harmonized to reduce information asymmetries that inflate green capital costs (Qachach et al., 2025).

8.2 For Financial Institutions

Progressive institutions should integrate climate risk management proactively—before regulatory mandates require it—to gain first-mover advantages in green finance markets. Green bond portfolios and ESG-screened holdings offer both direct risk management benefits and crisis-period hedging properties (Arif et al., 2022; Ren et al., 2023). Investment in digital finance capabilities—blockchain verification, AI-assisted climate risk modelling, real-time ESG monitoring—can enhance the efficiency and credibility of green finance operations (Ma et al., 2025).

8.3 For Governments

Public–private partnerships in green bond issuance can overcome market development bottlenecks (Fu and Ng, 2021). Green taxonomies, tax incentives, and first-loss guarantees can reduce private investor risk premiums. Crucially, the evidence on the education–technology–green finance nexus suggests that investments in educational systems and digital infrastructure—of the type empirically validated by Mammadov et al. (2026)—may generate important spillover effects on sustainable finance market development, creating a compelling case for cross-sectoral investment strategies.

8.4 For the International Community

Capacity-building programs that develop financial regulatory expertise, ESG analytical capacity, and green bond market infrastructure can address the human capital constraints that Hypothesis 7 identifies as fundamental. Harmonized international standards for ESG disclosure and green bond certification would reduce transaction costs and expand emerging market access (Dung and Hanh, 2025). Knowledge exchange programs that diffuse China's experimental green finance governance model (Cheng and Drahos, 2022) can reduce learning costs for countries at earlier developmental stages.

Conclusion

This article has synthesized a substantial body of Scopus-indexed empirical research on the nexus between climate risk, financial stability, and green investment in emerging markets, organized around seven research hypotheses and enriched by recent contributions on the education–technology–economy nexus (Mammadov et al., 2026) and geopolitical risk–green finance interactions (Dilanchiev et al., 2023).

The evidence reviewed supports four broad conclusions. First, climate risk constitutes a systemic threat to emerging market financial systems, operating through banking instability, capital market volatility, shadow banking disruption, and geopolitical risk interactions—with the severity of these impacts significantly moderated by institutional quality and macroprudential policy design. Second, green investments serve a dual function as climate risk mitigants and financial stabilizers, with demonstrated effectiveness in both normal and crisis-period market conditions. Third, the transformative potential of green finance is substantially constrained by regulatory fragmentation, institutional weakness, information asymmetries, and the human capital and technological capacity gaps that characterize many emerging market environments—constraints that must be addressed through coordinated developmental investments. Fourth, the seven hypotheses advanced in this paper chart a research agenda that connects financial stability analysis, green investment theory, development economics, and governance studies in ways that the existing literature has not yet fully integrated.

The policy implication is clear: emerging markets require not only better-calibrated climate-financial regulatory frameworks but also the foundational investments in education, technology, and institutional capacity that make those frameworks effective. Climate risk is already reshaping financial systems whether or not regulatory frameworks acknowledge it. The question facing emerging market policymakers is not whether to integrate climate considerations but how to do so in

ways that protect financial stability and enable the sustainable development trajectories their populations require.

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Khankendi Summit of the Economic Cooperation Organization: its Decisions and Significance

Abstract

The Economic Cooperation Organization (ECO) summit held in Khankendi is an important event in terms of strengthening regional cooperation and economic integration. The summit was organized at the initiative of the Republic of Azerbaijan and aimed to present the process of restoration and development of Karabakh on an international platform and ensure stability in the region. The speeches of the heads of state participating in the event reflected a common will on regional stability, energy security, development of transport corridors, expansion of trade relations, digital economy and environmental problems.

At the end of the summit, decisions were made to increase trade turnover, develop strategic transport routes, promote energy and green technology projects, as well as increase support for the restoration of Karabakh. This event marked the beginning of a new stage in the activities of the ECO and created conditions for strengthening cooperation between member countries, ensuring regional stability and promoting sustainable development.

Keywords: *Khankendi summit, transport corridors, energy projects, digital economy, environmental security, restoration of Karabakh, sustainable development*

Introduction

The role of regional cooperation organizations in the modern system of international relations is increasing and strengthening. These organizations, in addition to deepening economic integration between member countries, also contribute to strengthening mutual trust, ensuring stability and realizing sustainable development. One of them, the Economic Cooperation Organization, attracts attention with its wide geographical coverage and promoting strategic cooperation between member states. The holding of the organization's last summit in the city of Khankendi, Azerbaijan, is of particular importance from both political and economic perspectives. This event not only opened a new stage in the activities of the Economic Cooperation Organization, but also demonstrates the initiative role of the Republic of Azerbaijan in regional cooperation and the importance of international support in the development of the Karabakh economic region.

The Economic Cooperation Organization was established in 1985 at the initiative of Iran, Turkey and Pakistan. The basis of this organization was the Regional Cooperation Organization, which was formed earlier in 1964. The main goal of the new organization was to strengthen economic integration between member countries, increase trade turnover, and implement joint projects in the fields of energy and transport.

Research

The Economic Cooperation Organization includes 10 states: Azerbaijan, Afghanistan, Iran, Kazakhstan, Kyrgyzstan, Pakistan, Tajikistan, Turkey, Turkmenistan and Uzbekistan. These countries cover a large geographical area and have rich natural, especially energy, resources. In 1992, the Central Asian countries and the Republic of Azerbaijan joined the organization, further expanding the geography and importance of the ECO.

The main goals of the ECO include expanding trade between member countries, integrating infrastructure, especially transport and communication networks, promoting mutually beneficial cooperation in the energy sector, implementing joint projects in the fields of industry and agriculture, and exchanging experience in the field of science, technology and culture. Various programs and projects are implemented within the framework of the ECO, including through institutions such as the ECO Trade and Development Bank, the ECO Transport Master Plan, and the ECO Statistical Committee (Economic Cooperation Organization, n.d., p. 3).

The main objectives of the Republic of Azerbaijan's accession to the ECO were to integrate into regional economic cooperation, participate in regional projects in the fields of trade, transport and energy, develop economic relations with the Islamic world and Turkic-speaking countries, and strengthen its position at the international level as a newly independent state. The Republic of Azerbaijan takes an active position within the organization and comes up with important ECO initiatives in many areas. In the field of transport and logistics, the Baku-Tbilisi-Kars railway, Baku International Sea Trade Port and the Middle Corridor (Trans-Caspian international transport route) projects enabled the Republic of Azerbaijan to become a transit center within the ECO.

By cooperating in the field of energy, the Republic of Azerbaijan participates in ECO energy projects to bring the energy resources of the Caspian Sea to international markets. Through economic forums and meetings, Azerbaijan has hosted a number of ECO summits and come up with initiatives supporting the organization's activities. The membership of the Republic of Azerbaijan in the ECO has accelerated the country's integration into the regional economic system, increased trade and transport opportunities, and strengthened its international reputation. Within this organization, the Republic of Azerbaijan, in addition to implementing projects in line with its national interests, contributes to the deepening of stability and cooperation in the region.

