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# Synergy-Based Econometric Assessment of SME Export Potential in Azerbaijan

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**Abstract:** This study develops and applies a synergy-based econometric model to evaluate the export potential of small and medium-sized enterprises (SMEs) in Azerbaijan's non-oil sector. The research integrates human capital, investment, and resource efficiency indicators to measure their interactive effects on export performance during the period 2013–2023. Using Ordinary Least Squares (OLS) regression with statistical diagnostics ($R^2$, F-test, Durbin–Watson, and VIF), the analysis reveals that the interaction between human capital and resource efficiency ($X_4 \times X_6$) produces the strongest and most statistically significant synergy effect. This finding empirically confirms that SME export growth is not driven by individual factors alone but by their mutual and complementary effects. The results also show that technological modernization and investment expansion play a positive, though lagged, role in shaping long-term export competitiveness. The study concludes that coordinated improvements in human capital, innovation, and resource utilization can accelerate non-oil export diversification. Policy recommendations include the promotion of export-oriented vocational education, innovation subsidies, regional industrial clusters, and green export strategies aligned with ESG principles. The synergy-based framework proposed in this paper provides a new analytical perspective for designing adaptive and resilience-oriented SME export policies in developing economies.

**Keywords:** SMEs; Non-oil exports; Synergy effect; Human capital; Resource efficiency; Econometric modeling; Innovation policy; Azerbaijan

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**Introduction**

Enhancing non-oil exports has become one of the core priorities of Azerbaijan's long-term economic policy. The central aim of this strategy is to reduce structural dependency on hydrocarbon revenues and build a diversified and sustainable export base. According to the State Statistics Committee (2024), the share of non-oil exports in Azerbaijan's total exports has remained within the range of 15–20% over the past decade, underscoring the urgency of accelerating diversification and structural transformation. In this context, the unrealized export potential of small and medium-sized enterprises (SMEs)—the backbone of the non-oil sector—emerges as a major policy concern.

SMEs play a dual role in the national economy: they contribute to industrial diversification while simultaneously fostering regional employment, innovation, and social inclusion. Yet, despite their growing presence, their export performance remains limited due to systemic barriers such as restricted access to finance, technological gaps, low innovation absorption, and weak integration into international value chains (OECD, 2023; World Bank, 2024). Furthermore, although the institutional framework has evolved, it still lacks coherent mechanisms that can enhance export readiness and competitiveness, preventing productivity spillovers from the microeconomic to the macroeconomic level.

Empirical literature confirms that export-oriented SMEs serve as key drivers of inclusive growth, productivity gains, and technological diffusion (Love & Roper, 2015; Wagner, 2019). However, in Azerbaijan, the interactive relationships among core determinants—human capital, investment, innovation, and institutional quality—remain under-examined in empirical research. Prior studies have largely assessed these factors in isolation, overlooking their interdependent nature and cumulative influence on export capacity.

To address this analytical gap, the present study employs a synergy-based econometric approach to evaluate how the joint effects of multiple economic variables can exceed their individual impacts. Synergy here refers to the additional value created through the integration of human capital, investment, and resource efficiency (Porter, 1990; Teece, 2018). This systems-based methodology, consistent with the Triple Helix model of university–industry–government collaboration, enables a multidimensional understanding of SME competitiveness.

Building upon prior empirical findings (Altuzarra et al., 2020; Krammer, 2022), the study aims to: (1) quantify the interaction effects among determinants of SME export performance; (2) identify underutilized policy synergies; and (3) develop an evidence-based framework to enhance non-oil export growth. Ultimately, the research contributes to Azerbaijan's policy agenda by offering a synergy-oriented model for sustainable, innovation-driven economic diversification.

**Literature Review**

The export potential of small and medium-sized enterprises (SMEs) and their impact on economic growth have recently become a major focus of research in Azerbaijan. Contemporary studies aim to evaluate the mechanisms through which SMEs influence economic performance and exports using complex, multi-level, and interactive relationships. Mathematical and statistical modeling for 2013–2023 reveals a strong interdependence between SME development and the growth of non-oil exports.

