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EFEITO DISPOSIÇÃO NA COMERCIALIZAÇÃO DE GRÃOS: UMA INVESTIGAÇÃO JUNTO AOS PRODUTORES RURAIS DO NOROESTE GAÚCHO

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ABSTRACT

The disposition effect term was introduced by Shefrin and Statman (1985) and it was widely studied by other researchers in different contexts. Mattos and Fryza (2014) and Vollmer, Hermann, and Musshoff (2019) extended this discussion to the marketing of grains. In line with these authors, the aim of this study is to see if the disposition effect is manifested in rural producers in the northwest of Rio Grande do Sul when they sell grains. To accomplish this goal, an experiment was conducted with fifty-five rural producers. The data were analyzed quantitatively based on the methodology proposed by Odean (1998). Regarding the results, it was observed that the participants exhibit the disposition effect (disposition coefficient equal to 0.1689), contradicting the expectations of the rational perspective of decision-making. It is presumed that raising awareness among rural producers that they are not immune to behavioral biases can improve their decision-making process when marketing grains, contributing to increased income, stimulating the local economy, and reducing inequality and rural exodus.

Keywords: Disposition effect. Experimental economics. Decision-making. Regional development. Marketing of grains.

RESUMO

O termo efeito disposição foi introduzido por Shefrin e Statman (1985) e amplamente estudado por outros pesquisadores em diferentes contextos. Mattos e Fryza (2014) e Vollmer, Hermann e Musshoff (2019) estenderam essa discussão para a comercialização de grãos. Acompanhando tais autores, este estudo possui, como objetivo, verificar se o efeito disposição se manifesta nos produtores rurais do Noroeste gaúcho ao comercializarem grãos. Para cumprir o objetivo, foi conduzido um experimento com cinquenta e cinco produtores rurais. Os dados foram analisados de maneira quantitativa com base na metodologia proposta por Odean (1998). No que se refere aos resultados, foi observado que os participantes manifestam o efeito disposição (coeficiente de disposição igual a 0,1689), contrariando as expectativas da perspectiva racional da tomada de decisão. Presume-se que a conscientização dos produtores rurais, de que não são imunes a vieses comportamentais, pode melhorar seu processo decisório ao comercializar grãos, contribuindo no incremento da renda, no estímulo da economia local e na redução da desigualdade e do êxodo rural.

Palavras-chave: Efeito disposição. Economia experimental. Tomada de decisão. Desenvolvimento regional. Comercialização de grãos.

INTRODUCTION

The disposition effect is a well-recognized behavioral bias observed not only in the exercise of options (Heath; Huddart; Lang, 1999), but also in futures market operators (Coval; Shumway, 2005), investment fund shareholders (Chiu *et al*., 2004), college students (Macedo Jr., 2003) and in countries. It can be seen in nations such as: Portugal (Cerqueira Leal *et al*., 2010), Germany (Weber; Welfens, 2007), Hungary, (Ormos; Joó, 2014) Israel (Shapira; Venezia, 2001), Australia (Brown *et al*., 2006), Taiwan (Shu *et al*., 2005), South Korea (Choe; Eom, 2009), France (Boolell-Gunesh *et al*., 2009), and Brazil (Prates; Da Costa; Santos, 2019). In addition, the disposition effect has been studied in terms of gender (Fischbacher *et al*., 2017), age (Cheng *et al*., 2013), among other individual characteristics. Regardless of the context, this behavioral bias can be harmful to individuals.

The importance of studying the disposition effect is consolidated in the economics and finance literature, but is still in its early stages outside this field of study. Although there are studies on the decision-making process in grain marketing, such works (Bolen et al., 1978; Musser et al., 1996; Brum et al., 2015) are traditionally based on the notion of rationality. Mattos and Fryza (2014), based on empirical data, and Vollmer, Hermann and Musshoff (2019), based on experiments, were the first to confirm the presence of the disposition effect in the decisions of Canadian and German

rural producers when selling grains. Due to the economic importance of the sector and the fact that the decision-making process is still little explored from a behavioral perspective, they recommended further studies with rural producers, including those from other countries, in order to understand and improve the grain marketing process and contribute to the economic success of this activity.

The present study seeks to answer the following research problem: are rural producers in the northwest of Rio Grande do Sul affected by the disposition effect when selling grains? It is assumed that rural producers should not be affected by behavioral biases. As businessmen who make a living from productive activities carried out on their farms, their purpose is to make a profit from the production and marketing of grain, as well as constantly monitoring the market to make decisions about whether to sell or retain grains.

This is a significant topic as it is in some way linked to a crucial issue that affects a substantial segment of society. According to Feix, Leusin Júnior and Borges (2021), in 2018, agriculture accounted for 5.2% of GVA1 in Brazil and 9.0% of GVA in the state of Rio Grande do Sul, indicating greater dependence of the aforementioned region economy on this sector. When comparing the authors' findings with data from DEE (2020), when publishing the municipal GDP1 in Rio Grande do Sul, it can be seen that this dependence is even greater in the northwest of Rio Grande do Sul, where the share of agriculture was 19.31%, 20.55% and 19.44% in 2017, 2018 and 2019, respectively.

