DEMAND ANALYSIS ON FOOD: EFFECTS OF *BOLSA FAMÍLIA* ON DAIRY CONSUMPTION AS A SOURCE OF CALCIUM[1]

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Bolsa Família is a conditional cash transfer program in Brazil, which aims to improve education, health and nutrition in poor households. Dairy products are also representative in terms of food expenses in Brazil besides being an important source of calcium. This paper aims to evaluate effects of *Bolsa Família* on the dairy products demand. Survey data from 55,700 households collected in 2008/2009 by the Brazilian Bureau of Statistics (IBGE) are used. The Heckman two-step method is applied for the estimation. The results suggested that *Bolsa Família* increases the probability of buying milk powder and unpasteurized milk. As for policy consideration, managing unpasteurized milk and other nutritional education procedures should be considered to improve health and nutrition for low income families.

Keywords: cash transfer; food policy; nutrition; price-elasticity.

ANÁLISE DA DEMANDA DE ALIMENTOS: EFEITOS DO BOLSA FAMÍLIA SOBRE O CONSUMO DE PRODUTOS LÁCTEOS COMO FONTE DE CÁLCIO

Bolsa Família é um programa brasileiro de transferência de renda que visa melhorar a educação, a saúde e a nutrição em famílias de baixa renda. Os produtos lácteos são relevantes na despesa das famílias com alimentação e também uma importante fonte de cálcio. O principal objetivo deste artigo é identificar possíveis efeitos da participação no programa Bolsa Família sobre a demanda de produtos lácteos. Os dados utilizados foram oriundos da Pesquisa de Orçamento Familiar (POF), do Instituto Brasileiro de Geografia e Estatística (IBGE), a qual cobriu 55.700 domicílios em 2008/2009. O método de dois estágios de Heckman foi o utilizado para a elaboração da análise quantitativa. Os resultados sugerem que o Bolsa Família aumenta a probabilidade das famílias em comprar leite em pó e leite não pasteurizado. No âmbito de políticas públicas, uma melhor orientação sobre os riscos de leite não pasteurizado e educação nutricional para as famílias beneficiadas com o programa deveria ser considerada.

Palavras-chave: transferência de renda; política alimentar; nutrição; elasticidade-preço.

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ANÁLISIS DE LA DEMANDA DE ALIMENTOS: EFECTOS DE LA *BOLSA FAMÍLIA* EN EL CONSUMO DE PRODUCTOS LÁCTEOS COMO FUENTE DE CALCIO

Bolsa Família es un programa de transferencia condicional de dinero en Brasil, que tiene como objetivo mejorar la educación, la salud y la nutrición en los hogares pobres. Los productos lácteos son también representativos en términos de gastos de alimentación en Brasil, además de ser una fuente importante de calcio. En este trabajo se estudia el efecto de *Bolsa Família* en la demanda de productos lácteos. Se utilizan datos de una encuesta a 55.700 hogares recogida en 2008/2009 por la Agencia Brasileña de Estadísticas. Para la estimación se aplica un método Heckman en dos etapas. Los resultados sugieren que *Bolsa Família* aumenta la probabilidad de compra de leche en polvo y leche sin pasteurizar. En cuanto a la consideración de políticas, la gestión de la leche no pasteurizada y otros procedimientos de educación nutricional deben ser considerados para mejorar la salud y la nutrición de las familias de bajos ingresos.

Palabras clave: transferencia de dinero; política alimentaria; nutrición; elasticidad precio.

ANALYSE DE LA DEMANDE ALIMENTAIRE: EFFETS DE LA *BOLSA FAMÍLIA* SUR LA CONSOMMATION DE PRODUITS LAITIERS COMME SOURCE DE CALCIUM

Le *Bolsa Família* est un programme brésilien de transferts monétaires visant à améliorer l'éducation, la santé et la nutrition des familles pauvres. Les produits laitiers sont également représentatifs en termes de dépenses alimentaires au Brésil en plus d'être une source importante de calcium. Cette étude visait à évaluer les effects de la *Bolsa Família* sur la demande pour les produits laitiers. Les données utilisées proviennent de l'Enquête Budget des Familles, de l'Institut Brésilien de Géographie et de Statistique (IBGE), qui a couvert 55 700 maisons en 2008/2009. Heckman en deux étapes a été utilisée pour effectuer l'analyse quantitative. Les résultats suggèrent que le *Bolsa Família* augmente la probabilité d'acheter du lait en poudre et le lait non pasteurisé par les familles assistées. Dans le cadre de la politique publique, une meilleure orientation sur les risques de lait non pasteurisé et l'éducation nutritionnelle pour les familles bénéficiés du programme devrait être envisagée.

Mots-clés: transfert de fonds; politique alimentaire; la nutrition; l'élasticité des prix.

1 INTRODUCTION

Bolsa Família is a conditional cash transfer program (CCT) in Brazil. In summary, it is an anti-poverty program where the government gives cash to poor households in exchange for the beneficiaries fulfilling certain conditions, such as ensuring that their children maintain a given level of school attendance, bringing their children to health clinics for regular visits or other social services. *Bolsa Família* was created in 2003 by integrating the four main CCT programs (*Bolsa Escola*, *Bolsa Alimentação*, *Auxílio Gás*, and *Cartão Alimentação*) into one unified program.

Bolsa Família reaches approximately 13.7 million households according to the Brazilian Ministry of Social Development (MDS). As Brazil has nearly 64 million households, one out of five households is receiving money from the *Bolsa Família*. A household can receive basic and extra benefits. A family

that earns less than R$ 70 ($ 35 dollars) per month is qualified for the basic benefits without meeting any requirement. For additional benefits, a household has to meet the following requirements: *i)* a monthly income must be less than R$ 140 ($ 70 dollars) *per capita*; and *ii)* have children with less than seventeen years old.

