

PADDY PRICES, LAND AREA, AND RICE PRODUCTIVITY: WHO HAS THE GREATEST INFLUENCE ON FARMERS' EXCHANGE RATES IN CENTRAL JAVA (2014–2024)

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Abstract

This study aims to analyze the effect of paddy prices, land area, and rice productivity on the Farmer Exchange Rate (NTP) in Central Java Province during the period 2014–2024. The NTP is an important indicator of farmers' welfare, reflecting their purchasing power for goods and services, so understanding its determinants has strategic implications for agricultural policy and rural development. The study sample includes 10 rice-producing districts in Central Java, with annual panel data analyzed using Stata software. The analytical methods employed include panel data regression (Fixed Effect Model and Random Effect Model) to identify variables with dominant influence on the NTP. Initial estimation results indicate that paddy prices have a significant positive contribution to NTP increases, while land area and rice productivity also have an impact, though with varying levels of significance across districts. These findings indicate that stabilizing paddy prices is a key instrument in efforts to improve farmers' welfare in Central Java. This study recommends price policies that are more favorable to farmers, accompanied by interventions to increase productivity and sustainably protect agricultural land.

Keywords: Paddy prices, land area, rice productivity, farmer exchange rate, panel data, Central Java

INTRODUCTION

Rice farming plays a central role in Indonesia's economic structure and food security, including in Central Java Province. The Farmer's Exchange Rate (NTP) is an indicator of farmer welfare that shows their purchasing power for consumer goods and production costs (BPS Jateng, 2024). However, fluctuations in paddy prices, changes in land area due to land use conversion, and productivity dynamics often create uncertainty in farmers' incomes. NTP data for Central Java over the past decade shows varying trends across districts, raising questions about which factors most contribute to improvements in farmers' purchasing power.

A number of previous studies have examined the determinants of NTP and farmer welfare. For example, (Pramesti, 2024) found that harvest area has a negative effect on NTP, while production and GDP have a significant positive effect in Central Java during the 2014–2023 period. (Susetyaningtyas, 2023) showed that inflation does not significantly affect NTP, but paddy prices and the Farmer Card policy have a positive influence. Another study in Yogyakarta also confirmed that paddy prices have a significant positive contribution to NTP (Saridewi, 2021). Meanwhile, (Noviwiyanah & Yudhistira, 2024) emphasized the importance of rice field area in increasing food

production. (Khasanah & Gunanto, 2024) show that productivity and significant growth in paddy prices increase rice availability, although the area of harvest does not always have a positive impact. This study aims to analyze the impact of paddy prices on the Farmer's Exchange Rate (NTP) in ten rice-producing districts in Central Java during the period 2014–2024, while also examining the contribution of land area and rice productivity to the dynamics of NTP changes. Additionally, this study seeks to identify which variables have the most significant impact on improving farmers' welfare, thereby providing a basis for formulating more targeted agricultural policies.

However, there are still limited studies that simultaneously examine the effects of paddy prices, land area, and productivity on NTP using a multi-county panel data approach over a long period. This study aims to fill this gap, particularly in Central Java as one of the national rice granary provinces. Theoretically, this study contributes to expanding the literature on the determinants of the Farmer's Exchange Rate (NTP) by simultaneously combining output price variables, production inputs in the form of land area, and productivity through a panel data regression approach. This approach offers a more comprehensive perspective compared to most previous studies, which generally analyze one variable separately.

In practical terms, the findings of this study can be utilized by local governments and policymakers to design more targeted interventions, such as rice price stabilization policies or sustainable agricultural land protection programs. Additionally, the results of this study can serve as a reference for farmer support institutions in developing productivity enhancement strategies that are relevant and tailored to the characteristics of each region. The novelty explicitly highlighted in this study lies in the use of multi-county panel data over a long time span, from 2014 to 2024, to simultaneously analyze the effects of paddy prices, land area, and productivity on the Farmer's Exchange Rate (NTP). Additionally, this study emphasizes the identification of which variables are most dominant in determining farmer welfare—an approach that is still rarely done in studies at the district level in Central Java Province.

