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CHANGES IN BRAZILIAN DAIRY CONSUMPTION IN THE EARLY STAGE OF COVID-19 PANDEMIC: AN ANALYSIS BASED ON THE NOVA CLASSIFICATION

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ABSTRACT

The uncertainty caused by COVID-19 pandemic has impacted people's habits in many ways. Understanding the effects of the pandemic on food consumption becomes essential for industries, policymakers, researchers, and interested people. This paper investigates how the early stage of COVID-19 pandemic changed the consumption of dairy products in Brazil. Estimates show that the effects of the COVID-19 pandemic on dairy consumption in Brazil are aligned with the most recent Brazilian food classification (NOVA). With a few exceptions, the pandemic increased (decreased) the probability of increasing (decreasing) the consumption of minimally processed and processed dairy products, as well as dairy culinary ingredients. For the ultra-processed, the probability of increasing consumption was significant for indulgent products and those used in culinary recipes. Wealthier families could maintain or increase their well-being regarding dairy consumption, while lower-income families needed to reallocate their budget, which reinforces the importance of public policies in times of uncertainty.

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INTRODUCTION

The unexpected COVID-19 pandemic is a challenge for nations. A comprehensible scenario of the consequences of this moment is only possible in the future, but based on the evidence to date, the impact is extremely severe. Since the first alert of the Chinese government and World Health Organization (WHO) in December 2019, until now (BARUA, 2020), more than 65 million people have been infected worldwide and more than 1.5 million have died. Furthermore, many countries are in quarantine, lockdown, and/or social distancing for a defined period; we are facing the possibility of the deepest global recession in decades (a predicted contraction of more than 5% of the global GDP in 2020); and dealing with several other tragic effects such as overloaded health systems, shortages of basic products in vulnerable areas, and unemployment (HUNTER, 2020). The effects on several sectors of the economy of nations also tend to be devastating. Gopinath (2020) argues that on the demand side, the loss of income, fear of contagion, and heightened uncertainty decrease people's expenditure. Consequently, firms expect lower demand and reduce their spending and investment, aggravating worker layoffs and business closures. Other problematic effects arise from the supply side: temporary prohibition in times of quarantine, a drop in capacity utilization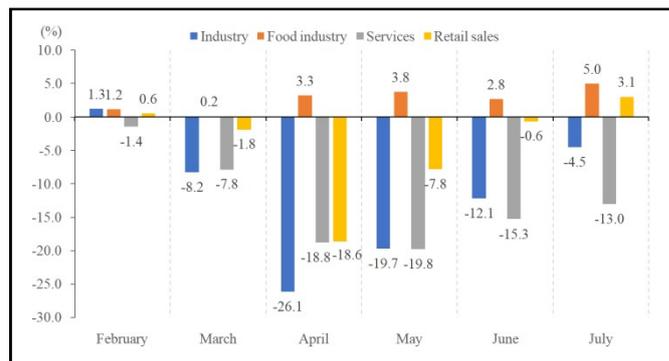 for the sectors allowed to operate, and difficulty in obtaining inputs from the domestic and international supply chain. These factors contribute to increasing business costs and constitute a negative productivity shock, reducing economic activity. Despite the supply and demand effects that occur in all sectors to some degree, Barua (2020) highlights that demand shocks in a pandemic can be distinct for essential and non-essential goods. Essential goods (e.g., food and medicine) are less affected by negative demand shocks, precisely because they are essential. Nicola et al. (2020) observe the panic-buying effect, which may even increase the demand for certain goods at times. Food and beverages represent one of the most essential sectors in countries' economies (LUA et al., 2011). For the population, these products are fundamentally necessary for living. However, the importance of this sector is also related to other aspects of the economy. The food and beverage industries involve several other important activities that provide inputs for production, such as agriculture, livestock, transport, oil, packaging, and many others; therefore, many jobs are linked directly or indirectly to this sector. Moreover, it is responsible for increasing the tax revenue of countries based on the velocity and amount of transactions, and for many countries, it is essential for the international insertion and equilibrium in public finance through exports. It is no coincidence that many efforts have been made to understand the behavior of the food industry and food consumption in times of crises, as in Zurawicki and Braidot (2005), Cudjoe et al. (2010), Kumar and Quisumbing (2013),

