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Asymmetric price transmission in the commercialization of rice in Brazil

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Abstract. This paper aims to investigate the presence of price transfer asymmetry (APT) in the rice production chain in Rio Grande do Sul incorporating in the analysis the effects of public policy interventions, specifically the agricultural minimum prices. The results indicate the occurrence of positive APT among all relations analyzed (contemporaneous, lagged or cumulative) in the rice production chain. In general, the industry-producer relationship presented the best adjustment and the existence of positive asymmetry indicates that this market link takes advantage of the direct relationship with the producer to pass through price increases more quickly reductions to its consumers. Finally, it was identified that in periods of market prices below the minimum price, the asymmetry was not rejected, indicating its permanence in times of greater government intervention.

Keywords: price transmission, minimum prices, rice market.
JEL codes: L11, L66, L81.

1. INTRODUCTION

Researchers of the agricultural sector have struggled to understand the phenomenon of asymmetric price transmission (APT) in the vertical structure of production chains. The traditional economic theory does not predict or explain APT occurrence (Meyer, Von Cramon Taubadel, 2004). When relating price transmission symmetry to perfect competition, the theory does not explain whether asymmetry is due to imperfect competition, market failures, or both (Lloyd, 2017). Moreover, the prevalence of an asymmetric response in price transmission can be interpreted as a gap in the economic theory (Peltzman, 2000). Thus, the diagnosis of the factors that induce APT and political implications of this phenomenon remain unclear. In addition, the deepening of issues related to the APT occurrence may provide a better understanding of the connection between the vertical links of a supply chain or market.

This study investigates occurrence of APT between the links of the rice supply chain in Rio Grande do Sul, Brazil, using monthly data from January 2003 to December 2018. In the literature on the rice market, the results of Aguiar and Figueiredo (2011) study indicate the occurrence of APT, given that increases in wholesale prices were transmitted more quickly than price decreases by the retail sector. That said, if there is APT in this market, two specific objectives are follow: i) to evaluate whether asymmetry in price transmission occurs contemporaneously or if there are lags in the process, ii) to evaluate whether the policy of minimum prices and its relationship with price practiced in the Rio Grande do Sul market had an impact on price transmission in the rice supply chain.

The original contribution of this study is the adaptation of the baseline method of diagnosing the occurrence of APT in a supply chain to incorporate the effects of government intervention into the analysis, such as the minimum price policy. The pioneering work of Kinnucan and Forker (1987) indicated government interventions as a source of asymmetry in support of producer prices. However, the methodological framework used by the authors did not incorporate this variable into the analysis.

Depending on how political intervention is carried out, it can either reduce the problem or cause distortions within the market. In the analysis of APT, political intervention means the policy of minimum prices, implemented at a federal level, but with important regional implications for the rice market. In this context, the geographic scope of the analysis was chosen due to the productive, agricultural and industrial concentration of the rice sector in Rio Grande do Sul. Both extreme climatic events such as prolonged floods or droughts, as well as decoupling between the prices practiced in this region and the minimum prices causing important economic impacts on this productive sector.

In short, in the presence of APT, price decreases for producers are not passed on to consumers in the same way as price increases are. For Meyer and Von Cramon Taubadel (2004), the occurrence of APT that results from market power, there is not only a transfer of welfare between agents, but also a welfare net loss, favoring political intervention. Although the relationship between market power and APT is widely analyzed by literature, the study of political interventions that cause shifts in characteristics of price changes (size and timing) is still considered a lag of knowledge.

This article comprises this introduction and a literature review on APT. The data analyses on the national and regional markets for rice justify the choice of the relevant market for the study. In the following section, the research methodological aspects are presented, followed by a description of the data used. Afterwards, the analysis and discussion of the results are carried out to present the main considerations, implications and limitations of the study.

2. THE MODEL OF ASYMMETRIC PRICE TRANSMISSION (APT)

The asymmetric price transmission (APT) model in food and agricultural markets has been developed based on the premise that in the absence of market imperfections, there is a symmetrical price adjustment at market level and changes in cost inputs, at the antecedent market level (Kinnucan, Forker, 1987). Thus, asymmetry occurs if certain groups or links in a supply chain have advantages (increased profits or markup) by transmitting price increases with more intensity (and/or magnitude) than decreases (Meyer, Von Cramon Taubadel, 2004) or when price decreases are more readily passed on to subsequent supply chain segments (Ward, 1982).

The construction of the concept of asymmetric transmission of prices, which is currently diversified in terms of scope of analyses and methodologies used, dates back to the 1970s with the theoretical contributions of Gardner (1975) and methodological input of Tweeten and Quance (1969). The Gardner (1975) approach focused on equilibrium or interdependent relations (regarding demand derived) and formation of mark-up between the vertical links of a perfectly competitive productive chain. When analyzing price elasticity of demand and price volatility between farm and retail price levels, the author showed that exogenous shocks could propagate asymmetrically between the links of a production chain.

Methodologically, in order to analyze demand elasticity, Tweeten and Quance (1969) created a partition technique of each price series into its increasing and decreasing components. With the methodological improvements of Wolfram (1971) and Houck (1977), this technique is used to evaluate the presence and magnitude of price transfer asymmetry (APT) between different links in a productive chain, especially in the agricultural sector. Moreover, methodological advances presented by Engle and Granger (1987), which established duality between cointegration and error correction, provided a new momentum to studies on APT (Lloyd, 2017).

In turn, Von Cramon Taubadel (1998) proposed a modification in the Wolfram-Houck specification to include the error term into the analysis. Recent developments expand the methodological scope to five main groups of analysis: Autoregressive Distributed Lag Model (ARDL), Partial Adjustment Model (PAM), Error Correction Model (ECM), Regime Switching Models (RSM) and their multivariate extensions (Frey, Manera, 2007).

In terms of factors that induce APT, the association between market power and APT becomes recurrent in the literature. In more concentrated markets, asymmetry may be associated to differences in information assimilation level in each link of the production chain (Ward, 1982), the exercise of market power in storage stages, transport, the processing of agricultural products (Kinnucan, Forker, 1987), vertical integration (Bernard, Willett, 1996) and price research costs in imperfect competitive markets (Miller, Hayenga, 2001). In addition, other APT sources commonly identified in the literature include product perishability (Ward, 1982), government interventions, such as price support and marketing quotas (Kinnucan, Forker, 1987), menu costs (Bailey, Brorsen, 1989), degree of organization of rural producers (Aguiar, Santana, 2002), positive trend inflation (Ball, Mankiw, 1994), and the management of inventories (Meyer, Von Cramon Taubadel, 2004; Vavra, Goodwin, 2005), among others.

Thus, given the multiplicity of aspects related to asymmetric price transmission, literature on the subject begins to adopt different classification perspectives: magnitude and velocity, positive or negative and vertical or spatial (Meyer, Von Cramon Taubadel, 2004). In terms of time, there are short-term analyses, most suitable to identify if asymmetry is positive or negative, as well as the long-term approach, more suitable for evaluating the adjustment speed (Frey, Manera, 2007).

