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Research Article

Multiple Linear Regression Model of Determinants of the Livestock and Fishery Sub-sectors' Contribution in Mandailing Natal Regency

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ABSTRACT

This study aims to analyze the determinant factors influencing the contribution of livestock and fisheries subsectors to the economy of Mandailing Natal Regency using a multiple linear regression model with a quantitative-mathematical approach. The study employs secondary time series data from 2015-2024 obtained from the Central Bureau of Statistics (BPS). The dependent variables are the Gross Regional Domestic Product (GRDP) of livestock and fisheries subsectors, while the independent variables include livestock population, meat production, egg production, capture fisheries production, aquaculture production, and number of fishery households. Mathematical analysis was conducted through two regression models with classical assumption testing (normality, multicollinearity, heteroscedasticity, and autocorrelation) to ensure the Best Linear Unbiased Estimator (BLUE) properties. The results show that the regression models have excellent predictive capability with R^2 values of 0.994 for livestock and 0.997 for fisheries. Livestock population is the dominant determinant for the livestock subsector ($\beta=0,852$; $p<0.01$), while capture fisheries production is the dominant determinant for the fisheries subsector ($\beta=0,789$; $p<0.01$).

Keywords: Multiple linear regression, mathematical modeling, determinant factors, fisheries, gross regional domestic product

INTRODUCTION

The agricultural sector plays a crucial role in Indonesia's economy and serves as the backbone of the economy in various regions; it acts not only as a provider of food but also as the largest source of employment and a contributor of foreign exchange earnings through exports. The agricultural sector is a key component in efforts to develop Indonesia's economy (Juansya et al., 2024). In 2018, the agricultural sector (comprising food crops, plantations, forestry, livestock, and fisheries) was the largest contributor of value-added to the Gross Regional Domestic Product (GRDP) of North Sumatra Province, accounting for 21.4%. Over a 34-year period, the agricultural sector's contribution to North Sumatra's GRDP averaged 27.29% (Hasibuan et al., 2022).

Research by Sari (2023) reinforces these findings by analyzing the impact of sub-sector farmers' terms of trade on the Gross Regional Domestic Product (GRDP) of North Sumatra Province, employing a multiple linear regression method with quarterly data from 2013 to 2022.

The results indicate that the farmers' terms of trade for food crops, horticulture, smallholder plantations, livestock, and fisheries have a positive and significant effect on GRDP, with an R-squared coefficient of determination of 96.27% (Sari, 2023). These findings indicate that the performance of the agricultural sub-sector is closely linked to regional economic growth. Consistent with that research, Harahap (2025) This study examines the factors influencing the Farmers' Terms of Trade (NTP) for the food crop and plantation crop subsectors in Sumatra during the 2019–2024 period. The results indicate that inflation, farm labor wages, the agricultural workforce size, and Gross Regional Domestic Product (GRDP) collectively have a significant impact on the NTP in the Sumatra region. Furthermore, the study finds that the NTP for plantation crops remained relatively stable and above 100—indicating better farmer welfare—whereas the NTP for food crops tended to decline and fall below 100, reflecting persistently weak purchasing power among farmers (Harahap, 2025).

Mandailing Natal Regency (Madina), with a territory stretching from the highlands to the west coast of Sumatra, possesses dual geographical potential for the simultaneous development of the livestock and fisheries subsectors. According to research by Hasanah (2026), the agriculture, forestry, and fisheries sector is the largest contributor to Mandailing Natal Regency's Gross Regional Domestic Product (GRDP), accounting for 49.68% of the total in 2024 (Hasanah, 2026). Research by Widiarsih and Sandri (2018) also identified agriculture, livestock, and fisheries as leading sectors in Mandailing Natal Regency; key livestock commodities include cattle, buffalo/goats and sheep, and poultry (free-range chicken), while key fishery commodities comprise pond aquaculture and river fishing (Widiarsih & Sandri, 2018).

Based on the 2024–2026 Master Plan and Roadmap for the Advancement of Science, Technology, and Innovation in North Sumatra Province, Mandailing Natal Regency is part of the West Coast Region. Its key products include rice, palm oil, coffee, and palm sugar, alongside capture and aquaculture fishery commodities all supported by the Batang Gadis River and the Indian Ocean coastline. The document also designates the development of an integrated farming system (combining agriculture, livestock, and fisheries) as a strategic regional initiative to foster inclusive economic growth and improve farmers' welfare (BAPPELITBANG, 2024).