This is work is divided into five parts, the first one being the introduction, followed by the theoretical framework; while the third part of the work describes its methodological procedures, the next section delves into the research results. Finally, the last part presents the final considerations.

THEORETICAL FRAMEWORK

This session begins with a brief presentation of the rational and behavioral perspectives, in order to introduce the disposition effect. Then, it presents the behavioral bias known as the disposition effect. Finally, it shows the relevance of the topic to the field of regional development studies from an economic point of view, regarding the northwest region of Rio Grande do Sul.

RATIONAL AND BEHAVIORAL PERSPECTIVES ON DECISION-MAKING

The history of decision-making is long-established, rich and diverse. The first theories about individuals' choice behavior date back to the mid-17th century. By proposing what later became known as the expected value theory, Pascal (1941) suggested that decision-makers should choose the option with the highest expected value. In 1738, Bernoulli (1954) paved the way for the development of the expected utility theory, with the work entitled "Commentari Academiae Scientiarum Imperialis Petropolitanae", when he observed the decision of St. Petersburg merchants to purchase insurance policies for their ships.

Later, von Neumann and Morgenstern (1944) resumed the work started by Bernoulli (1954) and published the work "Theory of Games and Economic Behavior", in which they suggested the expected utility theory (EUT). This theory introduced axioms that are still strongly accepted today, thanks to its solid and consistent structure. The theory tests whether an individual is a rational decision maker or not. According to Bernstein (1996), the assumption of rationality in the EUT, whose behavior could be measured in numbers, unleashed a torrent of exciting theories and practical applications.

However, with the emergence of the behavioral perspective, there was evidence of violations in the EUT. It begins with the introduction of the concept of a man who is not completely rational, constructed by cognitive psychology, when he proposed an alternative model of rationality. Subsequently, Kahneman and Tversky (1979) proposed an approach that opposed the EUT: the prospect theory (PT), a descriptive framework of the way in which individuals make decisions under risky conditions.

PT compares changes in value in relation to gains and losses around a reference point, unlike EUT that uses total wealth. Kahneman and Tversky (1979) found that these weights are not linear, causing the value function to be "S" shaped, that is, concave in the area of losses and convex in the area of gains, which makes the function more inclined towards losses than towards gains. This finding was called loss aversion.

Based on the observation that decisions can be influenced by loss aversion, Shefrin and Estman (1985) saw an application for the financial market. To this end, they developed a theory of the realization of capital gains and losses, and called it the disposition effect.

DISPOSITION EFFECT

This behavioral bias is related to the predisposition of individuals to keep, in their investment portfolio, assets with negative performance and quickly dispose of assets with positive performance (Lucchesi, 2011). As a result of this behavior, the disposition effect is characterized as the investor's resistance to incurring losses.

The evidence on the disposition effect essentially rests on two approaches: the empirical approach (Odean, 1998) and the experimental approach (Weber; Camerer, 1998). Both treat the disposition effect as an element of risk and uncertainty. Table 1 below provides an overview of some of the studies carried out based on these approaches.

Table 1 | Empirical and experimental studies on the disposition effect.

Author(s) (year)	Approach	Country	PGR	PPR	CD
Shu *et al*. (2005)	Empirical	Taiwan	0,3500	0,1400	0,2100
Dhar e Zhu (2006)	Empirical	United States	0,3800	0,1700	0,2100
Brown *et al*. (2006)	Empirical	Australia	0,5100	0,2300	0,2800
Boolell-Gunesh *et al*. (2009)	Empirical	France	0,1240	0,0730	0,0500
Choe and Eom (2009)	Empirical	Korea	0,6520	0,5800	0,0780
Ormos and Joó (2014)	Empirical	Hungary	0,5680	0,4270	0,1410
Weber and Welfens (2007)	Empirical	Germany	0,3000	0,2000	0,1000
Da Costa *et al*. (2013)	Experimental	Brazil	0,2210	0,1280	0,0920
Goulart *et al*. (2013)	Experimental	Brazil	0,1500	0,1120	0,0380
Vollmer, Hermann and Musshoff (2019)	Experimental	Germany	0,3300	0,1500	0,1800

Source: adapted from Plessner (2017).