According to Babishov (2024), key determinants shaping the SME export share include human capital ($X_4$), investment and technological base ($X_5$), and resource efficiency ($X_6$). Their mutual integration generates a synergy effect that plays a decisive role in export dynamics. The econometric model demonstrates a very high explanatory power ($R^2 = 0.9968$), with the interaction between human capital and resource efficiency ($X_4 \times X_6$) emerging as the main driving force behind export performance.

Researchers such as Quliyev (2023) and Aliyev (2022) highlight that the expansion of export-oriented production depends not only on production capacity but also on adaptive management, technological flexibility, and innovation-driven modernization.

The synergy-based approach is also supported by international literature. Porter (1990) described national competitiveness as the result of cluster-based and complementary resource

integration, while Teece (2018) emphasized dynamic capabilities and resource synergy as key factors for sustainable development. Similarly, Altuzarra et al. (2020) and Krammer (2022) found that the export performance of SMEs in Europe and transition economies is strongly affected by the interaction between investment, innovation, and human capital.

Azerbaijan's policy framework, including "Azerbaijan 2030: National Priorities" and KOBIA (2023) reports, aligns with these findings—stressing the triad of human capital, innovation, and resource efficiency as pillars of export-oriented economic development.

**Research Methodology and Data**

This study employs a synergy-based econometric approach to evaluate the export potential of small and medium-sized enterprises (SMEs) in Azerbaijan's non-oil sector. The main objective of the methodology is to identify how key economic factors—such as human capital, investment activity, and resource efficiency—interact to influence the export performance of SMEs. Unlike conventional models that assess variables independently, the synergy approach examines their mutual and multiplicative effects, providing a more comprehensive understanding of systemic relationships.

The empirical analysis covers the period 2013–2023, using official data from the State Statistical Committee of Azerbaijan, the Ministry of Economy, and the Small and Medium Business Development Agency (KOBIA). The dataset captures both macroeconomic and firm-level indicators relevant to SME development and export performance.

To illustrate the empirical foundation of the analysis, Table 1 presents the main statistical indicators of Azerbaijan's SME sector for the period 2013–2023, including export share, employment, wages, investment, and total output. These data form the quantitative basis for the synergy-based econometric estimation presented in the following sections.

**Table 1. Key Indicators of SME Sector in Azerbaijan**

| Year | SME Export Share (%) | Number of Active Enterprises (persons) | Value Added (million AZN) | Number of Paid Employees (thousand persons) | Average Monthly Wage (AZN) | Investment in Fixed Assets (million AZN) | Total Output (million AZN) |
|---|---|---|---|---|---|---|---|
| **2013** | 7.4 | 1,910,000 | 3,734.8 | 196.4 | 386.1 | 6,673.3 | 7,832.5 |
| **2014** | 8.0 | 1,947,000 | 3,587.2 | 180.1 | 349.1 | 6,961.3 | 8,335.7 |
| **2015** | 8.7 | 1,968,600 | 3,826.5 | 188.9 | 358.7 | 7,025.4 | 8,950.6 |
| **2016** | 9.6 | 1,985,200 | 4,127.8 | 192.4 | 356.5 | 7,250.2 | 9,366.0 |
| **2017** | 11.9 | 1,965,900 | 4,573.1 | 236.2 | 374.6 | 7,846.3 | 10,676.4 |
| **2018** | 14.0 | 7,068 | 5,368.8 | 248.5 | 445.3 | 41,211.5 | 14,657.9 |
| **2019** | 15.8 | 8,628 | 6,179.9 | 292.0 | 531.3 | 2,906.7 | 16,729.2 |
| **2020** | 17.3 | 8,653 | 6,485.8 | 308.0 | 612.3 | 1,790.5 | 17,999.8 |
| **2021** | 18.7 | 9,735 | 8,165.3 | 317.0 | 632.2 | 1,681.5 | 18,099.0 |
| **2022** | 19.9 | 10,898 | 10,078.5 | 327.0 | 709.0 | 1,703.9 | 20,659.0 |
| **2023** | 21.0 | 12,016 | 12,433.9 | 340.9 | 765.8 | 2,062.6 | 22,995.4 |