Regarding empirical studies, seminal studies that identified APT occurrence were performed in the United States. Among the main markets analyzed in that country are the vegetable market (Ward, 1982), dairy market (Awokuse, Wang, 2009; Capps, Sherwell, 2007; Hahn, Stewart, Blayney, Davis, 2016; Kinnucan, Forker, 1987), beef market (Goodwin, Holt, 1999) and chicken meat (Bernard, Willett, 1996).

In the international scenario, APT occurrence was also identified for the vegetable market in the Netherlands (Verreth, Emvalomatis, Bunte, Kemp, Oude Lansink, 2015), for the dairy market in Brazil (Azevedo, Politi, 2008) and Panama (Acosta, Valdés, 2014), and the swine market in Australia (Griffith, Piggott, 1994), Germany (Von Cramon Taubadel, Loy, 1999) and China (Dong, Brown, Waldron, Zhang, 2018). APT was also identified in the grain and flour market in Zaire (Minten, Kyle, 2000) and South Africa (Cutts, Kirsten, 2006), the pistachio market in Iran (Moghaddasi, 2009), and the markets of table grapes (Alves, Tonin, Carrer, 2013), beans (Cunha, Wander, 2014) and ethanol (Santos, Aguiar, Figueiredo, 2015) in Brazil.

Among empirical studies few of them analyze APT for the rice market. Internationally, it was the case for the rice market in Togo, from 1991 to 2013, with the application of the TAR model, Irazou (2015) showed that international price shocks to domestic prices tend to confirm the existence of market power between intermediary links; therefore, preventing a better price transmission. In turn, Alam *et al.* (2016) studied the rice market in Bangladesh from 2002 to 2007 and reported that intermediaries (retailers) respond more quickly to price changes that reduce their margins than when the margins are expanded.

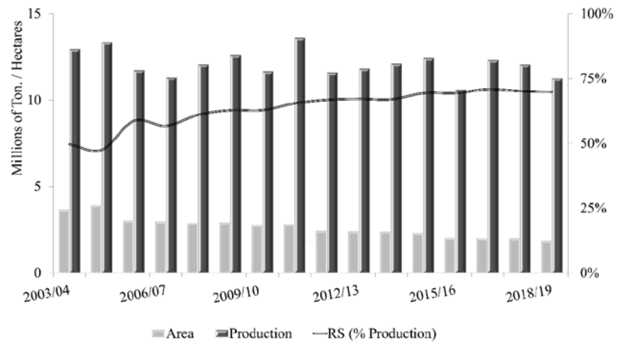
In the Brazilian rice market, we highlight the studies of Aguiar and Santana (2002) and Aguiar and Figueiredo (2011) who evaluated different food products and included rice in their analysis for the period between January 1989 and November 2008. Aguiar and Santana (2002) did not find APT between producers and retailers from 1987 to 1998, whereas Aguiar and Figueiredo (2011) report APT between wholesalers and retailers only in the short term, which indicated that increases in the wholesale price were transmitted by the retail sector more intensely than decreases, and in the wholesaler-producer relationship, APT was found in both the short and long terms. However, it appears that price decreases are transmitted more intensely than price increases in the wholesale market.

3. THE RICE MARKET IN BRAZIL AND RIO GRANDE DO SUL

In Brazil, between 2003/2004 and 2017/2018 crops, rice production amounted to 12 million tons, with a reduction of the cultivated area of 3.65 to 2 million hectares. Meanwhile, in Rio Grande do Sul, in an area of about 1 million hectares, the production of irrigated rice – thin, long and polished grains –increased from 6.4 to 8.5 million tons in the analyzed period. Because of the expansion of productivity over the last 15 harvests, the state of Rio Grande do Sul increased from 50% to 70% in national production (Fig. 1). The concentration of primary production has also led to concentration of industrialization, with Rio Grande do Sul accounting for 52% of the sales value of rice benefited by the Brazilian industry in 2016 (IBGE, 2019).

Between the 2003/2004 and 2017/2018 crops, important changes occurred in the national rice market, namely i) increased exports, from 92 to 1,400 thousand tons; ii) public invent or practically non existent

Fig. 1. Area planted and rice production in Brazil and participation (%) of Rio Grande do Sul in the national production, from 1997 to 2019.



Source: National Supply Company (CONAB, 2019a).

in 2003/2004, excess of 1.5 million tons in 2010/2011 and 2011/2012 crops, and then reaching a reduction of less than 100 thousand tons, recently. The private stock volume also reduced, but to a lesser extent, therefore, showed overall inventory reduction with increased participation of private stock of the total stocks in the country in recent years (Tab. A.1., Appendix).

The reduction in public inventories and the relative increase of private inventories results from the change in government activities in the market. Since the 1990s, with economic opening and monetary stabilization, there have been important changes in the different agricultural policy instruments (rural credit in the modality of funding, investment and commercialization, agricultural insurance, etc.), restructuring the Minimum Price Guarantee Policy (PGPM). This policy, although not mandatory, that is, not automatic, operates in several markets, such as rice, and its impacts are variable over time.

The PGPM has been redesigned to ensure reduced government intervention and costs, increasing storage and financing from the private sector (Rezende, 2000). In this context, government intervention during oversupply, made by purchase of production at the minimum guaranteed price for maintenance of regulatory inventory, such as the Acquisition of the Federal Government (AGF), is replaced by other commercialization instruments. In this new model, in the commercialization support instruments known as Prizes for Agricultural Product Flow (PEP) and the Equalizing Premium Paid to the Producer (PEPRO), subsidy is now given by the difference between the minimum and market prices. On the other hand, in instruments denominated Agricultural Products Selling Option Contract (COVPA) and Private Option Risk Premium (PROP), government actions resemble the policy of price insurance (Schwantes, Bacha, 2017).

In general, the government may a) directly purchase the production and stock it with the AGF, b) launch or encourage the private sector to create purchase options (COVPA, PROP) or c) offer subsidies to move the product to deficit regional markets (PEP, PEPRO). In any case, it is direct the importance of minimum price as an indicator of potential state intervention in the market. In other words, the level of minimum price (in comparison with the market price) increases government's chance to intervene in the market through the different support instruments mentioned.

Thus, in the last two decades, the PGPM has been reducing its magnitude and importance in the general context of the agricultural policy. However, rice is still among the crops most affected by this policy. Between 2003 and 2018, rice was the third largest agricultural product that received commercial aid from the Brazilian federal government, accounting for 2.5 billion of Reais or approximately 13% of the total spent, only after the wheat and corn crops (MAPA, 2019).

