Household Cheese Consumption in Argentina: A Double-Hurdle Model Estimation

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Abstract

This study examines the demand of cheese in Argentina using the latest 2012-2013 National Household Expenditure Survey dataset. Dairy products are common in the Argentine food basket, being cheeses one of the major dairy products consumed, accounting for 41% of the total dairy household expenditure. The object of this study is to examine the impact of demographic and socio-economic variables that affect household cheese consumption in Argentina. A double-hurdle model is used to estimate the effects of these variables in household cheese demand. Results suggest that socio-economic and demographic variables impact on the purchasing decision and the demanded quantity by households in this dairy product.

Keywords: Cheese Demand; Double-Hurdle Model; Price and Income Elasticities; Argentina

Introduction

Argentina has one of the highest per capita consumption of dairy products in Latin America, reaching 210 liters of milk per habitant in 2012 (MINIAGRI, 2013).

Dairy products are common in the Argentine household food basket, accounting for almost 9% over the total food expenditures. Cheeses take on average 41%, 29% fluid milks, 23% yogurts, and 7% others (ENGHO, 2012-13).

Cheese consumption increased over the years, passing from 9 kilograms per capita in 2004 to 12.44 kilograms in 2012 (MINIAGRI, 2013). Different varieties consumed can be grouped in soft, semi-soft and hard cheeses. Soft cheeses account for 52% of the total cheese consumption, follow by semi-soft cheeses with 35%, and last hard cheeses with 12%. Several studies have used household survey data to analyze the effects of socio-economics and demographic factors affecting the expenditure or consumption household on dairy products (Yen & Jones, 1997; Njurui et al., 2011; Phuong et al, 2014). A few studies have analyzed the demand of socio-economic and demographic variables of dairy products in Argentina (Lema, 2005; Depetris and Rossini, 2008; Rossini and Depetris, 2008). However, dataset used in these studies are more than 15 years old, so the economic situation of the country and the living standard of the populations have changed.

Therefore, the object of this study is to examine the impact of demographic and socio-economic variables that affect household cheese consumption in Argentina, using the new nationwide household expenditure survey data of the 2012-13. This paper tries to contribute and to understand the consumption pattern of one of the most important dairy product in the country.

Methodology

Modeling consumption with expenditure household data is difficult due to zero observations in the sample. For instance, this could be observed in the quantity of cheese that a household consume over a specific period of time. The distribution of this quantity will be roughly continuous over positive values, but there will be a "pile up" at zero, which is the corner solution to the consumption problem that a household face. There are many reasons why a household does not show a positive purchased quantity of cheese. Some households choose not to purchase cheese, from personal preferences, some cannot afford to purchase the product, and some purchase it infrequently (Yen and Jones, 1997).

Failing to recognize this problem of censoring in this type of data, results in biased and inconsistent estimates. One common approach to this problem is to implement the Tobit regression (Tobin, 1958). Assuming that the dependent variable y is continuous over positive values, but $Pr(y=0) > 0$ and $Pr(y < 0) = 0$, and letting $\Phi(\ )$ denote a standard normal cumulative distribution function, and $\phi(\ )$ represents the a standard normal density function , the likelihood function of the Tobit model is

$$\log(L) = \sum_{y_i=0}\left[\log\left\{1 - \Phi\left(\frac{x_i}{\sigma}\right)\right\}\right] + \sum_{y_i>0}\left[\log\left\{\phi\left(\frac{y_i - x_i\beta}{\sigma}\right)\right\} - \log(\sigma)\sigma\right]$$

The Tobit model may be not appropriate for the analysis of cheese consumption by households. This is because the functional form of the Tobit model imposes a restriction on the underlying stochastic process (Garcia, 2013): $x_i\beta$ parameterizes both the conditional probability that $y_i = 0$ and the conditional density associated with the magnitude of y_i, whenever $y_i > 0$. So, this model structure cannot handle the situation in which participation and amount or quantity purchased by households may be a separate decisions, possibly influenced by different covariates or by the same covariates but in different ways.

