

Analysis of Inter-Island Rice Supply Chain at Rice Mill in Pinrang Regency

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The supply chain of agricultural products is the entire production process from cultivation, processing, distribution, and marketing, to the products produced to the hands of consumers. The supply chain consists of various stakeholders who are involved either directly or indirectly. Thus, the supply chain is an integrated marketing unit that includes the integration of stakeholders and products to provide satisfaction to customers. Pinrang Regency is one of the largest rice-producing districts in South Sulawesi. The purpose of this study is to analyze the structure of the inter-island rice supply chain in rice mills in Pinrang Regency, analyze the relationship pattern in the inter-island rice supply chain in Pinrang Regency, analyze the influence of inter-island traders on the rice market in Pinrang Regency, the analysis used is descriptive analysis, panel data regression analysis. The results of this study indicate that the structure of the rice supply chain in the mill starts from farmers who supply grain to the mill, then the mill sells rice to inter-island traders, then the mill sells to wholesalers and retailers then finally the mill sells rice to direct consumers. The rice supply chain in each mill has 3 flows, namely product flow, financial flow and information flow. The pattern of relationships in the inter-island rice supply chain, namely the raw material supply channel (grain), the rice product distribution channel (milling), and the inter-island channel cooperate in completing a purchase transaction and the pattern of relationships in the supply chain uses a general trading partnership pattern. The results of the study using the Common Effect Model (CEM) show that the variable amount of production has a positive and significant effect on the volume of inter-island shipments. The destination price variable has a positive and significant effect on the volume of inter-island rice shipments. Then the variable Shipping cost has a positive and significant effect on the volume of inter-island rice shipments.

Keywords Rice supply chain, inter-island, rice mill, agricultural supply chain, Pinrang Regency.

INTRODUCTION

Indonesia is a tropical country with land conditions surrounded by mountains and fertile soil structures and rich in natural resources, so it is widely used by the population as agricultural land (Naylor *et al.*, 2007; Gupta *et al.*, 2022). Indonesia's characteristics as an agricultural country imply that the agricultural sector has an important role in national economic development (Ansari *et al.*, 2023). Sustainable agricultural development is directed at increasing agricultural production, meeting food needs and domestic industrial needs, increasing exports, farmer income, expanding employment opportunities, and encouraging equity in business (Widyanti *et al.*, 2014).

Food crop commodities have the most important position in meeting energy needs because they serve as a good source of

carbohydrate, fat, protein and vitamin nutrients for human consumption (Verma and Srivastav, 2020). In the field of human nutrition, rice fulfills more than 21% of daily calorie needs (Naeem *et al.*, 2024), and this figure reaches 76% in the Southeast Asian region (Mohidem *et al.*, 2022). Rice is one of the most important crops in the world, feeding at least 60% of the total population (Wang *et al.*, 2023). In general, the plant that produces rice is rice (Irmawati, 2018).

Rice belongs to a group of grain plants (cereals) that produce rice with important carbohydrate content worldwide (Maertens, 2017; Matsuda, 2019; Andriamparany *et al.*, 2021), and its consumption increases as the population increases (Wardani *et al.*, 2019 ; Tashi *et al.*, 2022). As an essential source of food for the community, the availability of rice must be able to keep up with the needs of the community, therefore the government continues to make efforts to

improve the agricultural sector such as the selection of superior seeds and the use of food technology to support increased rice production (Hanas, 2017; Andriamparany et al., 2021). Farmers are important contributors to the country's economic stability and growth (Talaviya et al., 2020; Elyasi and Teimoury, 2023). With maximum work, farmers can help stabilize the Indonesian economy by playing an active role in agriculture and food security. However, the problem is that currently the welfare of farmers in Indonesia is still low. The low welfare of farmers is due to the low added value of products enjoyed by farmers. Farmers sell their harvested agricultural products just like that. Many farmers sell agricultural products, such as rice, while still in the fields (Sihombing, 2015).

The agricultural product supply chain is one of the most influential sectors in any country's economy (FAO, 2020). The entire production process from cultivation, processing, distribution, marketing, to the products produced to the hands of consumers. The supply chain consists of various stakeholders who are involved either directly or indirectly (Elyasi and Teimoury, 2023). Thus, the supply chain is an integrated marketing unit that includes the integration of stakeholders and products to provide satisfaction to customers. Rice has a strategic role in the lives of the people and government of Indonesia because rice is the daily staple food of most of the population (Phillips et al., 2024). The position of rice as a staple food has not been replaced by other food sources (Liu et al., 2023). The marketing system is an important part of the chain of goods from production to consumers. The marketing system also determines the efficiency of the food market. The supply chain is an organizational system in the distribution of goods (flow of goods) to customers. Supply chain is a network of various organizations that are interconnected and have the same goal in organizing the distribution of goods properly. Supply chain is a concept in seeing the problem of distributing goods and solving it not only as an internal problem of each company, but seen as a broader problem from raw materials to finished products used by consumers, which is a whole chain of distribution of goods (Yunus, 2018). South Sulawesi is one of the largest rice production centers and has the highest harvest area after East Java, West Java, Central Java (BPS, 2018). The results of the analysis of Susilowati (2017) One of them is that Pinrang Regency has considerable potential in the field of rice paddy agriculture. The area, production, and crops of paddy rice in Pinrang Regency are shown in Figure 1.

In Figure 1, it shows that rice production in Pinrang Regency experienced fluctuations where there was a decrease in 2016-2017 of 643,866 tons, in 2017-2018 the amount of rice production also decreased to 639,228 tons due to weather factors and water availability, however, there was an increase from 2018 to 2020. Climate change or weather factors have a significant impact on water availability, growth, development, and crop production during the growing season,

and crop cultivation techniques on land (Hussain et al., 2020; IPCC, 2023). Reduced rainfall results in increased water stress (Kang et al., 2024). If these conditions are accompanied by rising air temperatures that increase evapotranspiration, higher temperatures will disrupt agricultural systems (Wang et al., 2024). Plants are particularly sensitive to high temperatures during critical stages such as flowering and seed development. High temperatures that occur together with drought can cause disasters on agricultural land in other words resulting in crop failure or a decrease in the amount of production (Hamdi, 2017). Based on the description and explanation of the literature above, it can be concluded that the inter-island rice supply chain has an important role in the volume of rice shipments. Therefore, the objectives of this study are to analyze the structure of the inter-island rice supply chain at rice mills in Pinrang Regency, analyze the relationship patterns in the inter-island rice supply chain in Pinrang Regency, analyze the influence of inter-island traders on the rice market in Pinrang Regency. The results of this study are expected to find factors that significantly affect the volume of rice shipments which can later become one of the basic policies in an effort to increase the volume of rice sales.

