

Rice marketing margins in Rio Grande do Sul: effects of the covid-19 pandemic

Margens de comercialização do arroz no Rio Grande do Sul: efeitos da pandemia de Covid-19

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ABSTRACT: This study aimed to analyze the marketing margins for rice in Rio Grande do Sul between 2015 and 2024 to understand the impact of the pandemic on the margins of different links in the production chain. A survey was conducted to collect secondary data to achieve the proposed objective: a) Prices paid per bag of rice to producers and b) Prices paid by rice consumers. The marketing margin was calculated for data analysis, graphical representations were produced, frequency distributions were calculated, and linear regression analysis was performed to assess structural change. The results showed that the COVID-19 pandemic caused significant changes in rice marketing margins in Rio Grande do Sul. Real growth also occurred in the producer's margin, indicating appreciation across all links in the chain. The results showed that, while prices remained stable in the pre-pandemic period, from 2020 onwards, there was consistent growth in the prices paid to producers and consumers.

Keywords: Agricultural economics; Agricultural markets; Agricultural prices; Rice farming.

RESUMO: O objetivo do estudo foi analisar as margens de comercialização do Arroz no Rio Grande do Sul entre os anos de 2015 e 2024, a fim de compreender o impacto da pandemia nas margens de diferentes elos da cadeia produtiva. Para atender ao objetivo proposto, realizou-se uma pesquisa por meio de levantamento e de coleta de dados secundários: a) Preços pagos pela saca de arroz ao produtor e; b) Preços pagos pelo consumidor de arroz. Para a análise dos dados, realizou-se o cálculo da margem de comercialização, representações gráficas, distribuições de frequência e análise de regressão linear para avaliação de mudança estrutural. Os resultados evidenciaram que a pandemia da Covid-19 provocou alterações significativas nas margens de comercialização do arroz no Rio Grande do Sul. O crescimento real também se deu na margem ao produtor, indicando valorização entre todos os elos da cadeia. Os resultados demonstraram que, enquanto no período pré-pandemia os preços se mantinham estáveis, a partir de 2020 observou-se um crescimento consistente nos preços pagos ao produtor e ao consumidor.

Palavras-chave: Economia rural; Mercados agrícolas; Oricultura; Preços agrícolas.

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1 INTRODUCTION

Rice is central to global food security, being the staple food for more than half of the world's population. Second only to wheat and corn, rice plays a strategic role in both combating hunger and in the socioeconomic stability of several nations, especially in developing countries (FAO, 2022; García *et al.*, 2021).

From an economic and political point of view, rice is more than just an agricultural product: it is an essential commodity whose supply is directly linked to the stability of governments and the prevention of social crises. According to the Food and Agriculture Organization of the United Nations (FAO, 2022), about 90% of global rice production and consumption is concentrated in Asia, especially in China, India, Indonesia, Vietnam, and Bangladesh, making the crop a pillar of the region's agricultural economies.

From an international trade perspective, rice has distinct characteristics from other commodities. While products such as soybeans, corn, and wheat are widely traded globally, the rice market tends to be more protected by tariff barriers and subsidies, given its direct link to domestic food security. This implies lower liquidity and greater volatility in international prices in times of crisis, as observed during the Covid-19 pandemic and, more recently, with extreme weather events in Asian countries (World Bank, 2023).

Rice production in Brazil plays an important role in domestic supply and the development of certain agricultural regions. Although the country is not among the world's largest exporters, rice is a strategic crop for food security and strengthening family farming in several regions. Brazil is self-sufficient in grain production and occupies a prominent position in Latin America, accounting for about 70% of Mercosur's rice production (EMBRAPA, 2022).

The rice production chain involves various agents, producers, cooperatives, processors, and distributors—whose coordination is essential to ensure domestic and foreign supply. The production chain in Brazil is marked by significant regional concentration. The South and Midwest regions are the main production centers, with the state of Rio Grande do Sul standing out, accounting for about 70% to 75% of the national production of paddy rice (IBGE, 2024). The predominant use of advanced technologies and the irrigated cultivation system guarantee high productivity rates for the state, making it a national benchmark in the sector.