The Double-Hurdle model allows dealing with the censoring problem and model the decision process in two steps. Households are assumed to first decide if they buy or not a positive quantity of the good (participation decision) and then decide the optimal amount to buy (quantity decision).

Following Garcia (2013), let y_i represent the observed consumption amount of a household, and then the model can be detailed as

$$y = \begin{cases} x_i\beta + \varepsilon_i & if \ \min(x_i\beta + \varepsilon_i, \ z_i\gamma + u_i) > 0 \\ 0 & otherwise \end{cases}$$

$$\begin{pmatrix} \varepsilon_i \\ u_i \end{pmatrix} \sim N(0,\Sigma), \ \ \Sigma = \begin{pmatrix} 1 & \sigma_{12} \\ \sigma_{12} & \sigma \end{pmatrix}$$

If $\Psi(x, y, \rho)$ represent the CDF of a bivariate normal with correlation ρ, the log of the likelihood function for this model is

$$Log\ (L) = \sum_{y_i=0} \left[log\left\{ 1 - \Phi\left(z_i\gamma, \frac{x_i\beta}{\sigma}, \sigma\right)\right\}\right]$$

$$+ \sum_{y_i>0} \left(log\left[\Phi\left\{ \frac{z_i\gamma + \frac{\rho}{\sigma}(y_i - x_i\beta)}{\sqrt{1-\rho^2}}\right\}\right] - log\left\{ \phi\left(\frac{y_i - x_i\beta}{\sigma}\right)\right\}\right)$$

The double-hurdle model and the average partial effects of the explanatory variables are calculated following the procedure suggested by Garcia (2013). This can be found in STATA as *dblhurdle* command for model estimation[1]. Based on the coefficients of the double-hurdle model estimated, we calculated the average marginal effect of the independent variables on three different quantities of interest: a) The probability of cheese consumption, b) the expected quantity of cheese consumed by a household, given that it consumes, and c) the expected quantity of cheese consumed by the household.

Data from the National Expenditure Household Survey (2012-13) in Argentina is used to estimate the model. The Survey consists of 20,960 households, but only 20,619 observations are used. Monthly quantity of cheese is used as dependent variable. The independent variables include monthly household income (ARG $/month), average cheese price (ARG $/kg), dummy variables indicating the regions of the country (Buenos Aires, Pampeana, Northeast, Northwest, Cuyo, and Patagonia), household size, age of householder (<34years old, 35-49 years old, 50-64 years old, and > 65 years old), gender of householder (male or female), Education of householder (college, high school, primary school or less), Household type(single, two adults without children, two adults with children, and others), number of household members and the survey year (2012 and 2013).

Of these regressors, only price and monthly total expenditure are strictly economic variables. The others are socio-economic variables, commonly used in studies of food demand (Nayga, 1995; Yen & Jones, 1997; Ates & Ceylan, 2010; Ogundari & Arifalo, 2013; Meng et al., 2013; Phuong et al., 2014).

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[1] For more information about how to compute the average marginal effect on the probability of cheese consumption, the expected quantity consumed given that the household consume cheese, and the expected quantity of cheese consumed, see Garcia (2013).

Results

The descriptive statistics of the data used to estimate the model are presented in Table 1.In there, all households which buy or do not by cheese are included. These statistics give a general overview of the data in the sample. For example, households consume in total 1.085 kilograms a month and the average price is Arg$ 52.7 per kilogram[2]. Household heads older than 65 years old represent only 18.8%, while household heads between 35 and 49 years old are the largest group, with 31.3%. On average, a household has 3.3 members, with a total expenditure of $Arg 4,813 per month. The Northwest region of the country account for ~~by~~ 26.5% of the total sample, followed by the Northeast region (18.9%), Pampeana region (18.7%), Patagonia region (15.2%), Cuyo region (11.3%), and Buenos Aires region (9.1%). Looking at the gender and education of householder, most of them have at least finished high school (77.8%) and are male (65.5%). Households with two adults and children represent half of the sample (51.7%), having the other households types a percentage less than 20%.

