Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 25, Issue 4, 2025
PRINT ISSN 2284-7995, E-ISSN 2285-3952

QUANTIFYING THE IMPACT OF INNOVATION BARRIERS ON THE PERFORMANCE OF AGRI-FOOD ENTERPRISES IN THE REPUBLIC OF MOLDOVA

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Abstract

The primary objective of this research is to evaluate the impact of innovation barriers on the performance of enterprises operating within the agri-food sector of the Republic of Moldova. Based on the results obtained, the study aims to propose strategic directions for enhancing innovation activities in the sector. To fulfill this objective, the analysis relies on data collected through a survey conducted between 2023 and 2024, involving a representative sample of 107 agri-food enterprises.The cause-effect relationship between innovation barriers and unrealized potential profit was estimated using the ridge regression method. The results indicate that high innovation costs and limited internal financial resources have a substantial impact on enterprise performance. A moderate influence is associated with factors such as the shortage of qualified personnel, difficulties in securing external funding, export restrictions, sales prohibitions related to the accumulation of state reserves, and obstacles in forming partnerships for innovation-related initiatives. Conversely, barriers such as weak market demand for innovative products, limited access to innovation-related information, and low employee motivation to engage in innovation activities were found to have minimal impact. The findings of the research served as a basis for proposing measures to reduce the influence of innovation barriers, differentiated according to their nature: endogenous and exogenous.

Key words**:** *agri-food sector, innovation barriers, performance, Republic of Moldova*

INTRODUCTION

At the current stage, strongly shaped by the phenomena of globalization, internationalization, and digitalization, the significant impact of innovations on enterprise performance is indisputable. This assertion is substantiated by numerous studies [3; 4; 7; 9; 10; 14; 18; 23] and is further confirmed by the multifaceted nature of innovation implications- namely economic, technological, instrumental, and socio-psychological dimensions [1]. In this context, considering that the focus of the present research is the agri-food sector, it is important to emphasize that the potential for creating, implementing, and disseminating knowledge-based innovations and solutions represents a key prerequisite for ensuring its sustainable economic and social development [2].

At the same time, the implementation of innovation is often hindered by a range of barriers**,** which act as limiting factors preventing companies or groups of companies from successfully carrying out research, development, and innovation projects [20]. These barriers can significantly affect firm performance by obstructing innovation opportunities or reducing the effectiveness of innovation outcomes.

Conceptually, innovation barriers are defined in the literature as factors that slow down, obstruct, or negatively influence innovation processes**.** For example, Lewandowska states that barriers represent "any factor that delays or even impedes innovation activity, and may negatively affect it to the extent that it does not deliver the expected results" [15]. Similarly, Madeira et al., based on a synthesis of multiple studies on the subject, argue that these factors may be internal (endogenous) or external (exogenous), and that their effects are manifested in the reduction or suppression of firms' innovation orientation, as well as in

their ability to introduce and sustain new or significantly improved products or processes—ultimately undermining business outcomes and performance [16].

Given the above, it becomes evident that precisely quantifying the impact of innovation barriers provides strategic value for enterprises. Such analysis enables a realistic evaluation of innovation opportunities, more accurate forecasting of expected outcomes in scenarios where certain barriers are removed or mitigated, and more efficient allocation of resources toward viable innovative solutions.

However, a major challenge in this endeavor lies in the lack of centralized and systematically reported data by enterprises, which results in a scarcity of accessible statistical information for researchers. This limitation restricts the application of rigorous methodological tools and hinders the academic community's ability to offer concrete support to the business sector in rational resource management and in the adoption of new technologies and innovation practices. In this context, the study quantified the impact of innovation barriers on the performance of enterprises in the agri-food sector of the Republic of Moldova and the directions for improving innovation in this sector.

MATERIALS AND METHODS

To achieve the objective of the research, the following methodological tools were employed: a) literature review, focused particularly on the conceptualization of innovation barriers and on examining existing approaches to quantifying their impact on the economic performance of enterprises; b) opinion survey, conducted during the period 2023–2024 on a sample of 107 enterprises from the agri-food sector, through which, among other aspects, respondents' perceptions regarding unrealized potential profit during the period 2021–2022 were collected, depending on various factors; c) ridge regression, applied to estimate the cause–effect relationship between innovation barriers and unrealized profit; d) deductive and generalization methods, used to formulate proposals for actions aimed at reducing or eliminating the effects of innovation barriers in the agri-food sector.