Climate, public policies, production costs, and international competition affect the Brazilian rice market. Neighbouring countries produce the grain at lower costs, compromising the competitiveness of Brazilian products and putting pressure on the marketing margin, which is often lower than other commodities (Sato; Reis, 2022). In 2024, domestic prices rose by more than 30% in the year's first half, driven by crop failures and high input costs (CEPEA, 2024).

The Covid-19 pandemic caused profound changes in this dynamic. There was an increase in demand for basic products, such as rice, leading to shortages in some regions and higher domestic prices (IPEA, 2021). The impacts extended into the following years due to the disruption of logistics chains, shortages of inputs, and higher production costs - as in the case of fertilizers, which rose more than 80% between 2020 and 2022 (IPEA, 2023). Even with the partial resumption of trade flows, exchange rate instability and logistics costs kept pressure on producers.

The marketing margin, defined as the difference between prices at different links in the production chain, was directly affected. The health crisis altered the bargaining power between agents, causing fluctuations in producer and consumer prices. However, there is still a gap in our understanding of the real impacts of the COVID-19 pandemic on the behaviour of marketing margins along the chain in Rio Grande do Sul, the central producing state.

Given this scenario, this study aimed to analyze the effects of the pandemic on rice prices and marketing margins in Rio Grande do Sul between 2015 and 2024. The investigation identified trends and possible structural changes in the rice sector, contributing to understanding the economic challenges faced by this production chain in the recent period.

2 MATERIALS AND METHODS

The research was descriptive, with a quantitative approach, using the survey method. The secondary data survey consisted of: a) prices paid to rice producers in Rio Grande do Sul, data extracted from the database of the Institute of Technical Assistance and Rural Extension (EMATER/RS, 2024) from June 2015 to December 2024, and b) prices paid by end consumers of the product were extracted from the Center for Economic Studies and Research database (IEPE/UFRGS, 2024) from June 2015 to December 2024.

This period was chosen because we needed to analyze a balanced number of observations before and after the start of the COVID-19 pandemic. That is, 57 months before and 58 months after March 2020, the month declared by the World Health Organization (WHO) as the start of the pandemic. After collection, the data were grouped and organized into spreadsheets for analysis.

The data analysis techniques were calculating the marketing margin, graphical representations, frequency distributions, and linear regression analysis to assess structural change. The marketing margin was calculated using Equations 1 and 2 presented by Santana (2005):

$$MC = \frac{P_v - P_p}{P_v} \quad (1)$$

$$MP = 100 - MC \quad (2)$$

Where: MC = marketing margin; MP = producer margin; P_v = retail price (to the consumer); P_p = price paid to the producer.

For a descriptive and graphical analysis over time, the nominal values of the marketing margin and prices paid to producers were adjusted for inflation using the General Price Index – Domestic Availability (IGP-DI), calculated by the Getúlio Vargas Foundation (FGV). This index is structured to capture the general movement of prices covering the entire production process, from agricultural raw material prices to intermediate product prices and final goods and services.

The IGP-DI updated the values for December 2024 (FGV, 2024). In turn, the nominal prices paid by consumers were adjusted for inflation using the Broad National Consumer Price Index (IPCA), calculated by the Brazilian Institute of Geography and Statistics (IBGE). The index aims to measure inflation for a set of products and services sold at retail related to the personal consumption of households with incomes ranging from 1 to 40 minimum wages. Thus, the prices paid by rice consumers were updated by the IPCA for December 2024 (IBGE, 2024).

The study then moves on to the third analysis technique to verify the impact of the COVID-19 pandemic on price and margin variables. According to Viana e Waquil (2013), models with independent dummy variables can be used in time series to identify variations in the intercepts and slopes of a function, allowing the discovery of structural changes. Thus, equation 1 presents the model that verified the presence (or absence) of structural change in prices and marketing margins in the Rio Grande do Sul rice chain with the onset of the pandemic. Thus, the multiple regression model (equation 3) was adjusted:

$$Y_i = \beta_0 + \beta_1 Time + \beta_2 Pandemic + \beta_3 Time.Pandemic + \varepsilon_i \quad (3)$$

Where: Y_i is the price paid to the producer; price paid by the consumer and marketing margin; β_0 is the intersection parameter; β_1 , β_2 , and β_3 are the slope parameters; Time is the unit of the historical series, in months, represented by the numbers 0,1,2, ...; Pandemic is the dummy variable for structural change, according to the health crisis (0=before; 1=after).