The OIC faces a number of difficulties in achieving its goals. Thus, political disagreements between member countries, insufficient relations in the field of transport and logistics, institutional weakness, bureaucratic obstacles and insufficient attraction of foreign investments prevent the organization from fully utilizing its potential. However, in recent years, against the background of increasing integration trends and changing global economic trends, the role of the OIC has become relevant again. The OIC is one of the rare regional platforms that unites different regions of Asia. If coordination between member states is strengthened and a common economic strategy is formulated, the organization can become a more effective regional powerhouse in the future. The initiative of the Republic of Azerbaijan and its growing role in the region are of particular importance in this regard. The successful future of the OIC will depend on the commitment of member states to cooperation and institutional reforms.

The 17th Economic Cooperation Organization (ECO) Summit was held in Khankendi, Karabakh region of the Republic of Azerbaijan, on 3–4 July 2025. The meeting was organized under the slogan "New ECO Summit: A Sustainable and Climate-Resilient Future" was held. Before the summit, the Youth Forum was held in Agdam on July 1, the Women's Forum in Lachin on July 2, and the 6th ECO Business Forum was held in Shusha.

The organization of the 17th summit of the Economic Cooperation Organization in Khankendi at the initiative of the Republic of Azerbaijan is of particular importance both politically and symbolically. Holding an international event in this city for the first time after the end of the long-standing conflict and the full reintegration of the Karabakh region is not only an affirmation of the sovereign rights of the Republic of Azerbaijan, but also marks the beginning of a new stage of development in the region. Our Republic tried to achieve several important goals with this initiative. First of all, the intention was to demonstrate to the whole world that Karabakh had transformed from a conflict zone into a zone of cooperation and stability (European Bank for Reconstruction and Development, 2023–2024, p. 112). On the other hand, holding the summit in Khankendi demonstrated to the international community the commitment of the Republic of Azerbaijan to the policy of peace and cooperation. This step also showed that the economic potential of the region is open to international projects, and that the process of Karabakh's restoration and development can bring

beneficial results not only for the Republic of Azerbaijan, but also for the entire Organization of Islamic Cooperation (Aliyev, 2023, p. 112) Thus, this decision, implemented at the initiative of the Republic of Azerbaijan, can be assessed as a strategic step in terms of both strengthening the country's diplomatic position and expanding regional cooperation.

The summit of the Economic Cooperation Organization held in Khankendi was characterized by a high level of organization and a rich agenda. The event hosted by the Republic of Azerbaijan was attended by heads of ECO member states, government representatives and international observers. The venue where the summit was held was specially restored and equipped with modern technical facilities, which demonstrated the achievements achieved in the process of Karabakh's reconstruction.

The summit's agenda included issues of expanding regional economic cooperation, developing transport corridors, prospects for energy projects, increasing trade turnover, as well as solving digital economy and environmental problems. In particular, the opening of the Zangezur corridor, the diversification of East-West and North-South transport lines were among the main topics of discussion (Hasanov, 2025, p. 47).

At the 17th Summit of the Economic Cooperation Organization held in Khankendi, many important and topical issues were discussed. These included 1. Strengthening regional economic cooperation - increasing trade volume between the ECO countries, promoting investment, and creating a free trade zone. Initiatives for digitalization, simplification of customs procedures, and optimization of border crossings were put forward. 2. Integration in the field of transport and logistics - the importance of projects such as the Middle Corridor (Trans-Caspian International Transport Route) and the North-South transport corridor was emphasized. The expansion of intra-regional railways, highways, and air connections was presented as a key priority (Asian Development Bank, 2023, p. 24). 3. Energy security and green energy - Issues such as diversification of energy resources, expansion of renewable energy projects and establishment of sustainable energy platforms were discussed. The ECO Clean Energy Centre has been launched, institutional foundations of energy cooperation will be strengthened (International Energy Agency. World Energy Outlook, 2023, p. 58). 4. Restoration of Karabakh and East Zangezur and the Great Return - President Ilham Aliyev provided detailed information on the reconstruction work carried out in the liberated territories, infrastructure projects, the process of demining and the return of the population. It was emphasized that these territories could be a development model for the ECO. 5. Environment and climate change - Since the Summit was held under the slogan "Sustainable and Climate - Sustainable Future", the fight against climate change, ecological stability, green economy and zero waste initiatives were at the forefront. The President of Kyrgyzstan proposed a new platform called "Mountain Youth and Climate" (United Nations. Transforming our world: The 2030 Agenda for Sustainable Development). 6. Gender equality and social inclusion - The role of women in regional development, gender equality, and support for social initiatives were discussed within the framework of the OIC Women's Forum held in Lachin. The leadership role of Azerbaijan's First Vice President Mehriban Aliyeva and Turkey's First Lady Emine Erdoğan in the "Zero Waste" initiative was specially noted. 7. Science, education and technology - An OIC Artificial Intelligence Center to be established in Iran was proposed. Education, youth exchange and technological innovation programs will be supported within the framework of the ECO. 8. International politics and security - There were speeches on the Israeli-Palestinian conflict and Iran's territorial integrity. Turkey and Iran noted the need to maintain regional stability, dialogue and take international law as the basis. such topics include (Organization of Islamic Cooperation. Economic Outlook Report, 2024, p. 77).

During the event, a number of bilateral and multilateral meetings were held between the participants and negotiations were held to bring cooperation opportunities to a more concrete level. The summit attracted attention with its businesslike atmosphere, as well as the spirit of mutual trust and cooperation, and created a solid foundation for future cooperation.

President of Azerbaijan Ilham Aliyev, speaking at the 17th OIC Summit, emphasized the special symbolic significance of holding the summit in Khankendi. He said that this city is hosting an international event for the first time after many years of occupation, and this is of great importance

as a confirmation of Azerbaijan's sovereignty. The President drew attention to Azerbaijan's economic achievements and noted that nearly \$350 billion has been invested in the country's economy over the past 20 years, half of which is foreign investment. He noted that Azerbaijan currently exports gas to 12 countries and plays the role of a reliable energy supplier in the region. In his speech, the President emphasized that large-scale restoration and reconstruction work is being carried out in Karabakh and East Zangezur, and noted that Armenia has placed more than 1 million mines in those areas, as a result of which nearly 400 people have been killed or injured. Recalling that more than a million Azerbaijanis were deported from their native lands as a result of ethnic cleansing during the occupation, he noted that their right to return with dignity is enshrined in international documents. It was noted that a Youth Forum was held in Agdam, a Women's Forum in Lachin and a Business Forum in Shusha prior to the summit, and that these events served to strengthen cooperation within the organization. It was noted that work was in the final stages towards establishing the ECO Clean Energy Center and the ECO Research Center in Azerbaijan. The President emphasized that the declaration of Shusha as the ECO Tourism Capital in 2026 was an important step in terms of the development of the region. In the field of transport, Azerbaijan has become a key participant in the North-South and East-West corridors, and the country has become a regional logistics center in these directions.

It was stated that it played a role as. Ilham Aliyev's speech reflected the economic power of the Republic of Azerbaijan, energy leadership, the recovery process and its contribution to regional cooperation (Aliyev, 2025, p. 102).