The main limitations of the research include the relatively low representativeness of the sample and the potential subjectivity of respondents' answers.

RESULTS AND DISCUSSIONS

To gather information on the barriers that hindered the implementation of innovations within the surveyed enterprises, responses were analyzed from company managers and specialists to the following question: "If you equate 100% with the potential gross profit unrealized due to innovation-related obstacles, what percentage would you attribute to each of the following factors?". The respondents were invited to distribute percentages across the following predefined options:

- Insufficient internal financial resources;
- Challenges in attracting external funding (credits, grants, subsidies, etc.);
- High costs of innovation;
- Lack of qualified personnel capable of developing and implementing innovations;
- Insufficient employee motivation for engaging in innovation-related activities;
- Inadequate access to relevant information and updates in the field;
- Low market demand for innovative products;
- Difficulties in establishing partnerships for innovation (with other enterprises, research institutions, etc.);
- Other (to be specified by respondents).

To process the collected data, several stochastic analysis methods were comparatively examined, including Spearman's correlation coefficient, ANOVA, and MANOVA. Ultimately, multiple linear regression was selected as the most appropriate method for analyzing the relationships involved. However, while multiple linear regression is suitable for identifying dependency relationships, it also carries the risk of multicollinearity among independent variables, which may distort the

econometric model. Multicollinearity, or linear dependence among explanatory variables, can severely impact parameter estimation and the accuracy of variable selection techniques [6]. In practical terms, when strong multicollinearity is present, the coefficients of the regression may become unreliable.

This challenge highlights the necessity for regularization - a statistical method aimed at reducing overfitting and estimation errors [17, p.253–254]. Two commonly used techniques for regularized regression are ridge regression and LASSO regression. Both aim to reduce the influence of predictor variables but differ in their approach: Ridge regression applies L2 regularization, adding a penalty to shrink all coefficient estimates toward zero without eliminating any predictors. LASSO regression, on the other hand, applies L1 regularization, which can shrink some coefficients to zero, effectively removing less relevant variables [5].

Considering the above, ridge regression was selected as the preferred analytical method for this study. The main rationale was the desire to retain all predictor variables provided by respondents, as their exclusion through LASSO could oversimplify the econometric model and diminish the value of the available data. The general formula for ridge regression is presented as follows [8]:

$$\hat{B}_{ridge} = (X^T X + \lambda I)^{-1} X^T Y, \ \lambda \geq 0 \qquad (1)$$

where:

X – values of the independent variables;

Y – vector of the dependent variable;

λ – regularization coefficient;

I – identity matrix of the same dimension as the matrix $X^T X$.

During the initial stage of data processing for analysis, the influence of each factor - originally expressed as a percentage - was transformed into binary sums by dividing the values by 100. Simultaneously, extreme values of gross profit reported by several enterprises were removed in order to avoid distortion of the ridge regression model. The identification of outliers was conducted using the interquartile range (IQR) method**,** as recommended in the e-handbook of statistical methods**,** developed by the National Institute of Standards and Technology (NIST) in collaboration with SEMATECH [19].

The relevant values were as follows:

- First quartile (Q1)**:** 1,084 thousand MDL;
- Third quartile (Q3)**:** 7,828 thousand MDL;
- Interquartile range (IQR)**:** Q3 – Q1 = 6,743 thousand MDL.

Based on these, the inner and outer bounds for outlier detection were calculated as follows:

- Lower bound**:** Q1 − 1.5 × IQR = −19,145 thousand MDL;
- Upper bound**:** Q3 + 1.5 × IQR = 28,057 thousand MDL.

Accordingly, five enterprises were excluded from the dataset because their gross profit values exceeded the upper threshold of 28,057 thousand MDL.

