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ARTICLE

Balanced Management of Meat Processing Enterprises Under Conditions of Food and Resource Instability in Kazakhstan

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ABSTRACT

The business operations of industrial enterprises engaged in the processing of agricultural animal-origin raw materials, including meat processing, are increasingly exposed to negative environmental, market, and institutional factors that constrain their sustainable development. These challenges are exacerbated by unstable production volumes and a shortage of domestically produced meat raw materials, particularly beef, which undermines the country's food security and intensifies competition among meat product manufacturers. In this context, the development and application of scientifically grounded management tools are crucial for enhancing the stability and efficiency of meat processing enterprises. The objective of this research is to provide theoretical justification and develop methodological and practical support for creating a balanced management system tailored to the specific business environment of meat processing enterprises. The scientific novelty of the study lies in developing a comprehensive set of scientific and methodological principles for building such a system, taking into account the distinctive

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features of meat processing business processes. The research results include the substantiation of methodological approaches for the economic assessment of development balance in enterprise management. A key element of the proposed approach is the use of specialized analytical matrices designed to assess the balance level across three main components: resource generation, cost absorption, and achieved economic outcomes. The practical application of these tools enables the identification of critical imbalances in enterprise operations, supporting informed management decisions aimed at improving production efficiency, strengthening competitiveness, and ensuring the long-term sustainable development of meat processing enterprises.

Keywords: Meat Processing Enterprises; Meat Products; Index; Production Factors; Efficiency Assessment; Meat Products Market; Consumer Market

1. Introduction

Currently, the operations of meat processing enterprises are significantly influenced by a complex set of internal factors, rendering them particularly vulnerable amid ongoing economic instability. The sustainable development of this sector is a strategically important and urgent task, especially in light of current global and national challenges, which include the following:

Firstly, the industry faces a persistent shortage of raw materials, primarily due to the low productivity of domestic livestock farming and the absence of modern systems for quality and safety control across the entire technological chain—from primary production to final processing. Compounding this issue is the limited implementation of closed-loop (circular economy) technologies, which results in the inefficient use of valuable resources and reduced overall production efficiency.

Secondly, the sector suffers from an acute shortage of qualified personnel across both technological and managerial domains. This challenge is further exacerbated by the industry's high dependency on imported equipment, inadequate levels of technological modernization, and constraints imposed by climatic and infrastructural conditions.

Thirdly, during periods of socio-economic crisis, ensuring national food security becomes a critical priority. Addressing this issue requires a comprehensive approach that encompasses increased investment, improved production efficiency, and the development of domestic agricultural and industrial capacities. In this regard, an economic development model focused on import substitution, innovation stimulation, domestic technology promotion, and skilled specialist training is being actively pursued. These efforts aim to establish a solid foundation for the sustainable growth of the meat processing industry.

Given these factors, it is of paramount importance to elevate the development level of meat processing enterprises to one that can meet domestic demand for meat products and reduce potential threats to national food security. However, a significant barrier to achieving these objectives lies in the insufficient professional competencies and managerial capabilities of enterprise leaders, particularly in the context of intensifying competition and the volatility of market dynamics. This is further compounded by the lack of modern scientific and methodological frameworks tailored to the specificities of the meat processing industry—frameworks that are essential for the systematic and effective management of industry competitiveness.

In this context, the insufficient development of both theoretical foundations and practical mechanisms for competitiveness management—adapted to the industry's specific conditions and the broader dynamic market environment—underscores the relevance and necessity of conducting comprehensive research in this area.

2. Related Work

A critical analysis of the literature reveals a wide range of interpretations of the term *"mechanism"* in current economic science, underscoring its conceptual significance. To clarify the essence of the "product competitiveness mechanism," this section examines the primary interpretations and classifications of the term *"mecha-*

nism" within the context of economics.

According to V.K. Lipskaya, the category *"mechanism"* cannot exist independently; it is inextricably linked to its field of application. She classifies economic mechanisms into several types—socio-economic, financial, and general economic—and, concerning product competitiveness, defines the mechanism as a set of methods that influence competitiveness factors [1].

E.V. Veklenko, based on the subjects and objects of influence, identifies two main conceptual approaches to interpreting an economic mechanism: institutional and economic. The institutional approach defines the mechanism as the process of managing the studied object, while the economic approach views it as a complex system of interactions among various actors [2].

A.L. Pustuev and F.A. Stepanov, in their study of the *"economic mechanism of sustainability in the agro-industrial complex management system,"* emphasize the necessity of implementing a range of measures across different levels of the economy. Their findings suggest a classification of mechanisms based on the scope of economic phenomena and processes, encompassing micro-, meso-, macro-, and mega-levels [3].

N.P. Ivanov classifies mechanisms according to their implementation principles, identifying three types: market, command-hierarchical (vertical), and information-network mechanisms. Market mechanisms operate on the principle of self-regulation, whereas the latter two rely on vertical or horizontal subordination of elements, respectively [4].

A.S. Kulman proposes distinguishing between two primary types of economic mechanisms: open and closed. Open mechanisms reflect the dynamic development of the influenced object, allowing for transformation from its initial state. Closed mechanisms, by contrast, represent a continuous cyclic process where the object changes through a recurring series of stages [5].

Based on the theoretical analysis, we identified several core approaches to understanding the term *"mechanism"* in economic science: as a set of influencing levers, as a collection of elements, as a sequence of processes, and as a system of interactions. These approaches collectively help define the *"mechanism for increasing product competitiveness"* as an ordered system of functional blocks, sequentially aligned toward the ultimate goal of enhancing product competitiveness [6].

Issues related to enhancing the competitiveness of meat processing enterprises continue to attract the attention of numerous researchers, as this sector plays a critical role in ensuring food security and advancing the agro-industrial complex. Contemporary studies emphasize the multifaceted nature of the factors influencing competitiveness, including the raw material base, technological innovations, human capital, and product quality management [7].