However, preliminary data reveal an interesting phenomenon worth examining. Despite possessing significant fisheries potential, the fisheries sub-sector's contribution to the Gross Regional Domestic Product (GRDP) of Mandailing Natal Regency tends to be lower and more volatile than that of the livestock sub-sector. Research by Hasanah (2026) indicates that the average contribution of the fisheries sub-sector to total GRDP reached 4.88%, whereas the livestock sub-sector contributed only 1.98%. Nevertheless, the livestock sub-sector demonstrated greater stability, with a standard deviation of 0.044, compared to 0.096 for the fisheries sub-sector (Hasanah, 2026). This disparity is believed to stem from several complex factors. The fisheries subsector particularly capture fisheries is highly vulnerable to natural factors such as seasonal variability and climate change, which directly impact catch yields (Illahi et al., 2023), as well as facing limitations in technology and capital that hinder business modernization (Tarno & Nurmala, 2023).

Research on this topic has been conducted by several researchers using various approaches. Juansya et al. (2024) analyzed the impact of the agricultural sector (plantation crops, livestock, and fisheries) on Indonesia's economic growth using time-series data from 2011 to 2022. The results indicate that the livestock and fisheries sub-sectors significantly influence Indonesia's economic growth, with probability values of 0.0222 and 0.003243, respectively, and an R-squared

value of 77.77% (Juansya et al., 2024). Hasibuan's (2021) study analyzed the factors influencing agricultural sector growth in North Sumatra using multiple linear regression and found that land area and exports have a significant impact on the growth of the agricultural sector (Hasibuan et al., 2022). Research by Rosnidah Siregar (2016) also analyzed the factors influencing the agricultural sector's Gross Regional Domestic Product (GRDP) in North Sumatra and found that agricultural labor, land area, and fertilizer consumption had a significant, inelastic effect on the sector's GRDP (Siregar, 2016).

Previous research analyzing the factors influencing oil palm farmers' income utilized multiple linear regression and found that production volume, land area, crop age, maintenance costs, and selling price significantly affected farmers' income ($\text{Sig. } 0.033 < 0.050$). This study demonstrates that the multiple linear regression approach is effective for analyzing the determinants of economic performance in the agricultural sector (Aswan & Tanjung, 2021). Furthermore, a study integrating regression and ANOVA to evaluate the determinants of plantation commodity production in South Tapanuli found that multiple linear regression indicated coffee prices ($p=0.033$) and cocoa prices ($p=0.027$) had a significant effect on production, while ANOVA ($F=11.048$; $p=0.000$) revealed significant differences in contributions to the Gross Regional Domestic Product (GRDP) among the commodities (Aswan et al., 2025).

The study by Ali & Wardhani (2025) also employed robust and resampling methods to estimate parameters for the national fisheries GRDP and found that export volume was a significantly influential variable (Ali & Wardhani, 2025). Meanwhile, in his research, Sempurna Silaban analyzed the impact of public expenditure on the transformation of the economic structure and regional development of Humbang Hasundutan Regency. The study results indicate that the agriculture, livestock, forestry, and fisheries sectors contribute an annual average of 47.62% to the Gross Regional Domestic Product (GRDP) of Humbang Hasundutan Regency. Simultaneously, public expenditure in the education, health, and infrastructure sectors influences the transformation of the economic structure by 88.10%. This research demonstrates that the agricultural sector plays a dominant role in the economies of various regencies in North Sumatra (Silaban, 2018).

Previous studies have largely addressed the agricultural sector's contribution in aggregate terms or focused on a single specific subsector. Research specifically comparing the performance, stability, and dynamics of the two-animal protein-producing subsectors—livestock versus fisheries—within a region possessing potential for both, such as Mandailing Natal Regency, remains very limited. Furthermore, no research has comprehensively analyzed the determinants influencing the economic contributions of the livestock and fisheries subsectors simultaneously using a multiple linear regression model with a robust mathematical approach—whether in North Sumatra generally or Mandailing Natal Regency specifically.

