Demographic and Economic Factors Affecting Demand for Brand-Level Milk in Texas

David Bingham*
Senarath Dharmasena**
Oral Capps, Jr.**
Victoria Salin**

*The Coca Cola Company
**Agribusiness, Food and Consumer Economics Research Center (AFCERC), Department of Agricultural Economics, Texas A&M University

Emails: sdharmasena@tamu.edu; ocapps@tamu.edu; v-salin@tamu.edu

Phone: (979) 862-2894

Selected Paper Southern Agricultural Economics Association Annual Meeting, Dallas, TX, February 1-4, 2014
(draft January 2, 2014)

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Abstract

Data from Texas households for year 2008 were used in examining market competitiveness of Promised Land milk (PLM) using tobit procedure. Private label, Poinsettia, and Oak Farms were substitutes to white PLM. Estimated demand elasticities for white PLM and chocolate flavored PLM were -2.33 and -0.54 respectively. Statistically significant drivers of PLM were income, age of shopper, age of children present in the household and race.

JEL Classification: D11, D12
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Background

Consumer demand studies centering attention to milk in the United States are numerous. Milk is positioned in the market as a beverage high in calcium, vitamin D and protein and backed by various advertising campaigns at generic and brand level (MilkPep, 2013; DMI, 2013; BMC 2013). However, per capita consumption of milk has been declining over the past 25 years, although consumption of processed dairy products, such as cheese and yogurt is on the rise (USDA-ERS, 2013).

One key factor in the decrease of per capita milk consumption was the growing number of substitutes in the non-alcoholic beverage market (Dharmasena, 2010; Harnack, et al., 1999). Change in consumer milk-fat preferences have been studied extensively by Cornick, et al., (1994) and Gould (1996). Articles illustrating the effects of advertising on milk consumption (Capps & Schmitz, 1991; Kinnucan, 1986) and consumer milk-fat preferences also have been widely studied (Kaiser, 1997; Kaiser & Reberte, 1996). Total per capita consumption of flavored milk has increased 61% from 1975 to 2010. It is noteworthy that research regarding flavored milk demand preferences remains largely unexplored. Additionally, organic production is growing in popularity due to the high premiums producers receive for their products (Valley, 2005).

Another facet to the milk market provides an additional layer of complexity, namely the numerous milk brands. Once a consumer identifies his/her preference (organic, low-fat, conventional, or whole milk), he/she still has to decide which brand to purchase. Our study uses Nielsen Homescan data for calendar year 2008, specifically centering attention to brands of milk consumed in the state of Texas.
The uniqueness of our work centers attention to investigating demographic and economic factors affecting demand milk at brand-level. Specific objectives are: to (1) estimate household demand for Promised Land white and chocolate milk; (2) assess the demographic drivers of demand for Promised Land white and chocolate milk; (3) estimate own- and cross-price elasticities for Promised Land white and chocolate milk; (4) To identify substitutes and complements of Promised Land white and chocolate milk.

Data and Methodology

Promised Land’s “home region” was identified to be Texas and the Southeastern states of the United States (Capps and Salin, 2010). This region accounted for over 90% of households that purchased Promised Land milk. Nielsen’s 2008 Homescan data revealed that Texas accounted for 78% of all households that purchased the Promised Land brand. However, only 5% of Texas households who purchased white milk purchased Promised Land milk. As for chocolate milk, 73.8% of all households who purchased Promised Land chocolate milk were Texas households. About 28.7% of the 1,023 households recording chocolate milk purchases in 2008 were for the Promised Land brand.

Demographic variables included in the study are household size, income, race and ethnicity, age and presence of children, and location within the state of Texas. Due to large number of zero observations (households that did not buy Promised Land brand milk), a tobit model (Tobin, 1958) was estimated. The conditional and unconditional effects were obtained through McDonald and Moffitt’s (1980) decomposition. The Texas sample comprised 4,578 households. Prices were expressed in terms of dollars per ounce. Competing brands for Promised Land white milk are, Borden, Oak Farm, Schepps, Poinsettia, Horizon Organic and private-label brands. Competing brands for Promised Land chocolate milk are Borden, Oak Farms, Nestle
Nesquick and private-label brands. Missing price observations were imputed using an auxiliary regression (see Alviola and Capps (2010)). Homogeneity was imposed during estimation (Zellner, 1962).