In economics, the concept of a "mechanism" has multiple interpretations, which vary depending on the field of application and the level of analysis. C. Lipskaya highlights the importance of the interaction between the elements of a mechanism and the object of influence, distinguishing between socio-economic and financial mechanisms [8]. In his research, E. C. Veklenko focuses on institutional and economic approaches, defining the mechanism as a management process and a system of interactions among actors [9]. Similar classifications based on scale and principles of interaction was proposed by A. L. Pustuev and F. A. Stepanov, as well as by N. P. Ivanov, who introduced the concepts of market, command-hierarchical, and network mechanisms [10–12].

A significant focus of current research is the integration of innovative technologies and digitalisation into meat processing operations, which enhances product quality and optimizes resource utilization. Recent studies have demonstrated the effectiveness of implementing quality management systems based on digital technologies and the Internet of Things (IoT), which reduce raw material losses and enhance control throughout all stages of production [13].

Human capital also plays a crucial role—training qualified personnel and developing managerial competencies are key factors for the sustainable development of enterprises in the meat industry.Challenges related to the shortage of specialists and reliance on imported equipment are particularly acute in regions with harsh climatic conditions and underdeveloped infrastructure, as confirmed by several studies [14].

Moreover, the academic literature extensively discusses the formation of pricing policies and the opti-

mal balance between product quality and price, both of which directly influence competitiveness in both domestic and international markets. To substantiate pricing strategies and assortment development, researchers actively use expert assessments, economic-mathematical modelling, and modern analytical approaches [15].

In conclusion, the review of the literature underscores the need for a comprehensive approach to enhancing competitiveness—one that integrates innovation, human capital development, technological process optimization, and efficient management of raw material resources. This affirms the relevance of the selected research topic.

Recent studies on increasing the competitiveness of meat processing enterprises further confirm the need for an integrated approach that encompasses economic, technological, and managerial dimensions. Alongside traditional economic mechanism models, considerable attention is given to the adoption of digital technologies and innovative production management systems [16].

Several works identify the development of human capital as a pivotal factor in ensuring sustainable enterprise growth [16]. Furthermore, the impact of climatic and infrastructural limitations on production efficiency in resource-constrained regions is well-documented [17, 18].

Models that incorporate raw material quality, supply chain optimization, and the integration of quality control systems are increasingly relevant, as reflected in the latest research [19, 20]. The effective implementation of such models requires the systematic application of multidimensional statistical and econometric methods.

The operational scheme of the proposed mechanism is presented in **Figure 1**. As shown, this scheme follows a process-based approach, but it also introduces several distinctive features compared to existing economic mechanism models developed within this framework.

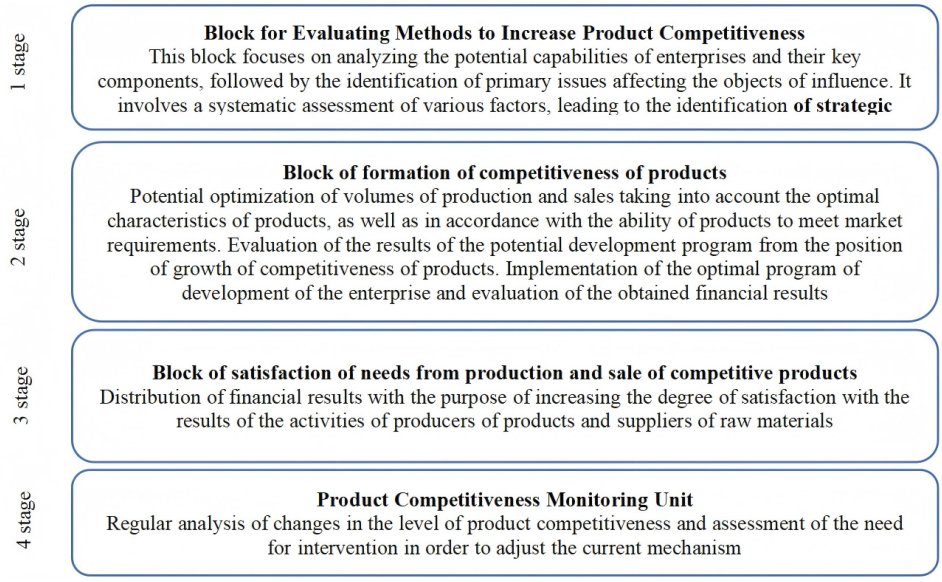

Figure 1. Scheme of the functioning of the mechanism for enhancing product competitiveness.

Source: Developed by the authors.

This method is based on constructing a power correlation-regression model to determine the formation of added value from production factors including labor (represented by the average number of employees), total capital (excluding the cost of purchasing livestock), and raw materials in the form of livestock delivered for processing. It enables the determination of the specific contribution of these resources to the formation of added value by calculating their average and marginal productivity.

To monitor and identify competitive and non-competitive products across different product groups of a processing enterprise, as well as to justify reserves for their growth, a methodology for assessing product

competitiveness from the perspective of a meat-packing plant has been developed [21]. For the actual and potential assessment of product competitiveness, it is proposed to use a composite indicator based on factors such as the share of exports of individual product types, the share of revenue from product sales in total revenue, and product profitability. According to the calculations, products will be considered competitive when the competitiveness coefficient is greater than or equal to the established standard [22].

It is known that price differentiation occurs depending on the quality level of the products sold, which necessitates justifying the optimal combination of the product's key characteristics, namely price and quality [23, 24]. To address this issue, we propose a pricing technique that ensures product competitiveness at a given quality level [25] (**Figure 2**). The novelty of this technique lies in considering consumer satisfaction with product quality, assessed through expert evaluation. The use of this approach allows the processing enterprise to promptly adjust its product assortment policy and respond to shifts in consumer demand, thereby better meeting consumer needs. The proposed technique was also applied to justify the initial data for the economic and mathematical model of the development program for a meat processing enterprise, based on the growth of its product competitiveness through various scenarios [26, 27].