Pandemic is the interaction variable (time and pandemic for slope differences), and ε_i is the residual. Calculating the intersection and slope coefficients before and after the pandemic allowed us to assess a possible structural change in the variables, as shown in Equations 4 (before the pandemic) and 5 (after the pandemic).

$$Y \text{ Before the pandemic} = \beta_0 + \beta_1 Time + \beta_2 .0 + \beta_3 Time.0 = Y \text{ Before the pandemic} = \beta_0 + \beta_1 Time \quad (4)$$

$$Y \text{ After the pandemic} = \beta_0 + \beta_1 Time + \beta_2 .1 + \beta_3 Time .1 = Y \text{ After the pandemic} = (\beta_0 + \beta_2) + (\beta_1 + \beta_3) Time \quad (5)$$

Before the crisis, β_0 comprises the intersection, and the trend of the price variable and marketing margin refers to parameter β_1 . After the health crisis, the intersection is represented by $(\beta_0 + \beta_2)$, and the trends in prices and marketing margin refer to $(\beta_1 + \beta_3)$. When the slope of a variable changes, it indicates that there will be a structural change in the variables with the advent of the pandemic.

Thus, the analyses seek to ascertain whether the coronavirus pandemic has caused significant changes in the trajectory of variables related to rice prices and marketing margins. The Student's t-test verified trajectory changes at a maximum significance level of 5%.

To complement the analyses of the trends in the variables and the structural change, it was possible to verify the variations in prices and marketing margins by estimating the semi-logarithm (semi-log). The application of semi-log regression allows the interpretation of the coefficients in the form of monthly variation rates, based on the notation of Viana and Waquil (2013), enabling a comparison of behaviour according to Equations 6 (before the crisis) and 7 (after the crisis).

$$\% \Delta Y \text{ Before the pandemic} \approx (100 \cdot \beta_1) \Delta \text{time} \quad (6)$$

$$\% \Delta Y \text{ After the pandemic} \approx 100 (\beta_1 + \beta_3) \Delta \text{time} \quad (7)$$

Data analysis was conducted on the Julius AI platform using Python software (version 3.x), utilizing Pandas libraries for data manipulation and Matplotlib for graphical visualization (McKinney, 2010; Hunter, 2007). Time series and graphical representations were constructed to observe behaviour patterns over the period. Marketing margins were analyzed at different times to observe significant variations associated with the COVID-19 pandemic. Including an extended analysis period provides a broader view of the market structure and prices in the rice sector.

3 RESULTS AND DISCUSSION

The analysis of rice marketing margins in Rio Grande do Sul from June 2015 to December 2024 revealed significant changes over time, especially during the COVID-19 pandemic. The marketing margin (MM), the difference between consumer and producer prices, was analyzed in absolute and relative terms (MM %), adjusting prices by the IPCA and IGP-DI indices.

At the beginning of the time series, in 2015, the relative marketing margin was around 70 to 75%, indicating a considerable difference between the prices paid by consumers and those received by producers. This margin remained relatively stable until the end of 2019, reflecting a consolidated and standardized marketing structure, as shown in Figure 1.

With the arrival of the pandemic in 2020, consumer prices sharply rose, particularly between April and September 2020, when demand for basic foodstuffs grew significantly due to the fragile state of the market. The adjusted consumer price exceeded R\$6.00/kg in constant values. However, the proportional increase in producer prices did not follow suit, leading to widening marketing margins.

Starting in 2022, there is a trend toward a return to normal margins, with a gradual reduction in the difference between consumer and producer prices. Even so, margins remain slightly above pre-pandemic levels. This behaviour may indicate a restructuring in how the rice market has been operating or delayed effects of shocks that occurred during the health crisis, as shown in Table 1.