Turkish President Erdogan, in his speech at the 17th ECO Summit held in Khankendi, covering the organization's cooperation opportunities and regional issues, noted that Turkey attaches great importance to regional stability. He emphasized the symbolic importance of holding the summit in Khankendi and stated that the city would become a center of peace and development in the Caucasus. Erdogan proposed to increase regional trade turnover to \$100 billion and implement the 2035 Strategy in order to strengthen economic cooperation. At the same time, he noted the "Zero Waste" initiative, Turkey's "net zero carbon" target by 2053 and the initiative to establish clean energy centers in the Republic of Azerbaijan. The President, who also touched upon regional security in his speech, criticized Israel's policy and defended the primacy of international law in the Palestinian issue. He called for ensuring peace and development in Afghanistan and Syria. Erdogan also stressed the importance of expanding the relations of the Turkish Republic of Northern Cyprus with the ECO. These speeches reflected Turkey's position in the organization and regional integration initiatives. (Hasanov, 2025, p. 88).

President of Kyrgyzstan Sadyr Japarov stressed the importance of the link between economic development and climate change. He put forward joint cooperation initiatives in areas such as the creation of the "Mountain Youth and Climate" international platform, smart infrastructure for agriculture and green energy. He raised the issues of simplifying border crossing procedures, unifying tariffs and digitizing logistics (Guliyev, 2025, p. 95).

Iranian President Masoud Pezeshkian, commenting on the events between Iran and Israel, assessed the attacks as a violation of international law. He stated that Iran responded to targeted operations against nuclear facilities and civilian objects on its territory and disrupted the enemy's plans. He put forward proposals to establish an "Artificial Intelligence Center" and a Free Trade Zone within the ECO by 2025.

At the Economic Cooperation Organization summit held in Khankendi, representatives of the participating states highlighted a number of important points in their speeches. First of all, it was emphasized that lasting peace and stability in the region are the main conditions for economic development. The leaders who spoke specifically noted that the reconstruction and construction work in Karabakh opens up new opportunities for international cooperation (Mammadov, 2021, p. 75).

The leaders of the member states focused on the issues of diversification of energy resources, development of alternative and green energy sources, ensuring energy security. Expansion of transport corridors and increasing transit opportunities, especially the strategic importance of the

Zangezur corridor for the region, were one of the main topics of the speeches. In addition, increasing trade turnover, simplifying cooperation in the field of customs and logistics, developing the digital economy and e-commerce were indicated as important directions. The participants also called for solving environmental problems, joint fight against climate change, and implementation of sustainable development goals emphasized the importance of the joint activities of the Organization of Islamic Cooperation in holding the 2015 Summit.

At the Khankendi Summit, the Economic Cooperation Organization adopted a number of important decisions. Their main directions are as follows:

1. Strengthening trade and economic relations - It was decided to develop new mechanisms to increase trade turnover between member countries and simplify customs procedures.

2. Expanding transport and transit opportunities - Supporting the development of the Zangezur corridor and other strategic transport lines, increasing the transit potential of the region were among the main priorities of the summit (World Bank, 2022, p. 35)

3. Energy and green technologies - It was decided to implement joint projects aimed at the efficient use of energy resources, the development of alternative and renewable energy sources, as well as ensuring energy security.

4. Digital economy and innovations - Strengthening cooperation in the field of e-commerce, digital services and technology, and establishing new innovative platforms were among the issues highlighted at the summit (United Nations Development Programme, 2021, p. 89).

5. Ecological and sustainable development issues – It was decided to implement joint measures against climate change, ensure environmental security and prepare sustainable development strategies (European Bank for Reconstruction and Development, 2024, p. 3).

6. Karabakh restoration and development projects – Increasing support for the socio-economic development of the region, implementation of infrastructure projects with the participation of the member states of the Organization of Islamic Cooperation was given special attention at the summit (State Statistical Committee, 2023, p. 210).

The Khankendi summit is of great importance for the Economic Cooperation Organization from both a symbolic and practical point of view. First, the event served to strengthen regional stability and increase trust between member countries. Through this summit, the Republic of Azerbaijan presented the process of restoration and development of Karabakh on an international platform and demonstrated the potential for reconstruction of the region.

Secondly, the decisions of the summit gave impetus to the expansion of economic and trade relations between the member states, the development of transport and energy projects. This is of practical importance in the implementation of the strategic goals of the Economic Cooperation Organization and serves to strengthen regional integration.

Thirdly, the summit created conditions for promoting joint activities in such future-oriented areas as climate change, environmental security and the digital economy. In this regard, the event serves as a platform not only for economic cooperation, but also for sustainable development and technological progress. Thus, the Khankendi summit symbolizes the beginning of a new stage in the activities of the Economic Cooperation Organization and plays an important role in the socio-economic development of the region.

As a result of the seminar, the Khankendi Declaration was adopted - the declaration highly appreciated the reconstruction work carried out in the Karabakh and East Zangezur regions of the Republic of Azerbaijan and confirmed the right of deported Azerbaijanis to return with dignity. The statement specifically noted that the “Zero Waste” initiative is led by female leaders - First Vice President of the Republic of Azerbaijan Mehriban Aliyeva and First Lady of Turkey Emine Erdogan. It was recommended to launch the OIC Clean Energy Center, expand the OIC Research Center, strengthen the mandates of structures such as the OIC Trade and Development Bank and chambers of commerce, and the Single Information Space. In addition, urban planning and sustainable development of the urban environment were highlighted as important topics. Thus, the importance of the World Urban Forum to be held in Baku next year was emphasized.

The final document of the summit, the “Khankendi Declaration”, was adopted. In this document, the member countries expressed their support for the territorial integrity and sovereignty of Azerbaijan, highly appreciated the restoration and reconstruction work carried out in Karabakh and East Zangezur, and recognized and supported the right of return of Azerbaijanis who were subjected to ethnic cleansing in the region. Hamshi's member states agreed that a strategic roadmap for the economic and institutional development of the OIC for the coming decade will be prepared. In particular, the OIC Clean Energy Center began its activities to strengthen regional cooperation on alternative and renewable energy. At the initiative of Iran, a proposal was put forward to establish the OIC Artificial Intelligence Center. The results of the Lachin Women's Forum and the Aghdam Youth Forum were supported to increase the role of youth and women. Initiatives were agreed on simplifying customs procedures, promoting digital trade and developing free trade zones among member states.

Conclusion

The Economic Cooperation Organization summit held in Khankendi was a significant turning point in the history of regional cooperation. The summit not only aimed to strengthen economic and trade relations of the Economic Cooperation Organization member states, but also served to provide international support for the restoration and development of Karabakh. It showed that the territorial integrity of the Republic of Azerbaijan over Karabakh is recognized internationally. Holding a global event in the liberated territories demonstrated the successful restoration and development strategy of the Republic of Azerbaijan in the post-conflict period. At the summit, the heads of state and government of 10 countries demonstrated a common position, which strengthened economic and political solidarity in the region. Member countries indirectly criticized Armenia's aggressive policy and supported the Republic of Azerbaijan. Agreements on the Middle Corridor, North-South transport route and Caspian energy projects on the ECO agenda received more concrete content at the summit. The summit was remembered for initiatives in the fields of climate change, green energy and zero waste. The “Zero Waste” movement and green energy cooperation were aligned with sustainable development goals. In conclusion, the 17th ECO Summit held in Khankendi strengthened the position of the Republic of Azerbaijan as a regional leader, deepened economic cooperation between member countries, presented the restoration of Karabakh as a model of regional development and made practical decisions on the preparation of strategic documents for the future of the organization (International Monetary Fund, 2024, p. 39).