Kaytaz and Gul (2014), Liefert and Liefert (2015), and Baker et al. (2020). The dairy industry is part of the food sector. Its importance for most countries is immeasurable. Among others, the dairy industry provides essential products for human consumption; provides inputs for processed products; supplies products particularly important for newborns, children, and the elderly; provides low-cost products fundamental for fighting hunger and malnutrition in vulnerable areas; creates jobs; provides families with subsistence; and ensures international insertion. Brazil is a suitable example for this scenario. Regarding the pandemic, the first official case of COVID-19 infection in Brazil was announced on February 26, 2020. The disease spread quickly, and in March 2020 the state and municipal governments started to enact and enforce quarantines and social distancing policiesi. Despite the differences in policies adopted in different locations based on the degree of infection, health system capacity, political view, among other factors, the number of cases and deaths increased significantly. In December 2020, Brazil had the third-highest number of cases worldwide (behind the United States and India) and the second-highest number of deaths (behind the United States), with more than 8 million cases and 200 thousand deathsii. In relation to food and beverages, the dairy sector in particular plays a pivotal role in Brazil. According to the Household Budget Survey 2017–2018 (IBGE, 2020b), dairy products are among the foods most consumed by the population and represent an important part of the Brazilian diet. Fluid milk is found in 91.6% of Brazilian households. Other dairy products with high penetration rates are condensed milk (90.1%), sour cream (89.7%), and cream cheese (64.5%) (EMBRAPA, 2020).

This study aims to investigate how the early stage of COVID-19 pandemic, period between April and May 2020, changed the consumption of dairy products in Brazil. Specifically, based on a structured questionnaire administered to 5,105 consumers countrywide, we aim to analyze how households modified their dairy consumption patterns in the early stage of COVID-19 pandemic considering social distancing, mental health, isolation, homeworking, childcare, and income loss, among other aspects to be considered later. Presumably, the undesirable consequences of the COVID-19 pandemic significantly impacted the consumption of dairy products in Brazil, which reinforces the importance of this study in providing useful information for the dairy industry, consumers, policymakers, researchers, and people interested in general. The questionnaires were administered from April 23 to May 3, 2020. Speaking briefly about the early stage of COVID-19 pandemic in Brazil, April 2020 represented a hard period regarding social distancing policies. As can be seen from the Figure 1, all major sectors showed cumulative negative variation in the level of activity in the highlighted period. However, within the industry sector, the food industry had a positive change in the period between March and May 2020, with a household consumption increase. Therefore, even when the Brazilian economy was going through the worst moment during the pandemic, the food industry showed a positive variation. Some factors may be related to this result. First, there was uncertainty and some consumers bought food for stock. Second, the lockdown required people to stay more at home, both because of the interruption of some economic activities, and for work in the home office. In this sense, the dairy sector may or may not have followed this trend in the food industry, and this is exactly what we intend to discuss.

The period of application of the questionnaire was exactly the one in which the negative economic effects of the early stage of COVID-19 pandemic in industry were most present. However, the harmful effects on people's income were only emerging. According to National Household Sample Survey data, the unemployment rate in the period March-April-May was 12.9%, while in the period February-March-April this rate was equal to 12.6%. The highest unemployment rate in 2020 was in the July-August-September period (14.6%) (IBGE, 2021f). Therefore, there was no great effect of variation in income from work during this period. Moreover, the Brazilian government had just started payments in line with the "emergency aid" policy of income transfer (auxílio-emergencial in Portuguese) to a few individuals, while many more people began

receiving these in the subsequent months (CARROL, 2020). In fact, the questionnaire does not have any question that allow controlling for income changes, but this is not a serious limitation due the reasons above.

Source: Authors' own elaboration based on IBGE (2021c, 2021d, 2021e).

