Monthly Retail Demand for Bread

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Researchers have found it difficult to estimate reliable elasticities of demand for bread. The reason for this difficulty undoubtedly has been the lack of data regarding consumption (production) levels for bread. This paper reports the results of a statistical demand analysis for bread and bread-type roll products using monthly production data derived from Government and industry sources. While there are data limitations in this case also, the results shed some light on the nature of the demand for these products.

Key words: Demand elasticities; bread.

Expenditures on bread and other bakery products are an important segment of the consumers' food bill, running consistently about 9 percent of total food expenditures (*4,5*).[1] Bread represents nearly half of this level. Despite its importance in the consumer food budget, there is little quantitative information on the nature of the demand for bread and bread-type rolls. Brandow (*1*, p. 38), for example, noted that "price elasticities of demand for bread, flour, and prepared cereals are so low, that attempts to measure them statistically are seldom made."

One of the major reasons for the shortage of previous analyses undoubtedly has been the lack of reliable data regarding consumption and/or production levels for bread. Although price series are available (*13*), comparable quantity figures are not reported.

This paper reports the results of a statistical demand analysis for bread and bread-type products using monthly data obtained from Government and industry sources. While there are data limitations in this case also, the results should shed some light on the nature of the demand for this good.

Results of Previous Analyses

Many prior analyses have focused on the demand for wheat products; however, more recent studies have related to the nature of the demand for bread itself.

Meinken (*7*) utilized single-equation methods to estimate the retail price and income elasticities of demand for bread, rolls, and coffee cake from Census of Manufactures data for intermittent years during 1923-47. The equation was fitted with per capita consumption as a function of price, per capita disposable income, and a time variable. At the means, the results indicated a price elasticity of demand for bread of -0.6, and an income elasticity of 0.4. However, none of Meinken's coefficients was statistically significant.

Rockwell (*9*) used cross-section consumer household data to estimate separate income elasticities associated with different levels of income. His estimates consistently decline as the level of income increases. In fact, the elasticity changes from 0.20 for low-income groups to -0.08 for high income levels, lending credence to the hypothesis that bread is an inferior good.

Brandow (*1*, p. 38) did not estimate the price elasticity for bread directly, but used a figure of -0.15 as a "rough estimate, but it cannot be far wrong in absolute terms." He further specified the income elasticity to be zero. George and King (*4*) adopted the same assumptions.

The Analytical Model

Bread has no close substitute or complement. Although certain other starchy foods (e.g., spaghetti) may be similar in food composition to bread, the latter is frequently served with the former without substitution. None of the prior studies incorporated either type of economic goods into the analysis. Furthermore, Brandow's estimates of cross elasticities with other types of food indicate that while bakery products substitute for other goods, the cross elasticity coefficients are quite small. Consequently, the small cross effects and the nature of the product support the omission of possible substitutes or complements from the model.

Studies of the wholesale baking industry note that price competition is almost nonexistent. Rather, prices in a particular market are administered through a form of price leadership so as to yield a nearly uniform bread price without the danger of cut-throat competition

[1] Italic numbers in parentheses indicate items in the Literature Cited, p. 62.

(*3,8,14*).[2] "Price leadership, then, involves the selection of a price by a leader as opposed to the case in a purely competitive market where price would be determined by independent market forces. It is imperative that the price level be satisfactory to all members of the oligopoly groups in order to forestall open price competition. . . . The umbrella price is frequently set at a level to cover costs not only of the large baking company participants but also of any large independent bakeries with a sizable share of the market"(*14*, p.85). If quantity produced is not compatible with quantity demanded at the preset price, excess bread is returned to the baker as "stales." This bread typically is sold at a discount in bakery "thrift" stores.

Given the nature of the pricing policies of the industry, it would seem appropriate to consider price as predetermined when analyzing the demand for bread. This factor, then, permits the use of single-equation estimation techniques with quantity as the dependent variable and price as predetermined.

The effect of consumers' income may also be important, although previous analyses have indicated a low income elasticity for bread. This variable also was included as predetermined.

The nature of the particular function used to analyze demand for bread is highly dependent upon the length of time unit involved (i.e., weekly, monthly, annual). Seasonal patterns are frequently disguised by use of annual data. As indicated previously, data on quantities of bread produced and/or consumed are few. Census data are available only for selected years. In this analysis, use was made of production indexes obtained from the American Bakers Association for January 1954 through October 1969. The ABA has developed a weekly production index based primarily on output of member bakeries. The index in 1967 represented nearly 50 percent of the total industry weekly bread and other yeast-raised products produced. This index was considered to be representative for bread production for the entire industry, and was combined to obtain monthly output indexes.