Tobit procedure

Since not all households purchased Promised Land, the dependent variable was censored. In order to overcome the censoring problem, the tobit model was employed. Tobin (1958) explained the problem that arises when a majority of observations are near a limit; in this case, the limit corresponded to zero expenditure or a non-purchase. Tobin (1958) explained that

Account should be taken of the concentration of observations at the limiting value when estimating statistically the relationship of a limited variable to other variables and in testing hypotheses about the relationship. An explanatory variable in such a relationship may be expected to influence both the probability of the limit responses and the size of non-limit responses. (p. 25)

Tobin (1958) illustrated that a probit model can only capture the “probability of [the] limit and non-limit responses,” (p. 25) but did not have the ability to measure “the value of non-limit responses” (p. 25). In other words, the probit model cannot measure the magnitude of the effect an explanatory variable will have on the dependent variable. Tobin (1958) then showed that a multiple regression model can only explain “the value of the variable” (p. 25) but does not provide any information as to the change in the probability. Tobin (1958) then announced that a “hybrid of probit analysis and multiple regression…is called for” (p. 25) and created a model that can measure both the probability and value of the effects. The tobit model is shown below:

\[
\begin{align*}
    y_t &= X_h \beta + u_h & \text{if } X_h \beta + u_h > 0 \\
    y_h &= 0 & \text{if } X_h \beta + u_h \leq 0 \\
    t &= 1, 2, ..., N,
\end{align*}
\]
where $N$ is the number of observations (households), $y_h$ is the dependent variable, $X_h$ is the vector of explanatory variables, $\beta$ is the estimated parameter and $\mu_h$ is the normally distributed error term with a zero mean and variance.

**McDonald Moffitt Decompositions**

Later McDonald and Moffitt (1980) reinforced Tobin’s view that when data sets “often have values clustered at zero… [Tobin’s technique] is to be preferred, in general, over alternative techniques that estimate a [model with only] the observations above the limit” (p. 318). McDonald and Moffitt’s (1980) contribution to Tobin’s model lies in being able to use the estimated coefficients to “provide more information than is commonly realized” (p. 318). Simply put, the method allowed the researcher to obtain the conditional and unconditional marginal effects. The conditional effect was defined as the change in $y_i$ of the observations above the limit, and the probability of being above limit. The unconditional effect was the change of $y_i$ on all observations both on and above the limit, and the probability of being at the limit. McDonald and Moffitt (1980) summarized their decomposition below.

$$\frac{\partial E y^*}{\partial X_i} = \beta_i [1 - z f(z)/F(z) - f(z)^2/F(z)^2]$$

This derivative provided the conditional marginal effects. Where $\beta_i$ is the estimated coefficient, $F(z)$ is the cumulative normal distribution function, $f(z)$ is probability density function for a normal distribution, and $z$ is the $z$-score $z=X\beta/\sigma$. The parameters to be estimated in the tobit analysis are $\beta_i$ and $\sigma$, the standard deviation or scale parameter associated with the use of the normal distribution.

$$\frac{\partial E y}{\partial X_i} = F(z) * \beta_i$$

This derivative provided the unconditional effects.
The demand estimation models are exhibited below. The explanation variables in the model for Promised Land white milk included: \( l\text{Promisedland}_h \), \( l\text{Borden}_h \), \( l\text{OakFarms}_h \), \( l\text{HorizonOrg}_h \), \( l\text{Scheps}_h \), \( l\text{Poinsettia}_h \) and \( l\text{PrivateLabel}_h \) represented the log of the white milk prices for household ‘h’; \( l\text{Income}_h \) was the log of household’s ‘h’ income; \( l\text{HHSize}_h \) was the log of the household size for household ‘h’; Houston, Dallas_FtWorth, Austin, and San Antonio represented the region where household ‘h’ was located; Black, Asian, and Other represented the race of the shopper for household ‘h’; Hisp_yes was the ethnicity of the shopper for household ‘h’; \( Ac_{6}, Ac_{6-12}, Ac_{13-17} \) represents the age and presence of children in household ‘h’; and \( v_h \) is the error associated with household ‘h’.