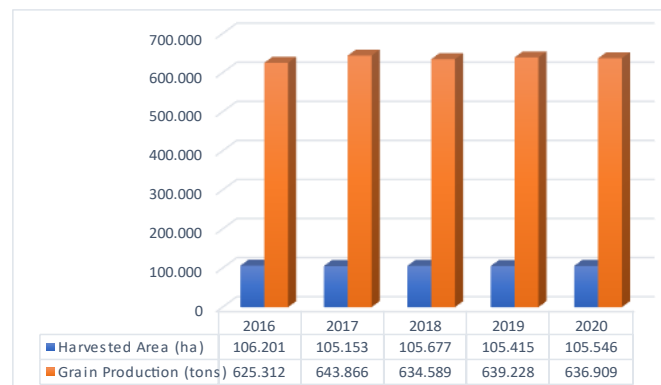


Figure 1. Rice paddy area, production, and crops in Pinrang Regency.

MATERIALS AND METHODS

Location and Time of Research: This research was conducted at rice mills in Pinrang Regency Determination of the research site was carried out intentionally (Purposive Sampling) with consideration of the 10 mills are the largest rice mills and do inter-island trade in Pinrang Regency This research was conducted in January-February 2024. Determination of respondents in the mill is done intentionally (Purposive Sampling).

Population and Sample: The population in this study were all rice milling business actors in Pinrang Regency. The sampling procedure used in this study is purposive sampling with the consideration that the mill is the largest rice mill and conducts inter-island trade where respondents from all mills



are taken intentionally which is expected to represent each region in Pinrang Regency.

Research methods: This study uses qualitative and quantitative research methods with a descriptive approach. According to (Sugiyono, 2011), qualitative research is inductive, meaning that the author allows problems to emerge from the data or leaves it open to interpretation. To determine the right supply chain flow, the most important thing you need to know is the supply chain structure and the pattern of relationships in the supply chain. Quantitative research can be interpreted as a research method based on the philosophy of positivism, used to examine certain populations or samples, sampling techniques are generally carried out deliberately, data collection uses research instruments, and data analysis is quantitative / statistical to test predetermined hypotheses..

Panel Data Regression Analysis Tool: In this study using panel data regression because the research is a combination of time series and cross section data. Data collected at one time on many observation units is called individual cross data, while data collected over time (Diputra et al., 2012). In this study using panel data regression because in the study.

$$Y = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + e$$

Description:

Y = Dependent Variable (Shipment Volume)

α = Constant

β_1 = Production Quantity

β_2 = Destination price

β_3 = Shipping cost

X_{1it} = Total production i in period t

X_{2it} = Price of destination i in period t

X_{3it} = Shipping cost I in period t

e = Error Term

Parameter estimation in panel data regression analysis is carried out with the Common Effect Model (CEM) approach. The simplest panel data model because it only combines time series data and cross section data. This model also does not pay attention to the time or individual dimensions, so it is assumed that the behavior of company data is the same in various periods. This method can use the Ordinary Least Square (OLS) approach or the least squares technique to estimate the panel data model. With the following model:

$$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + e$$

Description:

Y_{it} = Dependent variable of company i in period t

α = Constant

X_{it} = Independent variable of company i in period t

β = Regression Coefficient

e = Error Term

After estimating the parameters, the next model selection can be done in the following way:

Chow Test: The Chow test is a test to be able to determine the fixed effect model or common effect model that is most appropriate to use in estimating panel data. The hypothesis in the Chow test is as follows:

H0: Common Effect Model

H1: Fixed Effect Model

The basis for decision-making in the Chow test is as follows

1) H0 accepted if $F \geq 0,05$, then using the common effect model

2) H0 rejected if $F < 0,05$, then proceed with the fixed effect model

When the Chow test results show H0 is accepted, the panel data regression technique uses the common effect model, and the testing stops here. If the chow test results show that H0 is rejected, then the next step is to conduct the Hausman Test to choose between the fixed effect model or the random effect model.

Hausman Test: Hausman test is a statistical test to be able to choose whether the fixed effect model or the random effect model is the most appropriate model to use. The hypothesis in the Hausman test is as follows:

H0: Random Effect Model

H1: Fixed Effect Model

The basis for decision-making in the Hausman test is as follows:

1) H0 accepted if $F \geq 0,05$, then using random effect model

2) H0 rejected if $F < 0,05$, then proceed with the fixed effect model

Langrange Multiplier Test: The Langrange Multiplier test is a statistical test to determine whether the random effect model is better than the common effect model. The hypothesis in the Langrange multiplier test is as follows:

H0: Common Effect Model

H1: Random Effect Model

The basis for decision making in the langrange multiplier test is as follows:

1) H0 accepted if $F \geq 0,05$, then using the common effect model

2) H0 rejected if $F < 0,05$, then we continue with the random effect model

The following are the hypotheses in this study, namely:

First hypothesis:

H α : $\beta_1 > 0$ Total Production has a Positive Effect on the Volume of Inter-Island Shipments.

H σ : $\beta_1 \leq 0$ Total Production has a negative effect on the Volume of Inter-Island Shipments.

Second hypothesis:

H α : $\beta_2 > 0$ Destination Price has a positive effect on the volume of interisland shipments.

H σ : $\beta_2 \leq 0$ Destination Price Negatively Affects the Volume of Inter-Island Shipments.

Third hypothesis:

H α : $\beta_3 > 0$ Shipping Costs Positively Affect Interisland Shipping Volume.