This study aims to address this gap by employing a multiple linear regression approach—grounded in mathematical principles—to identify and analyze the determinants influencing the contribution of the livestock and fisheries subsectors to the economy of Mandailing Natal Regency. The study's objectives are to: (1) analyze the simultaneous impact of production factors on the contribution of the livestock and fisheries subsectors to the Gross Regional Domestic Product (GRDP) of Mandailing Natal Regency using a multiple linear regression model with matrix and ordinary least squares optimization approaches; (2) identify the determinants exerting a dominant influence on the economic performance of each subsector through standardized coefficient analysis and mathematical significance testing; and (3) formulate development

prospects and policy recommendations based on the established mathematical model to optimize the potential of both subsectors.

MATERIAL AND METHODS

Research Stages

This study employs an explanatory quantitative research design utilizing a mathematical time-series analysis approach. This approach was selected because it aligns with the research objective of identifying and analyzing the simultaneous influence of determinant factors on the contribution of the livestock and fisheries subsectors through mathematical modeling. Time-series analysis is utilized because the data under study spans a ten-year period (2015–2024), enabling the identification of patterns, trends, and structural changes over time (Zahriyah et al., 2021). The analysis method used is multiple linear regression (Hasibuan et al., 2022)(Sari, 2023)(Juansya et al., 2024)(Aswan et al., 2025).

The research stages involved: (1) problem identification and literature review; (2) secondary data collection from official sources; (3) data extraction and coding into Microsoft Excel spreadsheets; (4) data validation and cleaning using statistical methods; (5) data analysis using a multiple linear regression model with a matrix approach; (6) classical assumption testing via a series of mathematical-statistical tests; (7) interpretation of results and discussion based on the established mathematical model; and (8) drawing conclusions and formulating model-based policy recommendations.

Types and Sources of Data

This study relies entirely on officially published, aggregated quantitative time-series secondary data. The data utilized include: (1) Gross Regional Domestic Product (GRDP) data for Mandailing Natal Regency and North Sumatra Province at constant prices, categorized by economic sector, for the 2015–2024 period; (2) data on livestock populations (beef cattle, buffalo, goats, and chickens) and meat and egg production volumes for the 2015–2024 period; and (3) data on capture fishery production volumes, freshwater aquaculture production, and the number of fishery households for the 2015–2024 period. Data sources include Statistics Indonesia (BPS) of Mandailing Natal Regency specifically the publications "Mandailing Natal Regency in Figures" and "GRDP of Mandailing Natal Regency by Economic Sector" (2015–2024 editions) as well as Statistics Indonesia (BPS) of North Sumatra Province, the Ministry of Agriculture of the Republic of Indonesia, and the Ministry of Marine Affairs and Fisheries of the Republic of Indonesia.

Formulation of the Multiple Linear Regression Model

A multiple linear regression model is used to analyze the functional relationship between a dependent variable and several independent variables. Mathematically, the multiple linear regression model can be formulated as follows (Gujarati & Porter, 2013) (Siregar, 2016)(Aswan et al., 2025):

Model 1 (Livestock Sub-sector):

$$Y_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon_1$$

Model 2 (Fisheries Sub-sector):

$$Y_2 = \beta_0 + \beta_1 X_4 + \beta_2 X_5 + \beta_3 X_6 + \varepsilon_2$$

Where:

- Y_1 = GRDP of the livestock subsector (IDR billion)
- Y_2 = GRDP of the fisheries subsector (billion IDR)
- X_1 = Total livestock population (head)
- X_2 = Meat production (tonnes)
- X_3 = Egg production (tonnes)
- X_4 = Capture fishery production (tonnes)
- X_5 = Aquaculture production (tonnes)
- X_6 = Number of fishery households (units)
- $\beta_0, \beta_1, \beta_2, \beta_3$ = The regression coefficient to be estimated
- ε = The assumed error term $\sim N(0, \sigma^2)$

To estimate the regression coefficients, the Ordinary Least Squares (OLS) method is used, which minimizes the sum of squared residuals (Gujarati & Porter, 2013):

$$\text{Minimization: } \sum_{i=1}^n \varepsilon_i^2 = \sum_{i=1}^n (Y_i - \hat{Y}_i)^2$$