Figure 1. Economic activity level in Brazil's sectors in the early stage of the COVID-19 pandemic in 2020 (in % cumulative variation)

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Instead of income and prices issues, the focus of the paper is the consumption behavior in times of uncertainty. The results consider the entire socioeconomic and health environment at the time of the research. This can be seen as a positive work differential as well because it shows how consumers behave in times of adversity. Consumers have restrictions; thus the consumption behavior is not expected to be linear for all types of foods. Our intention is precisely to understand how people change the consumption of dairy products in consequence of the uncertainty generated in the beginning of COVID-19 pandemic. We aggregated the dairy products according to the NOVA classification system, the most recent Brazilian food classification that divides foods according to the extent and purpose of industrial processing. It includes four categories: ultra-processed, processed, or minimally processed foods and culinary ingredients (BRASIL, 2014). The NOVA classification provides dietary guidelines for the Brazilian population, and we believe that our results

are even more relevant in this context. The literature on the effects of COVID-19 is recent and ongoing. For household food consumption specifically,studies converge on job losses, income reduction, and the subsequent decrease in food purchasing to various degrees according to the research assumptions, methods, and regions analyzed, such as Gupta and Kishore (2020) for India and Power et al. (2020) for the United Kingdom. An interesting paper is Baker et al. (2020), which elaborates on panicbuying behavior in the United States: At the beginning of the pandemic, expenditure increased sharply, particularly in retail, credit card spending, and food items, followed by a significant decrease in overall spending. Regarding the dairy sector, Liu and Rabinowitz (2020) found evidence that the restrictions caused by the COVID-19 pandemic such as social isolation and changes in retail activities may have reduced prices for all dairy products in the United States by 8%. The products with the greatest price reduction were milk-half gallon (-28.8%), butter (-15.8%), and cream cheese (-13.5%). To our knowledge, this study is one of the first to focus on the COVID-19 pandemic and dairy consumption, and the first to analyze this scenario for the food industry in Brazil.

Model Specification: As in Moon et al. (2011), given the ordered and qualitative nature of the data, we estimated ordered probit models. Probit models assume a binary dependent variable, whereas in ordered probit models, the dependent variable can assume ordered values that can be ranked. According to Greene (2002), the ordered probit model is built as a latent regression in the same way as the binomial probit as follows:

$$Y^* = X'\beta + \varepsilon \tag{1}$$

where Y^* is the dependent variable, X is a matrix with independent variables, β is the parameters vector, and ε the error term. As is known, Y^* is unobserved; however, we do observe:

$$= \begin{cases} 0, Y^* \leq \mu_1 \\ 1, \mu_1 \leq Y^* \leq \mu_2 \\ 2, \mu_2 \leq Y^* \leq \mu_3 \\ \vdots \\ J, \mu_j \leq Y^* \end{cases} \tag{2}$$

Table 1. Descriptive statistics on consumer behavior in relation to the purchase of dairy products during the pandemic

NOVA Categories	Product	Not buy (%)	Decreased (%)	Kept stable (%)	Increased (%)	Total observation
Minimally processed	Pasteurized milk	49.07	7.83	35.44	7.67	4,549
	UHT milk	21.78	7.29	54.71	16.23	4,610
	Powder milk	40.04	7.09	41.76	11.11	4,473
Processed	Cheese	2.99	10.23	59.73	27.05	4,879
Ultra-processed	Dairy beverages	38.67	10.18	42.60	8.55	4,420
	Dairy alternatives	66.03	9.81	19.25	4.92	4,333
	Milk cream	8.00	9.46	61.45	21.08	4,649
	Dulce de leche	37.44	12.30	40.99	9.26	4,503
	Yogurt	11.29	12.29	58.50	17.92	4,721
	Condensed milk	12.70	9.74	56.02	21.54	4,670
	Fermented milk	42.04	10.20	39.78	7.99	4,382
	Petit Suisse	57.63	10.72	26.26	5.38	4,329
	Ice cream	23.52	22.95	41.62	11.91	4,541
Culinary ingredients	Butter	4.92	6.29	66.98	21.80	4,834

Source: Own elaboration.