H σ : $\beta_3 \leq 0$ Shipping Costs Negatively Affect Inter-Island Shipping Volume.

For the next step we will do the coefficient of determination which aims to measure how far the ability of the regression



model to explain the variation in the dependent variable. A small R2 value indicates that the ability of the independent variables to explain the dependent variable is very limited. The coefficient of determination is used to measure the percentage of variation in the dependent variable that can be explained by all independent variables. The coefficient of determination ranges from 0 to 1 ($0 < R^2 < 1$), where the higher the R2 value of a regression or the closer to 1, the better the regression results. This means that the independent variables provide almost all the information needed to predict the variation in the dependent variable.

T-test: The T test was conducted to test the regression coefficient partially. This test can be done by interpreting the results in the sig column while using the sig column results can be used as the basis for the decision from Sugiyono (2011).

1. If the probability value is smaller than or equal to the value of α ($p\text{-value} \leq \alpha$), then H_a is accepted and H_o is rejected, meaning that the amount of production, destination price and shipping costs have a real effect on the volume of inter-island shipments.

2. If the probability value is greater than α ($p\text{-value} \geq \alpha$) then, H_a is rejected and H_o is accepted, meaning that the amount of production, destination price and shipping costs have no effect on the volume of inter-island shipments. The purpose of using this analysis is to describe the nature of the situation that was running at the time the research was conducted, and examine the causes of certain symptoms. The results of this analysis are presented in tabulated form and simple statistics based on existing information to describe the state of the market and supply chain flow.

F-test: The F-test is used to determine whether all independent variables have the same effect on variable Y. In other words, the F test is conducted to test the effect of independent variables simultaneously on the dependent variable. The basis applied in the F Test in this study is the basic concept taken from Sarjono and Julianita (2011), namely:

1. If the probability value is smaller than or equal to the value of α ($P\text{-value} \leq \alpha$), then H_a is accepted and H_o is rejected, meaning that the amount of production, destination price, and shipping costs together have an effect on the volume of inter-island shipments.

2. If the probability value is greater than or equal to the value of α ($P\text{-value} \geq \alpha$), then H_a is rejected and H_o is accepted, meaning that the amount of production, destination price, and shipping costs together have no effect on the volume of inter-island shipments.

R Test (Determination): The coefficient of determination aims to measure how far the regression model's ability to explain variations in the dependent variable. A small R2 value indicates that the ability of the independent variables to explain the dependent variable is very limited. Each addition of one independent variable, R2 must increase no matter

whether the variable has a significant effect or not on the variable, a significant effect on the dependent variable. Therefore, for the number of independent variables, more than two should use the adjusted coefficient of determination. The coefficient of determination is used to measure the percentage of variation in the dependent variable that can be explained by all independent variables. The coefficient of determination ranges from 0 to 1 ($0 < R^2 < 1$), where the higher the R2 value of a regression or the closer to 1, the better the regression results. This means that the independent variables provide almost all the information needed to predict the variation in the dependent variable.

RESULTS AND DISCUSSION

Supply Chain Structure: The supply chain according to (Hindarti, 2019) is a series of activities that must be carried out starting from the procurement of raw materials, processing, distribution of goods, and up to the marketing activities of goods from producers to reach consumers. The flow in the rice milling supply chain in Pinrang Regency is product flow, financial flow, and information flow.

Product flow: Product flow according to Nurfadilah (2017) is a flow that involves the flow of physical products from suppliers to consumers through the chain. The following product flow in the milling supply chain in Pinrang Regency can be seen in Figure 2.

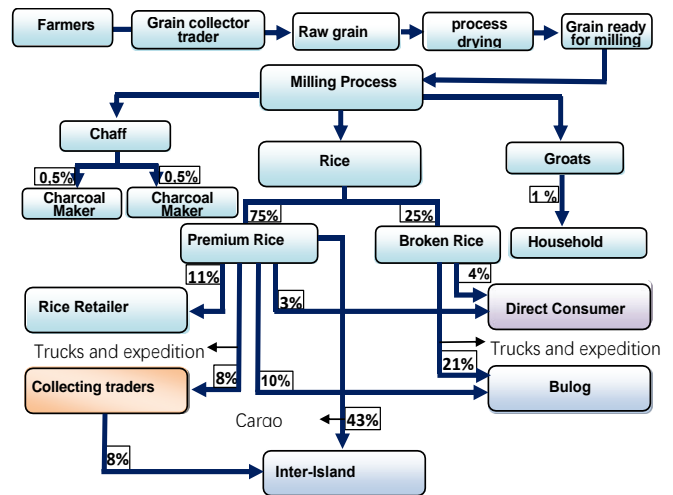


Figure 2. Product flow of rice supply chain in Pinrang district.

Based on Figure 2, the flow of rice products in milling in Pinrang Regency, raw materials are obtained from farmers and intermediary traders in the form of raw grain after the drying process, then the next stage is the milling process. The results of post-milling are premium rice, broken rice, husks and groats which will become products in each mill. For the marketing channel of husk type products, the surrounding



community in the Pinrang district area buys directly from each mill with an average volume of sales/purchases of 0.5% and chicken farmers of 0.5%. As for the menir-type products, the surrounding community also comes directly to the mill to buy. Product delivery uses a truck that has been provided by each mill. Then in the marketing channel for premium rice and broken rice products (1), namely milling - Bulog. For rice marketing channels (2) Milling - Retailer rice traders, (3) Milling - Direct consumers (4) Milling - Collecting traders, and (5) Milling - between islands. This is in accordance with [Aufar \(2018\)](#) statement that product flow moves from suppliers to consumers or from upstream to downstream. The flow of rice products (1) is that the mill sells premium rice products to Bulog with an average sales volume of 9% / two growing seasons, for broken rice milling to Bulog the average sales is 21%. Rice product flow (2) at the mill sells rice to retail rice traders with an average volume of 11% / two seasons. Rice product flow (3) in the miller sells broken rice to direct consumers with an average volume of 4% / two seasons. For premium rice, millers sell to direct consumers with an average sales of 2%. Rice product flow (4) in the mill sells rice to rice collectors with an average sales volume of 6% / two growing seasons, then rice collectors then sell rice to inter-island with an average sale of 6%, the destination areas for inter-island shipments are Kalimantan, Maluku, Tangerang, Medan and Jakarta. Then the flow of rice products (5) in the mill sells rice between islands with an average volume of 43% / two seasons.