CCT programs have grown quickly in many countries as a way to link income safety-nets directly to human-capital development. In Latin America, CCT programs dominate the social protection sector and their expansion can be attributed to cases of success in Brazil and Mexico in the late 1990s (Handa and Davis, 2006). Since CCT programs are heavily supported by the World Bank and the Inter-American Development Bank (IDB), Colombia, Honduras, Nicaragua, Ecuador, Chile and Jamaica are developing their own programs.

Bolsa Família is the largest conditional cash transfer in the developing world considering the number of beneficiaries (Lindert, 2005). In Mexico, the *Oportunidades*, originally known as *Progresa*, benefits around 5 million families. On the whole, conditional cash transfer programs aim to alleviate poverty in the short-term through the redistribution of wealth by cash transfers, and in the long-term by building up human capital among the poor through improved education, health and nutrition (Sewall, 2008).

An important issue of CCTs programs is how to evaluate and verify the information reported by the beneficiary of the program. Brazil's *Bolsa Família* is highly susceptible to beneficiary fraud and measurement errors since self-reported income, for instance, is not verified (Handa and Davis, 2006). In fact, *Bolsa Família* has been dealing with some limitations. These limitations are poor beneficiary targeting, lack of inter-ministerial coordination, inadequate monitoring, clientelism, weak accountability and alleged political bias (Hall, 2006). In addition, there are some concerns regarding its actual outcome: *i)* if the program does indeed contribute to poverty alleviation; and *ii)* whether it creates greater dependence of the poor on government hand-outs and political patronage at the expense of long-term social investment for development. Nevertheless, in some regions of Brazil like the Northeast, the program has a special importance because the economic and social structure is less dynamic in comparison with other regions (Araújo and Lima, 2010).

As for the impact on school attendance, Martini and Castanheira (2012) found that the welfare policies in Brazil are having a positive impact on school attendance. The authors used data from Household Expenditure Surveys collected by the Brazilian Bureau of Statistics (IBGE) covering the years of 2002-2003. They considered a group of welfare programs such as *Bolsa Escola* and *Auxílio Gás*, which became later part of the *Bolsa Família*.

In terms of impact on nutrition, controversial conclusions were reported from different studies. When analyzing the impact of *Bolsa Família* on consumption, Oliveira *et al.* (2007) showed that the expenditure on food was positively affected by the program. However, as shown by Soares (2010), the increment in food expenditure does not necessarily imply better nutrition for children and adults. In fact, the result would depend on the quality and nutrient composition of the food intake by members of the household. On the other hand, Paes-Sousa, Santos and Miazaki (2011) concluded that the program can lead to a better nutritional outcome in children from 12 months to 5 years of age. They evaluated the nutritional status in children by estimating the impact of the program on anthropometric indicators. Children from families exposed to the program were 26% more likely to have normal height by age in comparison with children from families in the same economic status but not enrolled.

Studying *Bolsa Alimentação*, Braido, Olinto and Perrone (2012) used propensity score matching and did not find statistically significant impacts of the program on expenditure shares of dairy as an aggregated group. However, some impacts were found in fruits and vegetables.

Cotta and Machado (2013) performed a literature review evaluating studies that considered *Bolsa Família* and food security and nutrition published between 2005 and 2011. The authors considered only studies that were performed using primary data. Moreover, their search was initially restricted to databases in the health field such as Lilacs, SciELO, Medline and Cochrane Library. After that, studies published by research institutes and dissertations were also considered. They selected ten papers out of sixty three related to this field and only five papers indicated positive impacts on nutrition. For those studies with positive impact, the majority had the food expenditure as the criteria to evaluate the program like in Duarte, Sampaio and Sampaio (2009) and Oliveira *et al.* (2007). In addition, three other papers suggested an increment of consumption for high caloric and low nutritional food which contribute to overweight and obesity development (Saldiva, Silva and Saldiva, 2010).

Many studies related to *Bolsa Família* can be observed in the literature but only few of them suggest that the program has been successful in helping poor families reach better nutrition levels. None of the studies reviewed in this research considered the relationship between demand for dairy and *Bolsa Família* using disaggregated data. Moreover, dairy products are the main source of calcium and calcium is considered to be an important element in daily diet for children. Thus, understanding the potential relationship between dairy products demand and the Brazilian CCT program can provide reasonable insights for future dairy policies and social planning. In addition, dairy products are the second most

representative group with around 11.5% of all household expenditure on food in Brazil (IBGE, 2010). The Brazilian dairy sector generates around US$ 66.7 billion per year and it is one of the most important segment in the Brazilian food industry (Cônsoli and Neves, 2006).

The main objective of this paper is to evaluate the possible effects of the *Bolsa Família* on the probability of purchasing products with high calcium content such as dairy. This analysis will fill this gap in the literature and bring more informative conclusions. In addition, price and expenditure elasticities for selected dairy products will be estimated. By using disaggregate data from the Household Expenditure Survey (called POF) from IBGE inferences about preferences and how underlying public policy could be improved will be discussed as well.

The paper proceeds as follows. In section 2, data description and its manipulation is discussed. In section 3, estimation models with censoring and truncated data are also reviewed and model specification is presented. In section 4, empirical results are analyzed. Finally, a conclusion is reported in section 5.