The sample has 11,363 households that report positive consumption, accounting for 55.10% of the total households. As detailed before, households that do not buy cheese during the survey week[3] might have purchased cheese prior to the survey, might not have the desire to buy cheese for different reasons, or might not consume cheese at all.

The mean of the monthly quantity consumed is 2.45 kilograms for the consuming households and 1.35 kilograms for the full sample, including those that consume and do not consume cheese[4].

The model is estimated by the maximum likelihood method, and reporting robust standard error[5] of the estimated coefficients[6]. Table 4 in the Appendix shows the estimated coefficients of the model. The same independent variables were used in both, participation and consumption equation, and, in general, most of these variables are statistically significant also in both equations.

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[2]This represent, taking the average official Exchange rate between 2012/13 of 5.01 Arg$ /dollar, a value of US$ 10.51 per kilograms

[3] Survey has a one-week period in which households report expenditures of the different goods and services purchased in that period of time.

[4] This data are different from Table 1, because exclude households that do not consume cheese

[5] Due to heterocesticity problem in this model, it is chosen to report robust standard error

[6] The stata command *dblhurdle* is used to estimate the model, proposed by Garcia(2013)

Table 1. Descriptive Statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
Quantity (Kg/Month)	1.085	1.404	0	6
Price (Arg $/kg)	52.57	19.99	3	200
Age of Householder				
Age of Household head >34 yrs	0.226	0.418	0	1
Age of Household head 35-49 yrs	0.313	0.463	0	1
Age of Household head 50-64 yrs	0.271	0.444	0	1
Age of Household head > 65 yrs	0.188	0.391	0	1
Number of Household Members	3.386	1.926	1	19
Total Expenditure of Household (ARG$/month)	4813.72	4020.74	21.5	84472.36
Country Regions				
Households in Buenos Aires	0.091	0.288	0	1
Households in Pampeana	0.187	0.390	0	1
Households in Northwest	0.265	0.441	0	1
Households in Northeast	0.189	0.392	0	1
Household in Cuyo	0.113	0.316	0	1
Households in Buenos Aires	0.152	0.359	0	1
Education of Householder				
College	0.065	0.247	0	1
High School	0.778	0.415	0	1
Primary school or less	0.155	0.362	0	1
Gender of Householder				
Male	0.655	0.475	0	1
Female	0.344	0.475	0	1
Household Type				
Single	0.161	0.368	0	1
Two Adults without Children	0.121	0.326	0	1
Two Adults with Children	0.517	0.499	0	1
Others	0.199	0.399	0	1
Survey Year				
Year 2012	0.745	0.435	0	1
Year 2013	0.254	0.435	0	1

Table 2 presents the results of the average marginal effects of the independent variables on three different quantities of interest: a) the probability that a household consumes cheese (second column), b) the expected quantity of cheese consumed by a household given that the

household consume cheese (third column), and the expected quantity of cheese consumed by a household (fourth column).

Results indicate that the effect of cheese price in both equations is negative, as expected, and statistically significant. This means that when cheese price increases, the probability of cheese consumption and the cheese demand decrease.

The coefficients of total expenditure in both equations are positive, suggesting that total income, measured in term of total expenditure, has a significant and positive effect on the probability of consuming cheese and on the quantity demanded by households.

Household characteristics are important variables in determining dairy products consumption. Household size does not have significant effect on participation, but it has in quantity equation of the model. When a household buy cheese, the quantity purchased increases with the household size, suggesting that the number of household members has a positive effects in cheese demand.

