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Subject: Estimates on Mushroom Demand Elasticities

Overview of Mushroom Demand Modeling Efforts

In an effort to provide the Mushroom Council with new information on consumer demand for mushrooms, we have developed a complete set of demand elasticities (own-price, cross-price, and expenditure elasticities) for five major mushroom subcategories--white mushrooms, Portabellas, other brown mushrooms (Italian Brown, Crimini), Shiitake, and other speciality mushrooms (Oyster, Enoki). The estimated demand elasticities provide a compact way of characterizing consumer responses to price changes and changes in expenditures. Estimated elasticities play a useful role in answering many managerial questions, such as (1) are industry revenues being maximized, (2) how effective are price promotions, (3) do price promotions cannibalize or support related product sales, and (4) how will mushroom demand change as income rises.

Model and Data

The demand elasticities were estimated using a Linear Approximate Almost Ideal Demand (LAIDS) system. This econometric model is widely used in the analysis of agricultural and food markets and is shown to provide theoretically consistent estimates of the desired demand parameters. A geometric lag structure is used to investigate the dynamics of price changes and changes in mushroom expenditures on the demand for each product subcategory, yielding estimates of short run and long run elasticities. The short run elasticities reflect consumer responses within a single period (one week in this data set). The long run parameters recognize that consumer responses may take place over several periods, as they adjust their purchase habits to new prices or expenditure levels or new information or experiences. For example, lagged responses may arise as consumers learn of new products by word of mouth or their past experiences may be reinforced by a reminder of a product that is featured or promoted. Consumer responses are also seen to be delayed, but they decline over time, as their memory of an advertisement or promotion fades.

The model was estimated using the regional composite scanner data provided by The Perishables Group. These data provide scanner-based sales information for individual PLU and UPC codes in the mushroom category for five regions in the United States, described by The Perishables Group as the West, Midsouth, Southeast, Central, and Northeast Region. Data for the weeks ending on January 3, 1998 through June 29, 2002 were available, providing 235 weekly observations for each region. The quantity reported for each product code for each week is the average store sales in the region. So while these data can not provide a measure of total product sales, they are useful for making comparisons on sales across product subcategories or across alternative product codes. As such, they are appropriately suited for developing estimates on how consumers respond to changes in product prices or adjust their purchases across mushroom subcategories as their total expenditures on mushrooms change. These data were pooled across the regions in estimating the model.

To develop the selected subcategories, it was necessary to adjust product prices, taking into account the various product forms. The objective was to convert all prices to a common basis ($/lb for whole bulk products). This was accomplished through the estimation of a hedonic price model, which provides estimates on the premiums or discounts associated with various product attributes, such as packaged products or sliced products. Once the price adjustment parameters are obtained, the prices of all the products (individual PLU's or UPC's) within each subcategory can be converted to a common basis ($/lb). Then the products can be aggregated to form the selected subcategories. Prices for the subcategories are calculated as weighted averages of the adjusted prices with the individual products sales volume serving as weights.

Results and Discussion

The price adjustment factors obtained from the hedonic model are presented in table 1 for each of the product subcategories. Each model was estimated using observations on all products in the subcategory. Both bulk and packaged products were observed for all the subcategories. However, sliced products were only available in sufficient volumes for white mushrooms and Portabellas. Prior to estimating the model, all packaged product prices were converted to a price per pound basis based on the reported package net weight. The model results show that packaged whole white mushrooms sell at a $0.34 per pound premium compared to bulk whole white mushrooms. Similarly, slicing white mushrooms adds an additional $0.47 per pound in value to the product. In each of these cases and for all the other parameters presented in table 1, the estimated coefficients are significant at the five percent level, meaning that we are 95 percent confident that they describe the "true" relationship. Premiums on packaging were found for all the mushroom subcategories. This premium may arise due to value the packaging offers consumers in terms of improved convenience or product quality or it may reflect the value of the brand associated with the packaged product. While slicing added value to white mushrooms, sliced Portabellas sold at a discount to whole Portabellas, suggesting that consumers prefer their Portabellas whole. To the extent to which packaging and slicing, at least for white mushrooms, adds value for consumers, suggests that new research on value adding opportunities is needed, particularly if it enhances convenience and promotes consumption. These estimated price adjustment coefficients were applied to the prices reported for each product code based on their product features to convert it to a whole, bulk price basis ($/lb). After aggregating these products to form the subcategories, the data were used in estimating the demand model.