Financial Flow: Financial flow According to [Sepang et al. \(2017\)](#) the financial flow in the supply chain is in the form of payment for products sold to its partners. The following financial flow in the rice supply chain in Pinrang Regency can be seen in Figure 3.

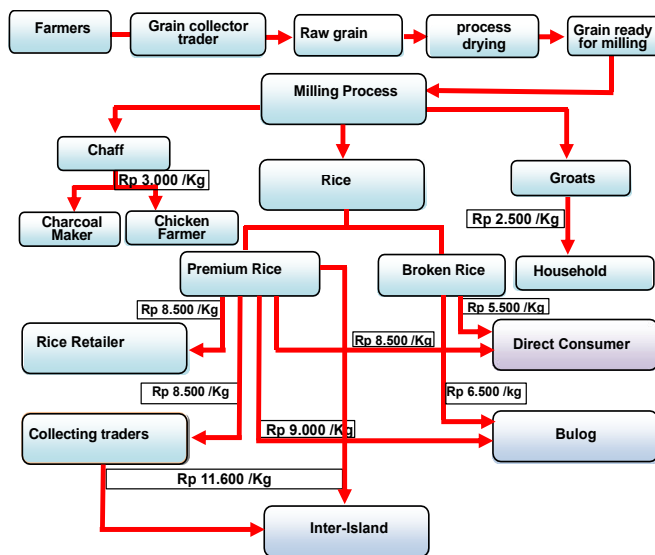


Figure 3. Financial flow of rice supply chain in Pinrang district.

Based on Figure 3, the financial flow of rice in network (1), the rice financial channel in husk and groats type products, the surrounding community in the Pinrang Regency area buys directly from each mill with an average price for husks of IDR 3,000 /kg and for groats the average price amounts to IDR 2.500 /kg, then delivering products using trucks that have been provided by each mill can be seen in the financial flow of rice in network (2), the mill sells premium rice to Bulog at an average price of Rp. 9,000 /kg per two seasons, for broken rice the mill sells to Bulog at an average price of Rp. 6,500 /Kg. The financial flow of rice in the network (3), mills sell rice to retail rice traders at a price of Rp 8,500 /kg per two seasons. The financial flow of rice in the network (4), the millers sell rice to direct consumers at an average price of IDR 8,500 /kg per two seasons, and for broken rice, the millers sell to direct consumers at IDR 5,500 /kg. The financial flow in network (5), the miller sells rice to the collecting traders at an average price of IDR 8,000 /kg per two seasons, then the rice collecting traders then sell the rice to the inter-islands with an average selling price of IDR 10,600 /kg, the transportation of goods delivery services used to send rice products to the inter-islands is using cargo ships, the cost of rice delivery has been determined by the delivery service. The financial flow in the network (6), the miller sells rice to the inter-island at an average price of IDR 11,600 /kg for inter-island shipping destinations. Milling sells to inter-island delivery destinations, namely Kalimantan, Maluku, Tangerang, Medan and Jakarta. Transportation used to send rice products with sea access using cargo ships and inter-island shipping costs have been determined by the shipping service.

Information Flow: Information flow is a flow that moves from two directions, namely from upstream to downstream and from downstream to upstream. This is in line with [Aufar \(2018\)](#) statement that information flow moves in two directions along the chain, namely from downstream to upstream and from upstream to downstream. The flow of information that occurs in the inter-island rice supply chain at rice mills in Pinrang district shows that the flow of information is well integrated. Information activities can be carried out via telephone or when the two parties meet each other directly. The flow of information that runs between institutions or actors in the rice supply chain includes information on market prices, types of seeds, the amount of demand, the amount of inventory to the status of rice collection and delivery.

Relationship Patterns in the Rice Supply Chain: The partnership pattern between partner millers with farmers and buyers in this case large traders, inter-island and direct consumers. The partnership pattern formed between millers and farmers with institutions or buyers is a general trade partnership pattern. [Alam and Hermawan \(2017\)](#), which we can see in the table below



Table 1. Pattern of relationships in the supply chain.

Partner	Relationship Pattern
Farmer – Mill	General Trade
Milling - Bologna	General Trade
Milling - Retailer	General Trade
Milling - Collector	General Trade
Milling - Direct Consumer	General Trade
Milling - Inter-island	General Trade

In this study, the implementation of the partnership is that farmers become suppliers of raw materials and then the harvest is collected and processed by partner mills which then become better rice products to be marketed either to large traders, inter-island, or direct consumers. In the partnership between farmers and millers as well as mills to large traders, inter-island, and direct consumers there is no written contract because the system that is run is a family with the principle of trust. In this study, there are 10 mills that have the same relationship pattern, namely the general trade partnership pattern. The following are the results of the supply chain relationship pattern in each mill:

1. Mill – Farmer: Based on Table 1, it can be seen that millers and farmers cooperate in completing the purchase transaction. The cooperation will include scheduling rice delivery, allocating rice, and agreeing on the price and payment of rice. The pattern of relationships between farmers and millers uses a system of trust they do not use black-on-white agreements, mills buy raw materials from farmers every harvest season, procurement of milling raw materials comes to farmers, the purchase price of milling with farmers is by mutual agreement and mutual benefit.

2. Mill - intermediary traders: Based on Table 1, it can be seen that millers and wholesalers cooperate in completing purchase transactions. The cooperation will include scheduling rice delivery, allocating rice, and agreeing on the price and payment of rice. The pattern of relations between the millers and the Gathering Traders uses a trust system, namely the millers buy raw materials (grain) to the collecting traders, with a trust system through mutual agreement.