2 DATA DESCRIPTION

Studies on consumer demand using aggregated level data (for example, commodity group and income group) are commonly observed. However, by doing such aggregation, particular characteristics related to people or family, such as level of education, gender, age, and other important demographic variables, are lost. The use of household level data gives the advantage of controlling for such variables.

For this study, data from the Household Expenditure Surveys (POF) collected by IBGE covering the years of 2008/2009 were used. The sample size is composed of 55,000 households throughout Brazil. The survey reports data collected in only one week and the member of the household is instructed to take notes of all the expenses and quantities bought during that specific week. The dataset also reports socioeconomic characteristics of all members such as age, gender, education level, and the head of household. Information regarding income level, location of the household, size of the family among others is collected as well.

This survey is also used to estimates the Consumer Price Indexes (IPCA) and it is a representative random survey of households in 26 states plus the Federal District in urban and rural areas. The data collection covered 52 weeks, from May 19, 2008 to May 18, 2009. The dataset was properly weighted using the weight provided by POF in such a way that the sample represents the whole country.

As for equation and data manipulation, weekly household expenditure is adjusted linearly on a monthly basis for every single dairy product and,

by addition, the monthly total expenditure on dairy was calculated.[6] Using the same procedure as in Agüero and Gould (2003), all households that did not record any dairy expenditure were dropped from the dataset as well as those with excessively high expenditure amounts. Therefore, sample size was reduced to 32,371 households.

The price of each good was calculated as the ratio between expenditure on the good and its quantity purchased. However, truncation issues usually increase as one disaggregates commodity groups in cross-section analysis. As a result, the following percentages of unknown expenditures are observed: pasteurized fluid milk (52%), unpasteurized fluid milk (78%), powder milk (78%), mozzarella cheese (86%), prato cheese (96%), other cheese (82%), yogurt (77%), condensed milk (91%), and other dairy products (91%). To deal with the unobserved price for non-consuming households we applied the zero-order method, which consists of replacing a given sample means for the missing values (Cox and Wohlgenant, 1986). The appropriate sample mean used was the average state price of each commodity.

In terms of aggregation, dairy products were analyzed by dividing the data in two groups. In the first aggregation, four products were considered and the result indicated that a more disaggregated level would be appropriate. Therefore, the second aggregation was formed considering nine dairy products as well as their respective expenditure shares (table 1). As for *Bolsa Família* we considered a dummy variable (*dvbf*) of one if the family receives money from the program and zero otherwise.

TABLE 1
Aggregation level and expenditure share for dairy products
(In %)

Aggregation 1		Aggregation 2	
Product	Expenditure share	Product	Expenditure share
Fluid milk	46.5	Pasteurized	33.0
		Unpasteurized	13.5
Cheese	20.5	Mozzarella	6.2
		Prato	2.0
		Other cheese	12.3
Yogurt	10.5	Yogurt	10.5
Others	22.5	Milk powder	16.6
		Condensed	3.3
		Other	2.6

Source: POF/IBGE.
Authors' elaboration.

6. We first converted weekly expenditure into annual expenditure by multiplying it by 52. Then, we divided the annual expenditure by twelve to get monthly expenditure.

3 METHODOLOGY

Evaluation of disaggregated data using cross-section survey is challenging as a significant percentage of households with a zero or unobserved expenditure are commonly observed. High proportion of zeros occur because some households decide not to shop a specific commodity every week. Therefore, a household may be observed to have zero expenditure on a commodity in a given week but it does not necessarily imply zero consumption.

Deaton and Irish (1984) and Blundell and Meghir (1987) developed several models differentiating between true corner solutions – which means zero consumption – and zero expenditure values due to infrequency of purchase.

Using data from US Bureau of Labor Statistics, Blisard and Blaylock (1993) found that about 18% of US households purchase butter over a two-week survey period and they conclude the survey period may be short to record household purchase. As a result, to allow inference about consumer behavior requires assumptions connecting the data itself to some latent variable that interferes on consumer's purchase policy (Meghir and Robin, 1992).

As pointed out by Keen (1986), the existence of zero expenditure can arise from three different aspects: *i)* infrequency of purchase; *ii)* misreporting; and *iii)* variation of preference across sample (a household does not consume some commodities). Leading causes of incompletely observed data are truncation and censoring. The main difference is that truncation implies some observations on both dependent and independent variables are lost, while in censoring just information on the dependent variable is lost.

Observed truncation and censoring in survey data leads to a shift up or down in the intercept. Moreover, under this specific data $E(y|x)$ is nonlinear in x and in β coefficient and OLS gives inconsistent estimation of the slope parameters and hence inconsistent estimates of marginal effects (Cameron and Trivedi, 2005). Instead of using OLS, the analysis should be based on the methodology that accounts for censoring and truncation. One approach is to use the Tobit model, originally proposed by Tobin (1958). However, this method requires strong distributional assumptions. The major problem of the Tobit Maximum Likelihood Estimator (MLE) is that if the error terms are either heteroskedastic or non-normally distributed, the MLE is inconsistent (Cameron and Trivedi, 2005).

As indicated in the study by Cameron and Trivedi (2009), the Tobit model assumes that both zeros and positive values are generated by the same probability mechanism and it would be more flexible by assuming independence between the decision to spend and the amount spent. This is basically the idea of the two-part model. The first part is a binary outcome equation for the

participation decision, and the probit method is applied. The second part uses a linear regression to estimate the level of the outcome.

A high percentage of unobserved expenditure is reported in the dataset used in this study, which generates drawbacks in the estimation process. Therefore, Heckman's model is considered to be appropriate when for some households the consumption is unknown, while the Tobit model or Cragg's model applies when losses of data are known to equal zero (Lin and Schmidt, 1984). The approach is described as follows.