METHODOLOGY

Data collection: The survey was conducted from April 23 to May 3, 2020 through social networks such as Facebook and WhatsApp. The data collection instrument was a virtual questionnaire created using Google Forms®, according to resolution 510 of April 7, 2016 of the National Health Council. For this cross-sectional study, the non-probabilistic sampling technique called snowball sampling was used, in which individuals selected as respondents invite new people from their network of friends and acquaintances. As the survey was online, responses were obtained from the Brazilian population with equipment with Internet access, corresponding to a nonprobabilistic sample with selection bias. This paper reports on the responses to the following question in the survey: "What changed in the consumption of the following foods during the pandemic?" In total, 5,105 consumers distributed throughout the Brazilian territory participated in the survey. Within the scope of income classes, the survey covered various patterns in the country. Families with a monthly family income of up to 1 minimum wage (MW) represented 4.76% of respondents (income level one). Families with 2 to 5 MW accounted for 34.67% (income level two), followed by 6 to 10 MW (25.8%) (income level three), and above 10 MW (34.77%) (income level four). Table 1 illustrates the distribution of responses for respondents' behavior regarding the consumption of different products during the pandemic. Note that the majority of responses indicated a maintenance of product consumption during the pandemic, but some exceptions were noted for pasteurized milk, vegetable-based drinks, fermented milk, and petit Suisse. Responses for these indicated that consumers were generally not in the habit of buying such products. On the other hand, when analyzing the increase or decrease in consumption during the pandemic, the responses were not homogeneous for the products or NOVA categories, generating the need for a more careful quantitative analysis involving changes in consumer behavior given income level.

where the μ's are the threshold unknown parameters to be estimated with vector β, while J is the number of categories of the dependent variable. It assumes that the independent variable X and categorical variable Y are observed, but the latent variable Y* is unobserved. As for the probabilities of Y, the estimation is described as follows:

$$Y = \begin{cases} P(Y = 0|X) = F(\mu_1 - X'\beta) \\ P(Y = 1|X) = F(\mu_2 - X'\beta) - F(\mu_1 - X'\beta) \\ P(Y = 2|X) = F(\mu_3 - X'\beta) - F(\mu_2 - X'\beta) \\ \vdots \\ P(Y = J|X) = 1 - F(\mu_J - X'\beta) \end{cases} \tag{3}$$

where function (·) is the cumulative normal density. The derivatives of the probabilities with respect to X correspond to the marginal effect of changes in the regressors. To better fit the model, Greene (2002) suggests the Likelihood Ratio (LR) test to determine if at least one of the coefficients is statistically different from zero. According to Greene (2002), the LR statistic is calculated as indicated in equation (4) and follows a chi-square distribution ($\chi2$) with q degrees of freedom, where q is the number of independent variables.

$$LR = -2(lnL_R - \ln L) \tag{4}$$

where LR and L are the values of the maximum likelihood functions estimated with restriction (coefficient vector restricted to zero, that is, $\beta = 0$) and without restriction (unrestricted coefficient vector, that is, $\beta \neq 0$). In this study, the estimation followed the two stages mentioned above. The first was the calculation of the coefficients and cutoff parameters for the four categories of income considered. Then, the marginal effect was estimated, which returned the probabilities of an increase or decrease in consumption for each dairy product in the different income patterns. The first income class, up to one minimum wage, was considered the reference for the model, and therefore, the

results are all in relation to it. This procedure was performed for the 14 dairy products considered.

RESULTS AND DISCUSSIONS

Economic theory indicates that the consumption levels for some products tend to increase in times of adversity, while those for other products tend to decrease (ALTHAUS, 2002; OHANIAN, 2010; ALONSO ET AL., 2015). In addition, the level of consumption is expected to be higher for higher levels of income (MUSGROVE, 1980). In this scenario, our goal is to understand the behavior of dairy products consumption in the early stage COVID-19 pandemic, a period of uncertainty where some initial social distancing policies started to be adopted.