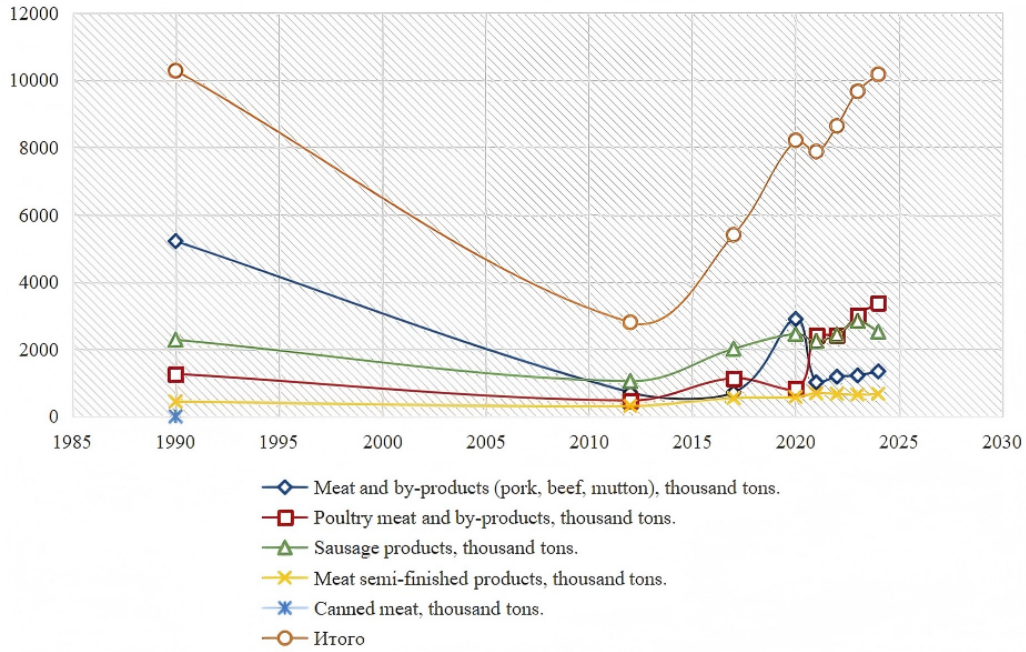

Figure 2. Dynamics of production volumes of the main types of meat industry products in Kazakhstan.

The novelty of the model lies in the introduction of restrictions: on the formation of added value, ensuring that the added value generated is at least equal to the actual achieved level, and on meeting consumer needs, which allows for maximizing the energy value of manufactured products about the costs of their acquisition [13, 28].

The application of this method enables the rational use of raw materials and optimizes production and sales volumes, aiming to improve the final results of the meat processing enterprise by enhancing the quality and competitiveness of its products. A four-stage method for assessing the choice of raw material suppliers for baby food production has been developed, with the novelty of incorporating and analyzing economic indicators, including the average annual number of animals, average daily weight gain, cost price of 1 ton of live weight gain, distance from the supplier to the meat processing plant, and the overall quality coefficient of raw materials. This coefficient is proposed to be calculated as the average value derived from the product of the quality coefficients of animals from different age

and sex groups, weighted by their share in the total purchase volume. Animal quality is determined based on the price ratio of raw materials of a given quality and the highest category [29].

The proposed mechanism includes the following elements: methods for assessing product competitiveness, evaluating the efficiency of resource use in meat processing enterprises, forming prices for products based on quality; a development program model for processing enterprises aimed at increasing product competitiveness; methods for assessing the selection of raw material suppliers; and bonuses for livestock supply for baby food production, along with justifications for the bonus amounts per ton of meat raw material based on its quality.

3. Materials and Methods

The scientific methodology of the research consists of an algorithm outlining the sequence for solving the problems addressed in the article at each stage of the study, thereby achieving the aforementioned goal. This methodology includes: collecting initial information for calculation, performing analytical processing, adjusting the data according to the arithmetic mean assessment of leading meat processing enterprises in the region, determining integral index indicators by calculating the ratio of reported data to the previous year, i.e., selecting a composite indicator of average indices for the enterprise, developing recommendations, and constructing a correlation-regression model along with an income forecast for the meat processing enterprises in the region.

This study employs a comprehensive methodological approach that integrates both quantitative and qualitative analyses to thoroughly examine the factors influencing the development of the meat processing industry in Kazakhstan.

Firstly, the research analyses absolute and relative changes in key production indicators within the meat industry from 2019 to 2024. This enables the identification of development dynamics, prevailing trends, and critical problem areas.

Secondly, to gain deeper insights into the relationship between input resources and production outcomes, correlation-regression analysis is applied using four key predictors: the average number of employees, total capital (excluding livestock acquisition costs), the volume of raw material supply (for livestock), and other significant factors. This approach enables the quantification of the contribution of each resource to the value-added output and the identification of the most influential drivers of production efficiency.

In addition, the methodology involves the development and application of specialized techniques for assessing product competitiveness, based on integrated indicators such as export share, sales revenue, profitability, and other financial and market metrics. This enables the evaluation of the current level of competitiveness and the formulation of evidence-based strategies for its improvement.

Particular emphasis is placed on developing a model for the strategic growth program of meat processing enterprises, which incorporates scenario analysis and economic-mathematical modeling. This model accounts for constraints on value creation and consumer demand satisfaction, enabling the optimization of production concerning both product quality and nutritional value.

Furthermore, a multi-stage methodology has been designed for selecting raw material suppliers, based on the assessment of economic and qualitative parameters. This contributes to improved raw material quality and reduced production costs.

In summary, the proposed methodological framework offers a systematic tool for analysing, evaluating, and forecasting the development of meat processing enterprises, to enhance their competitiveness and ensure sustainable growth.

4. Data Analysis

The meat industry is one of the most important sectors of the national economy. Its main objectives are to provide the country's population with food products that serve as the primary source of proteins and to ensure the country's food security. Over the past two decades, the Kazakhstani meat and meat products market has experienced fluctuations in effective demand.