3. Millers – Retailers: Based on Table 1, it can be seen that the millers and retailers cooperate in completing the purchase transaction. The cooperation will include scheduling the delivery of rice, allocating rice, and agreeing on the price and payment of rice. The pattern of relationships between millers and retailers is that millers market and sell rice to Bulog with a buying and selling system through mutual trust and mutual agreement.

4. Milling – Bulog: Based on Table 1, it can be seen that the millers and Bulog cooperate in completing the purchase transaction. The cooperation will include scheduling rice delivery, allocating rice, and agreeing on the price and payment of rice. The pattern of relations between milling and bulog is that milling markets and sells rice to bulog with a sale and purchase system on the basis of trust and in accordance

with mutual agreement. this can be attributed to Amir Syarifuddin's theory, the cooperation intended here is cooperation in obtaining profits so first there must be an agreement either formally with or in another way that shows that both parties have cooperated willingly. For the validity of cooperation, both parties must fulfill the conditions for entering into a cooperation agreement, namely adults in the sense of having the ability to act and being of sound mind, and on the basis of their own will without coercion from any party.

5. Mill - Direct consumer: Based on Table 1, it can be seen that the millers and consumers directly cooperate in completing the purchase transaction. The cooperation will include scheduling rice delivery, allocating rice and agreeing on the price and payment of rice. The pattern of relationships between millers and consumers is that the millers market and sell rice to consumers directly and vice versa, consumers go directly to the millers to buy rice with a buying and selling system in accordance with the mutual agreement.

6. Milling - Inter-Island: Based on Table 1, it can be seen that millers and inter-island traders cooperate in completing purchase transactions. The cooperation will include scheduling rice delivery, allocating rice and agreeing on the price and payment of rice. The pattern of the relationship between the millers and the inter-island traders is that the millers cooperate with the millers with a trust system with mutual benefit for all parties, then the millers sell rice to the inter-island traders according to the mutual agreement. This is in line with Amir Syarifuddin's theory, the cooperation intended here is cooperation in obtaining benefits so that first there must be an agreement either formally with or in another way that shows that both parties have cooperated willingly. For the validity of cooperation, both parties must fulfill the conditions for entering into a cooperation agreement, namely adulthood in the sense of having the ability to act and sound mind, and on the basis of their own will without coercion from any party.

The Influence of Inter-Island Traders on the Rice Market: The effect of inter-island trade is how the inter-island rice trade affects the rice trade in Pinrang Regency whether it has a positive effect or a negative effect in other words whether inter-island trade affects the scale of rice production, whether inter-island trade affects the high or low price of rice in the destination area and whether inter-island trade affects shipping costs. To find out, we will conduct an analysis as follows:

Chow Test: Chow test is conducted to determine whether the panel data regression technique with fixed effects model is better than the common effects model. The Chow test is a test to compare the common effects model with the fixed effects (Widarjono, 2009). The hypothesis formed in the Chow Test is:

H0: Common Effect Model is better than Fixed Effect Model
 Ha: Fixed Effect Model is better than Common Effect Model



The conclusion drawn in the Chow test is the following criteria, when the cross-section Chi-square probability value > 0.05 then H0 is accepted and Ha is rejected. If the cross-section Chi-square probability value < 0.05 then H0 is rejected and Ha is accepted. The results of the Chow Test in this study are presented in Table 2.

Table 2. Chow Test Results.

Effects Test	Statistic	d.f.	Prob.
Cross-section F	12,226309	(9,7)	0,0017
Cross-section Chi-square	56.331563	9	0,0000

Source: Data analysis using Eviews 12.0 (2024).

Based on the Chow Test results in Table 2, the cross-section Chi-square probability value is smaller than 0.05, namely 0.0000 < 0.05, it can be concluded that H0 is rejected and Ha is accepted. The interpretation of the Chow Test results is that the fixed effect model is better when compared to the common effect model, so the Hausman Test can then be carried out.

Hausman Test Results: The Hausman test aims to determine the best model between the random effect approach and the fixed effect method that should be used in panel data modeling (Widarjono, 2009). The hypothesis formed in the Hausman Test is:

H0: Random Effect Model is better than Fixed Effect Model

Ha: Fixed Effect Model is better than Random Effect Model

The criteria for drawing conclusions in the Hausman Test is when the probability value of cross-section random > 0.05 then H0 is accepted and Ha is rejected. If the cross-section random probability value < 0.05 then H0 is rejected and Ha is accepted. The results of the Hausman Test in this study are presented in Table 3.

Table 3. Hausman Test Results.

Test Summary	Chi ² Statistic	Chi ² d.f.	Prob.
Cross-section random	5.9802	3	0,1126

Source: Data analysis using Eviews 12.0 (2024).

The Hausman Test results in Table 3 show that the random cross-section probability value is greater than 0.05, namely 0.1126 > 0.05, it can be concluded that H0 is accepted and Ha is rejected. Based on the results of the Hausman Test, it is obtained that the random effect model is better when compared to the fixed effect model, because REM is selected, it can be said that the regression model does not occur Omitted Variable Bias.

Lagrange Multiplier (LM) Test Results: The LM test developed by Breusch-Pagan is used to determine whether the random effect model is better than the common effect model (Widarjono, 2009). The hypothesis formed in the Hausman Test is:

H0 : Common Effect Model is better than Random Effect Model

Ha : Random Effect Model is better than Common Effect Model

The conclusion drawn on the LM Test uses the following criteria, when the Bruesch-Pagan probability value > 0.05 then H0 is accepted and Ha is rejected. If the Bruesch-Pagan probability value < 0.05 then H0 is rejected and Ha is accepted. The results of the LM Test in this study are presented in Table 4.

Table 4. Lagrange Multiplier Test Results.