Table 1. Hedonic Model Product Form Adjustment Coefficients.

Product Attributes	Mushroom Subcategories				
	White	Portabella	Oth. Brown	Shiitake	Oth. Specialty
Packaged	0.344** (27.77)	3.651** (108.82)	1.515** (34.81)	5.954** (58.05)	8.222** (96.34)
Sliced	0.471** (37.79)	-0.157** (-3.52)	–	–	–

The values in parentheses are t-values. Two asterisks (**) denotes statistical significance at the five percent level.

The results from the demand analysis are reported as price and expenditure elasticities. These demand elasticities are index values showing how the quantity demanded responds to changes in price or expenditures. Specifically, the price elasticity of demand shows the percentage change in the quantity demanded resulting from a one percent change in price. For example, a demand elasticity of negative two would indicate that the quantity demanded decreases by two percent in response to a one percentage increase in price. These elasticities are computed not only for each product's own price, but also for changes in the price of other products and for changes in mushroom expenditures.

The estimated short run demand elasticities, which indicate the consumer responses observed within one week, are reported in table 2. The respective price and expenditure changes are indicated by the column headings in this table which can be traced to the product quantities in each row. For example, the estimated own-price elasticity for white mushrooms is -1.072, indicating that a one percent increase in the price will cause the quantity demanded to fall by 1.072 percent within a period of one week. All the own-price elasticities may be read as one moves through the diagonal elements of this table from the upper left to the lower right. The short run own-price elasticity for Portabella mushrooms is -1.522, indicating that quantity demanded would fall by 1.522 percent following a one percent increase in the price of Portabellas.

Own-price elasticities of demand that are greater than one in absolute value, as seen for Portabellas, other brown mushrooms, and whites (though only slightly), are described as elastic. In these cases, the percentage change in quantity demand is greater than the percentage change in price. Own-price elasticities of demand less than one in absolute value, as seen for the short run elasticities for Shiitake and other specialty mushrooms, are described as inelastic. Consumers of products with elastic demands are very sensitive to price changes. Faced with a price increase consumers will decrease their consumption by a larger proportional amount. This price sensitivity is primarily influenced by the ready availability of other competing products. Alternatively, products with inelastic demands are ones for which there are few substitutes or which constitute a fairly small share of the consumer's budget. When consumers in a product market with an inelastic demand face a price decrease, their proportional increase in demand will be relatively smaller, thereby resulting in a decrease in total revenue for the firm. Alternatively, when price declines for a product with an elastic demand, consumer quantity demanded increases by a proportional larger amount, resulting in an increase in total revenue. Depending on the margin for this product, there is a potential for firm profits to increase. For price increases, total revenue increases (decreases) for products with demands that are inelastic (elastic). In the short run, price promotions (price discounts) on white, Portabella, and other brown mushrooms will result a larger proportional increases in sales volume, increased total revenue, and potentially increased profits for retailers.

The estimated cross-price elasticities of demands, show how the demand for one product changes in response to a change in price of another. For example, a one percent increase in the price of Portabella mushrooms will only induce a 0.03 percent increase in the demand for white mushrooms, as consumers substitute away from Portabella to white mushrooms in the short run. While the positive sign on this elasticity indicates that the products are substitutes, white mushrooms are at best a weak substitute for Portabellas. Alternatively, an increase in the price of white mushrooms can induce consumers to more readily move to Portabellas, given the cross price elasticity of 0.86. Perhaps, when faced with an increase in the price of the common white mushroom, consumers are motivated to seek greater perceived value from the slightly more exotic and higher valued Portabella. A negative cross price elasticity suggests that products are complementary in consumption. Only a very few complementary relationships are found and most are not statistically significant or are inconsequential in terms of the magnitude of the estimated elasticity. (For example, a one percent increase in the price of other specialty mushrooms will cause white mushroom demand to fall by 0.004 percent).

