Consumer Demand for Greek-Style Yogurt and its Implications to the Dairy Industry in the United States

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Abstract

Although per capita fluid milk consumption in the United States has been declining, production and consumption of manufactured dairy products are on the rise. Growth in the Greek-style yogurt market can be attributed to growth in production and consumption of manufactured dairy products. Rapid growth in Greek-style yogurts could create both opportunities and problems for dairy-product consumers, producers, and marketers. This paper investigates the growth of Greek-style yogurt market in the United States focusing on quantifying implications on consumer demand and dairy farmer welfare as it relates to economic efficiency and product availability.

The objectives are to (a) estimate economic and demographic factors affecting U.S. demand for Greek-style yogurt, and (b) investigate the economic ramifications on U.S milk producers in the event that demand for Greek-style yogurt continues to grow as well as if over-capacity occurs, and leads to declines in the Greek-style yogurt price, the overall welfare of dairy farmers

Cutting-edge methodologies in censored demand modeling and calculation of farm-level welfare effects are used. This work will help set appropriate policies at consumer, producer and marketer level pertaining to Greek-style yogurts in the United States, and thereby contributing to long-range improvement and sustainability of U.S. agricultural and food systems.

Keywords: Greek-style yogurt, consumer demand, farmer welfare

JEL Classification: D11, D12, P46

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Background and Justification

The dairy industry in the United States offers a wide array of milk and processed dairy products such as butter, cheese, ice cream, sour cream and yogurt to consumers (Davis *et al.*, 2010). However, per capita consumption of milk has been declining over the past 25 years, even when consumption of processed dairy products, such as cheese and yogurt is on the rise (USDA-ERS, 2013). According to Progressive Grocer (2013) the total U.S. yogurt category reached $6.4 billion in sales in 2011, a 15% uptick from 2010 (Caldwell 2012) and continues to grow. Currently per capita consumption of yogurt in the United States is about 13 lbs per year and this is very low compared to its European counterparts where the per capita consumption is about 60 lbs (Carper, 2012).

This surge in yogurt sales can be partially attributable to the introduction and growth in Greek-style yogurt (Bowman, 2013). Between 2006 and 2011, Greek-style yogurt sales grew by 2,500 percent. Information Resources Inc. (IRI) reported that in 2012, Greek-style yogurt sales were 34% of total yogurt dollar sales and 22.5% of total yogurt volume sales (Boynton and Novakovic, 2013). Furthermore, non-Greek-style yogurt fell 10% by volume from 2011 to 2012, while Greek-style yogurt volume rose 72% during the same time period (Boynton and Novakovic, 2013). Two consumer segments contributed to this increase in consumption of Greek-style yogurt in the United States: (1) women who were already yogurt eaters, but switched from conventional to Greek-style yogurt, (2) men who saw Greek-style yogurt as a protein-rich sports nutrition product (Boynton and Novakovic, 2013).

Although, Greek-style yogurt products increased the overall demand for milk, it cannibalized (and will continue to cannibalize) production and sales of other dairy products, more specifically conventional yogurts. Not only has Greek-style yogurt shown rapid growth in retail food sector, but also it has begun to penetrate foodservice sectors as well (Boynton and Novakovic, 2013). Recently, United States Department of Agriculture (USDA) partnered with Greek-style yogurt manufacturer from the state of New York, Chobani, as a pilot to rollout Greek-style yogurt in nation's school cafeterias as part of USDA National School Lunch Program (NSLP) (Hattem, 2013; New York Governor's Office, 2013).

Production of Greek-style yogurt has quadrupled in New York State from 2008 through 2013 and currently is the largest yogurt manufacturer in the United States, producing 692 million pounds of yogurt in 2012 compared to that of state of California, which produced 587 million pounds (Boynton and Novakovic, 2013; New York Governor's Office, 2013). New York State has comparative advantage in the Greek-style yogurt production due to (a) presence of large farm milk production sector, (b) proximity to demographically large, rich and ethnically diverse population centers in the northern Atlantic coast (according to NASS dairy region classification), (c) quick access to interstate highway system which allows easy, quick and cost-effective distribution of their product to West as well as East Coast, and (d) establishment of modern and large (Greek-style) yogurt producing facilities in recent times (Boynton and Novakovic, 2013).