Let an asterisk define a latent variable and $y_2{}^*$ denote the outcome of interest (here quantity purchased). In a Tobit model this outcome is observed if $y_2{}^*>0$. Followed by $y_2{}^*$, a second latent variable $y_1{}^*$ is introduced and represents a selection equation. Therefore, $y_2{}^*$ is observed if $y_1{}^*>0$, where $y_1{}^*$ determines whether or not a household has any dairy product expenditure and $y_2{}^*$ determines the level of expenditure, and $y_1{}^* \neq y_2{}^*$. The two-equation model combine a selection equation that

$$y_1 = \begin{cases} 1 \text{ if } y_1^* > 0, \\ 0 \text{ if } y_1^* \leq 0 \end{cases}, \tag{1}$$

and an outcome equation that

$$y_2 = \begin{cases} y_2^* \text{ if } y_1^* > 0, \\ - \text{ if } y_1^* \leq 0 \end{cases}. \tag{2}$$

According to this model, y_2 is observed only when $y_1{}^* >0$ and the standard model is linear with additive error such that,

$$\begin{aligned} y_1^* &= x_1'\beta_1 + \varepsilon_1 \\ y_2^* &= x_2'\beta_2 + \varepsilon_2, \end{aligned} \tag{3}$$

with ε_1 and ε_2 possibly correlated. It is assumed the error terms are jointly normally distributed and homoscedastic. The Tobit model is a special case where $y_1^* = y_2^*$.

The two-step method is based on the conditional expectation as

$$E[y_2|x, y_1^* > 0] = x_2'\beta_2 + \sigma_{12}\lambda(x_1'\beta_1), \tag{4}$$

where $\lambda(\cdot) = \phi(\cdot)/\Phi(\cdot)$.

Hence,

$$E[y_2|\boldsymbol{x}, y_1^* > 0] = \boldsymbol{x}_2'\boldsymbol{\beta}_2 + \sigma_{12}\,\frac{\phi(x_1'\boldsymbol{\beta}_1)}{\Phi(x_1'\boldsymbol{\beta}_1)}, \tag{5}$$

where $\hat{\beta}_1$ is obtained by first-step probit regression of y_1 on x_1. The OLS regression of y_2 on x_2 and the inverse Mills' ratio, defined as $\lambda(\mathbf{x}_1'\hat{\beta}_1)$, produce a semiparametric estimate of (β_2, σ_{12}).

Compared to the maximum likelihood procedure under joint normality of the residuals, the Heckman two-step methodology yields to a consistent estimator of β_2 but some loss in efficiency is observed. Nonetheless, this procedure is commonly used for the following reasons: *i)* applicable to a range of selection models; *ii)* distributional assumptions required are weaker than joint normality of ε_1 and ε_2; and *iii)* distributional assumptions can be weakened even further to permit semiparametric estimation (Cameron and Trivedi, 2005).

As for identification, the Heckman two-step method requires an exclusion restriction. It means that at least one covariate in the selection equation (y_1^*) has to be excluded from the outcome equation (y_2^*). Moreover, as pointed out by Cameron and Trivedi (2009) having exclusion restrictions, such that x_1 is different from x_2 may reduce the collinearity problem that possibly arises from the relation between $\lambda(\mathbf{x}_1'\hat{\beta}_1)$ and the other regressors in the outcome equation.

Since it is often difficult to come up with an exogenous variable that affects the selection but not directly the outcome equation, this can be a major limitation in many applications. Therefore, household income and years of schooling of the head of household are used as exclusion variables. It is a strong assumption since there are reasons to believe that income is going to affect both the selection and the outcome equation. In addition, years of schooling does not have a substantial impact on the probability of selection. However, we expect that the knowledge about benefits of dairy products as a source of calcium will affect the decision of buying dairy products.

Regarding the estimation procedure, two different levels of commodity aggregation for the probit analysis are used (table 1). For probit, the probabilities and marginal effect for fluid milk, cheese, yogurt and others are estimated. The purpose here is to see the relationship between *Bolsa Família* and the probability of purchasing dairy products. Afterwards, the same analysis is performed by assuming another disaggregation level data, composed of nine products as described in table 1. The equation consists of the logarithm of quantity as the dependent variable and the logarithms of price and expenditure as the covariates.

Demographic variables are also included to capture household characteristics. All variables considered are described in box 1.

The expenditure and own-price elasticities were estimated using the Heckman two-step method. Initially, we estimated the expenditure share equation with stone price index approximation. However, the calculated elasticities were highly sensitive to the mean budget share – used to recover the elasticities – given that many products have large percentage of observed zero expenditures and zero budget shares. Therefore, we used the log-log model with quantity as the dependent variable which provided better and more meaningful results. Nevertheless, the model has a limitation. In particular, *Bolsa Família* participation is considered endogenous and an instrumental variable should be considered. However, this will be left for future research.

BOX 1
Variable descriptions

Dependent variable	
Log of quantity	Logarithm of quantity (lnq_i) of each dairy product i.
Independent variables	
Log prices	Logarithm of price ($\ln p_i$) of each dairy product i.
Log expenditure	Logarithm of total expenditure (lnx) on dairy products.
Head female	1 = female head of household; 0 = male head of household.
Head age (>65)	1 = head of household over 65 years old; 0 = otherwise.
Head age (<30)	1 = head of household under 30 years old; 0 = otherwise. Reference group has age between 30 and 65.
Proportion of children	Ratio between the number of children under 12 years old and number of people in each household.
Region	Geographic location of the household: 1 = North; 2 = Northeast; 3 = Southeast; 4 = South; 5 = Central-West.
Level of income	1 = until 2 minimum wage (MW); 2 = higher than 2 to 6 MW; 3 = higher than 6 to 15 MW; 4 = higher than 15 MW.
Dummy *Bolsa Família*	1 = family receives money from *Bolsa Família*; 0 = otherwise.
Exclusion variables	
Head years of schooling	Level of education of the head of the household, measured in years of schooling.
Household income	Total household income.