The results for the ridge regression coefficients are presented in Table 1**.**

Table 1. Ridge regression coefficients obtained with a regularization penalty of 0.1

Barrier name	Ridge coefficient value
Low market demand for innovative products	-0.331285
High costs of innovation (introducing something new is expensive)	-0.856716
Difficulties in attracting external resources (loans, grants, subsidies, etc.)	-0.524371
Difficulties in establishing partnerships for innovation activities (with other companies in the field, research institutions, etc.)	-0.419086
Insufficient information about developments in the field	-0.298338
Lack of qualified personnel capable of developing and implementing innovations	-0.617208
Insufficient internal financial resources	-0.738878
Other	-0.476477
Lack of employee motivation for innovation activities	-0.098001

Source: Own calculation.

The analysis of the results presented in Table 1 reveals that the highest-ranked innovation barrier, in terms of impact on unrealized potential profit, is the high cost of

innovations, with a coefficient of -0.856, followed closely by the lack of internal financial resources, with an impact of -0.738.
Moderate effects are observed for the following innovation barriers: insufficient qualified personnel capable of designing and implementing innovations; difficulties in attracting external resources such as loans, grants, and subsidies; and other factors cited by respondents, including export restrictions, sales bans for state reserve purposes, and emergency situations, including those related to the pandemic (institutional factors, according to the OSLO Manual [21]). Lower-impact barriers, as perceived by respondents, include low market demand for innovative products, insufficient information about developments in the relevant field, and low employee motivation for engaging in innovation activities.

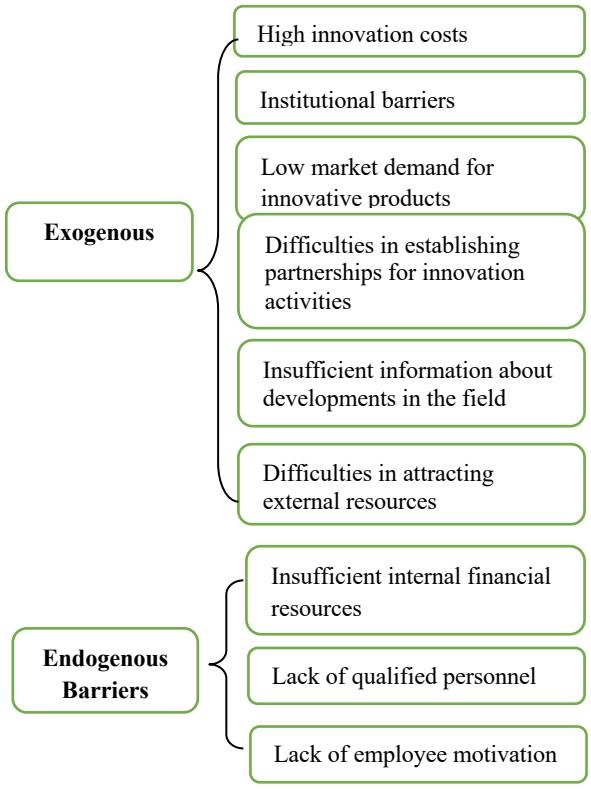

Fig. 1. Classification of innovation barriers by origin
Source: Developed by the authors based on [11;12; 13; 16].

The results obtained through ridge regression provide a valuable foundation for identifying possible courses of action to reduce the influence of the analyzed barriers and create additional opportunities for enterprises to enhance their performance. However, achieving this objective requires consideration of the nature of each barrier.
According to their origin, the analyzed barriers can be classified as exogenous or endogenous (Fig.1).
This classification supports the idea that some barriers can be addressed more easily, while others demand greater adaptability to changes in the external environment.
Nevertheless, the exogenous nature of certain factors is debatable, as some lie at the boundary between internal and external influences. For example, barriers such as difficulties in establishing partnerships for innovation, lack of information about sectoral developments, and challenges in accessing external financial resources could be mitigated through improved managerial negotiation skills, information-seeking competencies, language proficiency, and project development capabilities.
Additionally, there is a pressing need to enhance the efforts of managers and specialists toward market evaluation and identification of new product niches, partner identification for innovation design and implementation, development of employees' innovation capabilities, rationalization of motivational tools, and improvement of performance management systems to stimulate innovation activity within enterprises. This line of reasoning is supported by findings from previous research, which emphasized the urgent need for such competencies among managers and specialists in the sector [22].
A synthetic reflection on the necessary actions to be undertaken in order to reduce the influence of the identified innovation barriers in agri-food enterprises - derived logically from the nature of the observed barriers - is presented in Table 2. Although the actions presented in the table may appear complex, their relevance is indisputable, considering the well-established role of innovation in enhancing the performance of agri-food enterprises and the significant potential loss in gross profit caused by innovation barriers.