The decisions taken within the framework of the event – increasing trade turnover, developing transport corridors, expanding cooperation in the fields of energy and the digital economy – were an indicator of the common will of the member states. At the same time The summit focused on environmental issues and sustainable development goals, creating an opportunity to form a strategic vision for the future.

Thus, the Khankendi summit is of particular importance in terms of strengthening regional stability, deepening economic integration and increasing the international prestige of the Republic of Azerbaijan. This event symbolizes a new stage of mutual cooperation between the member states of the Economic Cooperation Organization and creates the basis for the implementation of broader economic, social and technological projects in the future.

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Assessing the Impact of Green Financial Instruments on Sustainable Economic Development

Abstract

This study examines the impact of green financial instruments on sustainable economic development. As global environmental challenges intensify, financial systems are increasingly required to support low-carbon and resource-efficient growth models. Green financial instruments, including green bonds, green loans, sustainability-linked bonds, and carbon markets, have emerged as effective mechanisms for mobilizing capital toward environmentally responsible projects. The paper analyzes the environmental, economic, and social contributions of these instruments, highlighting their role in reducing carbon emissions, promoting renewable energy investment, fostering technological innovation, and enhancing long-term financial stability. Furthermore, it evaluates empirical evidence demonstrating the positive relationship between green finance development and sustainable growth indicators. Despite their potential, green financial instruments face challenges such as greenwashing, regulatory fragmentation, and lack of standardized reporting frameworks. The study concludes that strengthening regulatory systems, improving transparency, and encouraging international cooperation are essential to maximize the effectiveness of green finance in achieving sustainable economic development objectives.

Keywords: *green finance, sustainable economic development, green bonds, carbon markets, low-carbon economy, sustainable investments*

Introduction

Global warming, driven by the accumulation of greenhouse gases such as water vapor, carbon dioxide (CO₂), and methane (CH₄), poses significant risks to both the economy and human welfare. These gases trap solar infrared radiation, leading to rising temperatures that negatively affect natural resources, productivity, and social well-being. Under the European Green Deal, transitioning to a carbon-neutral economy, with decarbonization of industry and the adoption of clean technologies, is critical for long-term sustainable economic development. In this context, green financial instruments—including green loans, carbon taxes, and sustainability-linked investments—emerge as key mechanisms for directing economic activities toward decarbonization.

Green finance stimulates economic transformation by promoting investments in energy efficiency, climate resilience, carbon management, and renewable energy. Moreover, foreign direct investment and government incentives encourage research and development in low-carbon technologies, fostering productivity growth and innovation. These mechanisms not only attract capital but also create employment opportunities, enhance social inclusion, and improve income distribution (Viktor, 2022, pp. 47-48).

Empirical evidence indicates that green finance supports environmental protection while simultaneously strengthening economic stability and long-term growth. Green bonds and sustainability-linked investments incentivize innovation, contribute to capital accumulation, and promote the efficient use of resources. By integrating ecological criteria into financial markets, green finance accelerates low-carbon economic transformation and reinforces the economic foundations of sustainable development.

This study aims to analyze the impact of green finance on economic, social, and environmental sustainability in high and upper-middle-income countries. Using panel data from 2015 to 2024 and applying CS-ARDL and cointegration models, the research examines how green finance promotes economic growth, mitigates environmental degradation, and enhances social welfare. The approach highlights the pivotal role of green financial instruments in aligning economic development with sustainable development objectives. (Akhtar, 2026). *The Role of Green Finance in Advancing Sustainable Development: An Analysis of Financial Instruments and Their Impact on Economic and Environmental Goals*. Springer Nature Switzerland.

Research

Sustainable finance generates a dual impact by integrating environmental protection and long-term economic growth into financial and investment decisions. On the one hand, it influences both the demand and supply dimensions of environmental sustainability. By channeling financial resources toward environmentally friendly initiatives, green finance increases consumer demand for greener goods and services while motivating firms to adopt sustainable and eco-conscious production methods.

In addition, areas such as sustainable finance, green technological innovation, renewable energy, and financial inclusion have been widely recognized as key contributors to reducing environmental degradation. Renewable energy, in particular, sends strong signals about environmentally responsible development and supports sustainable transformation. Advances in renewable energy technologies play a crucial role in lowering greenhouse gas emissions and fostering environmentally sustainable growth (Muhammad, 2025).

The global green finance market has experienced significant expansion in recent years, with its proportion within the overall financial market increasing markedly. In 2021, green finance accounted for nearly 4% of total finance, compared to only about 0,1% in 2012, reflecting a strengthening dedication to sustainability across the financial sector.

At the same time, the broader sustainable finance market demonstrated notable growth, reaching a value of USD 4,562.85 billion in 2022. This upward momentum persisted into 2023, as the issuance of sustainable finance products amounted to \$ 717 billion during the first half on the year. Future outlooks indicate ongoing expansion, with the market expected to grow at a compound annual growth rate (CAGR) of 22,4 % from 2023 to 2032. Overall, these developments signal a transformative shift toward environmentally responsible investment strategies and emphasize the rising significance of embedding sustainability principles into financial decision – making on a global scale. (Yarong, 2025, p. 11)

Table 1.

Key Indicators of Green Finance Development in Emerging Markets.

Indicator	2000-2010	2011-2015	2016-Present
Green Bond Issuance	Limited	Increasing	Significant growth
Policy Frameworks	Ad hoc	Developing	Comprehensive
ESG Integration	Minimal	Developing	Mainstream
Sustainable Finance Initiatives	Few	Expanding	Widespread
Innovative Instruments	Rare	Limited	Increasing
Regional Focus	Project-specific	China, India, Brazil	Expansion to other regions

Source: (Andreeva et al., 2018; Franczak & Warner, 2025; Goel et al., 2022; IFC, 2023; Mudalige, 2023) information elaborated by the author.

Green finance involves a variety of financial tools, policies, and strategies aimed at directing investments toward environmentally sustainable projects and initiatives, with the primary objectives of addressing climate change, enhancing resource efficiency, and supporting inclusive economic growth. In emerging markets and developing economies (EMDEs), green finance has evolved considerably over time. Beginning in the early 2000s with limited uptake and a focus on conventional project financing, it progressed through the emergence of green bonds and supportive policy frameworks between 2011 and 2015, and entered a period of global commitment and sustainable finance from 2016 onwards, influenced by the Paris Agreement and the Sustainable Development Goals.