Source: POF/IBGE.
Authors' elaboration.

4 RESULTS AND DISCUSSION

In this section, the results are presented in three different parts: descriptive statistics, probit and average marginal effects estimates, and analyses of elasticities.

As for the descriptive statistics, the average household expenditure per month on dairy products by region is presented in table 2. It should be noted that there are different consumer behaviors depending on the location and the dairy product considered. Overall, households located in the South and Southeast regions have higher expenditure on dairy products than those in the North and Northeast. When we examine the disaggregated data, a larger average expenditure in pasteurized fluid milk, cheese, and yogurt in the South and Southeast can be identified as well. On the other hand, unpasteurized fluid milk and powder milk have higher budget shares in the North and Northeast. Moreover, the proportion of households receiving *Bolsa Família* is higher in the North and Northeast regions.

TABLE 2
Average expenditure on dairy products and household receiving *Bolsa Família* by region
(In R$ per month and %)

Product	North	Northeast	Southeast	South	Central-West
Pasteurized fluid milk (R$)	7.12	7.60	23.73	23.97	19.15
Unpasteurized fluid milk (R$)	5.45	6.88	2.47	4.56	4.90
Powder milk (R$)	14.61	11.89	2.64	2.01	2.46
Mozzarella cheese (R$)	1.57	1.95	4.52	3.78	3.53
Prato cheese (R$)	1.23	0.91	1.12	1.87	0.37
Other cheese (R$)	1.85	6.02	7.93	6.21	4.94
Yogurt (R$)	4.24	4.10	5.97	5.23	5.39
Condensed milk (R$)	1.77	1.13	1.75	1.83	1.62
Other dairy (R$)	1.14	0.86	1.30	1.82	1.41
Total dairy (R$)	38.98	41.35	51.43	51.28	43.77
Proportion of households with *Bolsa Família* (%)	21.26	27.26	6.01	5.37	6.93

Source: POF/IBGE.
Authors' elaboration.

After controlling for *Bolsa Família* and putting households into two groups – one that receives benefits and another that does not receive it – a lower expenditure on dairy products in general from those families who are receiving benefits from the program is observed (table 3). The average cheese expenditure for households enrolled in the *Bolsa Família* is three times lower than those without the benefit. Overall, expenditure on dairy is 41% higher in households that are not enrolled in the program. Unpasteurized milk and powder milk are the only two products with higher consumption in lower income families.

TABLE 3
Average expenditure on dairy products and *Bolsa Família* participation
(In R$ per month)

Product	Household with *Bolsa Família*		Household without *Bolsa Família*		(b-a)/a (%)
	Mean (a)	Standard deviation	Mean (b)	Standard deviation	
Pasteurized fluid milk	10.28	23.40	19.53	31.50	89.98
Unpasteurized milk	7.93	18.85	3.78	15.18	-52.33
Powder milk	7.72	17.52	5.28	19.53	-31.61
Mozzarella cheese	1.05	5.66	3.84	10.80	265.71
Prato cheese	0.34	3.29	1.27	6.39	273.53
Other cheese	2.53	9.85	7.11	19.18	181.03
Yogurt	3.32	10.54	5.49	13.34	65.36
Condensed milk	1.07	4.80	1.68	6.26	57.01
Other dairy	0.65	3.98	1.37	5.68	110.77
Total dairy	**34.89**	**37.23**	**49.35**	**52.57**	**41.44**

Source: POF/IBGE.
Authors' elaboration.

As for the other variables, households receiving benefits from the program have lower average income and education than those outside the program (table 4). On the other hand, households in the program have higher proportion of children, which makes the nutrition issue more critical.

TABLE 4
Selected variables and *Bolsa Família* participation

Variable	Household with *Bolsa Família*		Household without *Bolsa Família*		(b-a)/a (%)
	Mean (a)	Standard deviation	Mean (b)	Standard deviation	
Total income (R$ per month)[1]	1,209.19	1,094.98	3,387.92	4,701.54	180.18
Years of schooling (head of household)	5.23	8.96	8.16	7.81	56.02
Proportion of children (%)	30.04	21.48	13.84	18.97	-53.93

Source: POF/IBGE.
Authors' elaboration.
[1] Average household income in R$/month.

Regarding empirical results, Heckman two-steps described in the previous section is estimated. The main objective is to identify possible effects of the participating in *Bolsa Família* on the probability of a household to spend income for a given dairy product. The first model takes into account only four dairy products: fluid milk, cheese, yogurt, and others.

The coefficients of the model for *Bolsa Família* are presented in table 5. From the first panel (first step Heckman), the coefficients are statistically significant at 1% level for all products, except for fluid milk. The sign of the coefficients is negative for cheese and yogurt and suggests that *Bolsa Família* has negative effect on the probability of families buying these products. One possible reason is because both cheese and yogurt are more expensive than other dairy products and families decide not to use the money received from the program to buy those products. On the other hand, the coefficient is positive for the equations that have fluid milk and other dairy products, respectively, as a dependent variable. However, since *Bolsa Família* variable is not significant in the fluid milk equation, being in the program has only a positive relationship with buying dairy products that compose the group of others.