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	3.07545 (0.0795)	0.76866 (0.3806)	3.84411 (0.1499)

Source: Data analysis using Eviews 12.0 (2024)

The Breusch-Pagan probability value from the LM Test results can be seen in Table 4 column both, which is 0.1499 > 0.05, so it can be concluded that H0 is accepted and Ha is rejected. The interpretation of the LM Test results is that the common effect model is better when compared to the random effect model, so it can be concluded based on the results of the Chow Test, Hausman Test and LM Test that the panel data regression estimate used in this study is the common effect model. For the next step, we will conduct a classical assumption test in this study, the model selected for panel data regression is CEM (common effect model) to answer the selected model, therefore the classical assumptions used are multicollinearity and heterokedasitas (Napitupulu *et al.*, 2021). Regression analysis is a statistical procedure in systematically estimating the average relationship between the dependent variable and the independent variable (Ilyas, 2022). The regression model used in this study is a panel data regression model with a common effect model estimation approach. The purpose of making a regression model is to process, discuss the samples that have been obtained and to assess the hypotheses that have been made. The results of panel data regression estimation with the common effect model approach in this study are presented in Table 5.

Tabel 5. Hasil estimasi regresi data panel common effect model.

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-240.25300	41.94601	-5.7277	0.0000
X1	0.56131	0.06910	8.1222	0.0000
X2	0.01282	0.00267	4.8124	0.0002
X3	6.65E-5	1.48E-5	4.5031	0.0004

Source: Data analysis using Eviews 12.0 (2024)

The panel data regression equation formed with the CEM (common effect model) approach based on Table 5 is as follows:

$$Y_{it} = -240.253 + 0.561290 X1_{it} + 0.012844 X2_{it} + 6.65E-05 X3_{it}$$



The constant value of -240.253 explains that if the amount of production, destination price and shipping costs are equal to 0, the volume of shipments outside the island will decrease. The coefficient value of X1 is 0.561290, which means that if the amount of production increases by 1%, the volume of shipments increases by 0.7296, assuming that the price of the destination and shipping costs are constant. X2 has a coefficient value of 0.012844, it can be interpreted that if the price of the destination area increases by 1 unit, the volume of shipments increases by 0.012844, assuming that the amount of production and shipping costs are constant and unchanged. The interpretation for X3 which has a coefficient value of 6.65E-05 is that when shipping costs increase by 1%, the volume of shipments increases by 6.65E-05 assuming the amount of production and the price of the destination area is constant.

The results of the t-test (Partial): The t-test is needed in testing the effect of each independent variable used in this study on the dependent variable partially (Priyatno, 2017). The t-test was conducted to test the hypotheses H1, H2, and H3 so that in this t-test the following hypothesis was formed: H01: Total Production has no effect on Shipping volume
Ha1: Total Production has a positive effect on Shipping volume
H02: Destination price has no effect on shipping volume
Ha2: Destination price has a positive effect on shipping volume
H03: Shipping cost has no effect on shipping volume
Ha3: Shipping cost has a positive effect on shipping volume
If the t value > t table or the probability value < 0.05, it can be concluded that H0 is rejected and Ha is accepted. If the t value < t table or the probability value > 0.05, it can be concluded that H0 is accepted and Ha is rejected. The results of the t-test in this study are presented in Table 6.

Table 6. Results of t-test (partial).

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-240.25300	41.94601	-5.7277	0.0000
X1	0.56129	0.06911	8.1222	0.0000
X2	0.01284	0.00267	4.8124	0.0002
X3	6.65E-5	1.48E-5	4.5031	0.0004

Source: Data analysis using Eviews 12.0 (2024)

Influence variable the amount of production on the volume of shipments: Based on the results of the t-test in Table 6. The amount of production (X1) has a t value greater than the t table, which is 8.1222 > 1.7459 and has a probability value of 0.0000 < 0.05 so it can be concluded that H01 is rejected and Ha1 is accepted. The amount of production in this case partially has a significant effect on the volume of shipments. In the results of this test it was found that the direction of the positive relationship between the amount of production and the volume of shipments, meaning that when the production volume increases, the volume of shipments will also increase

and vice versa. The results of this study indicate a relationship between the amount of rice production (X1) and the volume of shipments (Y). This means that an increase or decrease in the amount of rice production will affect the volume of rice shipments. With a large land area and fertile land, mills should be able to produce rice to meet consumer demand. Since rice is the main staple food of most Indonesians, it is certainly a commodity that will continue to be purchased and sought after by the community.

Variable effect of destination price on shipping volume: The t value of the destination price (X2) in terms of the t-test results is greater than the t table, which is 4.8124 > 1.7459 with a probability value of 0.0002 < 0.05, which means that H02 is rejected and Ha2 is accepted. Partially, the destination price has a significant effect on the volume of shipments when viewed from the probability value which is smaller than 0.05. In the results of this test it was found that the direction of the positive relationship between the price of the destination area and the volume of shipments, meaning that when the price of the destination area increases, the volume of shipments will also increase and vice versa, it is because when the price of the destination area where the miller or inter-island trader sends the rice product being sold rises in price, it will be more profitable. This is also by the theory of demand and supply in economics, the theory of demand and supply discusses how much the amount of goods or services demanded (want to buy) by consumers and how much the amount of goods or services offered (want to sell) by producers. The amount that consumers want to buy is often determined by demand. Meanwhile, what producers/companies want to sell is termed supply. In the law of supply of goods and services, there is a positive relationship between the price and the amount of goods provided.

Variable the effect of shipping costs on shipping volume: Shipping Cost (X3) has a t count greater than the t table, namely 4.5031 > 1.7459, while the probability value is 0.0004 > 0.05. Based on the t value and the probability value, H03 is rejected and Ha3 is accepted, which means that partial shipping costs have a significant effect on shipping volume. In the results of this test, it was found that the direction of a positive relationship between shipping costs and shipping volume, meaning that when shipping costs increase, shipping volume will also increase and vice versa. The results of this study are in line with research conducted by (Rasyid and Suzan, 2018) which states that "Distribution costs have a significant influence with a positive direction on the sales of food and beverage sector manufacturing companies listed on the Indonesia Stock Exchange in 2012-2016.