This was due to the deep economic crisis of the 1990s, followed by a rapid recovery from 2000 to 2008, and stagnation in 2009 as a result of the global economic crisis. Since 2010, the Kazakhstani meat and meat products market has been developing steadily, acquiring characteristics typical of food markets in developed countries. Overall, from 2012 to 2024, personal consumption of meat and meat products in Kazakhstan increased by more than 60% (**Figure 2**).

As the data in **Figure 1** show, despite the stable growth in meat production, significant changes are occurring in the production structure. In 1990, the majority of production consisted of meat and offal (pork, lamb, and beef); however, by 2024, producers had increasingly focused on the production of meat and poultry products. There has also been a significant rise in the production of semi-finished meat products. The production of sausages remains the most stable category of manufactured products. These structural changes are attributed to shifts in Russian society, where market relations are evolving, the pace of life has increased, and people's free time has decreased. When comparing monetary and time costs, many Russians opt for meat products and semi-finished goods.

For a more objective analysis of the meat industry, we examined the production volumes of meat processing plants in physical terms, measured in tons, as shown in **Table 1**.

Table 1. Volume of production of meat processing enterprises of the meat industry in physical terms (tons).

Name	Years					Absolute Deviation	
	2020	2021	2022	2023	2024	+, −	%
Meat and offal edible	263,529	303,767	295,421	339,009	349,727	86,198	32.70
Meat of cattle, pigs, sheep, goats, horses and animals of the equine family, fresh or chilled	66,378	66,375	59,419	65,673	72,913	6,535	9.84
Fats of cattle, sheep, goats, pigs	374	139	114	48	43	−331	−88.50
Canned meat	6,876	7,357	8,532	5,994	6,298	−578	−8.41
Prepared and preserved products made from meat, meat by-products or animal blood	79,812	94,032	103,464	105,905	113,261	33,449	41.90
Sausages, similar products made from meat, meat by-products or animal blood	45,009	55,983	62,335	63,299	65,787	20,778	46.16
Index of production of sausages and similar products from meat, meat by-products or animal blood, without units of measurement.	1.03	1.243	1.113	1.015	1.039	0.009	0.873
Total of all meat products from meat processing plants	461,978	527,653	529,285	579,928	608,029	146,051	34
Number of enterprises, units	156	160	165	168	172	16	10.25
Average annual output of meat products of one meat processing enterprise	2,961.397	3,297.831	3,207.788	3,451.952	3,535.052	573.65	19.37
Average monthly capacity of meat production of one meat processing enterprise	248	275	267	286	295	+47	+19

Table 1 shows that the total volume of meat production over five years by all meat processing enterprises in the industry increased by 34%, reaching 608,029 tons in 2024. The production volumes include

the following increases: sausages by 46.16%, totaling 65,787 tons in 2022; finished and canned meat products by 41.9%, amounting to 113,261 tons; and edible meat and by-products by 32.7%, or 349,727 tons. Specifically, the production of beef, pork, and small ruminants, whether fresh or chilled, increased by 9.84%. The greatest increase was observed in horse meat production, which rose by 7.3%.

A decrease occurred between 2020 and 2024 in the following categories of meat products: animal fats, which declined by 88.5%, amounting to just 43 tons in 2024, and canned meat, which decreased by 8.41%, totaling 6,298 tons in 2024.

The average annual output of meat products per processing plant in 2020 was 2,961.4 tons, and by 2024, it had increased to 3,535.1 tons, representing a 19.37% rise. The average monthly capacity per plant in 2024 was 295 tons, a 19% increase from previous years.

According to official statistics, Kazakhstan's meat products subcomplex currently comprises more than 600 specialized enterprises, over 80% of which are meat processing plants that carry out the entire production and technological cycle [30].

Let us now analyze the raw material base and production potential of the meat processing industry, considering them as key factors for sustainable development. The starting point for this analysis is the indicator of the number of livestock and poultry (**Table 2**). According to the National Bureau of Statistics, the number of livestock and poultry is stable and exhibits a clear positive trend. This trend contributes to increased production volumes and a greater saturation of the domestic market with products such as beef and lamb, making the country more attractive to the modern consumer.

Table 2. Volume of production of meat processing enterprises of the meat industry in physical terms (tons).

No.	Name	Years					Deviations, %
		2019	2020	2021	2022	2023	
1	Meat and food products	263,529	303,767	295,421	339,009	349,727	32.70
2	Meat of cattle, pigs, sheep, goats, horses and animals of the equine family, fresh or chilled	66,378	66,375	59,419	65,673	72,913	9.84
3	Cattle, sheep, goats, lard	374	139	114	48	43	−88.5
4	Canned meat	6,876	7,357	8,532	5,994	6,298	−8.41
5	Prepared and preserved products made from meat, animal meat or blood	79,812	94,032	103,464	105,905	113,261	41.9
6	Sausages, animals, by-products or similar products made from animal blood	45,009	55,983	62,335	63,299	65,787	46.16
7	Index of sausage production and meat, by-products or similar products from animal blood, units.	1.03	1.243	1.113	1.015	1.039	0.873
8	All meat products from meat processing plants	461,978	527,653	529,285	579,928	608,029	34
9	Number of enterprises, units	156	160	165	168	172	10.25
10	Average annual output of meat products of one meat processing enterprise	2,961.397	3,297.831	3,207.788	3,451.952	3,535.052	19.37
11	Average monthly capacity of meat production of one meat processing enterprise	248	275	267	286	295	+19

Note: Calculated based on data from the Bureau of National Statistics of the Republic of Kazakhstan (https://stat.gov.kz/ru/).

Currently, the Government of the Republic is actively taking measures and developing regulatory and legal acts to support the development of the meat industry [3]. The main objective is to create favorable conditions for the growth of the meat processing industry in Kazakhstan while protecting the regional market from foreign competition. These measures are crucial for achieving regional economic growth and ensuring the import substitution of domestically produced meat products.