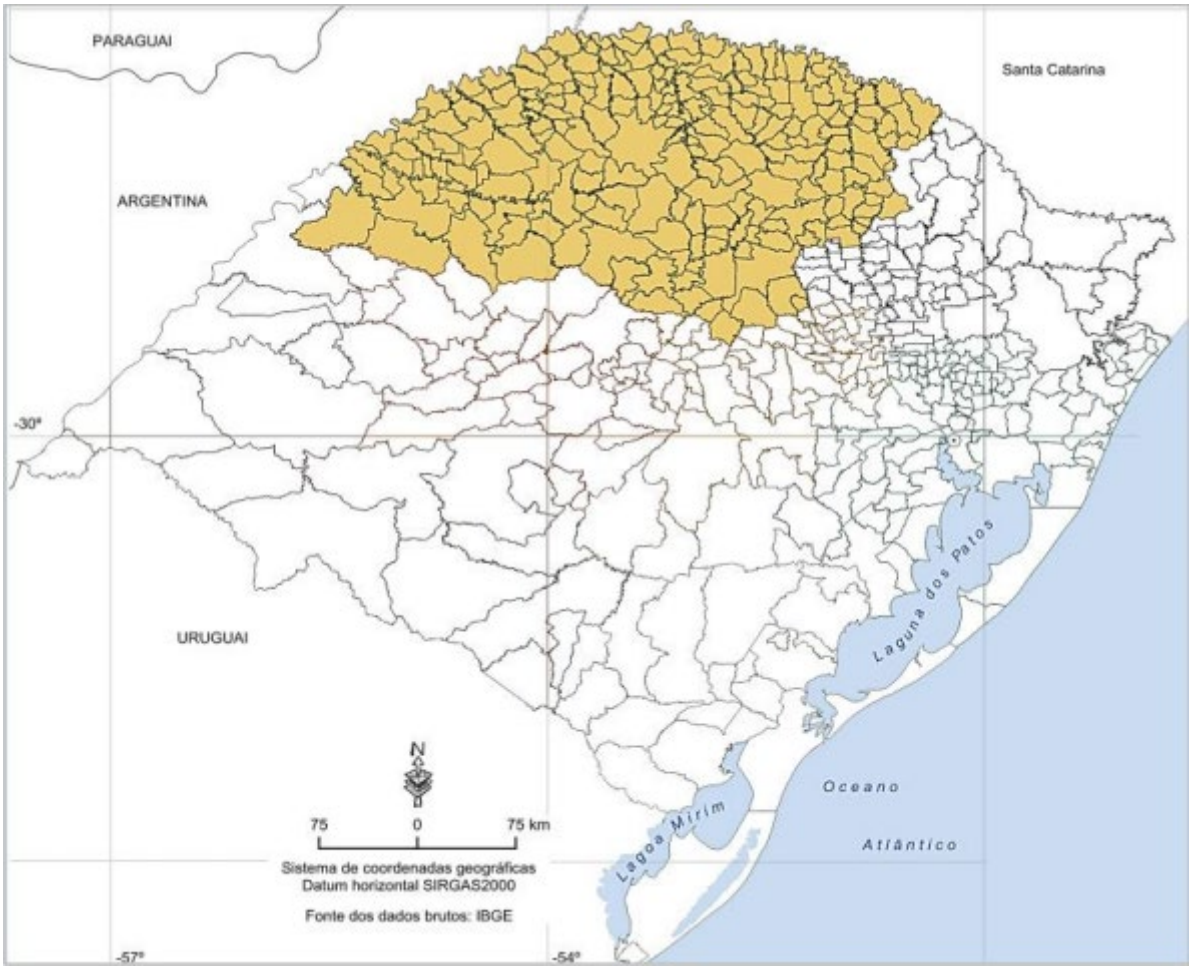
In addition to the research listed in Table 1, many others have been published on the subject. In his bibliometric research, Plessner (2017) found five hundred and twenty-one studies divided into theses, dissertations, scientific articles and books. Among those, two hundred and six had disposition effect as the main object of their research while three hundred and fifteen had it as a secondary object.

The first motivation for studying the disposition effect is a simple interest in psychological and economic phenomena. Why do individuals consistently show such bias in the way they treat their gains and losses? Neoclassical economic theory dictates that this is an irrational bias and should not occur. The second motivation has practical application: people who trade (including rural producers) predisposed to the disposition effect have lower returns than those who are not predisposed to it.

RELEVANCE TO THE FIELD OF REGIONAL DEVELOPMENT IN THE NORTHWEST OF RIO GRANDE DO SUL

The Northwest Region of Rio Grande do Sul is made up of 216 municipalities, 1,979,432 inhabitants, distributed over an area of 64,942 square kilometers, with a population density of 30.5 inhabitants per square kilometer (IBGE, 2011). In economic terms, it accounts for approximately 18% of the GDP of the state of Rio Grande do Sul.

Figure 1 | Location of the Northwest Mesoregion in the State of Rio Grande do Sul



Source: Bertotti *et al*. (2021).

There is a hegemonic social and economic process in the northwest of Rio Grande do Sul, influenced by its natural characteristics of topography, climate, soil and vegetation. It also features a peculiar land structure, with a strong presence of small family production units interspersed with large estates and agricultural production of grain crops and intensive dairy, pig and poultry farming, whose agricultural economic base plays an important economic role. (Trennepohl, 2010).

According to available official data, farming is one of the main economic activities in this region, especially the cultivation of grains such as soybeans, corn, wheat and oats. According to the IBGE (2020), in 2017 the northwest of Rio Grande do Sul had 180,248 agricultural establishments producing soybeans, corn, wheat and oats, i.e. 58.77% of the total in the state.