In the last two decades, government intervention has been concentrated mainly in the second half of the 2000s, with a peak in the 2011 crop, (Fig. A.1., Appendix) in which almost 3 million tons, of 13.6 million tons, were affected by some marketing instrument. In average terms, in the period 2001 to 2018, 4.3% of the rice crop benefited from some commercialization support of the federal government. Geographically, the state of Rio Grande do Sul accounted for 87% of the total amount of rice affected by marketing support instruments (MAPA, 2019). Still, in this environment of sectoral changes, reduction of public inventory, diversification of the instruments of commercialization support of agricultural products and increased participation of foreign trade are important to understand how price transmission between different links of the market place occurs.

4. EMPIRICAL STRATEGY

The theoretical approach to asymmetry price transmission (APT) adopted in this study is derived from the Engle and Granger (1987) approach, that is, it analyzes the vertical transmission of prices in a context of cointegration. In this sense, the relationship between prices is modeled by an error-correcting mechanism, following the adaptations of Von Cramon Taubadel and Loy (1999), Canêdo Pinheiro (2012), Jacomini and Burnquist (2018) and described by Frey and Manera (2007), according to equation (1):

$$\Delta p_{rt} = \alpha_0 + \sum_{k=1}^{K} \gamma_j \Delta p_{rt-j} + \sum_{J=0}^{J+} \beta_j^+ \Delta p_{f\,t-j}^+ + \sum_{J=0}^{J-} \beta_j^- \Delta p_{f\,t-j}^- + \theta^+ ECT_{t-1}^+ + \theta^- ECT_{t-1}^- + \varepsilon_t \quad (1)$$

Where: Δp_r and Δp_f are variations of the retail price and the producer level, respectively; subscript t denotes the time and superscripts (+) and (-) indicates whether the variation is positive or negative; $ECT_t = p_{rt} - \gamma_0 - \gamma_1\, p_{ft}$ is the error correction term obtained from the long-term relationship between prices. The lag operators are k and j for retail and producer price, respectively. Naturally, this relationship can be applied to the retail industry-case and/or producer-industry or any other relationship within the production chain.

Equation (1) allows testing some forms of asymmetry presented by Frey and Manera (2007), such as i) contemporary impact asymmetry (AIC) if $\beta_0^+ \neq \beta_0^-$; ii) asymmetry due to the distributed lags effect (AED), if $\beta_j^+ \neq \beta_j^-$ for all j; iii) cumulative impact asymmetry (AIA) if $\Sigma_{j=J}^{J+} \neq \Sigma_{j=J}^{J-}$, where $J \in [0, min\ (J^+, J^-)]$; iv) asymmetry in the equilibrium adjustment trajectory (ATAE) if $\theta^+ \neq \theta^-$, that is, testing whether the speed of convergence depends on the retail price is above ($ECT_{t-1} \geq 0$) or below ($ECT_{t-1} \leq 0$) the long-term equilibrium.

While the cases presented in i) and ii) (AIC and AED) refer to short-term asymmetry, comparing the positive or negative impact in a given period, the test of ECT terms refers to long-term asymmetry. In the latter case, if there is a cointegration between two market levels, only the equilibrium adjustment speed (ATAE) can be asymmetric (Meyer, Von Cramon Taubadel, 2004).

During investigation, statistical tests are used, such as the unit root tests Dickey and Fuller (1979) and Philips and Perron (1988) and cointegration test Johansen (1988). Using of the Granger causality test (1969), the empirical analysis starts from the assumption that pricing ranges from the primary sector to the other vertical links of the rice production chain. In each case, the Wald test is applied to verify the APT between the links of the Brazilian rice production chain. The Stata 14 was used to calculate all this tests.

As a contribution, we intend to evaluate if the policy of minimum prices practiced by the Brazilian government affects price transmission in the rice production chain in Rio Grande do Sul. To this end, Equation (1) is modified to cover two situations: i) price paid to the producer above the minimum price; ii) price paid to the producer below the minimum price.

$$\Delta p_{rt} = \beta_0 + \sum_{k=1}^{K} \gamma_j \Delta p_{rt-j} + \theta ECT_{t-1} + \left(\sum_{i=0}^{M1} \beta_{1i} \Delta p_{ft-i}^+ + \sum_{i=0}^{M2} \beta_{2i} \Delta p_{ft-i}^- \right) + \left(\sum_{j=0}^{M1} \gamma_{1j} \Delta p_{ft-j}^+ + \sum_{j=0}^{M2} \gamma_{2j} \Delta p_{ft-j}^- \right) + \vartheta_t \quad (2)$$

Where: i and j represent the time subperiods where $pp>pm$ or $pp \leq pm$, respectively; with pp being the producer-level price and pm the minimum price established in the PPGM of the federal government. In this context, it is intended to identify if the results on the existence of APT are kept in the segmented series $pp>pm$ and $pp \leq pm$, which define the subperiods where the price paid to the producer was above or below the minimum price, respectively.

In order to segment the sample, as described above, we use the information on the historical series of the producer prices in Rio Grande do Sul and the Minimum Price Guarantee Policy (PGPM) of the Federal Government for rice produced in Rio Grande do Sul (Fig. A.1. and Tab. A.3., Appendix). We create a segment when the market forces are the main driver (producer-level price greater than minimum price) and a second term, when the minimum price are greater than the market priced received by producers (the last part of equation 2, when the government intervention are more probable).

The Figure A.1. (Appendix) shows the comparison between the series from January 2003 to December 2018, in nominal terms. We have 49 of the 191 months analyzed with market price lower than the minimum price, which implies the possibility of implementation of the intervention policy and represents the third part of equation 2. We can also see that the policy of support is strongly concentrated during harvesting (first half of the year) from 2006 to 2009, as well as practically throughout the year of 2011.

Here, it is essential reinforce that the PGPM is executed by the National Supply Company (CONAB) who sets the minimum price annually, at least sixty days before the beginning of the planting of the crop, taking into account the cost of production (in general, it uses the average variable cost of production as a guide) and parameters as export and import price, internal and external supply, and others. The Table A.3. (Appendix) shows the minimum rice price in Rio Grande do Sul during the period analyzed.

Obviously, the effectiveness of minimum price policy depends on government-set price values, resource availability, and the volume of product operationalized compared to total production (Stefanelo, 2005)[1]. In other words, the existence of a minimum price in not guarantee that government will intervene (and in which magnitude) in the rice market.

Besides, it is not clear the way this intervention will affect the price transmission. On the one hand, as Kinnucan and Forker (1987) point, the existence a price support, often in the form of minimum prices, can lead to APT if retailers or wholesalers believe that the government intervention will reduce de uncertainty associated with interpreting a cost changes. In this context, a reduction in farm prices could be view as temporary because it will trigger government intervention, while an increase in farm prices is more likely to be permanent. Therefore, in this situation, it is expect that price support will probably result in positive APT. On the other hand, if the support price instrument pay the subside to the middlemen (that pass through it to farmers), as some PGPM instruments in Brazilian case, maybe they have an incentive to transmit more rapidly farm price decrease, in order to reinforce the probability of government intervention and increase his stocks with a lower average price. Consequently, the existence of minimum price could create APT, but it is not clear if it is a negative or positive price transmission.