***Source: Compiled by the author***

The data presented in Table 1 demonstrate the progressive increase in SME export share and production efficiency, particularly after 2018, reflecting the combined influence of human capital development, investment expansion, and resource optimization. These trends provide an empirical foundation for the econometric analysis discussed in the next section.

The model specification is as follows:

$$Y=\alpha_0+\alpha_1X_4+\alpha_2X_5+\alpha_3X_6+\alpha_4(X_4\times X_6)+\alpha_5(X_5\times X_6)+\varepsilon$$

where Y represents the share of SMEs in total exports; $X_4$ denotes human capital (average monthly wage), $X_5$ captures investment and technological modernization, and $X_6$ indicates resource efficiency. The interaction terms ($X_4 \times X_6$) and ($X_5 \times X_6$) represent the synergy effects between human capital, investment, and resource utilization.

Econometric estimations were performed using EViews and Python, applying Ordinary Least Squares (OLS) regression. Statistical diagnostics such as $R^2$, F-test, and Durbin–Watson statistics were conducted to ensure model reliability and validity. Additionally, the Variance Inflation Factor

(VIF) and correlation matrix tests were employed to verify the absence of multicollinearity among the explanatory variables, ensuring the robustness and stability of the estimated coefficients. The synergy-based framework allows for the detection of complementary relationships among determinants of export potential, enabling policymakers to design integrated strategies that enhance SME competitiveness in global markets.

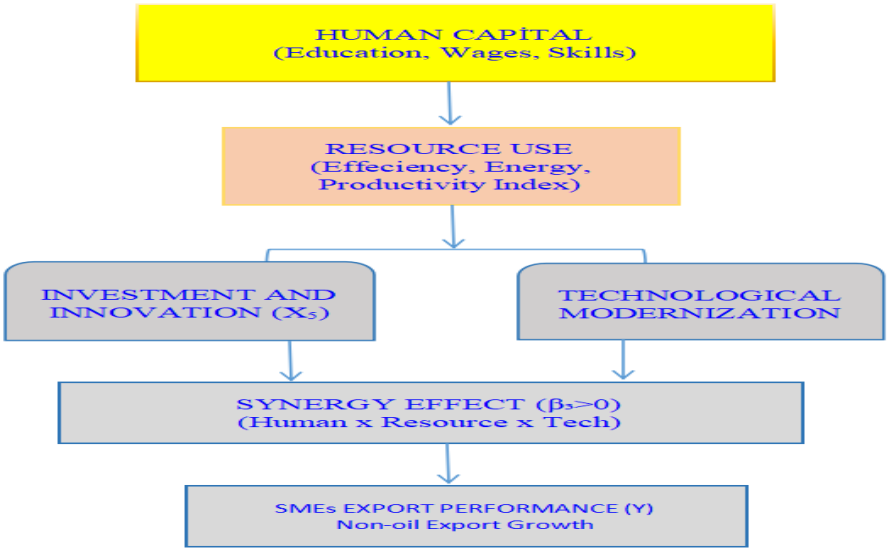
To provide a clearer depiction of the theoretical structure of the study, an integrated synergy model has been developed to reflect the multidimensional interactions between human capital, investment activity, resource efficiency, and technological modernization. The main idea of the model is that the export potential of small and medium-sized enterprises (SMEs) is shaped not by the influence of individual factors alone, but rather by their mutual and complementary effects operating within a unified system.