Table 1 shows that the marketing margin for rice decreased in the post-pandemic period. In turn, the producer margin grew by 16.78%, indicating a more substantial increase in the price paid to producers than that paid by consumers from 2020 to 2024.

Even so, post-pandemic, the rice chain's downstream sector retained approximately 70% of the value paid by consumers, with 30% going to the upstream sector (production and inputs). Table 2 presents the semi-log regression to assess structural changes in rice marketing margins in Rio Grande do Sul.

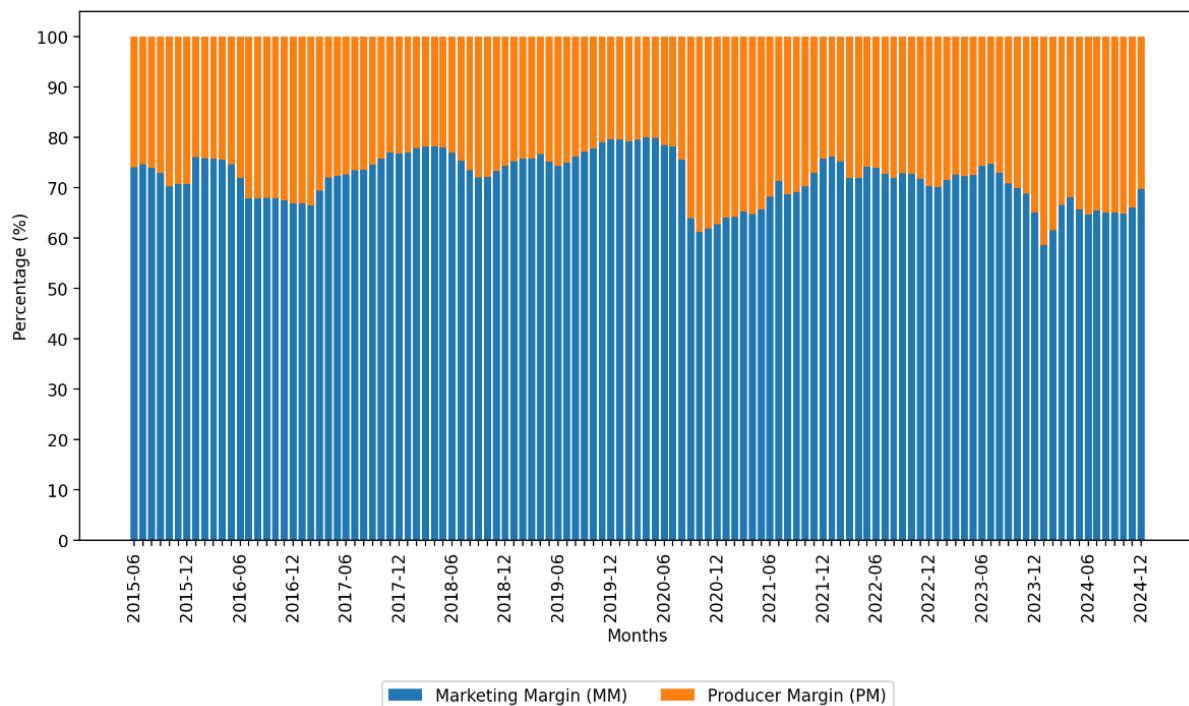


Figure 1. Behavior of the marketing margin in the Rio Grande do Sul rice chain from 2015 to 2024

Table 1. Marketing margin (MM) and producer margin (PM) for Rio Grande do Sul rice before and after the COVID-19 pandemic

Period	MM (%)	PM (%)
Before the pandemic	74.12	25.88
After the pandemic	69.78	30.22
Variation (%)	-5.86	16.78

Table 2. Semi-log regression coefficients ($\ln Y_t$) for trend and structural change in the rice marketing margin in Rio Grande do Sul from 2015 to 2024

Parameter	Coefficient	Standard error	Statistic t	p-value
Constant	1.0893	0.0325	33.44	0.0000
Time	-0.0002	0.0009	-0.3054	0.7606
Pandemic	-0.0994	0.0931	-1.0671	0.2882
Time x Pandemic	0.0045	0.0013	3.3073	0.0012

Before the pandemic, the sales margin remained stable, with no statistically significant variations. However, a significant growth rate of approximately 0.43% per month was identified after the pandemic. This structural change indicates that, after the onset of the pandemic, there was a continuous increase in the chain's marketing margins. This means a steady increase in margins, expanding the market value of the product. This fact has made rice a more expensive product on the consumer's table, significantly

impacting inflation in Brazil. The historical series of producer and consumer prices are shown in Figure 2.