5. DATA

As this study aimed to verify the occurrence of APT between the links in the rice production chain, price data was collected from February 2003 to December 2018 at three levels. The producer and industry prices in Rio Grande do Sul and the retail price in Porto Alegre (capital of the State) were obtained from the National Supply Company (CONAB, 2019b), the Rio Grande do Sul Rice Institute (IRGA, 2019) and the Center for Studies and Economic Research (IEPE, 2019), respectively. The producer price series consists of average selling prices of rice in shell per 50 kg bag, the price for the industry in 30 kg bags and retail are available in R$/Kg. The data were deflated using the General Price Index (IGP-M), calculated by Getúlio Vargas Foundation (FGV, 2019), with base of 100 for December 2018.

The data presented justify these choices. Firstly, Rio Grande do Sul is the main agricultural producer and industrial beneficiary of rice. Secondly, according to Miranda *et al.* (2009), in general, rice commercialization in Rio Grande do Sul from the rural producer is given by the deposit of cereal in some processing plant (cooperative or direct sale to an intermediary). In this system, the producer delivers their product to be stored at the plant without prior price adjustment, and transaction is made only when the parties (producers and industry) agree. Thus, although there is no formal contractual relationship, this practice functions as such, since the producer hardly takes the product from one plant to negotiate in another. In turn, the industry, usually by representatives, market their product already benefited with retail sector. In fact, in the rice market is usual the industry replace wholesale by marketing the product directly with retail, for this reason we use the industry price (the price that industry sells rice to their costumers) in our analysis.

Thus, the analyses of different market levels allowed to select the price to producers in the state of Rio Grande do Sul (largest primary producer), the price at the industry in the state (major rice producer) and retail in the main market of this region, metropolitan region of Porto Alegre, because it prevents modification of tax rates between states from affecting the relationship between the chain links, common in the Brazilian context.

Figure 2 shows the evolution of these prices in the period. The visual inspection of the data indicates that prices in the three levels considered are moving in the same direction with the retailer distancing slightly, showing an increase of the retail margin to the detriment of the others, as pointed out by Zanin (2013).

Finally, to evaluate jointly the different market levels, prices were converted into R$ / Kg at each market level[2]. Prices are in real terms, excluding the inflation as a source for asymmetry.

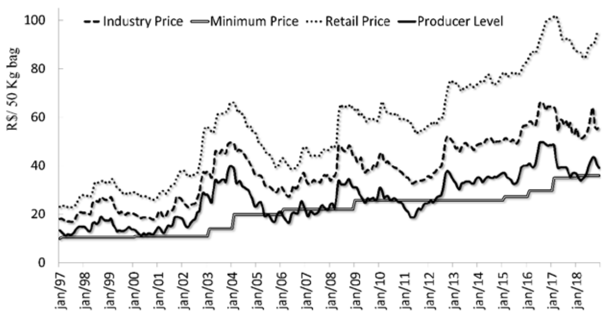
6. RESULTS AND DISCUSSION

In the context of cointegration, the first step is to analyze if the series are stationary. Table 1 shows that all the series of prices at level have unit root and in first difference are stationary (test ADF and PP). In addition, the

[1] The flow for approval of this minimum price is defined as follows: CONAB prepares the minimum price proposal and submits it to the Ministry of Agriculture and Livestock and Supply (MAPA); 2) MAPA analyzes and coordinates a meeting with the Ministry of Economy; 3) After technical approval, MAPA prepares and forwards votes to the National Monetary Council (CMN); 4) The CMN approves; 5) The MAPA launches Ordinance containing the minimum prices approved; 5) CONAB prepares and discloses the operating rules of this minimum price and 7) CONAB performs PGPM operations. This process follows the rules indicated by Decree-Law 79 of 12/19/1966 and Law 8171 of 01/17/1991.

[2] The price to the producer is not in an equivalent quantity, that is, no transformations were made in their unit to account for the equivalence between the product in shell (*in natura*) and the product benefited.

Fig. 2. Price of rice to the producer, in industry and retail of Rio Grande do Sul and minimum price of the Minimum Price Guarantee Policy (PGPM) for Rio Grande do Sul, monthly data, from January 2003 to December 2018.



Source: CONAB (2019b), CONAB (201;9d), IRGA (2019) and IEPE (2019).

series are leptokurtic and the hypothesis of normality of the residues is rejected (Jarque Bera test).

The long-term relationships between the price series in the different links of the rice production chain in Rio Grande do Sul (Tab. 2) are analyzed. The results of Johansen cointegration test indicate the existence of only a long-term cointegration relationship between different market levels analyzed, considering the different test specifications at a significance level of 5%.

Based on the results of the unit root (ADF and PP) and cointegration tests (Johansen), the Granger causality test was performed for the variable series. For the Johansen cointegration test specifications, we chose the case with the inclusion of a trend in the cointegration vectors, and because it is an agricultural product, factors such as increased productivity can influence the analysis. Following the recommendation of Miller and Russek (1990), in situations where there are cointegration relationships between the series analyzed, the residuals of the long-term equation are used as a mechanism of error correction in the short-term equation of the causality test (Tab. 3).

In general, the results of the Granger causality test demonstrate that each link in the rice productive chain has a causal effect on downstream links. Causality is observed in all cases, producer-retail, producer-industry and industry-retail, in a directional sense. These results corroborate the hypothesis that a supply shock tends to propagate to the subsequent links in the production chain. In the Brazilian literature on rice, Aguiar and Santana (2002) indicate producer-retail causality, while Aguiar and Figueiredo (2011) report wholesale-retail causality, reinforcing the hypothesis that shocks begin, predominantly, upstream and propagate downstream in the production chain.

The APT model for the rice market was performed considering the series in first difference, with bivari-

Tab. 1. Statistical properties of rice prices, level series and series returns.

Series	pp	pi	pr	D.pp	D.pi	D.pr
Panel A: Basic Descriptive Statistics						
Mean	0.951	2.306	3.368	-0.003	-0.006	-0.007
Std. Dev	0.248	0.492	0.564	0.062	0.11	0.101
Minimum	0.570	1.658	2.673	-0.276	-0.309	-0.284
Maximum	1.903	3.941	5.229	0.249	0.594	0.626
Skewness	1.885	1.746	1.713	0.565	1.468	1.742
Kurtosis	6.671	5.795	5.653	7.111	10.43	11.499
JB	81.41***	71.01***	69.15***	34.09***	79.65***	93.26***
Panel B: Unconditional Correlation Coefficients						
pp	1			1		
pi	0.974	1		0.736	1	
pr	0.938	0.937	1	0.397	0.554	1
Panel C: Unit Root Tests						
ADF	-2.483	-1.932	-2.325	-11.38***	-11.35***	-8.74***
PP	-2.16	-1.93	-2.19	-10.38***	-11.35***	-8.74***

Notes: 1. JB refer to Jarque–Bera test for normality; ADF and PP are the empirical statistics of the Augmented Dickey and Fuller (1979) and the Philips and Perron (1988) unit root tests were performed including the trend and constant terms, with lags based on the AIC and SBIC criteria (pp: 2 lags, pi and pv: 1 lag).
2. *, ** e *** denote 10, 5 and 1 percent significance levels, respectively.
Source: Prepared by the authors.