Finally, estimates on how demands for the mushroom subcategories respond to increases in consumer expenditures on the mushroom category are given in the last column of table 2. All subcategories enjoy an increase in demand as total expenditures on this category increases. In the short run, white mushrooms experience the greatest demand growth. The demand for white mushrooms increases by 1.03 percent given a one percent increase in expenditures on mushrooms. Recognizing that whites account for an average of 92 percent of mushroom sales during this period, this product would be expected to benefit the most in the short run.

However, in the long run different purchase patterns emerge as consumers change their shopping habits and learn about alternative products. Indeed, the results from the model show that consumers only adjusted their purchase levels by between 45 and 65 percent of their eventual change within the first week of a price change or change in category expenditure. The long run elasticities, presented in table 3, show how purchase patterns adjust in the long run.

As would be expected, the elasticities reflect much greater responsiveness in the long run, once consumers are able to fully adjust the purchase practices. For example, in the long run the own price elasticity of demand for white mushrooms is much more elastic at -1.97, compared with -1.07 in the short run. Furthermore, when faced with an increase in the price of white mushrooms, consumers are more inclined to substitute Portabella or other brown mushrooms for whites in the long run. This observation may signal a movement from the common white to these more exotic varieties. Still, whites continue to enjoy expanding sales in the long run as mushroom expenditures increase, as shown by the long run expenditure elasticity of 1.895. However, growth in the mushroom category also holds great promise for Shiitake, other brown, and Portabella mushrooms. In fact, as sales in the category expands, Shiitake may experience the greatest growth in share, given that it has the largest expenditure elasticity of 2.119.

Table 2. Short Run Mushroom Demand Elasticities.

Change in Quantity	Change in Price					Change in Expend.
	White	**Port.**	**O.Brown**	**Shittake**	**O.Spec.**	
White	-1.072** (-266.505)	0.029** (9.730)	0.016** (9.809)	-0.0005 (-1.344)	-0.004** (-6.535)	1.031** (364.602)
Portabella	0.861** (16.791)	-1.522** (-34.931)	0.068** (3.496)	-0.003 (-0.845)	-0.007 (-1.129)	0.304** (16.036)
Other Brown	1.552** (10.189)	0.351** (3.329)	-2.799** (-28.984)	0.033** (2.222)	0.006 (0.224)	0.858** (7.431)
Shittake	0.210** (4.826)	-0.035 (-1.082)	0.052** (2.283)	-0.998** (-35.470)	0.033* (1.778)	0.737** (26.561)
Other Specialty	-0.107 (-0.918)	-0.101 (-1.147)	-0.025 (-0.397)	0.0007 (0.021)	-0.275** (-4.606)	0.507** (6.428)

The values in parentheses are t-values. Two and one asterisks (** and *) denote significance at the five and ten percent levels, respectively.

Table 3. Long Run Mushroom Demand Elasticities.

Change in Quantity	Change in Price: White	Port.	O.Brown	Shiitake	O.Spec.	Change in Expend.
White	-1.971**	0.054**	0.030**	-0.0008	-0.007**	1.895**
	(-42.254)	(9.413)	(9.557)	(-1.346)	(-6.633)	(42.908)
Portaabella	1.607**	-2.842**	0.127**	–0.006	-0.014	1.126**
	(15.805)	(-26.370)	(3.493)	(-0.845)	(-1.129)	(14.457)
Other Brown	2.793**	0.631**	-5.038**	0.060**	0.009	1.544*
	(9.832)	(3.323)	(-23.951)	(2.219)	(0.224)	(7.337)
Shiitake	0.604**	-0.099	0.149**	-2.867**	0.096*	2.119**
	(4.600)	(-1.080)	(2.278)	(-17.793)	(1.790)	(16.665)
Other Specialty	-0.221	-0.209	-0.051	0.002	-0.566**	1.046**
	(-0.919)	(-1.146)	(-0.397)	(0.021)	(-4.415)	(6.233)

The values in parentheses are t-values. Two and one asterisks (** and *) denote significance at the five and ten percent levels, respectively.