The categories "processed" and "culinary ingredients" contain only one dairy product each, cheese and butter, respectively. Both products presented statistically significant results for all income levels and behavior consumption. In other words, there was a decrease in the probability of reducing the purchase and an increase in the probability of enhancing the purchase of cheese and butter in the early stage of COVID-19 pandemic in Brazil. These products are used as ingredients in many important meals in Brazil, including snacks, creams, sauces, and regional meals. According to Uggioni et al. (2020), the period of uncertainty and isolation caused by the pandemic influenced food choice, purchase, and preparation. Social distancing policies has brought about more home cooking and stimulated cooking skills. A similar behavior occurred in the United States, where more than half the participants in Hunter's (2020) study reported cooking more frequently than before the pandemic.

Table 2. Probability of changing dairy consumption in the COVID-19 pandemic in Brazil by NOVA category and income level

NOVA Categories	Product	Decrease			Increase		
		Income level			Income level		
		2	3	4	2	3	4
Minimally processed	UHT milk	-0.045	-0.038	-0.051	0.061	0.049	0.073
		(0.027)	(0.028)	(0.027)	(0.030)	(0.030)	(0.030)
	Pasteurized milk	-0.050	-0.053	-0.071	0.039	0.042	0.061
		(0.038)	(0.038)	(0.038)	(0.026)	(0.026)	(0.026)
	Powder milk	-0.055	-0.070	-0.087	0.052	0.071	0.098
		(0.030)	(0.030)	(0.029)	(0.024)	(0.024)	(0.024)
Processed	Cheese	-0.094	-0.109	-0.142	0.102	0.127	0.199
		(0.028)	(0.028)	(0.028)	(0.023)	(0.023)	(0.023)
Ultra-processed	Dairy beverages	0.039	0.029	-0.013	-0.026	-0.020	0.009
		(0.046)	(0.046)	(0.045)	(0.032)	(0.033)	(0.032)
	Dairy alternatives	-0.047	-0.027	-0.071	0.035	0.018	0.059
		(0.032)	(0.033)	(0.032)	(0.021)	(0.021)	(0.021)
	Milk cream	-0.039	-0.046	-0.064	0.050	0.061	0.094
		(0.023)	(0.023)	(0.023)	(0.026)	(0.026)	(0.026)
	Dulce de leche	-0.063	-0.061	-0.104	0.041	0.039	0.078
		(0.038)	(0.039)	(0.038)	(0.021)	(0.021)	(0.022)
	Yogurt	-0.057	-0.061	-0.094	0.053	0.058	0.104
		(0.029)	(0.029)	(0.029)	(0.023)	(0.023)	(0.023)
	Condensed milk	-0.063	-0.066	-0.087	0.075	0.081	0.118
		(0.026)	(0.026)	(0.025)	(0.025)	(0.026)	(0.025)
	Fermented milk	-0.063	-0.057	-0.102	0.040	0.035	0.076
		(0.040)	(0.040)	(0.039)	(0.021)	(0.021)	(0.022)
	Petit Suisse	-0.007	-0.002	-0.055	0.004	0.001	0.037
		(0.045)	(0.046)	(0.045)	(0.026)	(0.027)	(0.027)
	Ice cream	-0.018	-0.003	-0.053	0.011	0.002	0.037
		(0.036)	(0.036)	(0.036)	(0.022)	(0.023)	(0.023)
Culinary ingredients	Butter	-0.054	-0.066	-0.084	0.075	0.099	0.149
		(0.022)	(0.021)	(0.021)	(0.022)	(0.023)	(0.023)

Source: Own calculations.
Note: Parameters in bold are statistically significative at least at 10%.

Beginning with "minimally processed" dairy products, the NOVA guidelines recommend natural and minimally processed products as the basis of people's diets. In our case, the ideal scenario is the one where people significantly decrease the probability of reducing consumption while enhance the probability of increasing consumption, meaning that in times of uncertainty and social distance people rely on more natural products. This pattern can be observed for all income levels in relation to milk powder, the third-most sold dairy product in Brazil, which can be explained by the greater amount of time at home due social distance policies in the early stage of COVID-19 pandemic. Moreover, milk powder is one of the less perishable and more storable dairy products; therefore, it is not surprising to observe the storage effect and the panic-buying effect of Baker et al. (2020). For UHT and pasteurized milk, it is worth noting that the highest income level presented a decrease (increase) in the probability of reducing (enhancing) the consumption significantly, which is probably a consequence of the beginning of policies related to quarantines, homeworking, homeschooling, and everything else that entails staying more at home. The lowest income level for UHT milk was also significant in terms of increasing the probability of enhancing consumption.