Tab. 2. Johansen cointegration test on the different relations between market levels for rice in Rio Grande do Sul from January 2003 to December 2018.

Rank	Model2 (restricted constant)		Model 3(unrestricted constant)		Model 4(restricted trend)	
	Trace Stat. (λ)	Max Eigen Value (λmax)	Trace Stat. (λ)	Max Eigen Value (λmax)	Trace Stat. (λ)	Max Eigen Value (λmax)
Farm Price and Retail price						
r = 0	26.376	22.427	25.921	22.407	31.284	27.635
r ≤ 1	3.948[a]	3.948[a]	3.514[a]	3.514[a]	3.649[a]	3.649
Industry Price and Retail price						
r = 0	16.000[a]	12.0349[a]	15.673	12.031	36.139	31.808
r ≤ 1	3.965	3.965	3.641[a]	3.641	4.330[a]	4.33
Farm Price and Industry price						
r = 0	25.718	22.049	25.382	22.031	47.536	41.622
r ≤ 1	3.668[a]	3.668[a]	3.352[a]	3.352[a]	5.913[a]	5.913[a]

Notes: 1.Models 2, 3 and 4 refer respectively to the Johansen test specifications: Case 2 - restricted constant, Case 3 - unrestricted constant and Case 4 - restricted trend, in Stata context.
a. Level of significance of 5% and critical values for trace statistics (λ): Case 2 – 19.96; Case 3 – 15.41 and Case 4 – 25.32; and critical values for Maximum Eigenvalue are: Case 2 – 15.67; Case 3 – 14.07 and Case 4 – 18.96.
Source: Prepared by the authors.

Tab. 3. Results for Granger Causality Test between the levels of the Brazilian rice market, February 2003 to December 2018.

Market Levels	The nullhypothesis	F Stat.	Prob.	Lags	Causality
Retail *X* Producer	D.pp does not Granger-cause D.pr	13.780	0.000	5	Producer → Retail
	D.pr does not Granger-cause D.pp	1.390	0.230	5	
Retail *X* industry	D.pi does not Granger-cause D.pr	7.290	0.000	3	Industry → Retail
	D.pr does not Granger-cause D.pi	0.390	0.760	3	
Industry *X* Producer	D.pp does not Granger-cause D.pi	22.020	0.000	2	Producer → Industry
	D.pi does not Granger-cause D.pp	0.480	0.617	2	

Note: 1. * For the Granger Causality tests, the following equations were used:
$\Delta y_t = \alpha_0 + \sum_{i=1} \beta_{yi} \Delta y_{t-i} + \sum_{i=1} \beta_{xi} \Delta x_{t-i} + \alpha_1 \mu_{t-1} + \epsilon_t$ (direction $x \rightarrow y$) and
$\Delta x_t = \alpha_0 + \sum_{i=1}^{p} \beta_{xi} \Delta x_{t-i} + \sum_{i=1}^{q} \beta_{yi} \Delta y_{t-i} + \alpha_2 \mu_{t-1} + \epsilon_t$ (direction $y \rightarrow x$).
Source: Prepared by the authors.

ate analyses between the different market levels, in two distinct specifications: i) model with specification of the Error Correction Term (ECT); ii) model with segmentation of the error term. Thus, these two models (ECT and segmented ECT) were estimated for three relationships between the rice market levels, namely Retail-Producer; Industry-Producer and Retail-Industry, following the logic that shocks start upstream (in the primary sector, producer or industry) and propagate to the subsequent link (industry and / or retail).

In terms of methodological specification, there are indications of correct specification of the models with error correction term (ECT), since ECT coefficients are statistically significant (Tab. 4). In addition, the model with segmented ECT presented higher level statistical significance in all ATP tests.

The asymmetry tests demonstrate the occurrence of contemporary asymmetry (AIC) in the Retail-Industry relationship, the presence of asymmetry of lagged effect (AED) in the Retail-Producer case, and both contemporary and lagged asymmetries in the Industry-Producer relationship. The comprehensive cumulative impact asymmetry test (AIA) corroborates the diagnosis of the occurrence of APT between the links in the rice produc-

Tab. 4. Asymmetric Price Transmission models for the Brazilian rice market, monthly data from January 2003 to December 2018.

	Retail (dependent) x Producer (independent)		Industry (dependent) x Producer (independent)		Retail (dependent) x Industry (independent)	
Variables	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
$D.P_{ft}^{+}$	0.546***	0.544***	1.440***	1.450***	0.558***	0.584***
$D.P_{ft}$	0.233*	0.230*	0.755***	0.754***	0.266***	0.267***
$LD.P_{ft}^{+}$	0.936***	0.932***	0.913***	0.912***	0.272***	0.275***
$LD.P_{ft}^{-}$	0.310**	0.316**	0.175	0.155	0.226**	0.175*
$L2D.P_{ft}^{+}$	-0.379**	-0,382**				
ECT_{t-1}	-0.142***		-0.250***		-0.090***	
ECT^{+}_{t-1}		-0.135***		-0.302***		-0.187***
ECT^{-}_{t-1}		-0.147***		-0.195**		-0.028
L.D.PR	-0.284***	-0.284***			0.220***	0.236***
L.D.PI			-0.199***	-0.201***		
L2D.PI			-0.072**	-0.071*		
Cons.	-0.014***	-0.015***	-0.007***	-0.028***	-0.014*	-0.005
F-test	51.27	44.62	61.01	53.33	44.29	38.90
R^2	0.666	0.667	0.704	0.705	0.594	0.601
BG Test	0.554	0.577	1.577	1.731	0.125	0.02
(AIC)	2.08	2.08	10.26**	10.50**	5.46**	6.41**
(AED) (one lag)	8.96***	7.95***	12.16***	12.58**	0.13	0.62
(AIA)	3.72**	3.35***	30.86***	31.37***	4.24**	6.10**
(ATAE)		0.02		0.58		3.26*

Notes: In the nomenclature of the series used, D refers to the variables in first difference; L and L2 refers to lagged series, 1 lag and 2 lags, respectively; P_{ft} refers to the price paid to the producer in the Producer-Retail and Producer-Industry analyses, and the relationship between Industry-Retail $P_{ft}=P_{it}$ price in the industry; + (positive) represents price increases; and - (negative) refers to price decreases, at each market level analyzed.
2. We use the Breusch-Godfrey (BG) LM test for autocorrelation, H0 is: no autocorrelation.
3. In the selection of the number of lags, such as the Akaike (AIC), Schwarz-Bayes Criterion (SBIC) and Hannan-Quinn (HQ) information criteria, different lags were chosen, the parsimony criterion was chosen, maintaining the lower number of lags recommended (with significant coefficients).
4. The tests between the regression parameters are equivalent to (AIC) $\text{Wald}^{D}{:}\beta_1\Delta P_{ft}^{+} = \beta_2\Delta P_{ft}^{-}$; (AED) $\text{Wald}^{LD}{:}\beta_1\Delta P_{ft}^{+}(-1) = \beta_2\Delta P_{ft}^{-}(-1)$; (AIA) $\text{Wald}^{ALL} = \sum_{i=0}^{J+}\beta_{1i}\Delta P_{ft-i}^{+} = \sum_{i=0}^{J-}\beta_{2i}\Delta P_{ft-i}^{-}$ e (ATAE) $\text{Wald}^{ECT}{:}\theta^{+}ECT_{t-1}^{+} = \theta^{-}ECT_{t-1}^{-}$.
Source: Prepared by the authors.

tion chain, where price increases are transmitted more intensely, to the detriment of price drops.