**Empirical Models**

**White Milk Model**

**Quantity of Promised Land White Milk**

\[
\begin{align*}
\text{Quantity of Promised Land White Milk} & = \beta_1 + \beta_2 l\text{PromisedLand}_h + \beta_3 l\text{Borden}_h + \beta_4 l\text{OakFarms}_h \\
& + \beta_5 l\text{HorizonOrg}_h + \beta_6 l\text{Scheps}_h + \beta_7 l\text{Poinsettia}_h \\
& + \beta_8 l\text{PrivateLabel}_h + \beta_9 l\text{Income}_h + \beta_{10} l\text{HHSize}_h \\
& + \beta_{11} \text{Houston}_h + \beta_{12} \text{San Antonio}_h + \beta_{13} \text{Dallas_FtWorth}_h \\
& + \beta_{14} \text{Austin}_h + \beta_{15} \text{Black}_h + \beta_{16} \text{Asian}_h + \beta_{17} \text{Other}_h \\
& + \beta_{18} \text{HispYes}_h + \beta_{19} Ac_{6}_h + \beta_{20} Ac_{6-12}_h + \beta_{21} Ac_{13-17}_h + v_h
\end{align*}
\]
Chocolate Milk Model

Quantity of Promised Land Chocolate Milk

\[ = \beta_1 + \beta_2 lCPromisedLand_h + \beta_3 lCBorden_h + \beta_4 lCOakFarms_h \\
+ \beta_5 lNesQuick_h + \beta_6 lCPrivateLabel_h + \beta_7 lIncome_h + \beta_8 lHHSize_h \\
+ \beta_9 Houston_h + \beta_{10} San_Antonio_h + \beta_{11} Dallas_FtWorth_h + \beta_{12} Austin_h \\
+ \beta_{13} Black_h + \beta_{14} Asian_h + \beta_{15} Other_h + \beta_{16} HispYes_h + \beta_{17} Aclt6_h \\
+ \beta_{18} Ac6_{12}h + \beta_{19} Ac13_{17}h + e_h \]

Empirical Results and Discussion

Private Label, Poinsettia, and Oak Farms were substitutes to Promised Land white milk. Conditional own-price elasticity of demand for Promised Land white milk was -2.33. The unconditional own-price elasticity of the same was -1.65. The age of the shopper, income, “age of children”, and White shoppers were significant determinants of purchase of Promised Land white milk. Houston had the greatest positive conditional and unconditional marginal effect on sales, followed closely by Austin, and then by Dallas Ft. Worth and San Antonio. The only complement in the chocolate milk market was Nesquick, while other brands were substitutes. The conditional own-price elasticity for Promised Land chocolate milk was -0.54, while the unconditional own-price elasticity was -3.30. “Black” shoppers purchased significantly less Promised Land chocolate milk than “White” shoppers. Results will enhance the marketing efforts of Promised Land’s white and chocolate milk brands by targeting consumer segments. Also, owing to the results of own-price and cross-price elasticities, Promised Land producer may lower the price of Promised Land white or chocolate milk to increase the base of consumers.
Conclusions, Implications and Limitations

The findings from the tobit analysis for Promised Land white milk indicated a positive relationship between household income and purchases of Promised Land. Larger-sized households purchased less Promised Land white milk than smaller-sized households. Households with children less than the age of 6 and households with children between the ages of 13 and 17 were likely to purchase more Promised Land white milk than households with no children present. Conversely, households with children who were between 6 and 12 years old purchased less Promised Land white milk than households with no children present.