Preliminary estimates show that paddy prices have a positive and significant influence on increasing NTP. Meanwhile, land area and productivity also contribute, but the magnitude of the effect varies across districts. These findings underscore the importance of grain price stabilization and farmland protection policies as key strategies in improving farmers' welfare. Therefore, this study recommends that local governments ensure the stability of the basic price of grain through strengthening the role of Bulog and monitoring the supply chain. In addition, policy incentives are needed to reduce the rate of conversion of paddy fields and encourage the adoption of agricultural technology that can increase productivity evenly in rice centers.

The scope of this study includes panel data analysis of ten rice production center districts in Central Java during the period 2014-2024. The main variables analyzed include milled dry grain price, harvested land area, rice productivity, and NTP as the dependent variable. To test the relationship between variables, panel regression models with Fixed Effect and Random Effect approaches were used, so as to capture spatial and temporal variations in the data more accurately.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

Farmers' Exchange Rate Theory

The Farmers' Exchange Rate (NTP) is one of the indicators of farmers' welfare that describes the ratio between the price index received by farmers (I_t) and the price index paid by farmers (I_b) (Badan Pusat Statistik, 2023). If $NTP > 100$, it means that farmers are experiencing a real income surplus. Conversely, if $NTP < 100$, farmers' welfare is under pressure because consumption and production costs are higher than the selling price of agricultural products. This theory is relevant because it forms the basis for income protection policies for farmers in many developing countries (FAO, 2021).

The Impact of Paddy prices on NTP

The price of key commodities like paddy plays a significant role in determining the NTP. According to Simatupang and Timmer (2008), price volatility of rice and paddy in Indonesia directly impacts farmers' ability to meet their basic needs (Simatupang & Timmer, 2008). Recent research by Susetyaningtyas et al. (2023) found that rice paddy prices have a significant positive impact on the NTP of food crops in Central Java (Susetyaningtyas, 2023). Similarly, Saridewi (2021) shows that paddy producer prices are the main determinant of NTP in Yogyakarta. Consistent increases in paddy prices boost farmers' income and drive NTP above the equilibrium level (Saridewi, 2021). This study re-examines these findings in the context of Central Java by taking 10 samples of rice-producing districts during the period 2014–2024.

The Effect of Land Area on NTP

According to the economic theory of production, land area is an important input factor in determining agricultural output (Todaro & Smith, 2020). Noviwyanah and Yudhistira (2024) proved that an increase in the size of paddy fields contributed positively to the increase in food production. However, Pramesti (2024) found that in the context of NTP, the size of the harvest area has a significant negative effect due to land fragmentation and maintenance costs that are not proportional to the increase in selling prices. This shows that the impact of land area on NTP is not uniform and depends on the regional context.

The Effect of Productivity on NTP

Higher rice productivity increases output per hectare, resulting in higher potential income for farmers. FAO (2021) mentions productivity as an indicator of farmers' economic resilience. Research by Khasanah and Gunanto (2024) revealed that rice productivity growth is significantly positive for national food availability. However, in the context of NTP, productivity has not been studied much together with price and land area variables simultaneously. Increased rice productivity can mitigate the pressure of rising production costs and thus help maintain NTP at a stable level (FAO, 2021). This study explicitly examines the contribution of productivity in the multidistrict NTP calculation framework.

Hypothesis Formulation

Based on the economic theory of production, the theory of farmer welfare, and the results of previous research, the hypotheses developed are as follows:

H1: Paddy price has a significant positive effect on Farmer Exchange Rate in Central Java.

H2: Paddy land area has a significant effect on Farmer Exchange Rate in Central Java.

H3: Rice productivity has a significant positive effect on Farmer Exchange Rate in Central Java.

H4: Paddy price is the variable that has the most dominant influence on Farmer Exchange Rate compared to land area and productivity.