Despite these advancements, challenges remain, such as fragmented data and regulations, large financing gaps—especially for nature-based solutions (NbS) and transition finance—misaligned institutional frameworks, and the integration of social considerations into green finance initiatives. To accelerate the shift toward a sustainable, low-carbon economy, emerging markets need to address these obstacles while capitalizing on new opportunities. (Azad, Shivam, & Tulasi Devi, 2025).

The global transition toward a low-carbon and sustainable economy requires substantial investments, which can only be realized through active participation of the private sector. Green finance plays a crucial role in this transition by integrating environmental externalities into financial decision-making and mitigating perceived investment risks. Expanding green finance on a broad, economically sustainable scale ensures that projects aligned with environmental objectives are prioritized over conventional investments, which often reinforce unsustainable growth patterns. By fostering transparency and promoting long-term planning, green finance channels resources toward initiatives aligned with the environmental criteria outlined by the United Nations Sustainable Development Goals (SDGs). Green finance encompasses a wide range of financial products and services, broadly categorized into investment, banking and insurance instruments. Debt and equity remain the predominant tools in this domain. In response to rising demand, innovative instruments and dedicated institutions have been established. Investment activities in renewable energy and sustainable infrastructure continue to attract significant attention.

Sustainable finance extends these principles across financial sectors and asset classes by embedding environmental and social considerations into investment analysis into risk management processes. Reporting has evolved from a niche practice a mainstream requirement with potential balance sheet implications, prompting investors to seek clarity on how performance is assessed and managed. A notable issue is the mismatch between the horizon of green projects and the relatively of many investors. Furthermore, financial and environmental policies have often lacked coordination, limiting effective capital allocation. To scale up private sector involvement, governments can collaborate with diverse stakeholders to enhance capital flows, develop innovative financial approaches across various asset classes and implement capacity-building initiatives. (Damaniya, 2021)

From an economic perspective, the green economy concept emphasizes the role of biological processes, particularly plant-based primary production, in goods and services the efficient use of solar energy, without causing environmental harm. This positions green economy and growth as integral tools for achieving sustainable and balanced development. The theoretical-conceptual perspective underpins strategy development and program planning. This integration multiple dimensions, along intergenerational equity, forms the foundation for initiatives and evolving objectives. The economy provides an operational framework for distinguishing itself from development as a strategic instrument for achieving broader goals. The limitations of traditional industrial-market development models became evident as environmental degradation and climate change emerged as pressing issues. This recognition led to the conceptualization of development alongside related concepts. Threats arising from resource depletion and underscored the necessity of conserving biodiversity, ecological functions. (Mieczysław, 2022)

Conclusion

Green financial instruments play an increasingly important role in supporting sustainable economic development by integrating priorities into financial activities. These instruments facilitate the allocation of financial resources to environmentally friendly projects, promote efficient use of natural and encourage the transition toward low-carbon economic systems. Despite their growing importance, the successful implementation of green instruments requires effective regulatory mechanisms, clear standards. Existing challenges, including the risk of misleading claims, limited awareness among market participants and insufficient policy, may reduce their overall effectiveness. Therefore, strengthening improving monitoring systems and enhancing cooperation between public and private sectors are essential for maximizing their impact. As a result, they contribute not only to environmental protection but also to long-term economic stability and social welfare.

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Economic Efficiency Assessment of Drilling Highly Deviated Wells in the Oil and Gas Industry

Abstract

The drilling of highly deviated and horizontal wells has become a key technological advancement in the oil and gas industry, enabling access to complex reservoirs and improving hydrocarbon recovery rates. However, these operations are often associated with increased technical challenges, higher operational risks, and elevated costs. This study focuses on the evaluation of the economic efficiency of drilling highly deviated wells by analyzing both technical and financial indicators. Key factors such as drilling time, equipment utilization, well trajectory design, and operational risks are examined to determine their impact on overall project costs and productivity.

Furthermore, the research highlights the importance of optimization strategies, including advanced drilling technologies, real-time monitoring systems, and efficient resource management, in reducing expenditures and improving performance. Comparative analysis between conventional and highly deviated wells is also conducted to assess cost-benefit ratios and long-term economic outcomes. The findings suggest that despite higher initial investments, highly deviated wells can provide significant economic advantages through increased production rates and improved reservoir contact when properly planned and managed.

This study contributes to the development of more effective decision-making frameworks for drilling operations, emphasizing the integration of technical innovation and economic evaluation to achieve sustainable and cost-efficient outcomes in the oil and gas sector.

Keywords: *highly deviated wells, oil and gas industry, economic efficiency, drilling optimization, cost analysis, horizontal drilling, operational risk, resource management, drilling technologies, productivity*

Introduction

The oil and gas industry plays a crucial role in the global economy by ensuring energy supply, supporting industrial development, and contributing significantly to national revenues. As easily accessible hydrocarbon reserves continue to decline, the industry is increasingly turning toward more complex and technically demanding extraction methods. Among these, the drilling of highly deviated and horizontal wells has emerged as one of the most effective approaches for maximizing reservoir exploitation, especially in challenging geological environments. These advanced drilling techniques allow operators to reach previously inaccessible reserves, enhance well productivity, and increase overall recovery factors. (Yu, Wang, Dong, Tai, Chen, Zhou, & Sun, 2025)

Highly deviated wells are characterized by significant angular deviation from the vertical axis, often extending into horizontal sections that provide greater contact with hydrocarbon-bearing formations. This extended reach enables more efficient drainage of reservoirs, particularly in thin, fractured, or low-permeability formations where conventional vertical wells may be insufficient. As a result, such wells have become increasingly popular in both onshore and offshore operations, including mature fields where maximizing recovery is a priority. (Ponomarenko, Marin, & Galevskiy, 2022)

Despite their numerous advantages, the drilling of highly deviated wells presents substantial technical and economic challenges. Complex well trajectories require advanced planning, precise directional control, and the use of specialized equipment and technologies. Issues such as torque and drag, wellbore instability, drilling fluid management, and increased wear on drilling tools can lead to higher operational risks and costs. Additionally, the need for highly skilled personnel and sophisticated monitoring systems further contributes to the overall expenditure associated with these projects. (Ghosh, 2022)

In this context, evaluating the economic efficiency of drilling highly deviated wells becomes critically important. Economic efficiency is not solely determined by the reduction of costs but also by the optimization of resources, improvement of operational performance, and maximization of production output. A comprehensive assessment must consider both direct and indirect costs, including drilling time, equipment utilization, maintenance, and potential risks, as well as the long-term benefits such as increased production rates and extended field life.

Recent advancements in drilling technologies, including rotary steerable systems, measurement-while-drilling (MWD) and logging-while-drilling (LWD) tools, as well as real-time data analytics, have significantly improved the feasibility and efficiency of highly deviated well drilling. These innovations enable better control over well trajectories, reduce uncertainties, and enhance decision-making processes during drilling operations. Consequently, they play a vital role in improving economic outcomes by minimizing non-productive time and optimizing resource allocation. (Cinco-Lay et al., 2012)

Moreover, the growing emphasis on sustainability and cost-effectiveness in the energy sector has intensified the need for integrated approaches that combine technical excellence with economic evaluation. Companies are increasingly adopting optimization strategies to balance performance and cost, ensuring that investments in advanced drilling techniques yield maximum returns. This includes the use of digital technologies, automation, and predictive modeling to enhance operational efficiency and reduce risks. (Uteev, Mardanov, & Yussubaliev, 2022)

Therefore, this study aims to provide a comprehensive introduction to the economic evaluation of highly deviated well drilling within the oil and gas industry. It seeks to explore the key factors influencing efficiency, identify challenges and opportunities, and highlight the role of modern technologies in improving both technical and economic performance. By addressing these aspects, the research contributes to a deeper understanding of how to achieve sustainable and economically viable drilling operations in increasingly complex reservoir conditions.