However, rapid growth of Greek-style yogurt in New York is not without problems. Production of Greek-style yogurt takes three times the milk as conventional yogurt, and the supply of milk primarily sourced in New York State, is somewhat inelastic to meet this demand. New York State dairy farmers are reluctant to increase capacity citing that the Federal milk marketing order caps the price received by dairy farmers in each region, so that dairy farmers do

not explicitly benefit from the Greek-style yogurt boom (Sommerstein 2013). In addition, many Greek-style yogurt manufacturers in New York plan to expand production, which could lead to over-capacity of Greek-style yogurt production and drive some marginal players out of business. This over-production would put downward pressure on Greek-style yogurt prices and margins. There is ample evidence that wholesale and retail prices of Greek-style yogurt have fallen over the past few years, when more competitors of Greek-style yogurt entered the market (Boynton and Novakovic, 2013). For example, Greek-style yogurt prices fell from $4.88/pint to $3.31/pint between 2006 and 2011, while conventional yogurt prices rose (Boynton and Novakovic, 2013). Another contributory factor for this decline in price of Greek-style yogurt is the emergence of low-priced private-label (or store brand) manufactures. Therefore, on the one hand, if demand for Greek-style yogurt in New York continues to grow, it would put pressure on New York dairy farmers to meet the increasing demand for milk, and on the other hand, if due to over-capacity of Greek-style yogurt manufacturing if some of Greek-style yogurt producers go out of business, it would put counter pressure on New York milk producers to source different markets to sell milk in the light of decreasing milk prices.

Our study has three specific objectives. First, we estimate demand for Greek-style yogurt, conventional yogurts, sour cream and cream cheese, milk, ice cream and other dairy desserts. Second, we estimate the economic and demographic profiles of Greek-style yogurt consumers in the United States. Lastly, we investigate the economic ramifications on New York state milk producers in the event that demand for Greek-style yogurt continues to grow as well as if over-capacity occurs, and leads to declines in the Greek-style yogurt price, the overall price received by dairy farmers.

Data and Methodology

We will use both Nielsen Homescan consumer panel data (2008-2009) and IRI National Consumer Panel (2010-2013) for Greek-style yogurt, non-Greek-style yogurts, sour cream and cream cheese, and ice cream and other dairy desserts for the United States. Own-price, cross-price and expenditure elasticities for aforementioned separable food group will be estimated using quadratic almost ideal demand system (QUAIDS) of Banks *et al.,* (1997) using semi-parametric procedure suggested by Sam and Zheng (2010) in the presence of censored data.

Demand for Greek-style yogurt, conventional yogurt, sour cream/cream cheese and ice cream and other dairy desserts will be estimated in a complete demand system framework to uncover own-price, cross-price and expenditure elasticities and to determine economic and demographic profiles of consumption. We consider the aforementioned dairy products as a separable category and invoke weak-separability in estimating the demand system. Given that the data we use contains many households that do not purchase all the dairy products we estimate a censored demand system, more specifically a censored quadratic almost ideal demand system (C-QUAIDS) (Banks *et al.,* 1997).

Several approaches are available in the extant literature to estimate a censored demand system. Maximum likelihood method suggested by Wales and Woodland (1983), Lee and Pitt (1986) and Chiang and Lee (1992) among others is one such method used to estimate a censored demand system. This method has the advantage of being consistent with theory of consumer choice; however, statistical consistency of parameter estimates is contingent on the correctness of the joint distribution assumed and there is high computational cost associated with evaluation of multidimensional integrals. The two-step method suggested by Shonkwiler and Yen (1999) produces inefficient estimates as well as it is derived with the assumption that the disturbances in