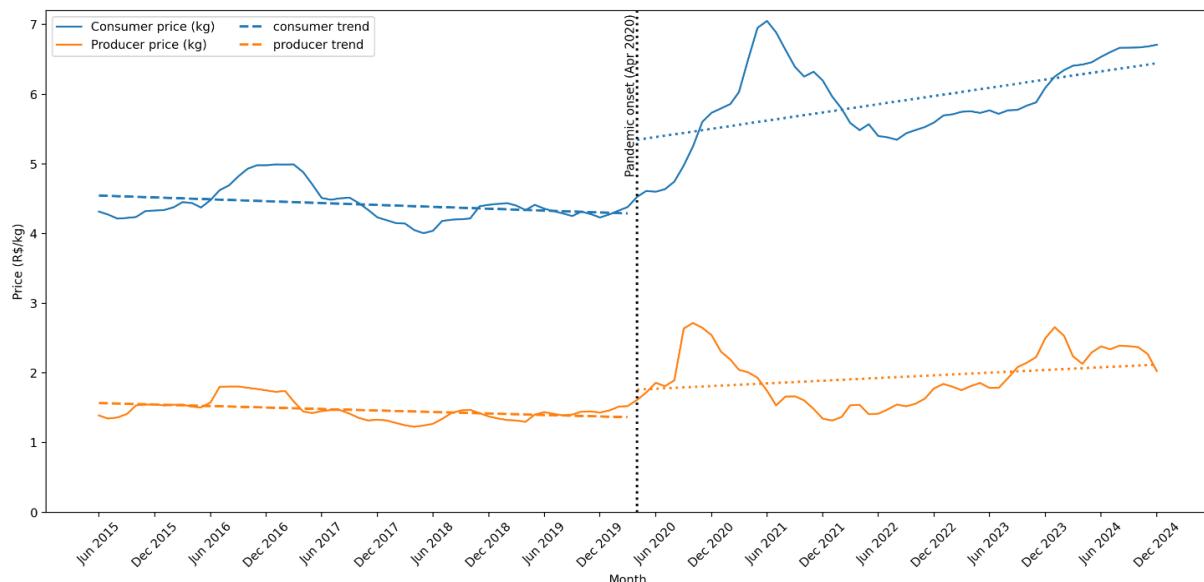


Figure 2. Evolution of producer and consumer prices for rice in Rio Grande do Sul (2015- 2024)

The trends observed confirm the hypothesis that the pandemic significantly impacted the rice production chain, temporarily altering how value is distributed among the links in the chain. Significant trends are confirmed by the regression models presented in Tables 3 and 4. A sharp price increase in the second half of 2020 was driven by increased global cereal consumption during the pandemic. The increase in consumer prices was more persistent, lasting until mid-2021. Meanwhile, the rise in producer prices dissipated more quickly, reversing the upward trend by the end of 2020.

However, from the end of 2021, producer prices grew persistently until the end of 2024 due to the global rice stock crisis. Table 3 presents the semi-log regression to assess structural changes in the prices paid by rice consumers in Rio Grande do Sul.