The evaluation of the economic efficiency of drilling highly deviated wells in the oil and gas industry demonstrates that such operations represent a complex but highly beneficial approach to resource extraction. While these wells require advanced technologies, higher initial investments, and careful operational planning, they offer significant advantages in terms of increased reservoir contact, enhanced production rates, and improved recovery factors. (Ding, Xian, & Zhang, 2019)

A comprehensive assessment of economic efficiency must integrate both technical and financial perspectives. Factors such as drilling time, equipment performance, risk management, and resource optimization play a decisive role in determining overall project success. The application of modern drilling technologies, along with real-time monitoring and data-driven decision-making, has significantly contributed to reducing operational uncertainties and improving cost-effectiveness.

At the same time, the importance of risk analysis, skilled workforce, and efficient project management cannot be overlooked. These elements ensure that complex drilling operations are executed safely, efficiently, and within budget constraints. Moreover, the incorporation of environmental considerations and sustainable practices further strengthens the long-term viability and economic value of such projects. (Jha & Sharma, 2014)

Overall, highly deviated well drilling, when properly planned and optimized, proves to be an economically viable and strategically important method in the development of modern oil and gas fields. Its successful implementation depends on the balanced integration of technology, economics, and management practices, ultimately leading to more efficient and sustainable energy production.

Research

The drilling of highly deviated and horizontal wells has become an essential component of modern oil and gas exploration and production strategies. This research focuses on analyzing the technical and economic aspects that influence the efficiency of such drilling operations, with particular attention to optimization approaches that enhance overall performance and profitability.

From a technical perspective, highly deviated wells require precise planning and execution due to their complex geometry. The design of the well trajectory plays a critical role in ensuring maximum reservoir exposure while minimizing operational difficulties. Advanced directional drilling technologies, such as rotary steerable systems (RSS), measurement-while-drilling (MWD), and logging-while-drilling (LWD), are widely used to achieve accurate well placement. These tools enable real-time data acquisition, allowing engineers to monitor and adjust drilling parameters continuously, thereby reducing uncertainties and non-productive time (NPT).

One of the key challenges identified in this research is the management of torque and drag forces, which tend to increase significantly in highly deviated sections. Excessive torque and drag can lead to equipment failure, reduced drilling efficiency, and increased operational costs. To address this issue, the use of optimized drilling fluids, lubricants, and specialized drill string designs has proven effective. Additionally, wellbore stability remains a critical concern, particularly in formations with complex geological characteristics. The application of appropriate mud systems and pressure management techniques helps prevent wellbore collapse and other stability-related problems.

From an economic standpoint, the cost structure of highly deviated well drilling is influenced by multiple factors, including drilling duration, equipment costs, personnel expenses, and risk-related contingencies. Although the initial investment is typically higher compared to conventional vertical wells, the long-term economic benefits often outweigh these costs. Increased production rates, improved reservoir drainage, and reduced need for multiple wells contribute to higher overall profitability.

This research also emphasizes the importance of optimization strategies in enhancing economic efficiency. Optimization involves the careful selection of drilling parameters, equipment, and technologies to achieve the best possible balance between cost and performance. Techniques such as rate of penetration (ROP) optimization, bit selection, and real-time performance monitoring play a significant role in reducing drilling time and associated expenses. Furthermore, the implementation of digital technologies, including data analytics and machine learning, enables predictive modeling and proactive decision-making, which further improves operational efficiency.

A comparative analysis between conventional vertical wells and highly deviated wells highlights the economic advantages of the latter in suitable reservoir conditions. While vertical wells are generally less expensive to drill, they may require a greater number of wells to achieve the same level of production as a single highly deviated or horizontal well. This results in higher cumulative costs over time. In contrast, highly deviated wells can maximize reservoir contact and production output, making them a more cost-effective solution in the long term.

Risk management is another critical aspect addressed in this research. The complexity of highly deviated drilling operations increases the likelihood of technical issues and uncertainties. Therefore, the application of risk assessment tools, such as sensitivity analysis and probabilistic modeling, is essential for identifying potential risks and developing mitigation strategies. Effective risk management not only reduces the probability of operational failures but also enhances the economic predictability of drilling projects.

Moreover, the role of human expertise and organizational efficiency is highlighted as a key factor in achieving successful outcomes. Skilled personnel, proper training, and adherence to best practices significantly contribute to minimizing errors and improving overall performance. Collaborative efforts between engineers, geologists, and project managers ensure that technical and economic objectives are aligned throughout the drilling process. (İsmayılov, Süleymanov, & Novruzova, 2022)

Environmental and regulatory considerations are also incorporated into the economic evaluation framework. Compliance with environmental standards, efficient waste management, and the

reduction of emissions are increasingly important in modern drilling operations. Although these measures may involve additional costs, they contribute to long-term sustainability and help avoid potential financial penalties and reputational risks.

In summary, this research demonstrates that the economic efficiency of drilling highly deviated wells is determined by a combination of technical innovation, cost management, risk mitigation, and strategic planning. The integration of advanced technologies, optimization techniques, and skilled human resources enables operators to overcome the challenges associated with complex well geometries and achieve superior economic outcomes. As the oil and gas industry continues to evolve, the importance of such integrated approaches will only increase, making highly deviated well drilling a key area of focus for future research and development.

Conclusion

The drilling of highly deviated wells in the oil and gas industry represents a significant advancement in the extraction of hydrocarbons from complex and challenging reservoirs. As conventional vertical wells become increasingly insufficient to access all economically viable reserves, highly deviated and horizontal wells have emerged as a critical technology to maximize reservoir contact, improve production efficiency, and enhance overall recovery factors. This research has shown that while such wells present substantial technical challenges, their economic potential is considerable when properly planned, executed, and optimized.

From a technical perspective, the success of highly deviated wells depends on precise well trajectory design, the application of advanced drilling technologies, and effective management of operational challenges such as torque and drag, wellbore stability, and equipment wear. Tools such as rotary steerable systems, measurement-while-drilling (MWD), and logging-while-drilling (LWD) instruments are indispensable for achieving accurate drilling and minimizing non-productive time. Real-time monitoring and data-driven decision-making allow operators to respond proactively to operational issues, ensuring that the drilling process remains efficient and controlled. (Li, Tong, & Yan, 2025)

Economically, highly deviated wells require higher initial investment compared to conventional vertical wells due to their complexity, specialized equipment, and need for skilled personnel. However, this research demonstrates that these upfront costs are offset by long-term benefits, including higher production rates, more effective reservoir drainage, and reduced need for multiple wells. A detailed economic evaluation, incorporating indicators such as net present value (NPV), internal rate of return (IRR), cost per meter drilled, and payback period, is essential for determining project feasibility and guiding strategic investment decisions. (Saleem, 2022)

Optimization plays a pivotal role in improving both technical performance and economic outcomes. Strategies such as optimizing drilling parameters, selecting appropriate drill bits, managing drilling fluids, and leveraging digital technologies like predictive modeling and machine learning can significantly reduce operational time and costs. These optimization techniques, combined with robust risk management practices, enable companies to mitigate uncertainties and enhance economic efficiency, even in complex and high-risk drilling environments.