In terms of region, households located in Houston purchased more Promised Land white milk than any other region, with Austin, San Antonio, and Dallas/Ft. Worth areas all purchasing more Promised Land white milk than all other areas in Texas. Shoppers who were less than 30 years old were likely to purchase more Promised Land white milk than any other age group. As for race, Black households were likely to purchase less Promised Land milk than White households, while Asian households purchased more Promised Land white milk than White households.

From these demographic indicators, it was found that income, household size, the age and presence of children, the age of the shopper, region, and race had a significant effect on the quantity of Promised Land white milk purchased. The demographic results were the same regardless of the consumer’s decision to purchase Promised Land white milk.

From the estimated elasticities, it was found that households who purchased Promised Land white were insensitive to changes in the price of Promised Land white milk, while households who did not purchase Promised Land milk were far more sensitive to changes in the price of Promised Land white milk. The price of private label milk was the only price that was
significant in the quantity of Promised Land white milk purchased. The estimated elasticities showed that Promised Land white milk and private label white milk were substitutes. Households who did not purchase Promised Land white milk were more sensitive to changes in private label white milk than households who already purchased Promised Land white milk. Borden, Horizon Organic, and Schepps were complements to Promised Land white milk, while Oak Farms and Poinsettia were substitutes for Promised Land white milk.

The findings from the tobit analysis for Promised Land chocolate milk indicated that income was not a significant factor in the purchase of this brand. Households with more family members were likely to purchase more Promised Land chocolate milk. Households with children of any age purchased less Promised Land chocolate milk than households with no children.

In terms of region, households located in San Antonio were most likely to purchase more Promised Land chocolate milk than the other regions. Households located in Houston and Dallas/Ft. Worth were more likely to purchase more Promised Land chocolate milk than households located in Austin and “all other regions.”

Households with shoppers aged 30 to 54 were likely to purchase more Promised Land chocolate milk than shoppers less than 30 years old. Conversely, shoppers who were 55 years old and older purchased less Promised Land milk than shoppers who were less than 30 years old.

As for race, Black households and households of other races purchased less Promised Land chocolate milk than White households, while Asian households were likely to purchase more Promised Land chocolate milk than White households. Finally, households with Hispanic heritage were inclined to purchase less Promised Land chocolate milk than households without a Hispanic heritage. From these demographic indicators, it was found that household size, the age
and presence of children, the age of the shopper, region, and race had a significant effect on the quantity of Promised Land chocolate milk purchased.

From the estimated elasticities, it was found that households that purchased Promised Land chocolate milk were largely insensitive to changes in the price of Promised Land chocolate milk, while households that did not purchase Promised Land chocolate milk, were very sensitive to changes in the price of Promised Land chocolate milk. It was also found that the prices of Nesquick, Oak Farms, and private label chocolate milk had a significant effect in the quantity of Promised Land chocolate milk purchased. Of these significant prices, Private Label chocolate milk and Oak Farms chocolate milk were substitutes for Promised Land chocolate milk and had the largest effect on the quantity of Promised Land chocolate milk purchased. The price of Nesquick chocolate milk demonstrated a complementary relationship with Promised Land chocolate milk. All price effects were larger for households that did not purchase Promised Land chocolate milk than for households that purchased Promised Land chocolate milk.

The results from this study will enhance the marketing efforts of Promised Land’s white and chocolate milk brands by targeting consumer segments specific to each product. For Promised Land white milk, the target market is affluent households, households with few family members, households with children less than 6 years old and children 13-17, White and Asian households, households located in Austin and Houston, and shoppers who are less than 30.

For Promised Land chocolate milk, the target market is households with larger sizes, households with no children, households located in San Antonio and Houston, White and Asian households, and shoppers between the ages of 30-54.

Also, owing to the results of own-price and cross-price elasticities, LALA USA should lower the price of Promised Land white or chocolate milk to increase the base of consumers.
Once the base of consumers has been widened, they should then increase price to increase revenue.

One of the major limitations of this study was that only one year of household data for 2008 was used. Findings would be enhanced with data over multiple years and more recent data. Further research would benefit by taking these limitations into account.
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