Table 3. Semi-log regression coefficients ($\ln Y_t$) for trend and structural change in prices paid by rice consumers in Rio Grande do Sul from 2015 to 2024

Parameter	Coefficient	Standard error	Statistic t	p-value
Constant	1.5132	0.0201	75.3155	0.0000
Time	-0.001	0.0006	-1.6704	0.0977
Pandemic	-0.0528	0.0575	-0.9188	0.3602
Time x Pandemic	0.0045	0.0008	5.3378	0.0000

The results indicate that, before the pandemic, consumer prices showed a slight downward trend (-0.10% per month), although this was not statistically significant. After the onset of the pandemic, this trend reversed, and prices began to rise significantly at a rate of 0.35% per month ($p<0.01$). The interaction coefficient between time and the pandemic is positive and statistically significant, evidencing a change in the trajectory of consumer prices, which began to reflect more intense inflationary pressures in the

pandemic context. Table 4 presents the semi-log regression to assess the structural change in prices paid to Rio Grande do Sul rice producers.

Table 4. Semi-log regression coefficients (lnYt) for trend and structural change in prices paid to Rio Grande do Sul rice producers from 2015 to 2024

Parameter	Coefficient	Standard error	Statistic t	p-value
Constant	0.4466	0.0404	11.0515	0.0000
Time	-0.0023	0.0012	-1.9625	0.0522
Pandemic	-0.1042	0.1156	-0.9015	0.3693
Time x Pandemic	0.0058	0.0017	3.3909	0.001

Similarly, prices paid to producers showed a slight downward trend (0.23% for the period) before the pandemic, with virtually stable behaviour. After the onset of the pandemic, the trend reversed, with growth of around 0.35% per month ($p<0.01$). This similar behaviour between producers and consumers after the pandemic indicates efficient price transmission throughout the production chain.

The joint analysis of the results for producer and consumer prices shows that both exhibited similar long-term growth behaviour after the pandemic, indicating full-price transmission in the rice production chain during the pandemic.

In this context, Chen and Zhao (2023) examined the volume and value of rice trade between 2000 and 2021, highlighting that during the pandemic, there were restrictions and suspensions on exports, which raised international prices. According to the authors, since 2020, there has been an increase in production costs (seeds, fertilizers, fuels), putting pressure on producers' incomes and affecting incentives but highlighting the need for stable supply chains for post-pandemic recovery.

Regarding the rice supply chain, authors Rosyadi and Wijaya (2024) analyzed uncertainty in the supply chain before (2017–2019) and after the pandemic (2020–2022) in six agricultural cooperatives spread across large islands in Indonesia. The results indicated that the rice chain was affected by labor and input shortages, logistics delays, and limited access to machinery or energy. Furthermore, disruptions due to health restrictions and difficulties in distributing the final product resulted in a drop in sales and an increase in price and lower availability of rice, requiring better systemic integration and governance (Rosyadi; Wijaya, 2024).

Studies conducted by Wei and Zhou (2025) investigated the resilience of basic food trade networks (including rice) from 1986 to 2022. They concluded that diversification of trading partners and flows is crucial for global food security and highlighted the rice trade as one requiring greater strategic attention.

In Brazil, research by Embrapa (2020) on household consumption of rice and beans during the pandemic showed that consumption remained stable, with no major supply difficulties. Price increases were mainly attributed to high demand and inelastic supply. As rice is one of the commodities sensitive to climate change, previous episodes have been associated with reductions of 4 to 11% in rice productivity (Mamun; Glauber, 2023). In addition, trade restrictions and related policies, such as export bans and licensing requirements, have contributed to the increase in global rice prices.

Therefore, a significant statistical effect in the interaction between weather and the pandemic shows an apparent change in how prices and margins behaved after the

pandemic began. The Covid-19 pandemic marked a turning point in the rice market, changing the trends of the previous period for the rice chain in Rio Grande do Sul. As Rio Grande do Sul is the leading Brazilian producer, the results are derived from the behaviour of the rice market in Brazil and its relationship with the health crisis faced.

4 CONCLUSION

This study revealed that the COVID-19 pandemic significantly altered rice marketing margins in Rio Grande do Sul. Margins expanded during the pandemic, with notable real growth in producers' earnings, reflecting increased value across the supply chain. While prices and margins were stable before 2020, both rose consistently afterwards. These changes result from the health crisis and the production chain's adaptation to shifting costs, consumer demand, and logistical conditions, highlighting the pandemic's broad economic impact on agricultural markets.

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