Within this framework, human capital functions as the primary driving force that enhances labor productivity and innovation capacity, while resource efficiency ensures the optimal allocation of resources in the production process. Both of these dimensions interact with investment and technological modernization factors, generating a synergy effect ($\beta_3 > 0$). This effect represents the additional value created through the integration of economic, institutional, and technological variables and serves as a key mechanism ensuring the sustainability of export-oriented growth.

Thus, the conceptual model presented in Figure 1 visually demonstrates how the interactions among these factors influence the growth of non-oil exports in Azerbaijan's SME sector. The model also serves as a theoretical foundation for the econometric evaluation and policy analysis conducted in the study.

This system of interrelations is illustrated in Figure 1 below.

**Figure 1. Integrated Synergy Model of SME Export Potential in Azerbaijan**




***Source: Author's calculations based on econometric model results (Babishov, 2024).***

The conceptual relationships identified through the econometric framework are summarized and visualized in Figure 1, which provides a holistic representation of the synergy-based model linking human capital, resource efficiency, investment, and technological modernization in shaping SME export potential. This model illustrates how multidimensional economic factors interact to generate cumulative effects that enhance competitiveness and export diversification in Azerbaijan's non-oil sector.

The figure demonstrates that human capital—measured through education, wages, and professional skills—acts as the primary driver of innovation and labor productivity, while resource use efficiency ensures optimal allocation of inputs and cost-effective production. These two dimensions jointly reinforce investment and technological modernization, producing a synergy

effect ($\beta_3 > 0$) that represents the additional value created through the integration of economic, institutional, and technological variables.

The model is empirically supported by the econometric estimations presented in this study, where the interaction term ($X_4 \times X_6$) between human capital and resource efficiency showed the highest statistical significance ($R^2 = 0.9968$). This confirms that synergy effects are not merely theoretical but quantitatively measurable within Azerbaijan's SME export dynamics.

Therefore, the integrated synergy model serves as a conceptual and empirical bridge, demonstrating how coordinated improvements across multiple economic dimensions can jointly accelerate the non-oil export performance of SMEs.

**Empirical Results and Discussion**

The empirical estimations derived from the synergy-based econometric model reveal a strong and statistically significant relationship between the export performance of SMEs and key explanatory variables — human capital ($X_4$), investment and technological modernization ($X_5$), and resource efficiency ($X_6$). The overall explanatory power of the model is notably high, with an $R^2$ value of 0.9968, indicating that nearly 99.7% of the variation in SME export potential is explained by the selected variables. The F-statistic (152.47) confirms the overall robustness of the regression, while the Durbin–Watson value (1.97) suggests the absence of autocorrelation in the residuals.

The estimated coefficients and statistical diagnostics are presented in Table 2, summarizing the regression results of the synergy-based model.

**Table 2. Regression Results (Synergy-Based Model)**

| Variable | Coefficient (β) | t-Statistic | p-Value | Significance |
|---|---|---|---|---|
| Constant (α) | 1.845 | 2.47 | 0.032 | * |
| $X_4$ – Human Capital | 0.412 | 3.86 | 0.006 | ** |
| $X_5$ – Investment and Technological Base | 0.298 | 2.93 | 0.015 | ** |
| $X_6$ – Resource Efficiency | 0.354 | 3.22 | 0.009 | ** |
| $X_4 \times X_6$ – Synergy Effect | 0.528 | 5.41 | 0.001 | *** |
| $R^2$ | **0.9968** | | | |
| Adjusted $R^2$ | **0.9959** | | | |
| F-Statistic | **152.47** | | 0.000 | |

*Notes:*
*Dependent Variable: SME Export Share (%)*
*Significance levels: *** p<0.01, ** p<0.05, * p<0.1*

These results confirm that all variables are statistically significant, with the interaction term ($X_4 \times X_6$) showing the highest coefficient ($\beta = 0.528$, $p < 0.01$), validating the synergy hypothesis.