This policy is particularly relevant, as the share of imported meat and meat products constitutes approximately 25% of the total volume of domestic resources, posing a threat to the country's food security [31]. To provide a more objective assessment of the state of the meat industry, we have analyzed the production volumes of meat processing plants, presented in physical terms (tons), as shown in **Table 1**. Over the five years, total meat production increased by 34%, reaching 608,029 tons in 2023, including: sausages by 46.16%, totaling 65,787 tons; finished and canned meat products by 41.9%, totaling 113,261 tons; and meat and edible by-products by 32.7%, or 349,727 tons. The largest growth was in horse meat production, which increased by 7.3%.

Between 2019 and 2023, a decrease in production volumes was recorded for the following categories of meat products: the production of animal fats declined by 88.5%, reaching 43 tons in 2023, and the production of canned meat decreased by 8.41%, amounting to 6,298 tons in the same year.

Additionally, there has been a positive trend in the average output per meat processing plant. In 2018, this figure was 2,961,397 tons per year, and by 2022, it had increased to 3,535,052 tons per year, reflecting a growth of 19.37%. The average monthly production capacity per plant in 2022 reached 295 tons, marking a 19% increase.

The meat industry in Kazakhstan continues to develop actively, supplying the domestic market with a diverse range of products. The country is home to several large meat processing enterprises, including Rubikom LLP, Kublei LLP, Aktep LLP, Kaiyp Ata LLP, MPK Bizhan LLP, Kaz Beef LLP, and Astana Agroprodukt LLP. Based on data from these enterprises, an assessment of their economic efficiency was conducted (**Table 3**).

Table 3. Dynamics of economic indicators of meat processing enterprises (%).

No.	Indicators	Years					Deviations, %
		2019	2020	2021	2022	2023	
1	Return on Income	0.04	0.04	0.20	0.19	0.16	240.90
2	Return on expenses	0.15	0.16	0.27	0.25	0.23	−42.7
3	Profitability of product sales	−0.033	−0.023	0.12	0.131	0.133	−503
4	Wear coefficient	0.29	0.2	0.19	0.21	0.21	−25
5	Fund yield	2.47	0.76	0.56	0.49	1.08	−55.97
6	Stock capacity	1.80	1.93	1.90	2.19	2.69	49.53
7	Profitability of OD	0.54	0.52	0.59	0.52	0.69	28.61

Note: Calculated based on data from the Bureau of National Statistics of the Republic of Kazakhstan (https://stat.gov.kz/ru/).

According to **Table 3** the average performance indices of meat processing enterprises in 2023 showed the following results: income profitability stood at 0.16; cost profitability decreased by 0.23, or 42.69%; the profitability of product sales decreased by 0.13, or 6.21 times; fund productivity dropped by 55.97%, reaching 1.08 in 2023; and the return on investment (ROI) increased by 28.61%.

The analysis of the efficiency of meat processing enterprises revealed several reasons for the low efficiency of most of these enterprises, highlighting the characteristics of profitability indicators that were significantly influenced by economic sanctions, geopolitical instability, and the consequences of the pandemic. A notable impact on the enterprises' operations was the decline in demand for meat products and difficulties in accessing raw materials [6]. Additionally, the enterprises faced challenges regarding the quality of their products, resulting in a loss of consumer confidence and a subsequent decline in demand.

The modern domestic meat market is primarily focused on domestic production. The share of imports is relatively small, amounting to only 648.0 thousand tons

in 2023. Export figures are also low, with exports reaching only 609.0 thousand tons in 2020.

According to experts, and in our view, the balance is unlikely to change in the near future (2–3 years), with domestic production significantly surpassing both exports and imports [7, 8].

An assessment of the structure of consumer spending reveals that a substantial portion of the population's expenditures is directed towards the food group of goods (~40%), of which approximately 10% is allocated to the purchase of meat and meat products. This highlights the high consumer importance of meat as a food product. **Figure 3** illustrates the dynamics of meat consumption per capita in Kazakhstan.

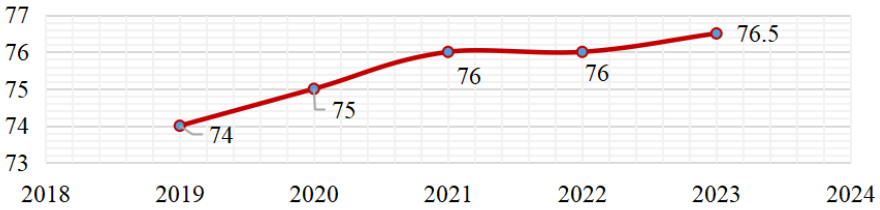

Figure 3. Dynamics of meat consumption per capita in Kazakhstan.

Note: Calculated based on data from the Bureau of National Statistics of the Republic of Kazakhstan (https://stat.gov.kz/ru/).

According to official data, in 2023, Kazakhstan's per capita meat consumption was 76.5 kg (+0.5 kg compared to 2019), with beef accounting for 36% and poultry meat for 44%. This figure is notably high and represents the highest value since 1990.

All the aforementioned meat processing plants are significant players in the Republic of Kazakhstan's meat products market. They supply the domestic market with meat products and also export their goods to other countries.

To ensure food security and assess the impact of import substitution on external meat product supplies, this article examines the volume and structure of foreign trade turnover (**Table 4**).

Table 4. Balance of resources of meat and meat products in Kazakhstan (thousand tons).

Indicators	Years					Deviations, %
	2019	2020	2021	2022	2023	
Resources						
Funds	812	804	8,620	912.0	977.6	20.3
Production	9,853	10,319	10,629.7	10,866.5	11,222.0	13.8
Import	1,246	1,103	879.7	771.8	648.0	−52.1
Total	11,911	12,226	12,371.4	12,550.3	12,847.6	0.99
Usage						
Consumption	49	33	29.1	26.9	26.9	5.4
Expenses	17	15	18.3	20.5	18.7	1.1
Export	236	307	354.4	415.3	609.0	58.1
Personal consumption	10,805	11,009	11,057.6	11,110.0	11,160.8	3.2
Funds	804	862	912.0	977.6	1032.2	128.4

Note: Calculated based on data from the Bureau of National Statistics of the Republic of Kazakhstan (https://stat.gov.kz/ru/).