TABLE 5
Estimated coefficient of *Bolsa Família* on probit and average marginal effect

Dependent variable	Selection equation (probit regression)	Average marginal effect
	Mean (*a*)	Mean (*b*)
Fluid milk	0.006^{ns}	0.002^{ns}
	(0.023)	(0.007)
Cheese	-0.252**	-0.069**
	(0.028)	(0.008)
Yogurt	-0.069**	-0.018**
	(0.026)	(0.007)
Other	0.083**	0.024**
	(0.024)	(0.007)

Source: POF/IBGE.
Authors' elaboration.
** Statistically significant at the 99% confidence level.
Notes: 1. Standard errors are in parentheses.
          2. ns: not significant.

The second panel in table 5 presents the average marginal effects and measures the partial effects of being in the program on the probability of purchasing dairy products. According to these estimates, a household receiving *Bolsa Família* has the probability of buying other dairy products increased by around 2.4 percentage point. On the other hand, a family that receives its benefit is less likely to purchase cheese (6.9 percentage points less likely) and yogurt (1.8 percentage points) compared to households that are not in the program, holding the effect of other independent variables constant.

This finding indicates that *Bolsa Família* has not being used to purchase dairy products other than the goods that compound the group other (milk powder, butter,

cream etc.). Moreover, with such aggregation, it is not possible to identify products that have being impacted by the program, which justifies the use of more disaggregated data. The results are reported in table 6. All dairy products, except for condensed milk, have statistically significant coefficients. Interestingly, with such a disaggregation, the *Bolsa Família* program is shown to have a positive effect on the purchase decision of unpasteurized milk and milk powder. On the other hand, households in the program are less likely to purchase pasteurized milk, cheese, and yogurt.

TABLE 6
Estimated coefficient of *Bolsa Família* on probit and average marginal effect with disaggregate data

Dependent variable	Selection equation (probit regression)	Average marginal effect
	Mean (*a*)	Mean (*b*)
Pasteurized fluid milk	-0.185**	-0.063**
	(0.023)	(0.008)
Unpasteurized fluid milk	0.253**	0.068**
	(0.023)	(0.006)
Powder milk	0.055*	0.011*
	(0.026)	(0.005)
Mozzarella cheese	-0.272**	-0.050**
	(0.037)	(0.007)
Prato Cheese	-0.190**	-0.014**
	(0.054)	(0.004)
Other cheese	-0.180**	-0.038**
	(0.032)	(0.007)
Yogurt	-0.087**	-0.023**
	(0.026)	(0.007)
Condensed milk	-0.018[ns]	-0.003[ns]
	(0.035)	(0.005)
Other dairy	-0.086*	-0.012*
	(0.036)	(0.005)

Source: POF/IBGE.
Authors' elaboration.
* Significant at the 95% confidence level.
** Significant at the 99% confidence level.
Notes: 1. Standard errors are in parentheses.
　　　 2. n.s.: not statistically significant.

The decrease in the probability of purchasing pasteurized milk may be explained by a substitution effect towards unpasteurized milk given that the latter is cheaper. Usually, unpasteurized milk is produced locally and distributed by family farms in a neighborhood. The consumption of unpasteurized milk can also come from own-production in rural areas which is more prevalent in the North and Northeast regions of Brazil. From a policy perspective, this finding suggests a higher risk of contagious bacterial diseases from drinking raw milk for families in the *Bolsa Família* program. Oliver (2009) showed that several milkborne disease outbreaks have been caused by consuming raw unpasteurized milk. Thus, educational programs and materials that increase awareness of microbial safety hazards to consumers are needed for public health policy.

In case of milk powder, besides being a storable product, it is also cheaper in a sense that people can control the dilution process (for example, put more water during scarcity periods). In other words, the milk powder could be watered down to provide a higher yield whenever necessary as pointed out in Paulilo and Rodolpho (2003).

Overall, except for unpasteurized milk and milk powder, all other dairy products have a negative marginal effect on probability of expenditure, which means that *Bolsa Família* is not improving the consumption of calcium from dairy in general.

For completeness, the coefficients of the other control variables used in this research are presented in the appendix in terms of average marginal effects. The coefficients behave as expected. Increasing the price of dairy negatively affects, on average, the probability of buying those products holding other things constant. On the other hand, the total expenditure on dairy is positively related to the probability of purchase. Similarly, having a female as the head of a household increases the probability of buying dairy products, except the unpasteurized milk. This result suggests that females are more aware of the risk of consuming unpasteurized milk. Likewise, the probability of dairy purchase is higher for younger and more educated head of households. In addition, the higher household income increases the probability of dairy product purchase in general. Regarding the proportion of children, families are more likely to spend on milk powder and yogurt as the percentage of children increases.

In terms of stratified income level, the coefficients were not significant. However, in terms of region, families located in the Southeast, South, and Central-West are more likely to buy pasteurized milk, cheese (mozzarella and other cheese), and yogurt than those in the North. The Northeast families have lower probability of purchasing pasteurized milk but are more likely to buy unpasteurized in comparison with the Northern families. These findings agree with the *Bolsa Família* results already discussed.

Finally, in terms of model assumptions, the hypothesis that the purchase decision is independent to consumption was also examined and rejected in five out of nine equations. Significant correlation coefficient between errors terms associated with the two stages of the Heckman procedure were found for unpasteurized milk, mozzarella, other cheese, yogurt, and other dairy. Similar results was also found by Gould (1992) using a two stage infrequency-of-purchase model for cheese consumption. However, we observed independence between selection and outcome equations for pasteurized milk, powder milk, prato cheese, and condensed milk.