F Test Results (Simultaneous): The F test aims to see the feasibility of a regression model by testing whether one or more independent variables in the model have an overall effect on the dependent variable (Priyatno, 2012). The criterion for the F test is that if the F value > F table or the probability value < 0.05, it can be concluded that H0 is



rejected and H_a is accepted, then one or more independent variables affect the dependent variable, which means that the regression model is considered significant. If the value of F count $< F$ table or probability value > 0.05 , it can be concluded that H_0 is accepted and H_a is rejected, then no independent variable affects the dependent variable, meaning that the regression model is not significant. The results of the F test in this study are presented in Table 7.

Table 7. Test Results f (simultaneous).

Weighted Statistics			
R-squared	0.892	Mean dependent var	111.500
Adjusted R ²	0.872	S.D. dependent var	40.882
S.E. of regression	14.643	Hannan-quin criter	8.422
F-statistic	44.029	Durbin-Waston stat	0.810
Prob(F-Statistic)	0.000		

Source: Data analysis using Eviews 12.0 (2024).

Based on Table 7, the panel data regression estimates with the common effect model approach used in this study has a calculated F value greater than the F table, which is $44.029 > 3.238$ and has a probability value of $0.0000 < 0.05$. Based on the calculated F value and the probability value, H_0 is rejected and H_a is accepted so that it can be interpreted that together the independent variables affect the dependent variable. The interpretation is that the panel data regression model with the common effect model approach in this study is considered significant or feasible to use.

R Test (Determination): The adjusted r-squared value of 0.8716 means that the variation in shipping volume can be explained by the variation in the joint relationship of production scale, destination price and shipping costs by 87.16%, while the rest is influenced by other independent variables outside the model.

Conclusion: Based on the results of the inter-island rice supply chain research on pengiilinagan in Pinrang district, it can be concluded that the structure of the rice supply chain in the mill starts from farmers who supply grain to the mill, then the mill sells rice to inter-island traders, then the mill sells to wholesalers and retailers then finally the mill sells rice to direct consumers. The rice supply chain in each mill has 3 flows, namely product flow, financial flow and information flow. The supply chain system in the rice milling business in Pinrang Regency consists of 3 groups, namely the raw material supply channel (grain), the product distribution channel (rice milling) and the inter-island trade channel. The raw material supply channel (grain) is dominated by the Farmer - Grain Collector channel while the product distribution channel (rice) is dominated by the milling factory channel and the channel to inter-island traders is dominated by rice traders from outside the island. The relationship patterns in the inter-island supply chain, the raw material supply channel (grain), the rice product distribution channel

(milling) and the inter-island channel cooperate in completing a purchase transaction. The cooperation will include scheduling rice delivery, allocating rice as well as price and payment agreements. The working relationship between raw material suppliers (unhulled rice), rice product distributors (millers) and inter-island traders uses a general trading partnership pattern that is still based on mutual trust between individual business actors, without a standardized cooperation agreement. Based on the results of the analysis in Pinrang Regency, the results of this study can be concluded that the variable amount of production has a positive and significant effect on the volume of inter-island shipments. The destination price variable has a positive and significant effect on the volume of inter-island rice shipments. Then the variable Shipping costs have a positive and significant effect on the volume of inter-island rice shipments.

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REFERENCES

- Alam, S.A. and H. Hermawan. 2017. Faktor-faktor yang mempengaruhi hubungan kemitraan antara petani budidaya jamur tiram dengan cv. Agro Corporation. *Journal Agrosience* Vol. 7.
- Andriamparany, J.N., H. Hanke and E. Schlecht. 2021 Food security and food quality among vanilla farmers in Madagascar: the role of contract farming and livestock keeping, *Food Security* 13:981-1012.
- Ansari, A., A. Pranesti, M. Telaumbanua, T. Alam, R.A. Taryono, Wulandari, B.D.A. Nugroho and Supriyanta.