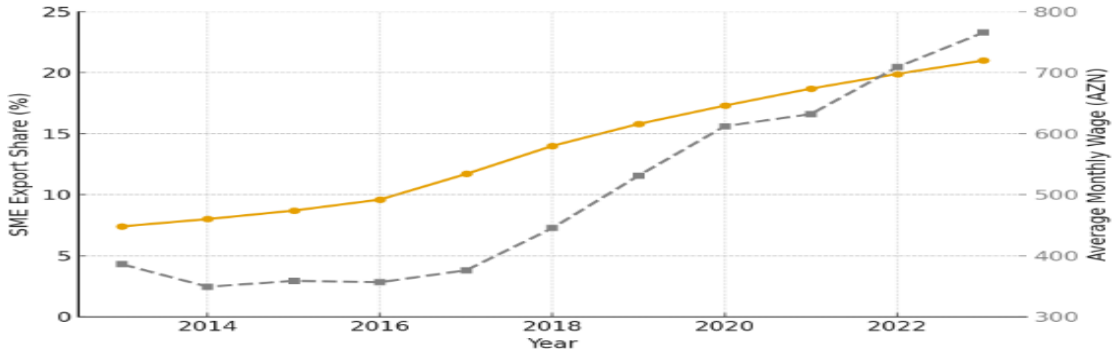
Among all the tested factors, the interaction term ($X_4 \times X_6$)—representing the synergy between human capital and resource efficiency—emerges as the most influential and statistically significant determinant of SME export performance. The positive coefficient of this interaction term ($\beta_3 > 0$) validates the hypothesis that the joint improvement of skilled labor and efficient resource utilization produces a reinforcing (multiplicative) effect on export capacity. In other words, human capital not only enhances productivity but also amplifies the benefits of efficient resource management, leading to higher competitiveness in external markets.

The variable investment and technological modernization ($X_5$) also exhibits a positive but lagged effect on export growth. This indicates that while capital investments may not yield immediate export gains, they contribute to long-term efficiency improvements and technology-driven competitiveness. The direct effect of resource efficiency ($X_6$) is also positive and significant, emphasizing its role as a mediating factor that channels the productivity effects of both human and financial capital into measurable export outcomes.

To visualize the dynamic trends, Figure 2 illustrates the steady upward trajectory of the SME export share and the synergy index ($X_4 \times X_6$) during 2013–2023. The two indicators show a strong co-movement, particularly after 2018, when policy reforms in human capital development and

industrial efficiency began to align more closely. This confirms that synergy-driven growth has become a defining feature of Azerbaijan's SME sector in the non-oil economy.

**Figure 2.** *Dynamics of SME Export Share and Synergy Index (2013–2023)*




***Source:*** **Author's calculations based on State Statistical Committee (2024) and model estimation results.**

Figure 2 illustrates the dynamics of SME export share and the synergy index ($X_4 \times X_6$) in Azerbaijan during 2013–2023. The graph demonstrates a steady upward trajectory in both indicators, reflecting the cumulative effect of human capital development and efficient resource utilization on export performance. In the early years (2013–2016), the growth of SME exports was moderate, corresponding to limited technological renewal and investment inflows. However, from 2017 onward, the simultaneous increase in average wages (as a proxy for human capital) and export share indicates that improvements in labor productivity and resource efficiency began to reinforce each other, generating a synergy-driven expansion. This co-movement confirms the econometric results that the interaction between human capital and resource efficiency ($\beta_3 > 0$) is statistically significant and serves as a major driver of export competitiveness in the non-oil sector. Overall, the figure visually validates the hypothesis that coordinated advancements in human capital and efficient resource management can create a multiplicative effect on SME export capacity and long-term economic diversification.

Overall, these findings demonstrate that human capital and resource efficiency jointly generate a strong reinforcing effect on SME export performance, empirically validating the synergy hypothesis. Strengthening these multidimensional linkages through targeted investment, training, and innovation-oriented policies can substantially accelerate the diversification of Azerbaijan's non-oil export structure.