The human factor is another critical component in ensuring successful outcomes. Skilled engineers, geologists, and drilling operators, supported by effective project management and knowledge-sharing practices, contribute to minimizing errors, improving operational efficiency, and maintaining safety standards. Collaborative and well-coordinated teams are essential for integrating technical solutions with economic objectives, ensuring that each drilling project achieves maximum value.

Furthermore, environmental and regulatory considerations are increasingly influencing the economic evaluation of drilling projects. Compliance with environmental standards, responsible resource management, and the implementation of sustainable practices may involve additional costs but ultimately contribute to long-term economic and reputational benefits. Incorporating these factors into project planning not only ensures regulatory adherence but also supports corporate sustainability goals, enhancing overall project viability. (Abdul, Ahmed, & Khan, 2023)

In conclusion, the drilling of highly deviated wells offers a unique opportunity to combine technological innovation with economic efficiency in the oil and gas sector. While challenges related to complexity, risk, and initial investment exist, the potential for increased production, improved reservoir management, and optimized resource utilization makes such wells a highly valuable tool for modern hydrocarbon extraction. Achieving maximum economic efficiency requires an integrated approach that balances advanced technology, strategic planning, risk management, skilled human resources, and environmental responsibility. As the industry continues to evolve and face new challenges, highly deviated well drilling will remain a critical area for research, technological development, and strategic investment, ensuring that operators can sustainably and profitably exploit hydrocarbon resources.

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Tax Policy and Economic Development in Azerbaijan

Abstract

Tax policy plays a crucial role in shaping the economic development of a country by influencing investment decisions, business activity, and overall fiscal stability. In the case of Azerbaijan, tax reforms implemented over the past decades have significantly contributed to the diversification of the economy, reduction of the shadow economy, and improvement of the business environment. This study examines the relationship between tax policy and economic development in Azerbaijan, focusing on key reforms, tax incentives, and their impact on entrepreneurship and economic growth. The research highlights how a balanced and transparent tax system enhances state revenues while simultaneously encouraging private sector development. Furthermore, it analyzes current challenges such as tax compliance, administrative efficiency, and the need for continuous modernization in line with global standards. The findings suggest that effective tax policy not only supports macroeconomic stability but also fosters sustainable and inclusive economic growth in Azerbaijan.

Keywords: *Tax policy, economic development, Azerbaijan, tax reforms, fiscal policy, economic growth, entrepreneurship, investment climate, public revenue, sustainable development*

Introduction

Tax policy is one of the most powerful instruments available to governments for regulating economic activity, ensuring fiscal sustainability, and promoting long-term development. It serves not only as a primary source of public revenue but also as a strategic tool for influencing investment behavior, income distribution, and the overall structure of the economy. In modern economic systems, an effective tax policy balances the need for sufficient budget revenues with the objective of fostering a competitive and business-friendly environment. Therefore, the design and implementation of tax systems have become central issues in economic policy discussions, particularly in developing and transition economies. (Abdullayeva, 2023).

Azerbaijan, as a post-Soviet country that gained independence in 1991, has undergone significant economic transformations, shifting from a centrally planned economy to a market-oriented system. During the early years of independence, the country faced serious economic challenges, including declining production, high inflation, and institutional weaknesses. In this context, establishing an efficient and transparent tax system became a priority for the government to stabilize the economy, generate public revenues, and support structural reforms. Over time, Azerbaijan has implemented a series of tax reforms aimed at simplifying tax procedures, reducing the tax burden, and improving tax administration. (Ahmadova, 2022)

The importance of tax policy in Azerbaijan has increased particularly due to the country's reliance on oil and gas revenues. While the energy sector has been a major driver of economic growth, it has also exposed the economy to external shocks and price volatility in global energy markets. As a result, the government has prioritized economic diversification and the development of non-oil sectors such as agriculture, manufacturing, tourism, and services. In this process, tax policy has been used as a key mechanism to stimulate investment, encourage entrepreneurship, and support small and medium-sized enterprises (SMEs). Tax incentives, exemptions, and preferential regimes have been introduced to attract both domestic and foreign investors and to create a more dynamic and resilient economy. (Aliyev, 2021)

Furthermore, the modernization of tax administration has been an essential component of Azerbaijan's fiscal policy. The introduction of digital technologies, e-services, and electronic tax reporting systems has significantly improved transparency, reduced administrative barriers, and enhanced tax compliance. These reforms have also contributed to reducing the size of the shadow economy, which has historically been a challenge for many developing countries. Strengthening institutional capacity and ensuring effective enforcement mechanisms remain critical for maintaining the credibility and efficiency of the tax system. (State Tax Service of Azerbaijan, 2024)

Despite notable progress, Azerbaijan still faces several challenges in aligning its tax policy with the demands of a rapidly changing global economic environment. Issues such as ensuring fair tax distribution, increasing voluntary compliance, minimizing tax evasion, and maintaining a balance between revenue generation and economic stimulation require continuous policy adjustments. Additionally, global trends such as digitalization, international tax competition, and economic integration place new demands on national tax systems, including that of Azerbaijan. (Ministry of Economy of Azerbaijan, 2025)

In this context, studying the relationship between tax policy and economic development in Azerbaijan is both relevant and necessary. Understanding how tax reforms influence economic growth, investment, and business activity can provide valuable insights for policymakers and researchers. This study aims to analyze the evolution of tax policy in Azerbaijan, assess its impact on key economic indicators, and identify the main challenges and future directions for improving the effectiveness of the tax system. Ultimately, a well-designed tax policy can serve as a cornerstone for sustainable, inclusive, and diversified economic development in Azerbaijan.

Research

This study employs a comprehensive and systematic research methodology to investigate the relationship between tax policy and economic development in Azerbaijan. Due to the complex and multifaceted nature of the subject, a mixed-methods approach is utilized, integrating both qualitative and quantitative research techniques. This approach enables a deeper and more accurate analysis of how tax policy influences macroeconomic indicators, investment behavior, and the overall business environment.

The research is structured as an analytical and explanatory study, focusing on identifying the link between tax policy reforms and economic performance. It combines descriptive and empirical analysis to evaluate trends in taxation and their effects on economic growth. Additionally, a comparative perspective is incorporated to assess Azerbaijan's tax system in relation to international standards and practices. (State Statistical Committee of Azerbaijan, 2024)

The study primarily relies on secondary data collected from official and credible sources. These include statistical reports, economic reviews, and policy documents published by the State Tax Service of Azerbaijan, the Ministry of Economy of Azerbaijan, and the State Statistical Committee of Azerbaijan. Furthermore, data and analytical reports from international organizations such as the World Bank, the International Monetary Fund, and the Organisation for Economic Co-operation and Development are used to provide a broader analytical framework and ensure the reliability of the findings. These sources supply essential data on tax revenues, gross domestic product (GDP), foreign direct investment, employment levels, and sectoral development.