In matrix form, the regression model can be written as (Gujarati & Porter, 2013):

$$\mathbf{Y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$$

With the dependent variable vector $\mathbf{Y}$ of dimension $n \times 1$, the design matrix $\mathbf{X}$ of dimension $n \times (k + 1)$, coefficient vector $\boldsymbol{\beta}$ dimensional $(k + 1) \times 1$, and error vector $\boldsymbol{\varepsilon}$ dimensional $n \times 1$:

$$\mathbf{Y} = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix}, \mathbf{X} = \begin{bmatrix} 1 & X_{11} & X_{12} & \cdots & X_{1k} \\ 1 & X_{21} & X_{22} & \cdots & X_{2k} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & X_{n1} & X_{n2} & \cdots & X_{nk} \end{bmatrix}, \boldsymbol{\beta} = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{bmatrix}, \boldsymbol{\varepsilon} = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}$$

The solution for the coefficient vector is obtained via the normal equations:

$$\mathbf{X}^T \mathbf{X} \hat{\boldsymbol{\beta}} = \mathbf{X}^T \mathbf{Y}$$

Thus, the OLS estimator for the coefficient vector is:

$$\hat{\boldsymbol{\beta}} = (\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{Y}$$

The variance-covariance matrix of the OLS estimator is given by:

$$\text{Var}(\hat{\boldsymbol{\beta}}) = \sigma^2 (\mathbf{X}^T \mathbf{X})^{-1}$$

Where σ^2 estimated by:

$$\sigma^2 = \frac{\sum_{i=1}^n \varepsilon_i^2}{n - k - 1} = \frac{SSE}{n - k - 1}$$

Coefficient of determination (R^2) calculated using the formula (Gujarati & Porter, 2013):

$$R^2 = \frac{SSR}{SST} = 1 - \frac{SSE}{SST}$$

where:

- $SSR = \sum_{i=1}^n (\hat{Y}_i - \bar{Y})^2$ = Sum of Squares Regression
- $SST = \sum_{i=1}^n (Y_i - \bar{Y})^2$ = Total Sum of Squares
- $SSE = \sum_{i=1}^n (Y_i - \hat{Y}_i)^2$ = Sum of Squared Errors

Adjusted R^2 which takes into account the number of independent variables calculated by:

$$\bar{R}^2 = 1 - (1 - R^2) \frac{n - 1}{n - k - 1}$$

Classical Assumption Test and Hypothesis Testing

Before conducting regression analysis, classical assumption tests are performed to ensure that the resulting regression model is the Best Linear Unbiased Estimator (BLUE) (Gujarati & Porter, 2013)(Sari, 2023)(Aswan et al., 2025):

Normality testing using the Jarque-Bera test with the statistic:

$$JB = \frac{n}{6} \left(S^2 + \frac{(K - 3)^2}{4} \right)$$

Where S is skewness and K is kurtosis. The null hypothesis (H_0) is that the residuals are normally distributed. If the p-value > 0.05 , then H_0 is accepted.

Multicollinearity test using Variance Inflation Factor (VIF) with:

$$VIF_j = \frac{1}{1 - R_j^2}$$

Where R_j^2 is the coefficient of determination from the regression of the j-th variable against the other independent variables. A VIF value of less than 10 indicates the absence of multicollinearity (Juansya et al., 2024).

The heteroscedasticity test is conducted using the Glejser test by regressing the absolute values of the residuals against the independent variables:

$$|\varepsilon_i| = \alpha_0 + \alpha_1 X_i + v_i$$

If the p-value is greater than 0.05, then heteroskedasticity is not present. **The autocorrelation test** employs the Durbin-Watson test with the statistic...:

$$DW = \frac{\sum_{i=2}^n (\varepsilon_i - \varepsilon_{i-1})^2}{\sum_{i=1}^n \varepsilon_i^2}$$

A DW value between 1.5 and 2.5 indicates the absence of autocorrelation. Hypothesis testing is conducted using the **Simultaneous Test (F-test)** with the statistic:

$$F = \frac{SSR/k}{SSE/(n - k - 1)} = \frac{R^2/k}{(1 - R^2)/(n - k - 1)}$$

And the partial **test (t-test)** using statistics:

$$t = \frac{\hat{\beta}_j}{SE(\hat{\beta}_j)} = \frac{\hat{\beta}_j}{\sqrt{\hat{\sigma}^2 (\mathbf{X}^T \mathbf{X})_{jj}^{-1}}}$$

If the p-value is less than 0.05, then the variable has a significant effect (Juansya et al., 2024)(Sari, 2023)(Aswan & Tanjung, 2021).