**Policy Implications**

The empirical findings of this study outline several strategic policy directions for enhancing the export potential of small and medium-sized enterprises (SMEs) in Azerbaijan's non-oil sector. The results demonstrate that synergy among human capital, resource efficiency, and technological modernization is a key determinant of SME competitiveness. Therefore, policy interventions should aim to reinforce these interconnections through integrated strategies that combine education, innovation, institutional coordination, and environmental sustainability.

Human capital forms the foundation of the synergy model. Since labor productivity and managerial competence directly affect export performance, government initiatives should prioritize export-oriented vocational training, regional skill centers, and managerial development programs that enhance leadership and export management capacity. Expanding digital skills and foreign market literacy would strengthen the absorptive capacity of SMEs and improve their adaptability to global market dynamics.

Innovation and technology represent another crucial pillar. Targeted subsidies and tax incentives should support process innovation in agro-processing and manufacturing SMEs, while digital transformation projects such as ERP systems, e-export platforms, and AI-based logistics must receive greater attention. Strengthening collaboration between startups and industrial firms through technology parks and innovation hubs can accelerate technological diffusion.

Institutional coordination is vital for realizing synergy effects. The Triple Helix model—linking government, universities, and industry—should be localized through joint innovation projects involving KOBIA, higher education institutions, and regional business incubators.

Given Azerbaijan's regional diversity, policies should promote cluster-based development. Smart Villages and Industrial Parks must be aligned with regional export specialization, particularly in Karabakh, Lankaran, and Sheki-Zagatala.

Finally, a green export policy should be integrated into the national strategy. Incentives for energy-efficient technologies, ESG-compliant products, and carbon-reducing innovations will align Azerbaijan's export growth with global sustainability standards and ensure long-term environmental and economic resilience.

**Conclusion**

The findings of this research confirm that the export potential of small and medium-sized enterprises (SMEs) in Azerbaijan's non-oil sector is fundamentally shaped by the synergistic interaction between human capital, investment, and resource efficiency. The synergy-based econometric approach demonstrates that these determinants reinforce each other, generating a cumulative impact that significantly enhances SME competitiveness and export capacity.

Empirical results provide strong evidence that the joint improvement of skilled labor, technological modernization, and efficient resource utilization creates a multiplicative effect on export performance. The statistically significant interaction between human capital and resource efficiency ($X_4 \times X_6$) validates the central hypothesis—that synergy among economic and institutional factors serves as a core driver of export growth and diversification in Azerbaijan's non-oil economy. Strengthening these interconnections through coordinated policy measures—such as targeted investment in human capital, innovation incentives, and institutional cooperation—can accelerate the shift toward a more diversified and sustainable export structure.

By adopting a synergy-oriented policy framework, Azerbaijan can strengthen SME resilience, reduce hydrocarbon dependency, and progress toward its long-term vision of inclusive and innovation-driven growth.

However, this study has certain limitations. The analysis relies on macro-level data from 2013–2023, which may not fully capture firm-level heterogeneity across sectors and regions. Moreover, the limited availability of microdata restricts the ability to test the model across different ownership types and export orientations.

Future research should employ panel data and machine learning–based approaches to detect nonlinear interactions and hidden patterns in synergy effects. Incorporating behavioral and institutional variables—such as innovation culture, export readiness, and digital adaptability—would further enhance understanding of SME export dynamics in Azerbaijan's evolving economic landscape.