RESEARCH METHODS

Research Design

This study uses a quantitative design with a panel data approach. This approach was chosen because it allows researchers to study the dynamics of variable relationships between regions (districts) and between years simultaneously (Baltagi, 2021). The model used is panel data regression with Fixed Effect Model (FEM) and Random Effect Model (REM), as well as Chow and Hausman tests to determine the most appropriate model. This research design is explanatory because it aims to explain the effect of paddy prices, land area, and productivity on Farmer Exchange Rate (NTP).

Population and Sample

The study population was all districts/cities in Central Java Province which are rice production centers. The study took 10 districts of rice centers as the research sample. The sample selection was done purposively with the criteria that the district has complete NTP data available from 2014-2024 and districts that have a significant contribution to provincial rice production. The observation period covers 2014-2024 with a total of 110 panel data observations (10 districts × 11 years).

Data Collection Techniques and Instrument Development

The data used are secondary data, obtained from the Central Java Provincial Statistics Agency (data on NTP, milled dry grain prices, harvest areas, and productivity), the Central Java Provincial Agriculture Office (reports on production and harvest areas) and the Ministry of Agriculture's official publications. The data collection instrument was a panel data tabulation template designed to facilitate variable coding and processing with Stata. Data validation was conducted through cross-checking between sources and checking time series consistency. The variables used in this study are dependent variable Farmer Exchange Rate (NTP), independent variable: Paddy price (Rp/kg), Harvested land area (hectares), Paddy productivity (quintals/ha).

Data Analysis Techniques

Data analysis was carried out in the following stages:

- Descriptive Test Displays the average, standard deviation, minimum, and maximum of each variable.
- Panel Data Regression Test The main analysis was carried out using Stata 17 with the following model specifications:

$$\text{NTP}_{it} = \alpha + \beta_1 \text{Paddy price}_{it} + \beta_2 \text{Paddy land area}_{it} + \beta_3 \text{Rice productivity}_{it} + \varepsilon_{it}$$

Description :

- **NTP_{it}** = Farmer Exchange Rate in district *i* and year *t*
- **Paddy price_{it} Paddy land area_{it} Rice productivity_{it}** = independent variable
- **ε_{it}** = error term

Testing steps: Descriptive statistics test, Common Effect, Fixed Effect, and Random Effect Model estimation, Chow, Breusch-Pagan, and Hausman tests for best model selection, Multicollinearity test using VIF, Final estimation using the selected model with standard errors clustered at the district unit.

RESULTS AND DISCUSSION

This study aims to identify which variables among grain prices, harvested land area, and rice productivity have the most influence on Farmer Exchange Rate (NTP) in Central Java Province during 2014-2024. The selection of the best panel regression model is done through a series of statistical tests, including the Lagrange Multiplier Breusch-Pagan test, the F test for individual effects, and the Hausman test.

The test results show that the Fixed Effect Model (FEM) is the most appropriate to explain the inter-temporal and inter-district variations in this study. This is evidenced by the prob > chi² value in the Hausman test of 0.0021 (see Table 1), which indicates that there is a systematic difference between the Random Effect and Fixed Effect models, so the assumption of independence between individual effects and regressors is not met. Therefore, FEM was selected for further analysis.

Table 1. Hausman Test Results

Variable	Coefficient FEM	Coefficient REM	Difference	Std. Error
PaddyPrice	0,0055705	0,0055663	0,0000042	0,0001421
landarea	-0,0000981	-0,0000161	-0,0000820	0,0000402
productivity	-0,1365062	-0,1231906	-0,0133156	0,0430702
Prob > chi ² = 0,0021 (significant)				

Source: Stata data processing results

With the FEM model, the regression estimation results show that the price of paddy has the most significant influence on NTP. The coefficient of 0.00557 with significance at the 1% level ($p = 0.000$), indicates that every Rp100/kg increase in grain price will increase NTP by 0.557 points, assuming other variables are constant.

In contrast, the land area variable shows a negative effect of -0.0000981 and is significant at the 5% level ($p = 0.017$), while rice productivity has a negative effect of -0.1365 but is not significant ($p = 0.106$). A summary of the FEM estimation results is presented in Table 2.

Table 2.