Table 4 shows that the foreign trade turnover of meat products in the Republic has increased by 118.46% over the past five years. Exports have increased by a factor of 2.62, totaling 128,369.20 thousand US dollars, while imports have increased by 79.85%, reaching 237,734.90 thousand US dollars in 2023. In the structure of the foreign trade turnover of meat products (expressed in thousands of dollars), imports decreased by 17.7%, and in 2023, they accounted for 64.94%, while exports made up 35.06%. This indicates that imports are

30% higher than exports.

Poultry exports are expected to increase by approximately 35% between 2025 and 2026, reaching around 438,000 tons.

To quantify the impact of various factors on the added value of products in meat processing enterprises, a multiple linear regression model was developed with the following dependent and independent variables:

Dependent Variable:

Y — Added value of meat products.

Independent Variables (Predictors):

X1 – Labour Force (average number of employees): Represents the level of employment and human capital available at the enterprise.

X2 – Capital Investment (total capital excluding livestock acquisition costs): Reflects investment in fixed assets and infrastructure.

X3 – Raw Material Supply (volume of livestock delivered for processing): Indicates the strength of the enterprise's raw material base.

X4 – Technology Index: A composite indicator capturing the level of automation, innovation, and resource efficiency.

Statistical Results of the Regression Model:

Indicator Value

Coefficient of determination (R^2) 0.87

F-statistic 15.6 ($p < 0.01$)

Coefficient β (X1) 0.32 ($p = 0.02$)

Coefficient β (X2) 0.45 ($p = 0.001$)

Coefficient β (X3) 0.28 ($p = 0.03$)

Coefficient β (X4) 0.55 ($p < 0.001$)

Model diagnostics confirmed that the assumptions of linear regression were satisfied: the residuals were normally distributed, multicollinearity was not detected, and homoscedasticity was observed. These results validate the appropriateness of using a linear regression model in this context.

Currently, the meat livestock sector in agriculture is experiencing growth in meat and meat product production, largely driven by the industrialization of production, the adoption of advanced innovative technologies, and the implementation of intensive farming practices. Productivity gains in livestock and poultry farming are attributed to these factors. This positive trend is particularly evident in innovation-oriented enterprises that apply modern management and business practices.

In conclusion, it can be stated that the domestic industrial meat processing sector, as well as the overall industry market, is developing relatively successfully. However, there are systemic problems that represent significant barriers to the sustainable and competitive growth of the entire meat processing industry within Kazakhstan's agro-industrial complex.

5. Results

For a more comprehensive assessment of the factors influencing meat production, we have developed an economic and mathematical model to forecast the future development of the meat industry in the Republic of Kazakhstan.

The results of the regression analysis reveal a strong correlation between the output indicator and consumer expenditures. This relationship is critical as it influences subsequent factors and determines the demand for various types of meat products within the selected factors. In other words, the higher the demand, the greater the supply, in accordance with the law of supply and demand. The econometric model, based on regression analysis, demonstrates its quality and reliability [Equation (1)].

$$\begin{aligned} \mathrm{Y} = 0.92 + 7.09992^{*}\mathrm{X}_1 + 1.052^{*}\mathrm{X}_2 \\ -8.97^{*}\mathrm{X}_3 + 0.297\mathrm{X}_4 + \varepsilon \end{aligned} \quad (1)$$

The economic and mathematical equation revealed the relationship between meat production volumes and various factors. The strongest correlation was found between consumption expenditure and meat consumption: the higher the population's spending, the greater the demand for meat products. Following this, the relationship between resource costs and production was established, indicating that to increase production, the development of livestock farming is essential to prevent downtime at meat processing plants.

The next factor, which had a negative correlation, was the share of imported products in domestic consumption. The greater the consumption of imported meat products, the lower the production of domestic Kazakhstani products. The fourth factor, however,

showed a positive effect on revenue from production: as the price of meat products increases, so does the income generated by enterprises.

Thus, the correlation analysis between all these factors at the national level revealed a strong extrapolated relationship, with a Pearson correlation coefficient greater than 0.95. Based on these indices, a forecast of meat production growth over the next five years was made, and the economic efficiency up to 2025 was determined (**Table 5**).

Table 5. Foreign trade turnover of meat products and its structure in the Republic of Kazakhstan for the period 2019–2023.

Indicators	Years					Deviations, %
	2019	2020	2021	2022	2023	
Foreign trade turnover of meat products, thousand dollars						
Import of meat products	132,185.8	196,254.8	204,967.3	238,595.4	237,734.9	79.85
Export of meat products	35,397.8	406,08.2	44,308.5	42,750.0	128,369.2	262.65
Foreign trade turnover of meat products	167,583.6	236,863.0	249,275.8	281,345.4	366,104.1	118.46
Structure of foreign trade turnover of meat products (in % of thousand dollars)						
Import of meat products	78.87	82.85	82.22	84.80	64.94	−17.7
Export of meat products	21.12	17.14	17.77	15.19	35.06	66.00
Total foreign trade turnover of meat products	100	100	100	100	100	0
Foreign Trade Turnover, in Tons						
Import of meat products	56,596.8	77,394.33	84,929.79	94,603.45	83,229.19	47.05
Export of meat products	10,017.70	10,657.90	13,114.70	10,251.10	29,692.70	196.4
Foreign trade turnover of meat products	66,614.50	88,052.23	98,044.49	104,854.55	112,921.89	69.51
Structure of Foreign Trade Turnover of Meat Products (in % of Ton)						
Import of meat products	84.96	87.89	86.62	90.22	73.70	−13.25
Export of meat products	15.03	12.10	13.37	9.77	26.29	74.85
Total foreign trade turnover of meat products	100	100	100	100	100	0

Note: Calculated based on data from the Bureau of National Statistics of the Republic of Kazakhstan (https://stat.gov.kz/ru/).