the censoring equations are homoscedastic, which is an untenable assumption when dealing with cross-sectional micro-level data. In this project, we propose to use two-step semi-parametric approach suggested by Sam and Zheng (2010) for the estimation of a censored demand system. This procedure is exempt from distributional misspecification (does not assume a normally distributed error in the first-stage equation) and accommodates a certain form of heteroskedasticity. We plan to use the Klein and Spady (1993) semi-parametric single-index model instead of the conventional probit model used in alternative two-step estimators such as Shonkwiler and Yen (1999) in the first-stage equation to model the decision to purchase any dairy product. The advantage of the Klein and Spady (1993) model is that, without relying on distributional assumptions, this method generates consistent and efficient estimates and furthermore accommodates heteroskedasticity of a certain form in the error term. In the second stage, the QUAIDS (Banks *et al*, 1997) will be used to model the conditional demand for Greek-style yogurt, conventional yogurt, sour cream/cream cheese, and ice cream and other dairy desserts.

The methodology explained below is from Sam and Zheng (2010). For *n* goods and *j* (cross-sectional) observations, binary (0-1) (d_{ij}) indicator function *I* can be expressed as follows:

(1) $$d_{ij} = I(W_{ij}^{'}\gamma_i + v_{ij})$$

where $W_{ij}^{'}$ is vector of regressors, γ_i is model parameter and v_{ij} is zero mean and finite variance error process. The conditional response variable, Y_{ij} in the second-stage equation is as follows:

(2) $$Y_{ij} = d_{ij} * (g(X_{ij}, \beta_i) + \epsilon_{ij})$$

where X_{ij} is vector of regressors, β_i is model parameter and ϵ_{ij} is zero mean and finite variance error. Given equations (1) and (2), the conditional mean can be expressed as follows:

$$E\left(Y_{ij}\middle|X_{ij},W_{ij}\right)=E\left(Y_{ij}\middle|X_{ij},W_{ij};d_{ij}=1\right)*prob(d_{ij}=1). \tag{3}$$

The unknown cumulative distribution function of the error term v_{ij} is denoted by $F_i(W_{ij}^{'}\gamma_i)$. Then we can write the system of equations of interest as follows:

$$Y_{ij}=\left(\ g\left(X_{ij},\beta_i\right)+\lambda_i\left(W_{ij}^{'}\gamma_i\right)\right)*F_i\left(W_{ij}^{'}\gamma_i\right)+\eta_{ij}. \tag{4}$$

The parameters of the first step are estimated using Klein and Spady (1993) semiparametric single-index model. The second stage conditional demand system (the QUAIDS model) can be expressed as follows: w_i is the budget share of dairy product; $a(P)$ is the Translog price index; $b(P)$ is the Cobb-Douglas price index; m is total expenditure; p is price of dairy product:

$$w_i=\left(\alpha_i+\beta_i\left(ln\frac{m}{a(P)}\right)+\sum_{k=1}^{n}\gamma_{ik}lnp_k+\sum_{l=1}^{L}\tau_{il}\left(W_i^{'}\widehat{\gamma}_l\right)^{l-1}+\frac{\lambda}{b(P)}\left(ln\frac{x}{a(P)}\right)^2\right)*\widehat{F}_l(W_i^{'}\widehat{\gamma}_i) \tag{5}$$

We use the estimates from the QUAIDS to predict how changes in demographic profiles, prices and income will likely affect demand for the aforementioned dairy products, and how these changes in retail demand will affect the blend price, production and producer surplus of New York State farmers subject to the federal milk marketing order system. To model the farm-side effects, we extend an equilibrium displacement model (EDM) of *N* inter-related food products linked to *L* inter-related farm commodities developed by Okrent and Alston (2012) to incorporate the role of federal milk marketing orders on pricing in the dairy industry.

Preliminary Results and Discussion

Preliminary analysis was performed using 2008 Nielsen Homescan data comprised of 61,440 households. For this preliminary analysis we estimated demand for refrigerated yogurt as a single equation and used a Heckman two-step estimator (Heien and Wessells 1990) to account for censoring in the data. Market penetration for yogurt (refrigerated) category was found to be 77.9%. The simple single-equation model also accounts for household composition and demographic characteristics by introducing these variables as an intercept shifter in the model.