Fixed Effect Model (FEM) Estimation Results

Variable	Coefficient	Std. Error	t	P> t	95% Conf. Interval
PaddyPrice	0,0055705	0,0004045	13,77	0,000	[0,0047677 0,0063733]
landarea	-0,0000981	0,0000405	-2,42	0,017	[-0,0001785 -0,0000178]
productivity	-0,1365062	0,0836399	-1,63	0,106	[-0,3025082 0,0294958]
_cons	92,11294	5,685608	16,20	0,000	[80,82858 103,3973]

Source: Stata data processing results

This result clearly shows that grain price is the dominant variable affecting farmers' welfare, as reflected in the farmer exchange rate. This finding reinforces the relative income theory proposed by Schultz and development economists, that an increase in the price of agricultural products has a direct effect on increasing farmers' purchasing power, more so than an increase in the quantity of production (Todaro & Smith, 2020).

This finding is also consistent with the results of an empirical study by Sari et al. (2022) which shows that grain price is the main determinant of NTP in rice production centers in Indonesia. In the study, the sensitivity of NTP to price fluctuations was much greater than the productivity or land area variables.

In contrast, the finding that land area has a negative and significant effect seems to indicate that the expansion of planting area is not always directly proportional to the increase in farmers' real income. This can occur due to increased management costs, higher risk of crop failure, and a yield sharing or land rental system that reduces farmers' net margins.

The insignificant productivity of rice provides an indication that an increase in the quantity of yields does not necessarily guarantee welfare if it is not followed by a fair distribution and price mechanism. Even in surplus conditions, such as the main harvest season, grain prices tend to decline and depress NTP. This is known as the production surplus paradox, which often occurs in the Indonesian agricultural sector.

Table 3. Economic Interpretation of Regression Results

Variable	Coefficient	Economic Interpretation
PaddyPrice	+0,0056	Rp100/kg increase in grain price →NTP rises ±0.56 points
landarea	-0,0000981	Additional 1 ha →potential decrease in NTP, related to cost/risk burden
productivity	-0,1365	Productivity increase→NTP decrease (not significant), indication of over-supply

Source: Stata data processing results

From a policy perspective, these results emphasize that price stabilization mechanisms through instruments such as government purchase prices, strengthening food SOEs, as well as facilitating market access and distribution, are far more urgent than simply encouraging productivity increases or land expansion. Farmers' welfare will increase if their bargaining power over prices can be improved - whether through cooperatives, contract farming schemes, or the use of digital platforms for trading agricultural products.

With an R^2 within of 0.71, the model is able to explain 71% of the variation in NTP over time within each district, indicating that the variables used are strong enough to explain the dynamics of farmer welfare in Central Java over the past decade.

CONCLUSION

This study aims to analyze the effect of harvested paddy price, harvested land area, and rice productivity on Farmer Exchange Rate (NTP) in Central Java Province during the period 2014-2024. Based on the results of statistical tests and selection of the best model, the Fixed Effect Model (FEM) proved to be the most suitable model for estimating the relationship between variables, with a $prob > chi^2$ value in the Hausman test of 0.0021.

The estimation results show that grain price is the most significant and dominant variable in influencing NTP. Every Rp100/kg increase in price has the potential to increase NTP by 0.56 points. In contrast, land area has a negative and significant effect, indicating that the expansion of planting area does not always improve farmers' welfare. Meanwhile, rice productivity has a negative but insignificant effect, which may reflect the surplus paradox, where an increase in yield is not followed by an increase in farmers' income.

This study suggests that price stabilization policies, such as price ceiling, strengthening the role of food SOEs, and better access to distribution, are more effective in improving farmers' welfare than simply encouraging productivity or land expansion. Strengthening farmers' bargaining power through cooperatives, contract farming and trade digitization is also important.

However, this study is limited to the Central Java region and only covers the three main variables, without considering other factors such as subsidies, infrastructure, or access to finance. The assumption of constancy between variables and the absence of consideration of seasonal and climatic factors are also limitations. For future research, it is recommended to expand the study area, add relevant variables, use a dynamic panel approach, and consider external factors such as climate and global prices. A qualitative approach can also be added to enrich the understanding of farmers' conditions.

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