Asymmetry in the speed of adjustment to the long-term equilibrium (ATAE) was significant and statistically valid only for the Retail-Industry case, and again, the positive impacts present the highest transmission speed. Even in this case, the term ECT was not significant (in the negative segment), but presented the expected signal, and since in the non-segmented case (Model 1), the term ECT is significant, it is understood that this non-significance is sampling result rather than the absence of cointegration between the variables.

For the links investigated, the industry-producer relationship presented the best fit (R^2> 0.71), most of its coefficients are statistically significant and showed positive asymmetry in all cases (contemporary, lagged, and cumulated).

As for the sources of APT, Meyer and Von Cramon Taubadel (2004) and Vavra and Goodwin (2005) list factors that may be relevant in the analysis of the rice production chain in Brazil. One of the factors is government intervention through minimum price policies for agricultural products. Kinnucan and Forker (1987) raised this and highlighted that government policies can lead to asymmetric price adjustments if agents, such as retailers / wholesalers or even industry, believe that price movements in one direction are more susceptible to interventions than in another direction.

In this sense, to capture the effect of the minimum price policy on the dynamics of price transmission between links in the rice chain, this study proposes a segmentation of the traditional model into two series of price increases and decreases, representing the sub periods when the price paid to the producer is above or below the

Tab. 5. Asymmetry Price Transmission Model of rice market in Brazil, segmented in moments that market prices are belowor above minimum prices, January 2003 to December 2018.

	Retail (dependent) x Producer (independent)		Industry (dependent) x Producer (independent)		Retail (dependent) x Industry (independent)	
Variables	Model 1	Model 3	Model 1	Model 3	Model 1	Model 3
$D.P_{ft}^{+}$ (all)	0.546***		1.440***		0.558***	
$D.P_{ft}^{-}$ (all)	0.233*		0.755***		0.266***	
$D.P_{ft}^{+}$ (in)		-0.203		1.244***		-0.391*
$D.P_{ft}^{-}$ (in)		0.593**		0.601***		0.688***
$D.P_{ft}^{+}$ (out)		0.909***		1.716***		0.630***
$D.P_{ft}^{-}$ (out)		0.380**		0.884***		0.267***
$LD.P_{ft}^{+}$	0.936***		0.913***		0.272***	
$LD.P_{ft}^{-}$	0.310**		0.175		0.226**	
$L2D.P_{ft}^{+}$	-0.379***					
ECT	-0.142***	-0.230***	-0.250***	-0.308***	-0.090***	-0.194***
L.D.PR	0.284***	0.285***			0.220***	
L.D.PI			-0.199***			
L2D.PI			-0.072**			
Constant	-0.014***	-0.009	-0.007***	-0.020***	-0.014*	-0.0110
F-test	51.27	42.20	61.01	52.63	44.29	32.64
R^2	0.666	0.582	0.704	0.67	0.594	0.47
BG Test	0.554	0.113	1.577	5.37	0.125	10.93
AIC	2.08		10.26**		5.46**	
AIC^{IN}		3.17*		4.62**		11.41***
AIC^{OUT}		5.64***		12.68***		3.41**
AIA^{ALL}	3.72**	0.23	30.86**	10.65***	4.24***	2.81*

Notes: In the nomenclature of the series used, D refers to the variables in first difference; L and L2 refers to lagged series, 1 lag and 2 lags, respectively; P_{ft} refers to the price paid to the producer in the Producer-Retail and Producer-Industry analyses, and in the analysis of the Industry-Retail P_{ft}=P_{it} price in the industry; + (positive) represents price increases; - (negative) refers to the price drops, at each market level analyzed; and IN refers to the periods when *pp≤pm* and OUT when *pp>pm*.

2. The tests between the regression parameters are equivalent to (AIC) $Wald^{D}$:$\beta_1 \Delta P_{ft}^{+} = \beta_2 \Delta P_{ft}^{-}$, performed for the periods in which *pp≤pm* (AIC^{IN}) and when *pp>pm* (AIC^{OUT}) and(AIA) $Wald^{ALL} = \sum_{i=0}^{J+} \beta_{1i} \Delta P_{ft-i}^{+} = \sum_{i=0}^{J-} \beta_{2i} \Delta P_{ft-i}^{-}$.

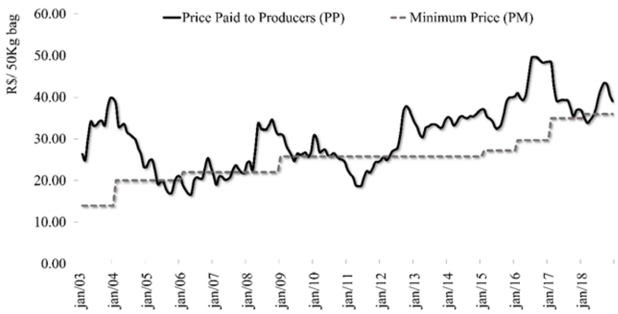
3. We use the Breuch-Godfrey (BG)LM test for autocorrelation, H0 is:no autocorrelation; When this test is significative we estimate the model without the lagged dependent variable and with the Newey-West standard error correction. Models with lagged dependent variable and more lags do not change the results.

Source: Prepared by the authors.

current minimum price. Table 5 shows the comparison between the results of the baseline model, without segmentation of the sample period (Model 1) in relation to the segmented APT model based on the relation between the market and the minimum prices (Model 3). Based on the statistical significance of the estimated parameters for all the relationships (producer-retail, industry-producer and industry-retail) the APT is observed in both periods, when the market price is higher than the minimum price (segment called "out") and when the market price is lower than the minimum price (segment called "in").

When the market price for rice is below the minimum price (period "in" in Tab. 5) the asymmetry are negative in cases involving retail sector. The coefficient for price increase is not significant for retail-producer and retail-industry relationship, whereas the price decrease coefficient are. In these cases, it seems that pass-through of price decrease occurs more rapidly, a behavior that is not present in the period drive by market forces (segment "out"). It could reflect a strategy of a more intense transfer of falls to the next link to increase sales and reduce inventories that tend to grow at these times. Finally, the results of the segmented sample confirm asymmetry (when market price less than minimum price) but in a different way (negative APT) and should be analyzed with caution given the size of the sample obtained and the not statistical significance of increase prices coefficients.