Although grain production might be a complex endeavor, requiring attention at every stage, the decision-making process at the time of trading is a decisive element in the economic success of rural establishments. For Egelkraut and Garcia (2006), the process of commercializing an agricultural commodity is an important variable in determining the success or failure of the activity.

According to Mattos and Fryza (2014), due to the volatility of agricultural prices, identifying the ideal time to market grain is a relevant decision, once selling production too early can eliminate the opportunity to market it at better prices later on. Similarly, holding on to it for too long, in addition to storage costs, can result in selling it at even lower prices. In this sense, given that grain production is a significant part on the economy of the northwest of Rio Grande do Sul, the fact that rural producers are not immune to behavioral biases has implications for this region's development.

METHODOLOGY

It will be initially presented the application of the experiment, its participants, financial rewards and data analysis. Finally, it will be shown the computer simulator developed for this study.

EXPERIMENT

Most of the experiments on the disposition effect involve undergraduate students, and are carried out in experimental economics laboratories. In this study, it was conjectured that it would not be possible to bring rural producers into a laboratory, since they are businessmen involved in their professional activities. In view of this, it was decided to select rural producers over the age of 18 living in the northwest of Rio Grande do Sul on a non-probabilistic basis.

A spontaneous invitation to take part in the survey was published on the social network LinkdIn®. As a result, 55 interested parties got in touch to arrange a date, place and time to carry out the experiment. The number of 55 individuals can be considered adequate, since most research in experimental economics relies on groups of around 35 individuals (Smith *et al*., 1988).

Camerer and Hogarth (1999) argue that monetary incentives are effective in judgment and decision-making tasks, encouraging participants not only to perform well and pay close attention to the instructions and stimuli of the experiment, but also to bring their behavior closer to real-life decisions. Following the literature, this study used monetary incentives (also known as rewards) in order to capture behavior that was closer to what was real and true for the participants. In order to reduce research costs, we decided to follow the methodology used by Goulart (2014), opting for rewards in the form of a tournament (when there are prizes only for the top finishers). The first place winner received five hundred reais, the second one three hundred reais, and the third one two hundred reais.

Two approaches were used to calculate the disposition effect, based on Odean (1998): aggregate (all subjects) and individual (per subject). In the aggregate analysis, two ratios are used to measure the disposition coefficient and its intensity: the proportion of realized gains and the proportion of realized losses. Realized gains (losses) comprise the number of transactions that were closed with a profit (loss).

This analysis is based on a comparison between the proportion of realized gains, given by the ratio of realized gains to the sum of realized gains and unrealized gains, and the proportion of realized losses, given by the ratio of realized losses to the sum of realized losses and unrealized losses, as described:

$$PGR = \frac{NGR}{NGR+NGNR}$$

$$PPR = \frac{NPR}{NPR+NPNR}$$

$$CD = PGR - PPR$$

In the individual analysis, a proportion of realized gains and losses is calculated for each participant, and then averaged across participants, as shown below.

$$PGR_i = \frac{GR_i}{GR_i+GNR_i}$$

$$PPR_i = \frac{PR_i}{PR_i+PNR_i}$$

$$CD_i = PGR_i - PPR_i$$

Where: GR are realized gains; GNR are unrealized gains; PGR is the proportion of realized gains; PR are realized losses; PNR are unrealized losses; PPR is the proportion of realized losses; CD is the disposition coefficient; i is the individual.

Several studies (Da Costa et al., 2013; Goulart et al., 2013; Paraboni, 2021, among others) have used approaches based on Odean (1998). In addition, Braga and Fávero (2016) state that among the different methodological procedures for processing data, the most common is the difference in means or proportions proposed by Odean (1998).

GRAIN MARKETING COMPUTER SIMULATOR

The designs of the experiments carried out by Weber and Camerer (1998) and by Vollmer, Hermann and Musshoff (2019) served as a basis for the simulator design. Table 2 summarizes the differences between the designs proposed by the authors and the one used in this study.

Table 2 | Design differences

Variables	Weber and Camerer (1998)	Vollmer, Hermann and Musshoff (2019)	Experiment
Number of assets	Six	Six	Six
Asset nomenclature	Anteile	Good	Product
Number of periods	3 + 15	3 + 11	3 + 11
Randomly-generated prices	Yes	Yes	Yes
Identical price range for all	Yes	Yes	Yes
Prices influenced by the trading actions of others	No	No	No
Probability of price variation	1/3	1/3	1/3
Assets with probability of rising	"++" = 65% "+" = 55%	"++" = 65% "+" = 55%	"++" = 65% "+" = 55%
Assets with neutral probability	"0" = 50% "0" = 50%	"0" = 50% "0" = 50%	"0" = 50% "0" = 50%
Assets with probability of falling	"-" 45% "--" = 35%	"-" 45% "--" = 35%	"-" 45% "--" = 35%
Initial price ($)	Different for each asset	Same for all assets (15)	Same for all assets (1.500)
Rising (or falling) price variation($)	1, 3 and 5	0,50, 1,50 and 2,50	50, 100 and 150
Display of previous prices	Yes	Yes	Yes
Allowed operations	Buying and selling	Selling	Selling
Initial value ($) allocated individually to subjects	10.000 (in cash for buying and selling)	90 (in assets stored for sale)	900.000 (in assets stored for sale)
Minimum marketing batch	Free	10%	10%
Short selling or the possibility of using borrowed money to trade	No	No	No
Remuneration of cash on hand	No	No	No
Subjects informed on probabilities of rising and falling	Yes	Yes	Yes
Use of financial rewards	Yes	Yes	Yes
Application methodology	In person	Online	In person
Method the experiment was carried out	Questionnaire	Computer simulation and questionnaire	Computer simulation and questionnaire
Subjects	College students	Rural producers	Rural producers