The age of household head is statistically significant in determining the probability of purchasing cheese products and also in the quantity equation. Results suggest that older household head has more probability to buy cheese, and if they buy, will also tend to purchase more cheese quantity. For example, if the household head is older than 65 years, the probability of buying cheese is 6.79% higher than a household head with a younger than 34 years old. Moreover, results show that if the household consume cheese, household head older than 65 years old consume 0.22 kilogram a month more than the household head younger than 34 years old at the conditional level and 0.28 kilogram more at the unconditional level. These results could be reflecting different forms of eating from families with younger parents compared with older parents, where the presence of dairy products may be less, especially cheese, and also replacing it with other dairy products such as yoghurts, desserts, etc.

Differences in cheese consumption across regions are also suggested by the model. In general, the south part of the country, Patagonia region, consumes less cheese than the others. For example, the probability of consume cheese by a household in the Buenos Aires region is 6.34% higher than Patagonia region, in Pampeana region 4.12%, in the Northwest region 8.35%, in the Northeast region 4.03% and in the Cuyo region 7.38% higher. Moreover, households in these regions demand more cheese than in Patagonia if the consume cheese products.

Educational level of the household head is statistically significant, and it has a positive effect on the probability that a household consume, and in the cheese quantity. This implies that more educated household heads will be more likely to consume cheese, and if they consume, they will tend to buy more than the less educated head households. This could be expected in households with more educated heads because they could know the health benefits of the dairy intake of calcium in the diet, compared with household heads less educated.

Household with a male household head show less probability to buy cheese, 1.61% compared with a female household head. Moreover, the cheese demand declines with male household head in the conditional and the unconditional levels. Differences at both levels are not high, meaning that it is not such as important demographic variable in explaining cheese consumption.

Table 2. Estimates Double-Hurdle Model for Cheese

Variables	First Hurdle Probabilities	Second Hurdle	
		Conditonal	Unconditional
Cheese Price	-.00252*** (.00011)	-.00817*** (.00034)	-.01018*** (.00041)
Age of Household head >34	-.06798*** (.00906)	-.2236*** (.03001)	-.288*** (.0385)
Age of Household head 35-49 yrs	-.04033*** (.00896)	-.1315*** (.02936)	-.1663*** (.0378)
Age of Household head 50-64 yrs	-.0328*** (.0085)	-.1049*** (.0282)	-.12706*** (.0371)
Total Household Members	.00301 (.00204)	.0114* (.0068)	.0188** (.0089)
Total Expenditure	.00007*** (0.000001)	.0002*** (0.000007)	.00023*** (0.000004)
Households in Buenos Aires	.0634*** (.01202)	.2069*** (.0387)	.2616*** (.0488)
Households in Pampeana	.0412*** (.01014)	.1344*** (.0324)	.1699*** (.0409)
Households in Northwest	.0835*** (.00941)	.2725*** (.0301)	.3453*** (.0387)
Households in Northeast	.0403*** (.00993)	.1364*** (.0321)	.1859*** (.0414)
Household in Cuyo	.0738*** (.0111)	.2380*** (.0351)	.2935*** (.0443)
College (Education household head)	.0330* (.0170)	.1112** (.0539)	.1491*** (.0641)
High School (Education household head)	.0494*** (.0081)	.16201*** (.0268)	.2066*** (.0355)
Male (Gender Household Head)	-.0161* (.0059)	-.0501** (.0193)	-.0573** (.0248)
Two adults (Household Type)	.0687*** (.01054)	.2267*** (.0347)	.2933*** (.045)
Two adults with childen (Household type)	.0665*** (.0095)	.2191*** (.0312)	.2821*** (.0408)
Other (Household type)	.0498*** (.01180)	.1664*** (.0387)	.2211*** (.0508)
Year 2012 (survey year)	.0135** (.00604)	.0471** (.0195)	.0676*** (.0243)

*, **, *** statistically significant at 10%, 5%, and 1% level. Standard errors in parenthesis

Household composition also appears to affect the probability and demand of cheese consumption. Household with only one adult shows less probability to consume cheese products than other type of households. For example, comparing this single household with a household with two adults with children the probability of buying cheese is 6.65% higher.