Fig. 3. Producer Prices and Minimum Price for 50-kg bag of rice in Rio Grande do Sul, from January 2003 to December 2018.



Source: Prepared by the authors, based on CONAB (2019b, 2019d).

On the other hand, the industry-producer relationship, in period "in", shows positive APT. In this case, both price coefficient (increase and decrease) are significant and shows that the industrial sector, which is directly related to the producer, tends to pass the price increases faster to its consumers than the falls, when intervention policy is more likely to occur. When market forces prevail, the period out, this positive APT remains. Therefore, for the industry-producer relationship the potential government intervention does not change the APT behavior and is detected as a source of it.

In short, it seems that intervention policy may be one of the explanations for APT in Brazilian rice market, but not the only one, as it remains and even strengthens in periods without government intervention. In this sense, other explanations could help to understand the APT. One of them is the management of rice inventory, as described by Meyer and Von Cramon Taubadel (2004) and Vavra and Goodwin (2005). Rice is a commodity; thus, storage has implications on price transmission. Therefore, intermediaries (as retail in our case) could benefit from reduced prices at producer level to replenish or increase their inventories (Reagan, Weitzman, 1982). Moreover, Balke *et al.* (1998) showed the accounting method used to manage the inventories can also generate APT, methods as first in first out (FIFO), might lead to adjustments of asymmetric price shocks. In addition, restriction of non-negativity to the stock, according to Blinder (1982), could also lead to APT.

In this context, as we saw in the Table A.1 the inventories had an important variation along the all sample with private sector replacing the public sector as the holder of rice stored in Brazil, maybe this modification could bring light to understand the APT. But, this is a difficult hypothesis to test for the rice market, due to the lack of known series of stocks of private agents (retailers / wholesalers/industry) available in a disaggregated way.

Furthermore, methodological adjustments are required to test inventory and APT relationship, in addition to the collection of data not available in the present study. These adjustments are not in the scope of this work; nevertheless, they are important points for further research. This study aims to contribute to a better understanding of price asymmetry. In addition to measuring it, this study sought to identify a possible cause of APT, namely the role of the policy of minimum prices, which were confirmed. For further research, maybe different methodological frameworks available in the literature could be implemented to confirm our results.

7. FINAL REMARKS

The objective of this work was to investigate asymmetric price transmission (APT), through the error correction model (ECM) between the links of the rice production chain in producer and industry markets of the state of Rio Grande do Sul, Brazil, and the retail market in the metropolitan region of the state capital, Porto Alegre, from February 2003 to December 2018. The period of analysis is fruitful in terms of changes in the rice market in Brazil. Changes are namely related to the regional concentration of primary production and the industrial processing of the cereal, the use of public policies, such as minimum prices, changes in inventory levels and greater insertion into the international market, among others, which allow testing the APT.

At the different levels analyzed (Retail-Producer, Industry-Producer and Retail-Industry), the APT tests indicated the presence of positive asymmetry, both contemporaneous or lagged and cumulatively, in prices transmission in the rice production chain. The result confirms the empirical results available in the literature. The evaluation of the different extracts of analysis shows that the industry-producer relationship presented the best fit, expected signs and positive asymmetry in the different measured forms (AIC, AED and AIA). This market link has a direct relationship with producers and the results indicate they could benefit from this proximity by passing on price increases more quickly than price reductions for their customers.

As a methodological contribution, this study aimed to adapt the model to evaluate the results in sub periods of time, specifically to differentiate the periods in which the market price was above or below the minimum price. The results show that when the market price was below the minimum price, the transmission of the price falls were greater than increases when the retail sector is considered, making negative asymmetry in retail-producer and retail-industry relationship. In the industry-producer case, we found positive asymmetry in the same sample segmentation. These results may indicate that the government intervention is a potential source of asymmetry in Brazilian rice market, but not the only one, as the APT remain in the period where the market price was above the minimum price.

Regarding the limitations of this study, although the results indicate the occurrence of APT, the price series adopted in the analysis, monthly basis, have limitations in the accurate monitoring of price dynamics between the links in the production chain. Finally, for future research on the process of price transmission in the rice sector in Brazil, we could assess which inventory levels have more influence on the APT process. Furthermore, studies could be conducted to evaluate the effects of changes on price transmission, namely changes in the contractual framework or in the negotiation policies between the links of the productive chain.

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APPENDIX

Tab. A.1. Rice supply and demand for Brazil, 1997 to 2018 (in thousand tons).

Harvest	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007
Initial Inventory	1,857.0	1,762.0	1,565.6	2,110.2	2,113.3	1,921.4	1,965.8	1,917.9	2,397.7	2,470.7	2,259.5
Production	9,524.5	8,462.9	11,582.2	11,423.1	10,386.0	10,626.1	10,367.1	12,960.4	13,355.0	11,721.7	11,315.9
Import	1,232.0	2,009.0	1,338.0	936.5	951.6	737.3	1,601.6	1,097.3	728.2	827.8	1,069.6
Total Supply	12,613.5	12,233.9	14,485.8	14,469.8	13,450.9	13,284.8	13,934.5	15,975.6	16,480.9	15,020.2	14,645.0
Domestic Consumption	10,846.9	10,658.4	12,305.4	12,335.4	11,505.1	11,271.4	11,993.1	13,485.7	13,630.5	12,308.4	12,305.5
Export	4.6	9.9	37.7	21.1	24.4	47.6	23.5	92.2	379.7	452.3	313.1
Total Demand	10,851.5	10,668.3	12,343.1	12,356.5	11,529.5	11,319.0	12,016.6	13,577.9	14,010.2	12,760.7	12,618.6
Final Inventory (Feb 28)	1,762.0	1,565.6	2,142.7	2,113.3	1,921.4	1,965.8	1,917.9	2,397.7	2,470.7	2,259.5	2,026.4
Final Public Inventory	449.1	99.5	867.1	1,933.4	1,320.5	79.7	1.8	4.6	956.7	1,060.4	1,413.1
AGF	449.1	99.5	867.1	1,046.2	767.8	71.8	1.3	2.4	504.9	607.5	505.2
Options Contracts	0.0	0.0	0.0	887.2	552.7	7.9	0.5	1.8	424.5	421.9	880.7
Agricultura Familiar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	27.3	31.0	27.2
Private Inventory	1,312.9	1,466.1	1.275.6	179.9	600.9	1,886.1	1,916.1	2,393.1	1,514.0	1,199.1	613.3
Private Inventory (% Total)	74.1	93.64	59.53	8.51	31.27	95.95	99.91	99.81	61.28	53.07	30.27
Harvest	**2007/2008**	**2008/2009**	**2009/2010**	**2010/2011**	**2011/2012**	**2012/2013**	**2013/2014**	**2014/2015**	**2015/2016**	**2016/2017**	**2017/2018**
Initial Inventory	2,026.4	2,033.7	2,531.5	2,457.3	2,569.5	2,125.3	1,082.1	868.2	962.9	430.8	711.6
Production	12,074.0	12,602.5	11,660.9	13.613.1	11,599.5	11,819.7	12,121.6	12,448.6	10,603.0	12,327.8	12,064.2
Import	589.9	908.0	1,044.8	825.4	1,068.0	965.5	807.2	503.3	1,187.4	1,042.0	1,000
Total Supply	14,690.3	15,544.2	15,237.2	16,895.8	15,237.0	14,910.5	14,010.9	13,820.1	12,753.3	13,800.6	13,775.8
Domestic Consumption	11,866.7	12,118.3	12,152.5	12,236.7	11,656.5	12,617.7	11,954.3	11,495.1	11,428.8	12,024.3	11,700
Export	789.9	894.4	627.4	2,089.6	1,455.2	1,210.7	1,188.4	1,362.1	893.7	1,064.7	1,400
Total Demand	12,656.6	13,012.7	12,779.9	14,326.3	13,111.7	13,828.4	13,142.7	12,857.2	12,322.5	13,089.0	13,100.0
Final Inventory (Feb 28)	2,033.7	2,531.5	2,457.3	2,569.5	2,125.3	1,082.1	868.2	962.9	430.8	711.6	675.8
Final Public Inventory	515.3	992.6	976.6	1,823.8	1,506.93	586.01	146.69	97.9	22.77	22.3	
AGF	63.8	67.6	67.9	461.4							20.45
Options Contracts	438.8	914.1	899.6	1,253.5							
Agricultura Familiar	12.7	10.9	9.1	11.5							
Private Inventory	1,518.4	1.538,9	1.480,7	745.7	618.4	496.1	721.5	865.0	408.0	689.25	655.35
Private Inventory (% Total)	30.00	30.00	30.00	29.02	29.10	45.85	83.10	89.83	94.71	96.86	96.97