Elasticity Analysis

To understand the responsiveness of the dependent variable to changes in the independent variable, an elasticity analysis was conducted at the mean point (Gujarati & Porter, 2013):

$$E_{Y, X_j} = \frac{\partial Y}{\partial X_j} \cdot \frac{\bar{X}_j}{\bar{Y}} = \hat{\beta}_j \cdot \frac{\bar{X}_j}{\bar{Y}}$$

Interpretation of elasticity values:

- $E > 1$: Elastic (responsive)
- $E = 1$: Elastic connector
- $0 < E < 1$: Inelastic (less responsive)

RESULTS AND DISCUSSION

Overview of the Economy of Mandailing Natal Regency

The economic structure of Mandailing Natal Regency is dominated by the agricultural sector. Research by Widiarsih and Sandri (2018) indicates that the agriculture, forestry, and fisheries sector makes the largest contribution 43.98% to the regency's Gross Regional Domestic Product (GRDP), a contribution dominated by the sub-sectors of agriculture, livestock, hunting, and agricultural services (Widiarsih & Sandri, 2018). This finding aligns with the research results of Hasibuan (2022), which state that the agricultural sector is a key economic support sector in North Sumatra Province, contributing the largest share of value-added to the province's Gross Regional Domestic Product (GRDP) at 21.4% (Hasibuan et al., 2022). This is further supported by research findings from Hasanah (2025), showing that the agriculture, forestry, and fisheries sector contributed 49.68% to the Gross Regional Domestic Product (GRDP) of Mandailing Natal Regency in 2024, with a growth rate of 3.91% (Hasanah, 2026)

The 2018 study on priority commodities (KPJU) for MSMEs in North Sumatra Province identified the agricultural sector as the top priority for Mandailing Natal Regency, with rubber, wetland rice, mangosteen, coconut, and oil palm designated as key agricultural commodities; meanwhile, in the fisheries sector, the priority commodities include pond aquaculture and river fishing (BAPPELITBANG, 2024). The results of the Location Quotient (LQ) analysis conducted by Hasanah (2026) also indicate that the livestock and fisheries subsectors are base sectors in Mandailing Natal Regency, with average LQ values of 1.11 and 2.13, respectively; this suggests that both subsectors possess a higher level of specialization compared to the provincial average and hold potential for export outside the region.

Multiple Linear Regression Analysis Results

The results of the multiple linear regression analysis for the livestock subsector are presented in Table 1.

Table 1. Results of Multiple Linear Regression Analysis for the Livestock Subsector

Variable	Coefficient (β)	Standard Error	t-count	p-value	VIF
Constant	25,450	12,340	2,062	0,085	-
Livestock	0,00852	0,00124	6,871	0,001	3,42
Population (X_1)					
Meat Production (X_2)	0,03520	0,01850	1,903	0,106	4,18
Egg Production (X_3)	0,04810	0,02130	2,258	0,065	2,95
	$R^2 = 0,994$	Adjusted $R^2 = 0,991$	F-count = 258,45	p-value F = 0,000	

Source: processed data (2026)

Based on Table 1, the regression model for the livestock subsector demonstrates excellent predictive capability, with a value of R^2 amounting to 0.994. This value is comparable to the

findings of Sari (2023), who reported an R-squared of 96.27%, and Juansya et al. (2024), with an R^2 of 77.77%. Aswan et al. (2025) also found that integrating regression and ANOVA is effective for evaluating production determinants and economic contributions. The calculated F-value of 258.45, with a p-value of 0.000, indicates that the regression model is statistically valid ($p < 0.01$), consistent with the findings of Hasibuan (2021), Siregar (2016), and Aswan and Tanjung (2021), who employed the simultaneous F-test. The resulting regression equation model is:

$$\hat{Y}_1 = 25,450 + 0,00852X_1 + 0,03520X_2 + 0,04810X_3$$

Based on the standardized coefficient (beta) value, the livestock population variable (X_1) is the most dominant determinant factor regarding the contribution of the livestock subsector ($\beta = 0,852$; $p < 0,01$). These findings align with the research of Juansya et al. (2024), which found that the livestock subsector significantly influences Indonesia's economic growth. Hasibuan (2021) also found that land area and exports significantly affect the growth of the agricultural sector. Furthermore, research by Widiarsih & Sandri (2018) identified cattle, goats and sheep, and poultry (free-range chickens) as key livestock commodities in Mandailing Natal Regency.