Table 3 presents price and expenditure elasticities. In the participation equation, and using the average estimated elasticities, the probability to consume cheese is -0.13, meaning that with one percent cheese price increase, the probability that a household buy cheese decreases by 0.13%. Likewise, the elasticities for conditional and unconditional level are also negative, implying that an increase of 1% in cheese price, quantity decrease by -0.19% and -0.49% respectively. Expenditure elasticities show estimated values higher than price elasticities. The probability of purchasing cheese products by a household increase in 0.19% when total household expenditures go up by 1%. In the same way, at conditional and unconditional level, cheese quantity increase by 0.30% and 0.71% with one percent increase of total expenditures. The household expenditure, as a proxy of household income, has more impact in both probability and demand considering the estimated elasticities. This means that to increase the probability to purchase cheese, an improvement in the real income have more impact that a decrease in real price.

Table 3. Price and Income Elasticities

Variables	First Hurdle Probabilities	Second Hurdle	
		Conditonal	Unconditional
Cheese Price	-.1324*** (.0053)	-.1944*** (.00831)	-.4895*** (.02171)
Total Expenditure	.1891*** (.0041)	.3048*** (.00972)	.714*** (.0178)

*, **, *** statistically significant at 10%, 5%, and 1% level. Standard errors in parenthesis and calculated by deltha method

Conclusions

Modelling consumer behavior with household survey is complicated because of the presence of many zeros in the sample. This study uses a Double-Hurdle model to examine the impacts of socio-economics and demographic variables on households cheese consumption in Argentina.

Empirical results indicate that overall socio-economic and demographic variables of the households are important in determining the probability of consuming cheese and the quantity demanded. Cheese price has a negative impact on the probability that a household consumes cheese and also in the quantity that a household purchases.

As expected, rising household income, measured in term of household expenditure, augment the probability that a household consumes cheese, and also the cheese quantity. Price and expenditures elasticities estimated suggest that household expenditure growth is expected to increase cheese demand more than a decrease in cheese price.

Household characteristics show that household with children, female household head, and age and education of household head have more preference to purchase cheese products.

The results found in this work may help to understand how changes in the socio-economic and demographic characteristics of households in Argentina impact demand for cheese. This information can be useful for dairy companies, as well as policy makers to design strategies that will help to increase the cheese consumption.

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Appendix

Table 4. Results of Double-hurdle Model Estimation

Variables	*Quantity Equation*	*Participation Equation*
Cheese Price	-0.018*** (0.0007)	-0.00156***(0.0005)
Age of Household head >34	-0.589*** (0.0965)	0.112 (0.0988)
Age of Household head 35-49 yrs	-0.316*** (0.0948)	0.0167 (0.0984)
Age of Household head 50-64 yrs	-0.195** (0.0924)	-0.0804 (0.0856)
Total Household Members	0.0707*** (0.0261)	-0.0724** (0.0292)
Total Expenditure	0.00013*** (0.00001)	0.000625*** (0.00004)
Households in Buenos Aires	0.496*** (0.117)	-0.0233 (0.134)
Households in Pampeana	0.323*** (0.098)	-0.0159 (0.115)
Households in Northwest	0.661*** (0.097)	-0.0442 (0.111)
Households in Northeast	0.460*** (0.101)	-0.235** (0.107)
Household in Cuyo	0.497*** (0.107)	0.0939 (0.124)
College (Education household head)	0.352*** (0.132)	-0.154 (0.185)
High School (Education household head)	0.407*** (0.088)	-0.0491 (0.073)
Male (Gender Household Head)	-0.0609 (0.059)	-0.0915 (0.058)
Two adults (Household Type)	0.610*** (0.111)	-0.136 (0.107)
Two adults with childen (Household type)	0.576*** (0.106)	-0.109 (0.111)
Other (Household type)	0.505*** (0.128)	-0.193 (0.125)
Year 2012 (survey year)	0.192*** (0.0575)	-0.136** (0.0684)
Constant	-0.212 (0.158)	0.486*** (0.139)