This index series was then applied to the total output of the baking industry for the base year 1963 as reported by the 1963 Census of Manufactures, and quantity levels were obtained by months for 1954-69. Monthly production, therefore, was used to represent consumption. While this procedure may create errors in measurement, the annual quantities generated by this method compared favorably with the levels reported for particular years by the Census of Manufactures. In 1958, the census reported production of 12,719.0 million pounds whereas the ABA index application resulted in an estimate of 12,585.5 million pounds. For 1967, the census data registered 14,371.4 million pounds, and the ABA index estimate was 14,984.3 million pounds. The errors in estimation for these years are 1.0 and 4.3 percent, respectively.

There is an apparent fluctuation in production within each year as evidenced by figure 1. Output is generally highest in the spring and summer (with the arrival of "the sandwich season") and lowest during the winter. Such fluctuations could be taken into account with monthly dummy variables; however, harmonic analysis offers a measuring of cyclical variation with continuous variables—a sine and cosine. Although the use of monthly dummy variables could be incorporated into such a model, the use of the two continuous variables may be more feasible if the number of observations is small. The latter procedure was followed in this analysis.

Monthly per capita demand for bread, therefore, was formulated as a function of its own price, per capita disposable income, and the seasonal variation represented by $\sin \theta t$ and $\cos \theta t$ where θ equals 30 degrees (0.5236 radian) because each month represents 360/12 degrees ($2\pi/12$ radians) of the total cycle and t equals 1,2,. . .,12.[3] Thus, market demand can be represented as:

$$(1)\quad Q_t = a + b_1 P_t + b_2 Y_t + b_3 \sin \theta t + b_4 \cos \theta t + u_t$$

where u is the error term, with mean of zero and variance σ^2.

Retail prices of white pan bread were obtained from U.S. Department of Labor reports on food prices (*13*).

Monthly disposable income figures were generated from the U.S. Department of Commerce surveys of business (*12*). Disposable income is reported only on a quarterly basis; however, personal income, which is disposable income plus personal taxes, is reported monthly. The monthly disposable income figures were estimated by calculating the ratio of monthly personal

[2] Some price competition may exist in the sense that private label bread (i.e., bread sold under the grocer's own brand) may sell at prices under those charged for wholesale bakers' regular brand goods.

[3] The sine and cosine variables are needed to estimate the amplitude $\sqrt{(b_3)^2 + (b_4)^2}$ of the cycle and the phase angle [arctan (b_3/b_4)] where b_3 and b_4 are the estimated coefficients of $\sin \theta t$ and $\cos \theta t$, respectively. Estimates of these two elements are used to combine the sine and cosine variables into a single variable as $\sqrt{(b_3)^2 + (b_4)^2} \cos [\theta t - \arctan (b_3/b_4)]$ to represent fluctuation (*2*, p. 347).

Table 1.—Consumer demand parameters for bread and bread-type rolls

Equation	Q_t [a]	N	Coefficients [b]						D-W	R^2	$S_{\hat{y}}$	Elasticities [c]	
			Constant	P_t	Y_t	Sin θt [d]	Cos θt [d]	Auto-correlation				Price	Income
(1)	6.196 (.213)	189	8.236	*−13.62 (01.16)	*0.0033 (.0004)	*−0.1262 (.0110)	*−0.1296 (.0111)	— —	1.11	0.737	0.107	−0.415	0.086
(2)	6.196 (.213)	189	[e]4.393	*−12.08 (01.90)	*.0034 (.0007)	*−.0483 (.0155)	*−.1105 (.0105)	*.4455 (.0671)	—	.790	.096	−.372	.086

[a]Mean values of the per capita consumption of bread and bread-type rolls are reported in pounds per month. Standard errors are reported in parentheses.

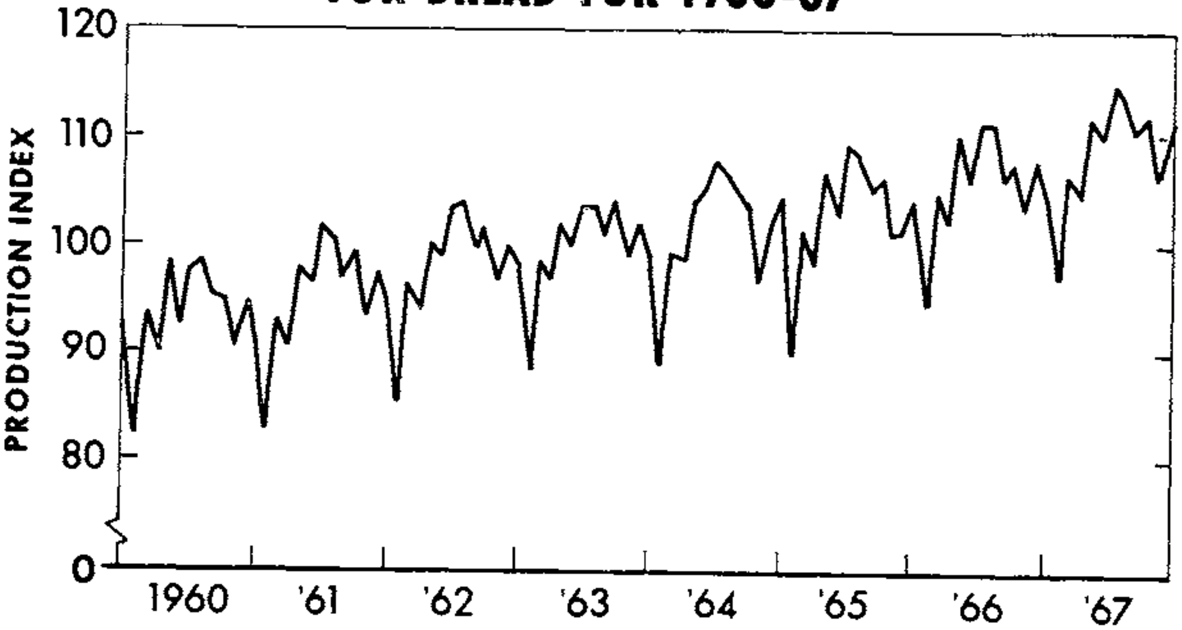
[b]Coefficients significantly different from zero at the 5 percent level are denoted by *. Standard errors of the estimates are reported in parentheses.