Elasticity Analysis of the Livestock Farming Model:

$$E_{Y_1, X_1} = 0,00852 \times \frac{20,459}{187,62} = 0,929$$

Elasticity value $E_{Y_1, X_1} = 0,929$ It shows that a 1% increase in the livestock population will raise the livestock sector's Gross Regional Domestic Product (GRDP) by 0.929% (inelastic-unitary). This means that an increase in the livestock population will be accompanied by an increase in the livestock sector's GRDP of nearly the same proportion.

The results of the multiple linear regression analysis for the fisheries subsector are presented in Table 2.

Table 2. Results of Multiple Linear Regression Analysis for the Fisheries Sub-sector

Variable	Coefficient (β)	Standard Error	t-count	p-value	VIF
Constant	12,580	8,450	1,489	0,187	-
Capture Fisheries Production (X_4)	0,00985	0,00102	9,657	0,000	2,85
Aquaculture Production (X_5)	0,02540	0,01250	2,032	0,089	3,12
Amount RTP (X_6)	0,01875	0,00980	1,913	0,105	2,45
$R^2 = 0,997$ Adjusted $R^2 = 0,996$ F-count = 456,82 p-value F = 0,000					

Source: Processed data (2026)

Based on Table 2, the regression model for the fisheries subsector has excellent predictive ability, with an R^2 value of 0.997. This value is higher than the livestock model, indicating that production factors in the fisheries subsector have a closer relationship with economic performance. This finding aligns with research by Juansya et al. (2024), which found that the fisheries subsector has a significant influence on economic growth (Ali & Wardhani, 2025) It was also found that export volume is a variable that significantly influences the fisheries sector's contribution to the Gross Regional Domestic Product (GRDP). Research on leading MSME business activities in North Sumatra Province identified pond-based fish farming and river fishing as key fisheries commodities in Mandailing Natal Regency (BAPPELITBANG, 2024). The regression equation model formed is:

$$\hat{Y}_2 = 12,580 + 0,00985X_4 + 0,02540X_5 + 0,01875X_6$$

Based on the standardized coefficient (beta) value, the capture fishery production variable (X_4) is the most dominant determinant factor regarding the contribution of the fisheries subsector ($\beta = 0,789$; $p < 0,01$). Sari (2024) also found that the fishery farmers' terms of trade have a positive and significant effect on the (GRDP).

Elasticity Analysis of Fisheries Models:

$$E_{Y_2, X_4} = 0,00985 \times \frac{43.700}{452,17} = 0,952$$

Elasticity value $E_{Y_2, X_4} = 0,952$ indicates that a 1% increase in capture fishery production leads to a 0.952% increase in the fisheries sector's (GRDP) (inelastic-unitary). A comparison of elasticities reveals that the fisheries sector (0.952) is slightly more responsive than the livestock sector (0.929). This can be attributed to the characteristics of capture fisheries, which feature shorter production cycles than livestock farming, allowing changes in inputs to be rapidly translated into changes in output.

Classical Assumption Test

The results of the classical assumption tests for both regression models are presented in Table 3.

Table 3. Classical Assumption Test Results

Assumption Testing	Livestock Sub-sector	Fisheries Sub-sector	Information
Normality (Jarque-Bera)	$JB = 1,245$ ($p=0,537$)	$JB = 0,987$ ($p=0,610$)	The residuals are normally distributed
Multikolinearitas (VIF)	$VIF < 5$	$VIF < 5$	Multicollinearity is not present
Heteroskedastisitas (Glejser)	$F = 0,845$ ($p=0,501$)	$F = 0,723$ ($p=0,542$)	Heteroskedasticity is not present
Autokorelasi (Durbin-Watson)	$DW = 2,145$	$DW = 2,087$	No autocorrelation occurs

Source: Processed data (2026)

Based on Table 3, all classical assumption tests are met for both regression models. These results are consistent with the research (Hasibuan et al., 2022);(Juansya et al., 2024);(Sari, 2023);(Aswan et al., 2025) which also involves conducting classical assumption tests prior to regression analysis. With all classical assumption tests satisfied, the resulting regression model can be considered the Best Linear Unbiased Estimator (BLUE) (Gujarati & Porter, 2013).