Source: Based on Weber and Camerer (1998) and Vollmer, Hermann and Musshoff (2019).

It was decided to name the assets with the neutral name “Product” to avoid any kind of influence that names of agricultural commodities such as soybeans, corn and wheat could cause. Using the market name of an asset would possibly influence the subjects’ decisions on when to sell or hold the asset.

The variables Initial price and Variation in price rise (or fall) were based on the values defined by Vollmer, Hermann and Musshoff (2019), but multiplied 100 times. This decision took into account that the $15 figure they used does not represent a value consistent with any considerable volume of an agricultural commodity.

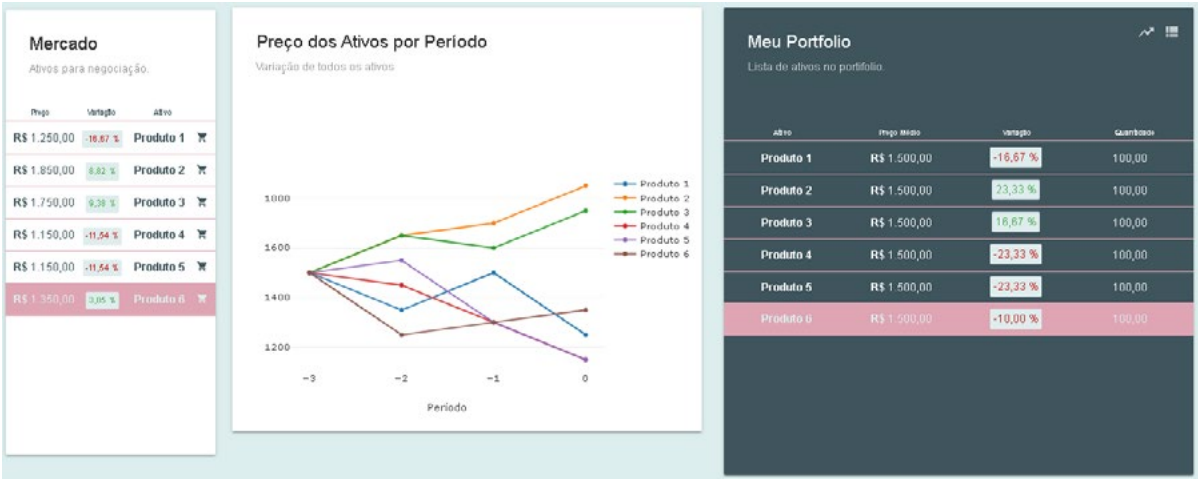
Building a design based on existing methodological configurations had some advantages. Firstly, given that the underlying designs have been tested and used before, it allowed the focus to be on the experiment and its participants. Secondly, it provided solidity and made it possible to compare results with those found in previous experiments.

SIMULATOR DEVELOPMENT AND INTERFACE

The design features described were implemented in a grain marketing simulator software. The simulator is a web application made up of the website, app, APIs and database. The website was developed on the WordPress platform, the app was built on Javascript and HTML5, the APIs were developed on the WordPress model and the database was built on MySQL. Its description and functionalities will be described below.

In the main interface, you can see the windows “market”, “asset price by period” and “my portfolio”. In it, participants in the experiment can follow asset prices, graphical price trends and check their portfolio. Figure 2 shows the simulator at the start of the experiment, i.e. at this point, the participant has not yet made any decision to sell and the “asset price by period” window displays the evolution of the historical price series, so that the participant can understand the price trend of each asset. It can also be seen in the window “my portfolio” that the participant has 100 tons of each asset in stock to be sold in the coming periods.

Figure 2 | Computer simulator main screen



Source: Grain marketing simulator, developed by the author.

After each participant performs their simulation, the software generates an output file indicating all operations carried out and the information is stored in a database. The goal was to develop a simplified interface that was as user-friendly as possible. According to Friedman and Sunder (1994), an experiment does not need to imitate the complex reality that is being tested; it only needs to contain the relevant variables that are being studied, allowing greater control of the experiment.

EMPIRICAL RESULTS OF THE PARTICIPANTS' BEHAVIOR IN THE EXPERIMENT

This section begins with a descriptive analysis of the data from the experiment and then verifies the existence of the disposition effect in the grain marketing process.