[c]Calculated at the means of the respective variables.

[d]θ equals 30 degrees (0.5236 radian) because each month represents 360/12 degrees ($2\pi/12$ radians) of the total yearly cycle. The integer value is represented by t for each month, i.e., t=1, 2,. . ., 12.

[e]This term includes adjustment with the autocorrelation coefficient.

MONTHLY PRODUCTION INDEXES FOR BREAD FOR 1960-67



SOURCE: AMERICAN BAKERS ASSOCIATION, BREAD SALES TRENDS, 1960 - 1968.

Figure 1

income to its quarterly levels and assuming the same ratio held for dispo:-ble income. Consumption and disposable income were put on a per capita basis by dividing by civilian population (*11*). Both prices and incomes were adjusted to 1958 levels with the consumer price index (*12*).

The estimated parameters of equation (1) in table 1 show positive autocorrelation. The Durbin-Watson statistic (1.11) is significantly below the lower bound (i.e., 1.59 for 100 observations and four independent variables), indicating either that relevant variables were omitted or that an autoregressive scheme should be considered. Since those variables were included which were considered theoretically relevant (with the possible exception of lagged values of the variables), the latter option was chosen for further study. Although the estimated parameters in (1) are unbiased, their sampling variances are underestimated and the statistical significance of the variables may be overstated. Thus, the reliability of our estimates may be improved by considering an autoregressive structure.

The model was reformulated as a first order autoregressive structure to obtain an estimate of the autocorrelation coefficient (ρ), i.e., $u_t = \rho u_{t-1} + e_t$. Thus the new form of equation (1) was:

$$(2)\quad Q_t - \rho Q_{t-1} = a(1-\rho) + b_1(P_t - \rho P_{t-1}) + b_2(Y_t - \rho Y_{t-1}) + b_3 \sin \theta t + b_4 \cos \theta t + u_t$$

The parameters of this equation were estimated by using an iterative procedure developed by Martin (*6*). The parameters of equation (2) in table 1 are all highly significant.

Conclusions

The yearly consumption cycle is well represented by the trigonometric variables. As was shown previously, these variables may be combined into one variable; the results of this combination are -0.1188 cos (0.5236t - 0.415). Holding other things constant, this relationship is used to determine the minimum of the cycle (i.e., where cos (X) = -1.0) and the maximum of the cycle (i.e., where cos (X) = 1.0). Thus, minimum per capita consumption occurs in mid-January (t=0.79) and maximum per capita consumption in mid-July (t=6.68).[4] Such results are expected because consumers use more sandwiches for picnics and other occasions in the summer.

The elasticities are reported at the means. Price is inelastic (-0.372) as suspected, but is of a greater magnitude than previous estimates.[5] A 10-percent increase in price would be associated with a 3.7-percent decrease in bread consumption. Income is very inelastic (0.086), and conforms reasonably well with Rockwell's (*9*) estimate for medium-income consumers (0.12). Since the income coefficient is significantly different from zero, it does not include Brandow's zero estimate. A 10-percent increase in per capita disposable income would only be associated with a 0.86-percent increase in consumption. Thus, the demand for bread is somewhat responsive to price but nearly unresponsive to income changes. Although the above results indicate the relative inelasticity of bread with respect to price and income, the fact that the data used were aggregate U.S. levels prompts questions for future research projects. It may well be, for instance, that demand for bread is more responsive to price for low-income consumers than for middle- and high-income persons. If such differences in demand exist, they have strong implications for price discrimination policies permitting lower prices in low-income neighborhoods and higher prices in other areas where demand is less responsive to price. Similarly, derivation of income elasticities by income level rather than use of an aggregate figure would shed light on expected results of such Government programs as the Food Stamp Program.

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[4] This allows integer values of t to lie at the midpoint of each month.

[5] Price elasticities at two standard deviations from the mean slope are -0.254 and -0.490.

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