Discussion of Determinant Factors and Policy Implications

The analysis results indicate that physical production factors exert a highly dominant influence on the economic performance of both sub-sectors, as evidenced by the very high R^2 value. These findings are consistent with research (Hasibuan et al., 2022) which found that land area and exports have a significant impact on the growth of the agricultural sector. In the study (Siregar, 2016) It was also found that agricultural sector workers, land area, and fertilizer consumption have a significant, inelastic effect on the agricultural sector's (GRDP). Research results (Aswan & Tanjung, 2021);(Aswan et al., 2024);(Aswan et al., 2025) It was also found that the variables of production, land area, crop age, maintenance costs, and selling price significantly influence farmers' income. A comparison of coefficients and elasticities between the two

subsectors indicates that the fisheries subsector ($E=0.952$) is slightly more responsive than the livestock subsector ($E=0.929$). This can be attributed to the characteristics of capture fisheries, which involve shorter production cycles compared to livestock farming, allowing changes in inputs to be rapidly translated into changes in output.

The disparity in contribution between the more dominant fisheries sub-sector and the livestock sub-sector stems from several factors: (1) the geographical comparative advantage of extensive coastal areas for fisheries; (2) a more open fisheries market structure; and (3) more adequate infrastructure and institutional support for the fisheries sector. Research (Widiarsih & Sandri, 2018) it has been identified that the Batahan District is the recommended location for industrial development in Mandailing Natal Regency, as it is the site of the Palimbangan Port currently under construction which is expected to offer investors an alternative option for investing in the planned industrial area.

Based on the analysis, the future development prospects for the two subsectors have different strategic directions. The livestock subsector focuses on downstreaming and integration with agricultural systems. The fisheries subsector focuses on modernization and risk mitigation through the provision of cold storage facilities and the development of aquaculture. Based on the analysis of research conducted by (Silaban, 2018) It is recommended that public spending in education, health, and infrastructure can influence the transformation of the economic structure, so that well-targeted public policies can encourage growth in the agricultural sector. The results of research conducted by (Hasanah, 2026) It also recommends accelerating the construction of post-harvest facilities such as cold storage and ice plants to maintain price stability and fishermen's incomes during periods of bad weather or bumper harvests.

CONCLUSION

Based on the analysis and discussion regarding the multiple linear regression model of the determinants of the livestock and fishery sub-sectors' contribution in Mandailing Natal Regency for the 2015–2024 period, the following conclusions can be drawn:

1. The multiple linear regression model demonstrates excellent predictive capability for both subsectors, with coefficients of determination (R^2) of 0.994 for the livestock subsector and 0.997 for the fisheries subsector.
2. Livestock population is the most dominant determinant of the livestock sub-sector's contribution ($\beta=0.852$; $p<0.01$) with an elasticity of 0.929, whereas capture fisheries production is the most dominant determinant of the fisheries sub-sector's contribution ($\beta=0.789$; $p<0.01$) with an elasticity of 0.952.
3. The disparity in contribution between the more dominant fisheries sub-sector and the livestock sub-sector stems from differences in geographical comparative advantage, market structure, and infrastructure support.
4. The development prospects for the livestock subsector lie in increasing value-added through processing industries and integration, whereas for the fisheries subsector, they lie in the modernization of fishing gear and the development of aquaculture.
5. The resulting mathematical model can serve as a decision-support tool for the local government to conduct policy simulations and forecast the economic contributions of the two sub-sectors, thereby enabling the optimization of limited resource allocation to achieve sustainable economic growth in Mandailing Natal Regency.

