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Impacts on Producer Profits Attributed to Fortifying Processed Cheese with Omega-3 Fatty Acids

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Background

While it has been shown that dietary omega-3 polyunsaturated fatty acids (as DHA and EPA) are important for health and development, it is difficult for most people to get enough through diet alone. The most widely available source is fish such as salmon which are not always consumed on a regular basis. The increased recognition of the importance of DHA in the diet, coupled with its limited availability in natural food sources, makes fortifying foods with DHA a noteworthy solution.

Recent reports have targeted dairy foods as having a high opportunity or potential for growth in the omega-3 fortification business. First, most dairy foods provide the minimal fat basis needed to more easily incorporate omega-3 oils. Additionally, all dairy products share the image of "being good-for-you" given that they deliver essential nutrients to consumers. This choice also is justified by the existence in the market of several dairy products already carrying added health benefits (probiotics in yogurt). This exposure is very important when looking for new opportunities to proliferate healthy functional food ingredients such as omega-3s.

Objectives

The chief objective is to determine the effects of potentially fortifying processed cheese with omega-3 fatty acids on the profits of manufacturers. Fortification implies an additional cost of production for cheese processors. This ex-ante analysis takes into account market conditions and evaluates the increase in the demand for processed the case of linear demand and sucheese needed to offset these costs of fortification in order to maintain the level of profitability of producers.

To attain this goal, we need to estimate initially the demand for processed cheese products. Then, we determine the actual producer surplus considering pply functions. Finally, we establish by how much the demand for the new product (fortified cheese) would have to shift to the right so that the producer surplus remains the same after the fortification. That is, we determine the minimum demand increase required so that manufacturers would at least cover the marginal costs in producing omega-3 fortified cheese.

Data

The source of data used in this analysis is the ACNielsen Homescan Panel of U.S. households (38,040 households) for calendar year 2005. The panel provides not only information regarding purchases of cheese but also socio-demographic information. In this study, we focus on transactions where American processed cheese has been bought. The quantities purchased and expenditures are aggregated by household on a monthly basis. We ended up with a panel data structure with 426,504 observations, 35,542 households and 12 monthly purchase periods.

Prices are not observed directly in the panel data. An estimate of price, the unit value, is obtained by dividing reported expenditures, less any coupon value redeemed, by the quantity purchased. In this analysis, we impute prices h household using a regression model of the logarithm of price on regional dummy variables, monthly dummy variables, household income, and promotion variables.

Description of the Economic Model

Given the nature of household data used, zero-purchase observations are expected, requiring the use of econometric approaches accounting for censoring. To determine the demand for American processed cheese, a panel sample selection model with random effects is used as discussed by Greene (2002). It was developed following the same approach using the Heckman selectivity correction (1979) as presented by Verbeek (1990), Zabel (1992) and Verbeek and Nijman (1992). The model is fit using a simulated maximum likelihood procedure .The structural equations are:

Censoring mechanism (Decision to purchase)

$$z_{it}* = \boldsymbol{\alpha}'\boldsymbol{w_{it}} + u_{it} + d_i \quad (1)$$

$$z_{it} = 1(z_{it}* > 0), u_{it} \sim N[0,1] \quad (2)$$

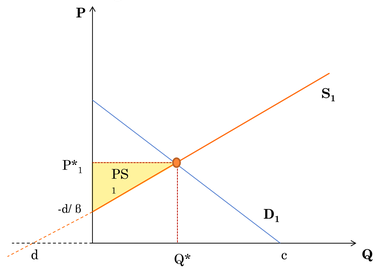
Corrected Regression (Amount to purchase)

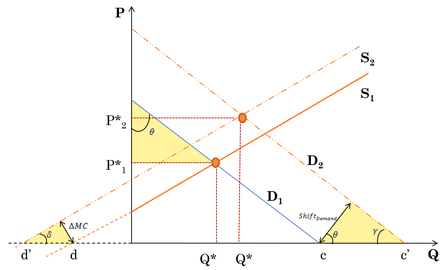
$$y_{it} = \boldsymbol{\beta}'\boldsymbol{x_{it}} + \varepsilon_{it} + c_i, \ \ \varepsilon_{it} \sim N[0,\sigma^2] \quad (3)$$

y_{it} refers to the quantity of American processed cheese purchased by household i during month t, and z_{it} is a binary variable referring to the purchase of American processed cheese in month t by i. $\boldsymbol{x_{it}}$ and $\boldsymbol{w_{it}}$ are the vectors of explanatory variables for equation (1) and (3) respectively.
The selectivity comes through the correlation of the unique components, ε_{it} and u_{it} , and also the correlation of the group specific components, c_i and d_i .

After estimating the demand for American processed cheese, we need to calculate the producer surplus for the industry and to determine by how much the demand for this cheese would have to increase so that manufacturers would at least cover their marginal costs in producing omega-3 fortified cheese.