2023. Evaluating the effect of climate change on rice production in indonesia using multimodelling approach. In *Heliyon* Vol. 9.
- Aufar, M.R. 2018. Analisis rantai pasok (supply chain) agribisnis jagung (kasus: desa tigabinanga, kecamatan tigabinanga, kabupaten karo) (doctoral dissertation, universitas sumatera utara) Menyatakan.
- Badan Pusat Statistik. 2018. Luas Panen dan Produksi Padi di Indonesia 2018:1.
- Elyasi, A. and E. Teimoury. 2023. Applying critical systems practice meta-methodology to improve sustainability in the rice supply chain of iran. *Sustainable Production and Consumption* 35:453-468.
- FAO 2020. Transforming Food Systems for Affordable Healthy Diets. FAO
- Gupta, D., N. Gujre, S. Singha and S. Mitra. 2022 Role of existing and emerging technologies in advancing climate-smart agriculture through modeling: a review *Ecology Information* 71:101805.
- Hamdi, S. 2017. Dinamika dan Teknologi Benua Maritim Indonesia: Analisis Regresi Linear Sederhana dan Uji Korelasi Curah Hujan terhadap Penyinaran Matahari Tahunan di Kota Bandung pp.83-91.
- Hanas, D., Frenky, E. Kriswiyanti and I.K. Junitha. 2017. Karakter morfologi beras sebagai pembeda varietas padi. *Indonesia Journal Of Legal and Forensic Sciences*. Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Udayana. Denpasar Bali 1:23-28.
- Hindarti, S. and D. Sari. 2019. Manajemen Agribisnis-Suatu Pengantar (Agribusiness Management-An Introduction). Available at SSRN 3431495.
- Hussain, S., J. Huang, J. Hung, S. Ahmad, S. Nanda, S. Anwar, A. Shakoor, C. Zhu, L. Zhu, X. CaO, Q. Jin, J. Zhang. 2020. Rice production under climate change: adaptations and mitigating strategies. *environment, climate, plant and vegetation growth*. springer, berlin. pp. 659-686.
- Ilyas, S.R. 2022. Pengaruh indikator makroekonomi terhadap harga saham perusahaan (studi pada perusahaan yang tercatat dalam indeks lq45). *Jurnal Ekonomi Manajemen Sistem Informasi* 4:93-105.
- IPCC. 2023. Climate change 2023: synthesis report. In: Lee, H., Romero, J. (Eds.), Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.
- Irmawati, E. 2018. Produktivitas beras dalam pemenuhan kebutuhan pangan penduduk kecamatan moga kabupaten pematang. Skripsi.Fakultas Ilmu Tarbiyah dan Keguruan. Universitas Islam Negeri Syarif Hidayatullah. Jakarta pp. 1-99.
- Kang, Y.G., J.Y. Lee, G. Cho, Y. Yun and T.K. Oh. 2024. Synergy effect of silicate fertilizer and iron slag: a sustainable approach for mitigating methane emission in rice farming. *Science of The Total Environment* 935:173392.
- Liu, X., J. Guo, L. Xue, D. Zhao and G. Liu. 2023. Where has all the rice gone in china? a farm-to-fork material flow analysis of rice supply chain with uncertainty analysis. *Resources, Conservation and Recycling* 190:106853.
- Maertens, M. and V.V. Katrien. Contract-farming in staple food chains: the case of rice in benin. *World Development* 95:73-87.
- Matsuda, T. 2019. Rice flour: a promising food material for nutrition and global health. *Journal of Nutritional Science and Vitaminology* 65:S13-S17.
- Mohidem, N.A., N. Hashim, R. Shamsudin and H.C. Man. 2022. Rice for food security: revisiting its production, diversity, rice milling process and nutrient content. *Agriculture* 12:741.
- Naeem, I., A. Ismail, M. Riaz, M. Aziz, K. Akram, M.A. Shahzad, M. Ameen, S. Ali and C.A.F. Oliveira. 2024. Aflatoxins in the rice production chain: a review on prevalence, detection, and decontamination strategies. In *Food Research International* Vol. 188.
- Napitupulu, J. Hasiholan, N. Ellyawati and R.F. Astuti. 2021. Pengaruh literasi keuangan dan sikap keuangan terhadap perilaku pengelolaan keuangan mahasiswa kota samarinda. *Jurnal Pendidikan Ekonomi* 93:138-144.
- Naylor, R.L., D.S. Battisti, D.J. Vimont, W.P. Falcon, M.B. Burke, Assessing risks of climate variability and climate change for Indonesian rice agriculture. *Proceedings of the National Academy of Sciences of the United States of America* 104:7752-7757.
- Nurfadilah, A.P. 2017. Analisis rantai pasok dan rantai nilai pada jeruk pabelan. makassar: universitas hasanuddin Vol.7.
- Phillips, J., A. Durand-Morat, L. L. Nalley, E. Graterol, M. Bonatti, K. Loaiza de la Pava, S. Urioste and W. Yang. 2024. Understanding demand for broken rice and its potential food security implications in colombia. *Journal of Agriculture and Food Research* Vol. 15.
- Priyatno, D. 2012. Belajar Cepat Olah Data Statistik dengan SPSS. Andi Offset. Yogyakarta.
- Rasyid, R.A. and L. Suzan. 2018. Pengaruh biaya promosi dan biaya distribusi terhadap penjualan (suatu studi pada perusahaan manufaktur sektor food and beverage yang terdaftar di Bursa Efek Indonesia 2012-2016). *Akrab Juara: Jurnal Ilmu-ilmu Sosial* 3:1-11.
- Sarjono, H. and J. Winda. 2011. SPSS vs Lisrel : Sebuah Pengantar, Aplikasi Untuk Riset, Salemba Empat, Jakarta
- Sepang, G.Y.M., R.J. Mandei and B.D. Caroline Pakasi. Manajemen rantai pasok beras di kecamatan kotamobagu selatan, kota kotamobagu. *Agri-Sosioekonomi* 13: 225-238.
- Sihombing, D.S. 2015. Analisis nilai tambah rantai pasokan beras di desa tatengan kecamatan pusomaen kabupaten



- minihasa tenggara. *Jurnal Emba Universitas Sam Ratu Langi Manado* 3:2303-1174.
- Sugiyono, 2011. *Metode penelitian kuantitatif, kualitatif dan r&d*. Bandung: Alfabet pp. 1-329.
- Susilowati, S.H. 2017. *Perdagangan antarpulau beras di provinsi sulawesi selatan*. *Jurnal Analisis Kebijakan Pertanian* 15:19-41.
- Talaviya, T., Dhara, S. Nivedita, P. Hiteshri and Y. Manan. 2020. *Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides*. *Artificial Intelligence in Agriculture* 4:58-73.
- Tashi, T., C. Dendup and N.S. Gyeltshen. 2022. *Rice self-sufficiency in Bhutan: an assessment*. *Asian Journal of Agricultural Extension, Economics & Sociology* pp. 18-28.
- Verma, D.K. and P.P. Srivastav. 2020. *Bioactive compounds of rice (Oryza sativa L.): Review on paradigm and its potential benefit in human health*. *Trends in Food Science & Technology* 97:355-365.
- Wang, J., Y.Y. Qiu, X.Y. Zhang, Z. Zhou, X. Han, Y. Zhou, L. Qin, K Liu, S.Y. Li, W.L. Wang, Y. Chen, J.C. Yang, L.J. Liu. 2023. *Increasing basal nitrogen fertilizer rate improves grain yield, quality and 2-acetyl-1-pyrroline in rice under wheat straw returning*. *Frontier Plant Science* 13:1099751.
- Wardani, C., J. Jamhari, S. Hardyastuti and A. Suryantini. 2019. *Kinerja ketahanan beras di Indonesia: Komparasi Jawa dan luar Jawa periode 2005-2017*, *Jurnal Ketahanan Nasional* Vol. 25.
- Widarjono, A. 2009. *Ekonometrika pengantar dan aplikasinya*. Edisi Ketiga. Ekonisia, Yogyakarta.
- Widyanti, A., I. Sunaryo and A.D. Kumalasari. 2014. *Mengurangi ketergantungan terhadap beras sebagai makanan pokok di Indonesia – pendekatan intervensi perilaku*, *Journal of the International Society for Southeast Asian Agricultural Sciences* 20:93-103.
- Yunus, E.N. 2018. *Memfaatkan kolaborasi rantai pasokan dalam mengejar inovasi radikal*. *Jurnal Internasional Ilmu Inovasi* 10:350-370.