DESCRIPTIVE ANALYSIS OF THE EXPERIMENT DATA

This analysis is based on the individual output files generated by the simulator. These files provide not only information on the time each participant took to carry out the experiment, but also the trades made, the financial results obtained, among other things.

The time taken for each participant to complete the simulator periods is of great importance because it allows identification and discarding of individuals who have not completed the experiment or who have done it too quickly. The average time taken by participants was 15.78 minutes, with a

standard deviation of 6.10 minutes. The rural producer who took the shortest time completed the activity in just 6 minutes, while the one who took the longest completed it in 35 minutes.

The number of operations carried out at a gain (when the sale price is higher than the cost of production), the number of neutral operations (when the sale price is equal to the cost of production) and the number of operations carried out at a loss (when the sale price is lower than the cost of production) total 1,013 operations. Out of these, five hundred and sixty-seven (55.97%) were gains, eighteen (1.78%) were neutral and four hundred and twenty-eight (42.95%) were losses.

As for the financial return, the experiment revealed losses for all participants. The average return was -R$ 69,845.45, with a standard deviation of R$ 23,297.26 and a median of -R$ 67,500.00. The highest negative result recorded was -R$ 133,500.00, while the lowest was -R$ 25,000.00.

Table 1 shows that the group of participants made a total loss of -R$ 3,841,500.00. Of this amount, -R$401,500.00 came from operations carried out up to the last period, while -R$3,440,000.00 came from unsold products. When analyzing the results by product, it can be seen that products 1, 2, 3 and 4 generated gains for the participants, while products 5 and 6 incurred losses.

Table 1 | Financial return per product and period

Period	Product 1	Product 2	Product 3	Product 4	Product 5	Product 6	Total
0	(60,00)	374,50	217,50	(98,00)	(91,00)	(36,00)	307,00
1	(9,00)	58,00	650,00	(71,00)	(130,00)	(24,00)	474,00
2	(47,00)	322,00	20,00	(17,50)	(157,50)	(94,50)	25,50
3	186,00	228,00	17,00	(64,00)	(20,00)	(28,00)	319,00
4	12,50	440,00	(18,00)	25,50	(177,50)	(49,50)	233,00
5	0,00	32,00	(17,00)	0,00	(95,00)	(90,00)	(170,00)
6	13,00	40,00	(7,50)	305,00	(82,50)	(187,50)	80,50
7	64,00	310,00	(33,00)	236,00	(161,00)	(240,00)	176,00
8	137,50	154,00	(50,00)	130,50	(208,00)	(566,50)	(402,50)
9	82,00	24,00	(162,00)	184,00	(234,00)	(294,00)	(400,00)
10	(15,50)	264,00	(112,50)	27,00	(773,50)	(433,50)	(1.044,00)
Sold (R$)	363,50	2.246,50	504,50	657,50	(2.130,00)	(2.043,50)	(401,50)
Unsold (R$)	(41,50)	93,50	(267,50)	48,00	(1.547,00)	(1.725,50)	(3.440,00)
Total	**322,00**	**2.340,00**	**237,00**	**705,50**	**(3.677,00)**	**(3.769,00)**	**(3.841,50)**
In thousands of reais.							

Source: research results, own elaboration.

It is worth noting that in the design of this experiment, following the studies conducted by Weber and Camerer (1998), as well as by Vollmer, Hermann and Musshoff (2019), two products had price increase probabilities, two other products had neutral probabilities, and the remaining two had price drop probabilities. These probabilities were explained in the instructions to the participants. Although the products were not identified, participants could deduce which products were likely to fall in price. In this context, a rational individual should try to identify the products likely to fall in price and sell them as quickly as possible, while keeping hold of the products likely to rise in price. Since products 5 and 6, those likely to fall in price, were the least sold during the experiment, such behavior did not materialize.

It seems that all the participants were reluctant to sell below the cost of production during the experiment, which resulted in losses for them. This behavior, which diverges from that advocated by the defenders of rationality, refers to the behavioral bias known as the disposition effect. In the next session, it will be examined whether rural producers in the northwest of Rio Grande do Sul show the disposition effect when marketing grains.

CHECKING THE PRESENCE OF THE DISPOSITION EFFECT

Below you will find the results of the analysis designed to verify the existence of the disposition effect among rural producers in the northwest of Rio Grande do Sul when marketing grains. Tables 2 and 3 show the results at aggregate and individual level, respectively, for the 55 rural producers who took part in the experiment.

Table 2 | Descriptive statistics of disposition coefficients at aggregate level

Variables	Total
Realized gains (GR)	567
Realized losses (PR)	428
Unrealized gains (GNR)	1.210
Unrealized losses (PNR)	2.421
PGR=GR/(GR+GNR)	0,3191
PPR=PR/(PR+PNR)	0,1502
Disposition effect (CD = PGR - PPR)	0,1689
Standard error of (PGR-PPR)	0,0129
Z statistic (standard normal)	13,0630*
(p-value)	0,0000

*significant at 1%.