The average price paid by households who purchased yogurt was $0.10 per ounce ($3.11 for 32 ounces; the most popular bulk yogurt container size). The average consumption/purchase by a consuming household was estimated to be 423.12 ounces per year (approximately thirteen 32 oz. containers per household per year).

Conditional demand estimates of demand for refrigerated yogurt category for the United States are shown in Table 1. We estimated the conditional own-price elasticity of demand for yogurt to be -0.20. This is consistent with findings in the literature in that the own-price elasticity of demand for dairy products is generally found to be quite inelastic and much more so for processed dairy products (Okrent and Alston 2011). The income elasticity of demand was 0.21.

We also found that household composition and demographic characteristics played an important role in demand for yogurt. Households with heads over 35 years of age showed a higher probability of purchasing yogurt. Household heads who are college or post-college educated purchased more yogurt than those who has lower educational attainment. Households in the Western United States consumed more yogurt than those from other regions (East, South, and Midwest). Those who are classified as White consumed more yogurt. Households with

Hispanic household heads consumed more yogurt than those who are not Hispanic. Households with children purchased more yogurt than those who do not have children.

While the present analysis is somewhat limited with our focus on overall demand for yogurt, this preliminary analysis puts us in position to estimate own-price, cross-price and expenditure elasticities for the separable group of goods, namely Greek-style yogurt, non-Greek-style yogurts, sour cream and cream cheese, milk, ice cream and other dairy and non-dairy desserts for U.S. consumers. Also, we will be profiling demographic characteristics of consumers with regards to these food groups. Lastly, using estimated elasticities, we will be in position to discuss the welfare effects of the U.S. Greek-style yogurt boom on New York State dairy farmers.

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Table 1: Parameter estimates of conditional demand for refrigerated yogurts in the United States

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	30	482384867	16079496	55.14	<.0001
Error	47833	13949091736	291621		
Corrected Total	47863	14431476603			

Root MSE	540.01914	**R-Square**	0.0334
Dependent Mean	423.12444	**Adj R-Sq**	0.0328
Coeff Var	127.62655		

Variable	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	147.66	75.51486	1.96	0.0505
P_Yogurt	-854.42	61.75007	-13.84	<.0001
hinc	1.46	0.17087	8.58	<.0001
agehh2529	43.07	44.98780	0.96	0.3384
agehh3034	48.33	43.64077	1.11	0.2680
agehh3544	35.93	43.59533	0.82	0.4098
agehh4554	43.35	44.36312	0.98	0.3284
agehh5564	41.53	44.90492	0.93	0.3549
agehhgt64	35.59	45.30319	0.79	0.4320
emphhpt	19.04	8.64734	2.20	0.0277
emphhft	-7.72	6.43218	-1.20	0.2297
eduhhhs	60.40	20.61555	2.93	0.0034
eduhhu	146.36	26.94428	5.43	<.0001
eduhhpc	199.56	31.41	6.35	<.0001
East	-13.91	8.18	-1.70	0.0894
MidWest	-58.96	8.57	-6.88	<.0001
South	-132.44	10.98	-12.05	<.0001
Black	-191.26	20.65	-9.26	<.0001
Asian	-93.28	17.24	-5.41	<.0001
Other	-52.33	14.37	-3.64	0.0003
hisp_yes	-10.80	13.28	-0.81	0.4159
aclt6_only	163.59	21.72	7.53	<.0001
ac6_12only	109.01	18.81	5.79	<.0001
ac13_17only	69.35	13.27	5.22	<.0001
aclt6_6_12only	226.90	23.23	9.77	<.0001
aclt6_13_17only	81.27	36.26	2.24	0.0250
ac6_12and13_17only	158.00	23.29	6.78	<.0001
aclt6_6_12and13_17	211.81	33.37	6.35	<.0001
fhonly	-89.82	7.62	-11.78	<.0001
Mhonly	-238.36	51.02	-4.67	<.0001
Mills_D_Yogurt	521.95	134.63	3.88	0.0001