Source: CONAB (2019a; 2019c).

Tab. A.2. Support from the Federal Government for the commercialization of rice (thousand tons) - harvest year (March / February) from 2001 to 2018.

Item /Crop	2001/2002	2004/2005	2005/2006	2006/2007	2008/2009	2009/2010	2010/2011	2017/2018
PEP								
Offered			480	485		307.5	2238	543
Sold			459.8	157.5		143.3	1,538.2	390.2
AGF Direct	60	571.4	307.7	62	0.3		396.3	20.4
PROP								
Offered		700.1	548					
Sold		327.6	238.9					
PREPO								
Offered							307	369
Sold							64.3	109.4
OPTIONS								
Offered	1,374.3	350		910.2	878		1,113.1	
Sold	611.5	350		857.7	668.6		982.8	
Accomplished	4.4	350			156.8		403.3	
Total	671,5	1,249	1,006.4	1,077.2	668.9	143.3	2,981.6	520
Production	11,076.1	13,405.2	11,721	11,315.9	12,603	11,660.9	13,613.1	12,064.2
Participation (%)	*6.1%*	*9.3%*	*8.6%*	*9.5%*	*5.3%*	*1.2%*	*21.9%*	*4.3%*

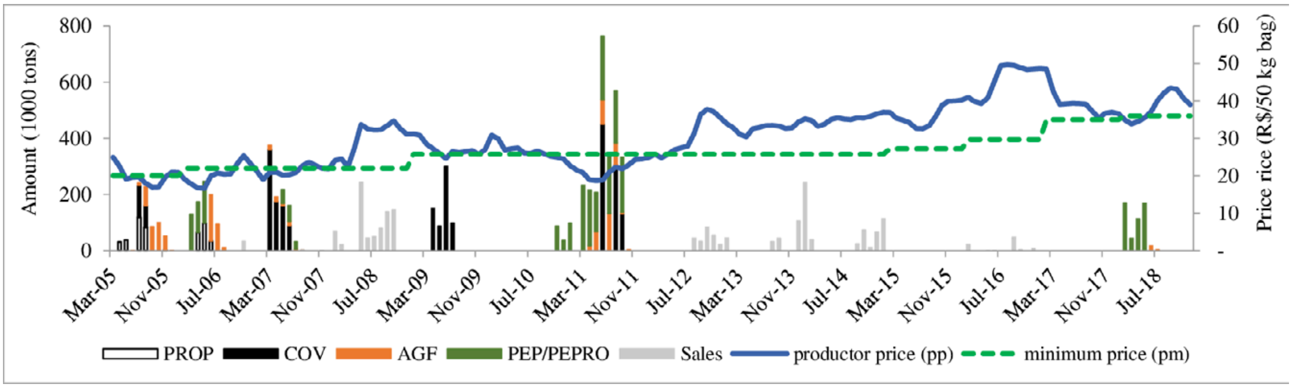
Note: 1. Only the years in which there was support from the federal government for the commercialization of rice are presented.
Source: Ministry of Agriculture Livestock and Supply (MAPA, 2019b).

Tab. A.3. Minimum price for rice in Rio Grande do Sul, by type, duration and value from 2003 to 2020.

Product	Type/Class	UF	Region	Start (month/ year)	End (month/ year)	Unity	R$/ bag
PADDY RICE	Type 1-58/10	RS	South	02/2003		50 kg bag	14.00
PADDY RICE	Type 1-58/10	RS	South	02/2004		50 kg bag	20.00
PADDY RICE	Type 1-58/10	RS	South	02/2005		50 kg bag	20.00
PADDY RICE	Type 1-58/10	RS	South	02/2006		50 kg bag	22.00
PADDY RICE	Type 1-58/10	RS	South	02/2007		50 kg bag	22.00
PADDY RICE	Type 1-58/10	RS	South	01/2008		50 kg bag	22.00
PADDY RICE	Type 1-58/10	RS	South	01/2009		50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	01/2010		50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	02/2012	01/2013	50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	02/2013	01/2014	50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	02/2014	01/2015	50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	02/2015	01/2016	50 kg bag	27.25
PADDY RICE	Type 1-58/10	RS	South	02/2016	01/2017	50 kg bag	29.67
PADDY RICE	Type 1-58/10	RS	South	02/2017	01/2018	50 kg bag	34.97
PADDY RICE	Type 1-58/10	RS	South	02/2018	01/2019	50 kg bag	36.01
PADDY RICE	Type 1-58/10	RS	South	02/2019	01/2020	50 kg bag	36.44

Source: National Supply Company (CONAB, 2019d).

Fig. A.1. Market price and minimum price for rice in Rio Grande do Sul and quantity of rice marketed by Minimum Price Guarantee Policy (PGPM) in Rio Grande do Sul, monthly data, from March 2005 to December 2018.



Source: National Supply Company (CONAB, 2019b, 2019d).