Source: research results, own elaboration.

Considering the results presented in Table 2, it can be seen that, in general, rural producers in the northwest of Rio Grande do Sul sold a higher proportion of agricultural commodities when the price was higher than the cost of production, compared to when the price was lower than the cost of production. In this case, the ratio of realized gains to total gains (PGR) was 0.3191, and the ratio of realized losses to total losses (PPR) came to 0.1502. This result contains evidence confirming that the disposition effect is present at an aggregate level among rural producers in the northwest of Rio Grande do Sul, since the positive difference between PGR and PPR (CD = 0.1689) is statistically significant at 1% level.

Table 3 | Descriptive statistics of individual disposition coefficients

Variables	Total
Total number of participants	**55**
Individuals who showed disposition effect	**52**
Individuals who showed no disposition effect	**3**
Average PGRi	**0,3201**
Average PGRi	**0,1446**
Average CDi	**0,1755**
Median CDi	**0,1700**
Maximum CDi	**0,3954**
Minimum CDi	**-0,1260**
Standard deviation of CDi	**0,1098**
t-test for mean CDi= 0	**11,8524***
(p-value - two-tailed)	**0,0000**
*significant at 1%.	

Source: research results, own elaboration.

When analyzing the results obtained at individual level, Table 3 shows that rural producers in the northwest of Rio Grande do Sul were more likely to sell agricultural commodities when their prices were above the cost of production (PGRi = 0.3201) compared to selling agricultural commodities when prices were below the cost of production. (PPRi = 0,1446). These results are consistent with the CDi statistics (0.1755) indicating that, in general, the participants demonstrated a disposition effect at individual level.

Finally, Table 4 shows the asymmetry and kurtosis values for the disposition effect variable and the corresponding associated standard errors needed to measure the Z score to verify normality. Z values do not exceed the limits of |1.96|, indicating that there are no statistically significant deviations from normality. This can also be verified by the statistically non-significant result of the Shapiro-Wilk test (W [degrees of freedom = 55] = 0,979; *p* = 0,441).

Table 4 | Identification of normality using asymmetry and kurtosis

Variables	Value	Standard error	Z score
Asymmetry	-0,008	0,322	-0,025
Kurtosis	-0,088	0,634	-0,139

Source: research results, own elaboration.

Based on the values obtained and the methodological procedures adopted, both in relation to the results at aggregate and individual level, there is evidence that the rural producers participating in the experiment express the disposition effect. This confirms that rural producers in the northwest of Rio Grande do Sul are affected by the disposition effect when marketing grain.

The results of the proportion test at the aggregate level resulted in a CD equal to 0.1689. This value is lower than those found by Shu et al. (2005), who obtained a CD = 0.2100 when investigating investor accounts in Taiwan, and by Brown et al. (2006), who found a CD = 0.2800 when analyzing daily investor data from the Australian stock exchange.

However, the value measured (CD = 0.1689) is higher than the values found by other researchers. This includes the study by Boolell-Gunesh et al. (2009) with CD = 0.0500, which investigated the buy and sell orders of investors in a French stock brokerage firm. It is also higher than the values found by De Choe and Eom (2009) with CD = 0.0780, when examining the disposition effect in the Korean stock futures market; by Ormos and Joó (2014) with CD = 0.1410, when analyzing the trading patterns of Hungarian university students; by Da Costa et al. (2013) with a CD = 0.0920, when carrying out an experiment with experienced investors and Brazilian university students, and by Goulart et al. (2013) with a CD = 0.0380, when applying an experiment on Brazilian university students examining the relationship between psycho-physiological variables and the disposition effect.

When considering the studies that served as a reference for this study, such as Odean (1998), who found a CD equal to 0.1680, and Vollmer, Hermann and Musshoff (2019), who measured the CD equal to 0.1830, we found a very similar result. Furthermore, when comparing the results of the research with the experimental study carried out by Weber and Camerer (1998), it can be seen that, similarly to the participants in that experiment, rural producers in the northwest of Rio Grande do Sul made more sales of agricultural commodities when prices were above the cost of production

than when they were below the cost of production.

These results are in line with previous studies that have identified the presence of the disposition effect in different contexts. Although the CD value found is slightly different from other studies, it remains within a comparable range and indicates the consistent presence of the disposition effect among rural producers in the northwest of Rio Grande do Sul. These findings are significant, as they reinforce the notability of recognizing the disposition effect as a factor in the behavior of rural producers when marketing grain.

The behavioral bias identified undeniably has an adverse impact on the wealth of rural producers and, consequently, on the Northwest region of Rio Grande do Sul overall. Underestimating the disposition effect is a difficult task. Odean (1998) estimated that this bias can reduce investors' returns by more than 4.4%. Vollmer, Hermann and Mussohoff (2019) calculated a potential loss of 15% for German rural producers who postpone grain sales due to low prices. Considering the value of 35.821 billion reais referring to the production of soybeans, corn, wheat and oats in the northwest of Rio Grande do Sul in 2021, along with the average return obtained by the participants in the experiment, which was -7.76%, a potential loss of 2.772 billion reais can be estimated, to illustrate. This potential loss may, in part, arise from the disposition effect.