In addition to secondary data, the research may incorporate primary data through qualitative methods such as expert interviews and surveys. Economists, tax professionals, and business representatives are considered as potential respondents in order to gain practical insights into the effectiveness of tax policies and administrative mechanisms.

Several analytical methods are applied throughout the research. Descriptive analysis is used to present the structure and evolution of Azerbaijan's tax system, including changes in tax rates, tax types, and administrative reforms. Statistical and econometric methods are employed to examine the relationship between tax policy variables and key economic indicators. Correlation and regression analyses help to identify the extent to which tax policy influences economic growth and investment activity.

Moreover, comparative analysis is conducted to evaluate Azerbaijan's tax policy against those of other countries with similar economic structures. This allows for the identification of best practices and potential areas for reform. Document and content analysis are also applied to review legislative acts, strategic development plans, and tax reform programs, providing insight into the objectives and outcomes of policy changes.

Overall, the combination of diverse data sources and analytical methods ensures a comprehensive and reliable assessment of the role of tax policy in Azerbaijan's economic development. This methodological framework allows for both theoretical understanding and practical evaluation, contributing to more informed policy recommendations.

Tax policy in Azerbaijan has undergone significant transformation since the country gained independence, evolving from a rigid, centrally planned fiscal system into a more flexible and market-oriented framework. This transformation has been essential for supporting economic stabilization, increasing public revenues, and fostering sustainable development. The main components of Azerbaijan's tax policy include direct taxes such as income and profit taxes, as well as indirect taxes like value-added tax (VAT), excise duties, and customs-related payments. Each of these elements plays a distinct role in shaping economic activity and influencing the behavior of businesses and individuals.

One of the key objectives of tax policy in Azerbaijan has been to ensure macroeconomic stability while promoting economic growth. In this regard, the government has implemented a number of reforms aimed at reducing the overall tax burden and simplifying tax procedures. Lower tax rates and streamlined administrative processes have made it easier for businesses to operate legally, thereby encouraging entrepreneurship and reducing the size of the informal economy. The efforts of institutions such as the State Tax Service of Azerbaijan have been particularly important in improving tax compliance and enhancing transparency. (World Bank, 2023)

Another important aspect of tax policy is its impact on investment activity. Azerbaijan has introduced various tax incentives and preferential regimes to attract both domestic and foreign investors. These include tax exemptions in industrial parks, special economic zones, and priority sectors such as agriculture, information technology, and manufacturing. The Ministry of Economy of Azerbaijan has played a leading role in designing and implementing these policies to stimulate economic diversification and reduce dependence on oil revenues. As a result, non-oil sectors have gradually expanded, contributing to a more balanced economic structure.

The relationship between tax policy and small and medium-sized enterprises (SMEs) is also of great importance. SMEs are considered the backbone of a diversified economy, and their development is closely linked to the effectiveness of the tax system. In Azerbaijan, simplified tax regimes and reduced reporting requirements have been introduced to support small businesses. These measures have lowered entry barriers, increased business formalization, and enhanced competitiveness. Consequently, the growth of SMEs has had a positive impact on employment generation and income distribution.

In addition to promoting business activity, tax policy plays a crucial role in generating state revenues necessary for financing public expenditures. Tax revenues are used to support infrastructure development, education, healthcare, and social protection programs. Data provided by the State Statistical Committee of Azerbaijan indicate that tax revenues constitute a significant portion of the state budget, reflecting the importance of an efficient tax system for fiscal sustainability. At the same time, maintaining a balance between revenue generation and economic stimulation remains a key policy challenge.

The modernization of tax administration has been another major achievement in Azerbaijan's fiscal policy. The introduction of electronic services, online tax filing systems, and digital payment mechanisms has significantly improved efficiency and transparency. These innovations have reduced administrative costs, minimized opportunities for corruption, and increased voluntary compliance among taxpayers. Furthermore, digitalization has enabled better monitoring and analysis of tax data, allowing authorities to make more informed policy decisions.

Despite these positive developments, several challenges remain in the implementation of tax policy in Azerbaijan. One of the main issues is the persistence of the shadow economy, which limits the effectiveness of tax collection and creates unfair competition among businesses. Although significant progress has been made, further efforts are required to strengthen enforcement mechanisms and promote a culture of tax compliance. Additionally, the complexity of certain tax regulations and frequent legislative changes can create uncertainty for businesses and investors.

Another challenge is the need to adapt tax policy to global economic trends. Increasing globalization, digitalization, and international tax competition require continuous reforms to ensure that Azerbaijan's tax system remains competitive and aligned with international standards. Cooperation with international organizations such as the World Bank and the International Monetary Fund has been instrumental in this regard, providing technical assistance and policy recommendations. (Asian Development Bank, 2024)

In conclusion, the main body of analysis demonstrates that tax policy is a fundamental driver of economic development in Azerbaijan. Through targeted reforms, improved administration, and strategic incentives, the country has made significant progress in creating a more efficient and growth-oriented tax system. However, ongoing challenges highlight the need for continuous improvement and adaptation to ensure long-term economic stability and sustainable development.

Conclusion

The research clearly demonstrates that tax policy is a crucial instrument for promoting economic development in Azerbaijan. Since gaining independence, Azerbaijan has implemented significant reforms to transition from a centrally planned fiscal system to a more market-oriented and transparent tax system. The adoption of a comprehensive Tax Code provided the legal and institutional framework necessary to regulate taxation effectively, define taxpayer responsibilities, and establish mechanisms for fair revenue collection. (Safarova, 2023)

These reforms have had a measurable impact on macroeconomic stability, including an increase in state revenues and improved fiscal discipline. Simplified tax procedures, moderate tax rates, and improved administration have facilitated business activity and enhanced investor confidence. Moreover, the introduction of electronic filing systems and digitalization of tax administration has improved transparency, reduced bureaucratic obstacles, and contributed to greater compliance among taxpayers.

Tax policy has also played a significant role in economic diversification. Given Azerbaijan's historical reliance on oil and gas revenues, the government has strategically used tax incentives to promote growth in non-oil sectors such as agriculture, manufacturing, and services. Special regimes, exemptions, and incentives for SMEs have strengthened entrepreneurship, created employment opportunities, and increased the formalization of the economy.

Despite these achievements, challenges remain. The shadow economy, complexity in certain tax regulations, and the need for broader tax base expansion are still issues that require attention. Additionally, global trends such as digitalization, economic integration, and international tax competition demand continuous adaptation of Azerbaijan's tax policies.

In conclusion, an effective, transparent, and growth-oriented tax policy is essential for sustaining economic growth in Azerbaijan. Continued reforms, modernization of administration, and alignment with international standards will be critical for ensuring fiscal stability, encouraging investment, and supporting long-term, inclusive economic development.

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