Furthermore, IBGE (2020b) indicates that both the consumption of cheese and butter has recently increased in Brazil; thus, the pandemic may have intensified a trend that was already in course. The "ultra-processed" category contains distinct types of dairy products. The first noteworthy result was milk cream, with all coefficients significant. This means that the first measures to combat COVID-19 and all the uncertainty involved are related to a decrease (increase) in the probability of reducing (enhancing) the consumption of milk cream, which could be associated with a longer time at home and homemade meals. Like cheese and butter, milk cream is highly used in Brazilian cooking. The coefficients for yogurt were also statistically significant. Yogurt is highly consumed by children, especially those with sweet flavors, while for adults, it is associated with convenience, practicality, and many times with health. The early stage of COVID-19 pandemic increased the probability of consuming more yogurt and decreased the probability of reducing consumption. Dulce de leche and condensed milk are indulgent dairy products, usually associated to satisfy consumers' desires and appetite for some pleasures, consumed alone or used in cakes, pies and candies. Many studies reported an increase in the consumption of indulgent products during the pandemic period (WERNECK et al., 2021; MALTA et al., 2020; SCARMOZZINO & VISIOLI, 2020; RUIZ-ROSO et al.,

2020), known as emotional or stress eating. More specifically, they represent highly sugary products that people rely on in moments of stress, anxiety, and emotional issues, which are some of the effects caused by the pandemic (POWER, 2020). It is not by coincidence that all coefficients for dulce de leche and condensed milk in Table 2 were significant, except for the probability of decreasing the consumption of dulce de leche for income level 2. For the remaining "ultra-processed" products, all coefficients related to increasing the probability of consumption of fermented milk were significant, a product highly related to children consumption. For dairy alternatives, there was no clear pattern, while for petit-Suisse and ice cream, no coefficient was statistically significant. These three last cited products were the least purchased among the samples. For ice cream, even as an indulgent product like dulce de leche and condensed milk that tends to have increased consumption during periods of stress such as a crisis, the questionnaires were distributed in the middle of autumn in Brazil, when the consumption of ice cream is not very expressive.

CONCLUSION

Analyzing the results of the study by NOVA category, the effects of the early stage of COVID-19 pandemic on dairy consumption in Brazil were aligned with both economic theory and consumption recommendations. With a few exceptions, the estimates showed a significant probability of increasing consumption of the recommended food groups: minimally processed, processed, and culinary ingredients. Among ultra-processed foods, the probability of increasing consumption was significant for indulgent products and those used in culinary recipes, reinforcing the effect of stress eating and staying at home, as reported in other studies. Noteworthy is that the highest income class demonstrated a decreased (increased) probability of reducing (enhancing) the consumption of a great number of dairy products than the other classes, meaning that wealthy households are privileged. In other words, in the COVID-19 pandemic and considering all aspects discussed in the paper, wealthier families are able to maintain or increase their well-being in relation to dairy consumption by purchasing products for children and the elderly, healthy products, culinary ingredients, indulgent products, and so on. On the other hand, lower-income families needed to reallocate their budget; thus, for some products, the coefficients were not significant. According to our model, this does not mean they do not buy these products, but the pandemic did not change the probability of increasing or decreasing consumption. The discussion in this paper reinforces the importance of public policies in times of crisis to support people and minimize uncertainty, especially income transfer policies. It is essential to support households' income and food consumption, which supports families in adapting to new realities. As stated in the Introduction, Brazil adopted an income transfer policy aimed at reducing the pernicious effects of the pandemic, but unfortunately, this paper was not able to capture its effects. It is presumed that this policy helped low-income families adapt their food consumption to the new situation, including of dairy products, which constitute an important part of the Brazilian diet.

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