Identifying the existence of the disposition effect and calculating potential losses may not be enough to contribute to the development of the northwest of Rio Grande do Sul. Part of its wealth is generated by grain production, where soybeans, corn, wheat and oats are the main crops. According to the Agricultural Census, carried out by IBGE in 2018, 9,733,253 tons of soybeans, 3,683,810 tons of corn, 1,818,579 tons of wheat and 426,255 tons of oats were harvested in an area of 4,161,819 hectares. In this context, it is essential that soybean, corn, wheat and oat producers in the northwest of Rio Grande do Sul adopt effective strategies to mitigate the disposition effects.

Researchers (Fischbacher et al., 2017; Vaarmets; Liivamägi; Talpsepp, 2019) describe that the use of the stop loss strategy can reduce and even reverse the disposition effect. According to Nolte (2016), the stop loss strategy is one of the most common investment tools for risk management and loss control, and is widely used by institutional and individual investors to avoid behavioral biases.

From a behavioral point of view, the stop loss strategy is just a mechanism to avoid or anticipate the usual pitfalls of human judgment, and can be beneficial for rural producers by removing cognitive biases, especially in the case of a constant fall in agricultural commodity prices. This could be seen in the experiment carried out in this study, in which the participants tended to hold on to their products even longer with increasing losses, thus adopting irrational trading behavior. This emphasizes the importance of them learning to deal with their behavioral biases, with the stop loss strategy being just one dimension.

FINAL CONSIDERATIONS

Based on the statistical tests and the proposed methodology, it was confirmed that rural producers in the northwest of Rio Grande do Sul tend to keep grain in storage when the price is below the cost of production and sell it quickly when the price is above the cost of production. In other words, the individuals taking part in the experiment exhibited the disposition effect, and did not behave as expected from a rational decision-making perspective.

When considering regional development from an endogenous perspective, the results of this study show that the behavioral approach can be an ally in increasing rural producers' income in the northwest of Rio Grande do Sul. Obviously, as De Oliveira and De Souza Lima (2003) point out, regional development cannot be understood only in terms of economic growth, but also in terms of social, cultural, environmental and political factors, along with improved quality of life. Nevertheless, increasing the income of rural producers, especially small producers, can be seen as a crucial issue for the development of the northwestern region of Rio Grande do Sul in its entirety. This issue can be addressed in different dimensions:

- Reducing inequality: some regions have high levels of economic inequality, and rural producers account for a portion of the population in these areas. Increasing the income of these producers is crucial to reducing inequality in those regions;

- Boosting the local economy: increasing the income of rural producers helps strengthen the local economy. With more financial resources available, they are more able to consume goods and services within their communities, strengthening local economic growth;

- Sustainable rural development: by increasing the income of rural producers, more sustainable agricultural practices can be encouraged. This includes investments in modern agricultural technologies, training in sustainable farming methods and efficient management of natural resources. Sustainable rural development is crucial to preserving the environment and ensuring long-term viability of agricultural activities;

- Reducing rural exodus: rural exodus is often driven by a lack of opportunities and difficult living conditions in rural areas. Increasing the income of rural producers can help keep individuals in rural areas, creating a more attractive environment for them to remain in their communities of origin and also contributing to the vitality and diversity of these regions.

In short, increasing the income of rural producers in the northwest of Rio Grande do Sul is not only beneficial for these individuals, but can also play a fundamental role in the development of the region. However, for the findings of this study to be passed on from the academic world to rural producers in general, some links need to be established. These links, in which both researchers and universities participate as regional players, can include:

- University extension programs to raise awareness among rural producers of the possible damage caused by the disposition effect and other behavioral biases;

- Establish partnerships between universities and entities linked to rural producers to explain the behavioral approach in language accessible to the lay public.

By implementing these links, rural producers in the northwest of Rio Grande do Sul can be effectively involved and informed about scientific advances, contributing to a culture of valuing science and its application in solving contemporary challenges..

As far as we know, the present study was the first experiment carried out with rural producers in Brazil and the second worldwide. By demonstrating the existence of the disposition effect in the agricultural context, space is opened for new insights and possibilities to fill some knowledge gaps. In this sense, we suggest future experiments that seek to: verify the presence of the disposition effect, considering other points of reference besides the cost of production; compare groups of rural producers before and after receiving training on the influence of behavioral biases in grain marketing; investigate characteristics of farms with the disposition effect; evaluate the influence of socioeconomic variables of rural

producers regarding the disposition effect.

In addition, it is recommended that the verification of the disposition effect should be carried out using empirical data made available by cooperatives and cereal growers, preferably based on a broad database. This database would make it possible to relate the disposition effect to a series of characteristics of rural producers, such as managed and mismanaged clients, income level, among other relevant variables.

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