Moreover, it is worth noting that several of these measures effectively address multiple barriers simultaneously. For example, continuously evaluating available external funding opportunities and leveraging professional training and information resources offered by various organizations can address several constraints simultaneously. Thus, it can be deduced that implementing the proposed actions would significantly reduce innovation-related obstacles and create real premises for enhancing the performance of enterprises in the agri-food sector.

Table 2. Recommended actions for minimizing the effects of exogenous and endogenous barriers to innovation in the agri-food sector of the Republic of Moldova

Content of innovation barriers	Necessary actions
Exogenous Innovation Barriers	
High innovation costs; Difficulties in attracting external resources (e.g., loans, grants, subsidies).	Ongoing evaluation of available external funding opportunities; Participation in information and capacity-building activities related to project management organized by external funding bodies such as the Organization for Entrepreneurship Development, the Agency for Payments and Intervention in Agriculture, etc.
Institutional Barriers	Streamlining the risk management system through: a) Use of advanced risk forecasting tools; b) Development of risk response strategies; c) Continuous risk monitoring and control; More rigorous strategic planning based on post-factum analyses over extended periods to identify trends in indicators, phenomena, and processes; Studying and adopting survival strategies applied by domestic and foreign enterprises.
Low market demand for innovative products	In-depth analysis of the market for innovative products to identify uncovered niches in line with technological developments and consumer preferences; Identifying new market segments for various innovative products; Strengthening efforts to promote new products in order to attract potential customers.
Difficulties in establishing partnerships for innovation activities; Insufficient access to up-to-date information in the field of activity	Strengthening collaboration with national and international research and innovation organizations; Pooling efforts and resources with other enterprises in the sector for the design and implementation of innovations; Leveraging opportunities for information, consultancy, and training provided by the aforementioned funding bodies, as well as the Ministry of Agriculture and Food Industry, producer associations, research and innovation organizations, and other public and private institutions.
Endogenous Innovation Barriers	
Insufficient internal financial resources	Improvement of internal financial planning and forecasting mechanisms; Identification of internal sources of reinvestment and reallocation of resources toward innovation; Strengthening collaboration between financial and innovation departments to ensure budget alignment with innovation goals.
Insufficient number of qualified personnel capable of developing and implementing innovations	Strengthening collaboration with vocational education institutions and universities to align curricula with the needs of the sector; Continuous professional development and internal training programs focused on innovation management and technical skills; Attracting young talent and specialists from diaspora through targeted incentive programs.
Low motivation of enterprise staff to engage in innovative activities	Revising and improving internal incentive systems to reward innovation-related performance; Implementing participatory management practices to encourage initiative and creativity among employees; Developing a culture of innovation at the organizational level through regular communication and team involvement in innovation projects.

Source: Developed by the authors.

CONCLUSIONS

Stimulating innovation in the agri-food sector is essential for its long-term prosperity. A crucial first step in strengthening innovation in this field lies in eliminating - or at least mitigating - the barriers that hinder its development.

Necessary actions should primarily target financial barriers, which have the greatest impact, while not overlooking other constraints that, when combined, can significantly affect enterprise performance. At the same time, the significance of these other barriers should not be overlooked, regardless of their individual level of impact, as only a comprehensive and integrated approach to addressing all obstacles can ensure optimal outcomes in the innovation process. While the measures required to mitigate innovation barriers may be complex, their implementation is essential, given the critical role that innovation plays in advancing the agri-food sector and its broader implications for the country's economic and social development.

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