4.1 Elasticities

As for the expenditure elasticities, the separability assumption was assumed. The estimation was performed using the Heckman method and the results are presented in table 7. The estimated expenditure elasticities are statistically significant at the 99% confidence interval for all dairy products, except for yogurt (significant at 95%). Moreover, all coefficients, as expected, are positive. The demand for fluid and powder milk was slightly more sensitive to the variation in expenditure than the other products but all expenditure elasticities are inelastic. These results are in common with the findings by Agüero and Gould (2003). The authors estimated expenditure elasticities for fluid milk and other dairy products. For fluid milk, the authors found elasticities varying from 0.30 to 0.49 which are less responsive than our estimation. As for the other dairy products, their results were between 0.27 and 0.70. By using household survey data for 1995/1996, Hoffmann (2000) estimated expenditure elasticities from a piecewise linear regression with logarithm of quantity as the dependent variable. He found elasticities in the range of 0.04 to 0.41. Similar method was applied by Oliveira and Carvalho (2006) to 2002/2003 survey data and they estimated expenditure elasticities between 0.42 and 0.64.

In terms of the own-price elasticities, all coefficients are statistically significant at the 99% confidence level and, as expected, they all have negative signs. Pasteurized fluid milk is demand-elastic and condensed milk has own-price elasticity close to unitary. These results suggest that prices play an important role in determining the consumption. The lowest elasticity is observed for yogurt, yielding the value of -0.239. Coelho and Aguiar (2007) calculated the own-price elasticities based on 2002/2003 Brazilian households survey data but the authors used different aggregation level. They found the following results: milk powder (-0.81); fluid milk (-1.25); and cheese (-1.34).

TABLE 7
Estimates expenditure and own-price elasticities

Product	Expenditure elasticity	Own-price elasticity
Pasteurized fluid milk	0.692**	-1.038**
	(0.012)	(0.050)
Unpasteurized milk	0.705**	-0.785**
	(0.008)	(0.052)
Powder milk	0.697**	-0.710**
	(0.022)	(0.048)
Mozzarella cheese	0.238**	-0.571**
	(0.028)	(0.073)
Prato Cheese	0.280**	-0.599**
	(0.048)	(0.211)
Other cheese	0.297**	-0.869**
	(0.043)	(0.072)
Yogurt	0.082*	-0.239**
	(-0.044)	(0.089)
Condensed milk	0.376**	-0.970**
	(0.110)	(0.193)
Other dairy	0.330**	-0.972**
	(0.059)	(0.137)

Source: POF/IBGE.
Authors' elaboration.
* Significant at the 95% confidence level.
** Significant at the 99% confidence level.
Note: Standard errors are in parentheses.

5 CONCLUSION

The primary objective of this research was to evaluate the possible effects of the *Bolsa Família* on the purchasing decision on dairy products. Due to a high percentage of unobserved expenditure, the estimation was conducted using the Heckman's two-step method. The findings suggest that a household receiving *Bolsa Família* is less likely to purchase dairy products in general. However, unpasteurized milk and milk powder has been positively affected by the program. In case of unpasteurized milk consumption, the risk of contagious bacterial diseases should be considered as a policy issue. Training in managing unpasteurized milk (boiling it) and other nutritional education procedures could be included as a part of the program. Powder milk consumption is also positively affected by the *Bolsa Família*. The results indicate that in some extent the program has been helping the beneficiaries in terms of the amount of calcium intake through milk. However, the effect of the *Bolsa Família* to improve nutritional status of lower income families is not evident when analyzing dairy products in general. Future studies should be conducted including other sub-groups of food.

The gender of the head of the household was also important in terms of purchasing decision. The results indicate that females are more likely to spend on those goods. Therefore, giving the money to females instead of males could be also considered as for program improvement.

In terms of elasticities, expenditure elasticities were found to be inelastic for all products. Similar conclusion was drawn for the own-price elasticities, with an exception of pasteurized milk which turned out to be elastic. Unpasteurized milk and milk powder expenditure elasticities were relatively high compared to other dairy products. This result suggests that cash transfer program would induce to higher response in the consumption. The expenditure elasticities of cheese and yogurt were quite low. Overall, the consumption of dairy would respond more to changes in price given that the price-elasticities are higher than the expenditure elasticities.

Some limitations and improvements for future research are proposed. To better evaluate the impact of *Bolsa Família* on nutrition, other sub-groups of food could be considered. In addition, an effort to find good instrumental variables to represent *Bolsa Família* would contribute greatly to dealing with potential endogeneity problem. Because of high proportion of zeros, infrequency of purchase models using Bayesian approach or nonparametric models could be adopted as an alternative method. Finally, zero observations in the household survey data are still a challenge to modeling family behavior. As a result, elasticities have to be interpreted with caution because the misclassification of zeros due to infrequency of purchase rather than non-consumption may cause biased estimates of expenditure elasticities of demand.