In the calculations, we assume both the demand and the supply functions are linear and that the shift in supply due to the change in fixed and marginal costs is a parallel shift. We also assume that the shift in demand is not only parallel, but also the shift is to the right due the health benefits associated with omega-3 fatty acids.





$Q_d = -\alpha P + c$: Demand
$Q_s = \beta P + d$: Supply
$Q_d = Q_s$: Equilibrium condition

After fortification we have:
$Q_d' = -\alpha P + c'$: Demand
$Q_s' = \beta P + d'$: Supply

The change in producer surplus is given by

$$\Delta PS = \frac{\beta}{(\alpha+\beta)^2}c'^2 + \left[\frac{\alpha d'}{(\alpha+\beta)^2}\right]c' + \left[\frac{-\alpha(d'^2-(c-d)^2)}{2(\alpha+\beta)^2} - \frac{c(c-d)}{2(\alpha+\beta)} + \frac{\alpha(d'^2+d(c-d))}{2\beta(\alpha+\beta)} - \frac{dc}{2\beta}\right]$$

To determine the percentage shift in demand necessary to at least offset the marginal costs of producing omega-3 fortified cheese, we set ΔPS equal to zero and solve for c'.

$$c' = \frac{\frac{-\alpha d'}{(\alpha+\beta)^2} \pm \left[\left(\frac{\alpha d'}{(\alpha+\beta)^2}\right)^2 - \frac{4\beta}{(\alpha+\beta)^2} * \left(\frac{-\alpha(d'^2-(c-d)^2)}{2(\alpha+\beta)^2} - \frac{c(c-d)}{2(\alpha+\beta)} + \frac{\alpha(d'^2+d(c-d))}{2\beta(\alpha+\beta)} - \frac{dc}{2\beta}\right)\right]^{\frac{1}{2}}}{\frac{2\beta}{(\alpha+\beta)^2}}$$

The percentage shift in demand necessary to at least offset the marginal costs of producing omega-3 fortified cheese is

$$\%\ Shift_{Demand} = \frac{(c'-c)\cos\left[\arctan(-\alpha)\right]}{c} \times 100$$

Estimation and Empirical Results

The estimation of our model of censored demand with random effects was performed using the software package *Limdep* (version 8.0). We adopted the simulated maximum likelihood (SML) approach. Equation (1) provides information on variables influencing the decision to purchase processed cheese products. Once the decision to purchase is made, equation (3) allows the identification of statistically significant drivers associated with how much of processed cheese to buy. The estimated parameters, standard errors and p-values of the explanatory variables associated with equation (1) and (3) are not presented here. Please contact the authors for further information on the household demand for processed cheese products.

Our main objective is to determine by how much the demand for process cheese products would have to increase so that the manufacturers would at least cover their marginal costs in producing omega-3 fortified cheese. To solve for this percentage we need to know the values of the parameters α, c, β, d, d'.

The demand parameters have been estimated previously in our model. α = -46.69, c = 22.98, and the own-price elasticity of demand is -0.68. The short and long-run impacts of cost changes are simulated assuming different scenarios, using different supply parameters (β and d), and also different changes in marginal costs ΔMC (d'). The values we chose for ϵ_s range from 0.001 to 10, and the values for ΔMC ranged from 1¢ to 20¢/oz.

- According to our findings, the more elastic the supply, the less the demand function for processed cheese products needs to shift to the right in order to cancel out the fortification costs.
- Increasing the change in marginal cost due to fortification leads to an increase of the percentage shift in demand needed to make the fortification strategy viable for producers. However the shift values are very small.
- Apart from cases of very inelastic supply or very high change in the marginal cost, the fortification of processed cheese with Omega-3 turned to be a viable diversification strategy for the American processed cheese industry.

To push our analysis further, we decided to investigate the impact of fortification with omega-3 on the producer surplus and product profitability for demand elasticity values other than the one estimated for processed cheese products in this study. We allow the demand elasticity to vary and we compute the shift in demand needed to offset the increase in marginal cost for different values of supply elasticity and marginal cost.

- For the range of own-price elasticities of demand investigated (between -0.4 and -1.2), the shift in demand needed never exceeded 2%. This finding makes fortification of processed cheese a feasible and attractive option for manufacturers to diversify their product line and maintain profitability.

Conclusions

In this study, we investigated the feasibility of fortifying processed cheese with omega-3. We first estimated the demand for processed cheese products and then used this estimation to determine the profitability of manufacturing this product.

The analysis of the impacts of fortification on producer profits showed that, in most of the cases, the fortification of processed cheese products with omega-3 is profitable to manufacturers. Within reasonable market conditions, realistic values of elasticities of demand and supply, and likely marginal costs due to the fortification process, the values by how much the demand for the new fortified product would have to shift so that the change in producer surplus equal the incremental costs of fortification are relatively very small. Therefore, fortification of processed cheese products with omega-3 fatty acids can occur without any loss in producer profits, subject to minimal shifts in the demand for processed cheese.