Over the past five years, the foreign trade turnover of meat products in the Republic has increased by 118.46%. Exports have grown by a factor of 2.62, reaching $128,369.20 thousand, while imports have increased by 79.85%, amounting to $237,734.90 thousand in 2023. In the structure of foreign trade in meat products (measured in thousand USD), the share of imports decreased by 17.7%; however, in 2023, imports still accounted for 64.94%, whereas exports made up 35.06%. This indicates that imports exceed exports by nearly 30%, resulting in a persistent trade imbalance in the sector.

Forecast estimates suggest that between 2025 and 2026, poultry exports may increase by approximately 35%, reaching around 438,000 tons, which represents a positive signal for the development of the industry's export potential (**Table 6**).

In general, the meat industry is experiencing positive growth, particularly in primary meat processing. However, there is a shortage of meat products for secondary processing, such as sausages and canned goods. This gap significantly affects the volume of import substitution for these products, especially from Russia and Belarus, which poses a threat to food security for this range of products. The processing of meat products at meat processing plants in Kazakhstan is underdeveloped, primarily due to uneven production loads of raw materials. This results in irregular production schedules, decreased profitability, and limited investment opportunities. Additionally, the industry faces challenges such as outdated technologies, a shortage of highly qualified personnel, and a reluctance from second-tier banks to lend to enterprises with temporary operations.

Poultry farms and enterprises in the Turkestan region have implemented additional innovative production lines aimed at the deep processing of their raw materials—primarily poultry meat. This strategic move has led to a significant increase in production volumes and has fostered a higher level of vertical integration. As a result of the effective economic activity of these poultry enterprises, the region has witnessed positive developments in terms of production scale, product diversification, quality improvement, and overall efficiency.

Table 6. Forecasting the production of meat products with dynamic changes in intra-production factors.

Indicators	Key Years	Estimated Years		Expected Effect
	2023	Forecast for 2024 10 + 2%	Forecast for 2025 9 + 2%	Forecast for 2026 6 + 2%	
Gross income from production of Meat products, million USD tenge	24,965.353	31,705.99	35,193.66	38,009.15	13,043.796
Growth of intra-production factors, %	0	1.0	2.0	3.0	3.0
Volume of meat production in the Republic of Kazakhstan, tons	608,029	680,992.48	755,901.65	816,373.78	208,344.78
Revenues from meat production in Kazakhstan, million USD tenge	486,088.72	548,593.36	597,838.89	645,665.90	159,577.19
Import substitution, %	14	12.7	11.4	10.5	3.5

Note: Compiled by the authors.

Using statistical data from the past twelve years (2010–2021) on beef cattle breeding and poultry farming in Kazakhstan, mathematical models were developed with the aid of specialized software. These models enabled the formulation of trend equations and forecasts for key indicators, including the number of cattle, sheep, and goats, as well as the volume of slaughtering and meat processing (in carcass weight) for both cattle and poultry.

Based on this longitudinal data, a forecast trend for the national cattle population was generated. The resulting trend equation is as follows:

The forecast trend equation for the national cattle population is expressed as:

$$Y_1 = a_1 + b_1 \cdot t$$

where:

- Y_1 — number of cattle in Kazakhstan (thousand heads);

- t — time variable (year);

- a_1, b_1 — parameters estimated using least squares method.

$$y = 6,022.7 - 135.17t + 27.252t^2 \quad (2)$$

The model demonstrated a high coefficient of determination (R^2), indicating strong explanatory power and a high level of reliability for forecasting purposes.

Based on statistical data from the past twelve years, a forecasting trend model for the number of sheep and goats in Kazakhstan was developed. The model is expressed by the following equation:

$$Y_2 = a_2 + b_2 \cdot t$$

where:

- Y_2 — number of sheep and goats in Kazakhstan (thousand heads);

- t — time variable (year);

- a_2, b_2 — estimated parameters.

$$y = 18,481 - 393.6t + 48.358t^2 \quad (3)$$

This equation was obtained through computer-based calculations, and the corresponding coefficient of determination confirms the model's adequacy and reliability R^2 = 0.9761 [4].

Additionally, a forecast trend model for the volume of slaughter and processing of livestock and poultry (in carcass weight) was constructed and is represented by the following equation:

$$Y_3 = a_3 + b_3 \cdot t$$

where:

- Y_3 — volume of slaughter and meat processing (thousand tons);

- t — time variable (year);

-a_3, b_3—estimatedparameters.

$$y = 824.7 + 1.0388t + 2.7696t^2 \quad (4)$$

This mathematical model, also derived using specialized software, demonstrated a high coefficient of determination, indicating strong predictive accuracy $R^2 = 0,9985$.

According to the predictive trend model for the cattle population, calculated using specialized software, the number of cattle in Kazakhstan is expected to reach 13,292 thousand heads by 2028. This is nearly double the average for the period 2010–2021, which stood at 6,620.2 thousand heads.

Similarly, based on long-term statistical data and the constructed model, the number of sheep and goats is projected to increase from the average of 18,542.2 thousand heads (2010–2021) to 28,460.0 thousand heads by 2028, marking a 53.4% growth.

Forecasting for the poultry sector suggests that the number of birds will rise from 38.4 million (average for 2010–2021) to 69.8 million by 2028—an 81.7% increase.

On average, the annual volume of livestock and poultry slaughter (in carcass weight) was 981.4 thousand tons between 2010 and 2021. This figure is expected to reach 1,024.5 thousand tons by 2028, indicating a moderate increase in output (**Table 7**).

Table 7. Forecast indicators for the development of the meat and poultry industry in Kazakhstan until 2028.