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REFERENCES

- Ali, R. S., & Wardhani, N. W. S. (2025). Pendugaan Parameter Melalui Robust Weighted Least Trimmed Square, Resampling Bootstrap dan Jackknife pada Data Produk Domestik Regional Bruto (PDRB) Perikanan Nasional. Universitas Brawijaya Malang.
- Aswan, N., Fadhillah, Y., Siregar, M. N. H., Puspita, N. R., Mahaji, T., & Harahap, A. U. (2024). Analisis regresi linier dalam estimasi produktivitas kelapa sawit (*elaeis guineensis*) di Kabupaten Tapanuli Selatan. *Innovative: Journal of Sosial Science Reseach*, 4(1), 10264–10276.
- Aswan, N., Fadhillah, Y., Tambunan, R. A., & Tambunan, R. R. (2025). Integrasi regresi dan anova dalam mengevaluasi faktor penentu produksi dan kontribusi ekonomi komoditas perkebunan Tapanuli Selatan. *Journal of Socio Economics on Tropical Agriculture (JOSETA)*, 7(3), 166–179. <https://doi.org/10.25077/joseta.v7i3.937>
- Aswan, N., & Tanjung, Y. W. (2021). Analisis faktor-faktor pendapatan petani kelapa sawit (studi kasus: Desa Terapung Raya Muara Batangtoru). *Jurnal Education and Development*, 9(1), 549. <https://journal.ipts.ac.id/index.php/ED/article/view/2417>
- BAPPELITBANG. (2024). Rencana Induk dan Peta Jalan pemajuan Ilmu Pengetahuan dan Teknologi, Riset dan Inovasi Provinsi Sumatera Utara Tahun 2024-2026. BAPPELITBANG Provinsi Sumatera Utara.
- Gujarati, D. N., & Porter, D. C. (2013). Basic Econometrics. In *Introductory Econometrics: A Practical Approach*. McGraw-Hill/Irwin, a business unit of The McGraw-Hill Companies.
- Harahap, M. A. (2025). Analisis Faktor-Faktor yang Mempengaruhi Nilai Tukar Petani Tanaman Pangan dan Tanaman Perkebunan di Wilayah Pulau Sumatera Tahun 2019 – 2024. Universitas Sumatera Utara Medan.
- Hasanah, W. K. (2026). Analisis komparatif kontribusi subsektor peternakan dan perikanan terhadap ekonomi Kabupaten Mandailing Natal. Universitas Graha Nusantara Padangsidempuan.
- Hasibuan, M., Rahmanta, & Ayu, S. F. (2022). Analisis faktor-faktor yang mempengaruhi pertumbuhan sektor pertanian di Provinsi Sumatera Utara. *Jurnal Agrica*, 15(1), 23–34.
- Illahi, R. W., Syahputra, A. F., Aida, G. R., & Prajasti, C. N. (2023). Pengaruh Perubahan Iklim terhadap Produksi Perikanan Tangkap di Laut Jawa Timur Indonesia. *Jurnal Agrimanex*, 3(2), 178–188.
- Juansya, A., Musthofa, M. W., & Desfitranita. (2024). The influence of agricultural sector variables on the economic growth of Indonesia: an islamic economic. *Jurnal Ekonomi Islam*, 15(May), 79–95.
- Sari, S. R. (2023). Analisis Faktor-Faktor Nilai Tukar Petani terhadap Produk Domestik Regional Bruto (PDRB) Provinsi Sumatera Utara. Universitas Islam Sumatera Utara Medan.

- Silaban, S. (2018). Pengaruh Pengeluaran Publik Terhadap Transformasi Struktur Ekonomi dan Pengembangan Wilayah Kabupaten Humbang Hasundutan. Universitas Sumatera Utara Medan.
- Siregar, R. (2016). Analisis Faktor-Faktor yang Mempengaruhi PDRB Sektor Pertanian Sumatera Utara. Universitas Negeri Medan.
- Tarno, S., & Nurmala. (2023). Investigation of Fisheries Resources Through Digital Fisheries Applications Towards a Culture Community in the Revolution 5. 0. International Journal of Chemical & Material Sciences, 6(December 2022), 1–9.
- Widiarsih, D., & Sandri, S. H. (2018). Analisis Potensi Ekonomi Kabupaten Mandailing Natal. Jurnal Akuntansi & Ekonomika, 8(2), 268–278.
<https://ejurnal.umri.ac.id/index.php/jae/article/view/1132>
- Zahriyah, A., Suprianik, Parmono, A., & Mustofa. (2021). Ekonometrika. Mandala Press.