ECONOMETRIC MODELING OF THE ECONOMIC EFFICIENCY OF AGRO-SERVICE PROVIDERS IN THE AGRO-INDUSTRIAL COMPLEX UNDER DIGITALIZATION

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Abstract. *This study examines the issues of enhancing and optimizing the economic efficiency of service delivery in agro-industrial complexes within the framework of the digital economy. The development of technical, logistical, information-advisory, financial, and other agro-services directly influences production costs, service cost prices, labor productivity, gross revenue, and profitability indicators. The utilization of digital technologies provides significant opportunities to minimize operational time, mitigate transaction costs, enhance resource allocation efficiency, and expand the overall scope of service delivery. This research systematizes the evaluation indicators of economic efficiency and proposes an econometric approach based on correlation and regression analysis to model key influencing factors. Furthermore, strategic directions are articulated to maximize the economic impact of digitalization on agro-service sustainability.*

Keywords: *digital economy, agro-industrial complex, agro-service, economic efficiency, production costs, revenue, cost price, profitability, labor productivity, digitalization, correlation analysis, regression modeling.*

Introduction

The rapid progression of the digital economy creates novel opportunities across key economic sectors for rationalizing resource allocation, optimizing cost structures, and elevating the quality of managerial decision-making. Within the agro-industrial complex (AIC), ensuring comprehensive service support across various stages of the agricultural production lifecycle exerts a substantial influence on the financial performance of agricultural producers. The efficient organization of technical maintenance, material-technical supply, logistics, financial, and information-advisory services contributes directly to reducing production expenses, boosting labor productivity, and improving the profit margin of agricultural output. Consequently, evaluating the agro-service system necessitates going beyond volume and qualitative parameters to encompass integrated economic efficiency metrics.

Digital tools enable the automation of service workflows, digital order placement, real-time coordination among service entities, and rapid data processing.

These capabilities reduce operational delays, eliminate superfluous overhead, and lower transaction costs associated with information asymmetry. Therefore, an empirical evaluation of digitalization's role in driving the economic efficiency of agro-services represents a highly relevant scientific task.

Research Objectives

Main Objective: To assess the economic efficiency of service delivery in agro-industrial complexes under the digital economy and formulate organizational-economic pathways to boost overall performance through econometric modeling.

Research Tasks:

To achieve this goal, the research focuses on several interconnected tasks: clarifying the theoretical economic essence and role of service provision within the agro-industrial complex; establishing a systematic set of economic indicators representing service efficiency; examining the direct impact of digital tools on service cost structures and economic outcomes; identifying key driver factors influencing the economic efficiency of agro-services; modeling the functional relationships among key factors using correlation and regression analysis; and proposing actionable recommendations for optimizing the economic efficiency of agro-services through digital mechanisms.

Research Methodology and Indicator System

The methodological framework incorporates a systems approach, statistical analysis, comparative analysis, grouping, time-series dynamics, economic efficiency assessment, and econometric (correlation-regression) modeling. Within this framework, a comprehensive indicator system is established to measure the economic efficiency of service provision, selecting core parameters that capture both financial performance and operational performance: revenue generated from service delivery, total service operational expenses, unit cost price of services, service profitability rate, service volume output per employee, labor productivity, time spent per service transaction, share of digital service utilization, and cost savings achieved through digital adoption.In general terms, economic efficiency (E) is expressed as:

$$E = (Result - Cost) / Cost \times 100$$

where:

- E — rate of economic efficiency (in percent);
- Result — economic effect (revenue or net profit) derived from service delivery;
- Cost — total expenditure incurred to achieve the specified outcome.

, and financial results before and after The economic impact of digitalization is evaluated by comparing expenditure levels, time consumption the implementation of digital solutions.

Economic Importance of Agro-Services in the Agro-Industrial Complex

Agro-service provision forms an essential economic backbone that ensures continuity throughout agricultural production cycles. A well-developed service network governs the extent to which producers can access modern machinery, resource inputs, financial capital, transportation, and agronomic expertise. The economic efficiency of agro-services is fundamentally determined by the ratio of economic output generated to the resources consumed. When digital technologies reduce service delivery times and resource inputs per unit of service, overall economic efficiency increases proportionally. Furthermore, timely and high-quality services prevent machinery downtime, resource delivery delays, and unnecessary operational losses across farms.

Impact of Digitalization on Economic Efficiency

Digitalization influences the economic efficiency of agro-services through multiple structural mechanisms. First, electronic ordering and automated scheduling systems significantly reduce transaction turnaround times. Second, digital data exchange lowers administrative, operational, and informational transaction costs.

Thus, the economic effect of digitalization is realized not merely through technological modernization, but via tangible cost containment, labor productivity gains, expansion of service scope, and revenue growth.

Factors Influencing Economic Efficiency

The economic efficiency of agro-services is shaped by an interconnected matrix of digital, financial-economic, labor, organizational, and technical factors. Key determinants include the adoption rate of digital technology, high-speed internet and platform accessibility, the share of e-services, overall cost prices, investment volume, profitability margins, staff qualifications, labor productivity, service turnaround speed, and the adequacy of machinery and logistics infrastructure. A comprehensive evaluation of these variables enables evidence-based management decisions.

Correlation and Regression Analysis

To quantify the impact of key factors on the economic efficiency of service provision, a multi-factor linear regression model is applied:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

where:

- Y— economic efficiency level of service delivery;
- X1 — degree of digitalization;
- X2— total service operational expenses;
- X3— revenue derived from service delivery;
- X4 — labor productivity;
- X5 — service execution speed (time efficiency);

- β_0 — constant (y-intercept);
  β_1–β_5 — regression coefficients representing the marginal impact of each factor on Y;
- ε— random error term.

Estimating the model parameters using empirical data enables the identification of statistical dependencies and impact vectors. Model diagnostics are performed using the coefficient of determination (R^2), F-test for overall model significance, and t-statistics for individual parameter significance.

Pathways to Enhance Economic Efficiency

To improve the economic efficiency of agro-service providers, several key measures are recommended: implementing phased digital transformation across all service workflows, establishing electronic ordering systems and digital service platforms, introducing real-time digital monitoring for cost tracking and expense management, building a unified electronic database of regional agro-service entities, conducting systematic analyses of unit cost price dynamics and profitability, leveraging digital management software to boost employee labor productivity, eliminating unnecessary intermediaries to minimize transaction overhead, fostering market competition among service entities, and enhancing digital literacy and platform adoption skills among agricultural producers. Primary emphasis must be placed on measuring concrete financial and economic returns rather than focusing solely on digital adoption as an end in itself.

Conclusion

Enhancing the economic efficiency of service delivery in agro-industrial complexes under digital transformation is a pivotal factor in optimizing production expenses, ensuring rational resource usage, and improving financial sustainability.

This study demonstrates the appropriateness of utilizing revenue, cost, cost price, profitability, labor productivity, and time consumption metrics to evaluate agro-service performance, viewing digital tools as key economic enablers. Econometric modeling via correlation and regression analysis allows for the empirical measurement of factor relationships, providing a quantitative foundation for managerial decisions regarding digital investments. Ultimately, digitizing the agro-service framework must remain closely linked with cost reduction, productivity growth, and improved economic outcomes.

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