Indicators	$\hat{y}$	R^2	Average for 2010–2021	Forecast						
				2022	2023	2024	2025	2026	2027	2028
1	2	3	4	5	6	7	8	9	10	11
Number of Cattle in Kazakhstan (thousand heads)	$6{,}022.7-135.17t+27.252t^2$	0.978	6,620.2	8,871	9,471	10,126	10,836	11,600	12,419	13,292
Number of Sheep and Goats in Kazakhstan (thousand heads)	$18{,}481-393.6t+48.358t^2$	0.976	18,542.2	21,537	22,449	23,457	24,563	25,765	27,064	28,460
Slaughtered Livestock and Poultry in Kazakhstan (carcass weight, thousand tons)	$842.7+1.0388t+2.7696t^2$	0.998	981.4	1,306.2	1,382	1,463.3	1,550.3	1,642.3	1,740.3	1,843.4
Number of Poultry in Kazakhstan (million heads)	$32.061+0.1951t+0.0944t^2$	0.941	38.4	50.5	53.2	56.2	59.3	62.6	66.1	69.8
Export of Meat Products from Kazakhstan (thousand tons)	$1.0477+0.5139t+0.1831t^2$	0.950	14.3	38.6	43.2	49.9	56.1	62.6	69.5	76.9
Import of Meat Products to Kazakhstan (thousand tons)	$230.58+0.6306t+0.3194t^2$	0.543	251.9	292.6	302.0	311.8	322.3	333.5	345.3	357.8
Specialization Level of Innovative Poultry Enterprises in Kazakhstan (%)	$19.77-0.042t+0.1137t^2$	0.909	28.0	38.4	41.3	44.6	48.2	51.8	55.8	59.9

Note: Forecast values for 2022–2028 are based on estimated trend equations, where the explanatory variable is denoted as t (time in years).

The import volume of meat and meat products—serving domestic demand—averaged 251.9 thousand tons per year during the same period. However, projections for 2028 estimate this volume will rise to 357.8 thousand tons. Meanwhile, the forecast for meat product exports in 2028 is 76.9 thousand tons, indicating that imports will continue to significantly exceed exports, highlighting Kazakhstan's ongoing reliance on foreign meat supplies.

To ensure future food self-sufficiency, it is essential to strategically develop the meat and poultry industries through the establishment of innovative production and processing enterprises. This includes the adoption of advanced technologies and the launch of high-value-added products designed to enhance both productivity and competitiveness.

Thus, the industrial and integrated model of production organization at the regional level emerges as the most effective and optimal form of agricultural enterprise development. Regardless of ownership structure, this model enables deep processing and efficient marketing of agricultural products, while simultaneously transforming traditional distribution channels and enhancing national food security. In this context, state support and regulatory measures are essential to

facilitate the integration of entrepreneurial structures in beef cattle farming on an innovative and sustainable basis.

These factors negatively impact exports, imports, and foreign trade turnover, with imports of foreign sausages and canned goods exceeding domestic production. To address these issues and achieve a synergistic

effect, it is essential to combine state support with the development of livestock and meat processing enterprises. The establishment of a meat cluster could be a key solution to overcoming these challenges and fostering sustainable industry growth.

6. Conclusion

For the further development of the meat industry in Kazakhstan, a comprehensive systemic assessment of the underlying phenomena is essential. While the industry is showing positive growth, this progress is not sufficiently intensive, which impacts exports, imports, and import substitution of meat products. Based on the analysis, we can draw the following conclusions:

- Many enterprises in the meat industry offer a wide range of products, but the excessive diversification of their portfolios can lead to decreased gross profits due to internal competition among products. Negative consequences of an inflated product portfolio include increased warehouse stock, higher packaging costs, instability in product quality, and a higher cost per unit of production, often due to frequent changes in production shifts.
- Overall, the export of meat products from Kazakhstan shows a positive trend, although exports of certain meat product types have declined. The increase in exports to Kazakhstan in 2023 compared to 2019 can be attributed to several factors: the rise in domestic production due to state support for agriculture, growing demand from Central Asia, Uzbekistan, the Middle East, and China, as well as improvements in the quality, safety, and range of Kazakhstani meat products. Furthermore, enhancements in export infrastructure and the continued need for export diversification contribute to this positive development.
- Among the negative aspects, several challenges remain: market imbalance and volatility, price disparities, and the high cost of quality meat products, which reduces their economic accessibility for a significant portion of the population. Additionally, there are issues related to the disorganization and underdevelopment of the small business sector, unfair competition, limited production capacity, outdated material and technical equipment, and a lack of industry-specific innovation. The industry also suffers from a shortage of qualified personnel, inadequate strategic plans for the development of meat production, and insufficient integration and cooperation among economic entities at the internal and inter-industry levels. Moreover, the industry faces high resource consumption, low energy efficiency, and insufficient environmental sustainability in production processes.

Based on the developed economic and mathematical model, it can be concluded that further to improve the efficiency of meat processing enterprises in Kazakhstan, it is necessary to enhance the raw material base and ensure full capacity utilization at the enterprises. A key step would be to unite all participants in the meat industry into a cluster, aligning production with consumer costs and demand. By 2027, this approach is expected to generate a synergistic effect, increasing the volume of meat products produced in Kazakhstan to 208,344.784 tons, with income from meat product production reaching 159,577.188 million tenge, thereby boosting investment income within the country. The results of the regression analysis indicate that an increase in both the number of employees and the volume of raw materials positively contributes to the formation of added value in meat processing enterprises. Capital investment in fixed assets plays a particularly significant role, underscoring the necessity of modernizing production infrastructure to enhance operational efficiency. Furthermore, the technological level exerts a substantial influence on economic outcomes, highlighting the critical importance of innovation and the optimization of production processes.

These findings, derived from empirical data analysis, reveal observable trends in the impact of various factors on value creation within the sector. However, they should be interpreted as preliminary and indicative rather than definitive. Further research is required to validate the model, expand the dataset, and provide more robust statistical justification. Specifically, it is essential to account for the potential influence of latent variables and to conduct additional diagnostic tests to

confirm the model's stability and predictive reliability.

In conclusion, while the presented model offers valuable insights and helps identify key directions for strategic development, its results should not be regarded as entirely conclusive. Future studies aimed at improving the model's rigor, scope, and precision are necessary to ensure scientifically grounded and actionable outcomes.

Author Contributions

Conceptualization, K.R.; methodology, M.A.; validation, A.A.; formal analysis, U.M.; data curation, M.A. and U.M.; writing—original draft preparation, M.A.; writing—review and editing, A.A. and K.D.; visualization, U.M.; supervision, K.R. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare that there is no conflict of interest.

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