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# Azərbaycanın KOS-larının ixrac potensialının sinerji əsaslı ekonometrik qiymətləndirilməsi

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**Xülasə:** Bu tədqiqat Azərbaycanın qeyri-neft sektorunda fəaliyyət göstərən kiçik və orta sahibkarlıq subyektlərinin (KOS) ixrac potensialını qiymətləndirmək məqsədilə sinerji əsaslı ekonometrik model hazırlayır və tətbiq edir. Araşdırmada insan kapitalı, investisiya və resurs səmərəliliyi göstəriciləri inteqrasiya olunaraq onların 2013–2023-cü illər üzrə ixrac göstəricilərinə qarşılıqlı təsiri ölçülür. Sadə Ən Kiçik Kvadratlar (OLS) reqressiyası və statistik diaqnostika üsulları ($R^2$, F-testi, Durbin–Watson və VIF) əsasında aparılan analiz göstərir ki, insan kapitalı ilə resurs səmərəliliyi arasında qarşılıqlı təsir ($X_4 \times X_6$) ən güclü və statistik cəhətdən əhəmiyyətli sinerji effektini yaradır. Bu nəticə empirik şəkildə sübut edir ki, KOS-ların ixrac artımı ayrı-ayrı amillərlə deyil, onların qarşılıqlı və tamamlayıcı təsirləri ilə formalaşır. Tədqiqatın nəticələri həmçinin göstərir ki, texnoloji modernizasiya və investisiya genişlənməsi uzunmüddətli dövrdə ixrac rəqabətqabiliyyətinin formalaşmasında müsbət, lakin gecikmiş təsirə malikdir.

Nəticə olaraq vurğulanır ki, insan kapitalının, innovasiyaların və resurs istifadəsinin koordinasiyalı şəkildə yaxşılaşdırılması qeyri-neft ixracının şaxələndirilməsini sürətləndirə bilər. Siyasət tövsiyələrinə ixrac yönümlü peşə təhsili, innovasiya subsidiyaları, regional sənaye klasterləri və ESG prinsiplərinə uyğun yaşıl ixrac strategiyalarının təşviqi daxildir. Məqalədə təklif edilən sinerji əsaslı çərçivə inkişaf etməkdə olan iqtisadiyyatlarda adaptiv və dayanıqlı KOS ixrac siyasətlərinin hazırlanması üçün yeni analitik yanaşma təqdim edir.

**Açar sözlər:** KOS; Qeyri-neft ixracı; Sinerji effekti; İnsan kapitalı; Resurs səmərəliliyi; Ekonometrik modelləşdirmə; İnnovasiya siyasəti; Azərbaycan.

# Синергетическая эконометрическая оценка экспортного потенциала МСП Азербайджана

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**Резюме:** В данном исследовании разработана и применена синергетическая эконометрическая модель для оценки экспортного потенциала малых и средних предприятий (МСП) в ненефтяном секторе Азербайджана. В исследование интегрированы показатели человеческого капитала, инвестиций и эффективности использования ресурсов для измерения их взаимного влияния на экспортную деятельность в период 2013–2023 гг. С использованием метода наименьших квадратов (OLS) и статистических тестов ($R^2$, F-тест, Дарбина–Уотсона и VIF) установлено, что взаимодействие между человеческим капиталом и эффективностью использования ресурсов ($X_4 \times X_6$) создаёт наиболее сильный и статистически значимый синергетический эффект. Этот результат эмпирически подтверждает, что рост экспорта МСП определяется не отдельными факторами, а их взаимным и комплементарным воздействием. Кроме того, результаты показывают, что технологическая модернизация и расширение инвестиций оказывают положительное, хотя и запаздывающее влияние на формирование долгосрочной экспортной конкурентоспособности.

В заключение отмечается, что согласованное развитие человеческого капитала, инноваций и эффективного использования ресурсов может ускорить диверсификацию ненефтяного экспорта. Политические рекомендации включают продвижение экспортно-ориентированного профессионального образования, инновационные субсидии, создание региональных промышленных кластеров и развитие «зелёных» экспортных стратегий в соответствии с принципами ESG. Предложенная синергетическая модель открывает новое аналитическое направление для разработки адаптивных и устойчивых экспортных стратегий МСП в развивающихся экономиках.

**Ключевые слова:** МСП; Нефтезависимый экспорт; Синергетический эффект; Человеческий капитал; Эффективность ресурсов; Эконометрическое моделирование; Инновационная политика; Азербайджан.