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APPENDIX A

TABLE A.1.
Estimated average marginal effect for consumption of dairy products

Dependent variables	Logarithm of quantity								
	Logarithm of price[1]								
	Pasteurized milk	Unpasteurized milk	Powder milk	Mozzarella cheese	Prato cheese	Other cheese	Yogurt	Condensed milk	Other dairy
Pasteurized milk	-0.288**	-	-	-	-	-	-	-	-
	(0.007)	-	-	-	-	-	-	-	-
Unpasteurized milk	-	-0.246**	-	-	-	-	-	-	-
	-	(0.010)	-	-	-	-	-	-	-
Powder milk	-	-	-0.231**	-	-	-	-	-	-
	-	-	(0.009)	-	-	-	-	-	-
Mozzarella cheese	-	-	-	-0.180**	-	-	-	-	-
	-	-	-	(0.011)	-	-	-	-	-
Prato cheese	-	-	-	-	-0.092**	-	-	-	-
	-	-	-	-	(0.007)	-	-	-	-
Other cheese	-	-	-	-	-	-0.205**	-	-	-
	-	-	-	-	-	(0.007)	-	-	-
Yogurt	-	-	-	-	-	-	-0.231**	-	-
	-	-	-	-	-	-	(0.008)	-	-
Condensed milk	-	-	-	-	-	-	-	-0.122**	-
	-	-	-	-	-	-	-	(0.011)	-

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Dependent variables	Logarithm of quantity								
	Pasteurized milk	Unpasteurized milk	Powder milk	Mozzarella cheese	Prato cheese	Other cheese	Yogurt	Condensed milk	Other dairy
Other dairy	-	-	-	-	-	-	-	-	-0.143**
	-	-	-	-	-	-	-	-	(0.009)
Log of expenditure	0.074**	0.000	0.106**	0.064**	0.020**	0.118**	0.110**	-	0.059**
	(0.003)	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Head female	0.055**	-0.077**	0.012**	0.029**	0.004	0.017**	0.021**	0.008*	0.008*
	(0.006)	(0.005)	(0.004)	(0.004)	(0.002)	(0.004)	(0.005)	(0.003)	(0.003)
Head age (>65 years old)	-0.048**	0.047**	0.012*	-0.050**	-0.000	-0.000	-0.044**	-0.036**	-0.026**
	(0.007)	(0.006)	(0.006)	(0.005)	(0.003)	(0.005)	(0.007)	(0.005)	(0.005)
Head age (<30 years old)	0.008	-0.047**	0.015**	0.021**	0.001	-0.005	0.054**	0.011*	0.013**
	(0.008)	(0.007)	(0.006)	(0.006)	(0.003)	(0.006)	(0.006)	(0.005)	(0.005)
Proportion of children	-0.013	-0.004	0.071**	-0.065**	-0.027**	-0.151**	0.173**	-0.053**	-0.057**
	(0.014)	(0.012)	(0.010)	(0.010)	(0.006)	(0.011)	(0.011)	(0.008)	(0.008)
Regions[2]									
Northeast	-0.023*	0.087**	0.011	0.031**	-0.009*	0.090**	0.023**	-0.047**	-0.015**
	(0.010)	(0.008)	(0.008)	(0.006)	(0.004)	(0.006)	(0.008)	(0.006)	(0.006)
Southeast	0.157**	-0.022*	-0.223**	0.078**	-0.007	0.103**	0.044**	-0.038**	-0.021**
	(0.011)	(0.009)	(0.009)	(0.007)	(0.005)	(0.007)	(0.009)	(0.007)	(0.006)
South	0.158**	-0.050**	-0.184**	0.050**	0.039**	0.080**	0.035**	-0.028**	0.018*
	(0.013)	(0.010)	(0.011)	(0.008)	(0.007)	(0.009)	(0.011)	(0.008)	(0.008)
Central-West	0.119**	-0.012	-0.193**	0.057**	-0.029**	0.041**	0.034**	-0.020*	-0.001
	(0.012)	(0.010)	(0.010)	(0.008)	(0.004)	(0.008)	(0.010)	(0.008)	(0.008)

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Dependent variables	Pasteurized milk	Unpasteurized milk	Powder milk	Mozzarella cheese	Prato cheese	Other cheese	Yogurt	Condensed milk	Other dairy
				Income level[3]					
Higher than 2 to 6 MW	0.001	0.020*	-0.013	0.006	0.003	-0.004	0.013	0.005	0.003
	(0.010)	(0.008)	(0.007)	(0.008)	(0.004)	(0.008)	(0.009)	(0.006)	(0.006)
Higher than 6 to 15 MW	-0.004	0.005	-0.019	0.021	0.008	0.010	0.014	0.009	0.008
	(0.016)	(0.014)	(0.012)	(0.012)	(0.007)	(0.013)	(0.014)	(0.010)	(0.010)
Higher than 15 MW	-0.055*	-0.019	-0.014	0.011	0.006	0.048*	0.024	-0.007	-0.008
	(0.024)	(0.020)	(0.018)	(0.017)	(0.010)	(0.020)	(0.021)	(0.014)	(0.014)
Bolsa Família	-0.063**	0.068**	0.011*	-0.050**	-0.014**	-0.038**	-0.023**	-0.003	-0.012*
	(0.008)	(0.006)	(0.005)	(0.007)	(0.004)	(0.007)	(0.007)	(0.005)	(0.005)
Head years of schooling	0.002**	-0.004**	-0.001*	0.002**	0.001**	0.002**	0.001**	0.000	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log (household income)	0.017*	-0.043**	-0.029**	0.046**	0.011**	0.028**	0.030**	0.010*	0.021**
	(0.008)	(0.006)	(0.005)	(0.006)	(0.003)	(0.006)	(0.006)	(0.005)	(0.005)

Authors' elaboration.
* Significant at the 95% confidence level.
** Significant at the 99% confidence level.
[1] Off diagonal was omitted since the model does not consist of a system of equations. Therefore, the cross price coefficients are not meaningful.
[2] North is the reference group for region.
[3] Until 2 minimum wage (MW) is the reference group for income level.
Note: Standard errors are in parentheses.