Experimental Price Variability and Consumer Response: Tracking Potato Sales With Scanners*

by.

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Problem Addressed

Food manufacturers, with their relatively large market research budgets, are often able to make reasonable estimates of the profit-maximizing price for their branded products. Retailers have a similar responsibility for pricing decisions regarding products as diverse as deli foods, private label goods, meats and fresh product. Yet retailer investments in marketing research at the item level approach zero. Most often, retailer pricing decisions are based on a combination of judgment and rules-of-thumb. While retail pricing decisions thus made are likely quite good in general, mis-estimates can develop over time, leading to prices which are notably over, or under, profit-maximizing levels.

The broad adoption of Universal Product Code (UPC) scanning systems by many retail firms (approximately 35 percent of all supermarkets had electronic scanners in 1985) now makes it possible for these organizations to conduct in-house marketing research at modest expense. By systematically varying prices and tracking subsequent movement through scanning reports, retailers can calculate appropriate demand elasticities for individual products, even for individual stores. This paper reports on the results of one such pilot experiment.

Methodology and Data Sources

One regional food chain cooperated with the study team by identifying eight test stores of comparable size, all of them in upstate New York, to analyze the influence of changing prices on potato sales. Potatoes were selected as the subject of study for a number of reasons. First, although conventional wisdom and past research (see, for example, Clevenger and Geithman, 1977) suggest that the price elasticity of demand exhibited by potatoes falls in an inelastic range, very few studies have devoted explicit attention to the

*Margaret Meloy provided valuable research assistance in this project.

retail level; Hee's (1967) study is a notable exception. Second, the retail produce department has undergone substantial change in recent years as retailers attempt to capitalize on the increased interest in and per capita consumption of fresh fruits and vegetables by consumers (McLaughlin and Hamm, 1985). Finally, since potatoes retain their commodity form throughout the distribution system, the implications of their responsiveness to retail price changes can be incorporated more directly into growers' pricing and marketing strategies.

During the four-week test period, March 8, 1986 to April 5, 1986, the chain agreed to adjust the prices of ten-pound bags of round, white potatoes according to the Latin-Square design in Table 1. Latin Square designs have been found very effective in marketing research for controlling or measuring variations due to store and time differences (see Brunk and Federer, 1952). The prices in Table 1 straddle the then-prevailing price of $.99 a bag. Prices were changed each Monday morning. Random checks of the test stores verified the correctness of the posted prices, and those entered by the checkers on the price look-up (PLU) system employed by the cooperating chain. These special prices were *not* advertised, and even the produce manager was not informed of the pending price changes. Price was simply indicated above the normal display of ten-pound bags of potatoes on the standard price card. Sufficient stock was shipped from the produce warehouse to prevent stock-outs during the test period. No other round white potato specials were featured by that chain over the four-week test.

Scanner file data for all the included stores were provided for a total of 42 weeks, from July 27, 1985 to May 5, 1986. Data were by product/package type for all fresh potato items. Previous experience with the scanning files of this chain suggest that the data provide good estimates of actual disappearance (Lesser and Smith, 1986).

Data were analyzed with standard analysis of variance techniques (ANOVA: ANOVA Minitab and SPSS) utilizing a simple two-factor table. Replicated price combinations allowed nesting two observations per cell. All data were standardized to a 100-shopper basis as a means of controlling for differences in the number of customers. Shopper-count data were derived from the scanning information and supplied by the chain headquarters.

Table 1

Price Schedule for Ten-Pound Bags
Of Round White Potatoes,
Four Week Period

Stores	1	2	3	4
	- - - - - Dollars - - - - -			
1-2	.49	1.39	1.09	.79
3-4	.79	.49	1.39	1.09
5-6	1.09	.79	.49	1.39
7-8	1.39	1.09	.79	.49

In addition to the statistical data, an exit survey of consumers was conducted with a total of 441 shoppers at four randomly selected stores. The survey was scheduled during the last week of the test period and the week immediately following to determine consumer perceptions of and sensitivity to the rather dramatic experimental price changes. Over 80 percent of interviewed shoppers made potato purchases during the experimental period.

Major Findings

Intra-Store Sales Variability

Scanning data on price and movement of all potato varieties were collected from the eight designated stores for 32 weeks prior to the onset of the Latin Square pricing experiment in order to establish sales patterns and identify any particular abnormalities in the responses of potatoes to normal weekly price changes. Despite similar size and formats of the eight supermarkets, and identical prices for each of the potato varieties, these data revealed dramatically different sales levels among the eight stores. Two stores serve to illustrate the point (Figure 1). In store #2, for example, sales averaged 19.3 pounds per

100 customers over the 42-week period while in store #1 weekly potato sales averaged nearly 70.0 pounds per 100 customers, 360 percent greater than store #2. Since the variables normally associated with changes in sales were effectively constant, and display space and competitive conditions varied very little across stores, the vast differential in sales responses to price changes must be attributed primarily to differences in localized consumer demand. These differences include such factors as income levels, household size and ethnic background.

Not only did average sales levels differ across stores, but frequently so did the magnitude and, occasionally, even the direction of the sales response. Referring to Figure 1, when price was reduced to $.69 from the prevailing $.99 level (a 30% drop) during the two weeks beginning November 9 and 16, sales in store #2, perversely, fell initially to 8 pounds per 100 customers. The second week, sales increased to approximately 88 pounds per 100 customers, over a 1000 percent rise. In store #1, the same change in prices generated a comparably modest sales reduction in the first week. However, in the second week, sales increased to approximately 200 pounds per 100 customers, or over twice the sales of store #2. In several other instances equally dramatic sales changes occurred even when prices did not change.

Three basic insights are gained by the inspection of these scanning data. First, store-level demand factors appear to differ considerably. Second, under certain circumstances, weekly potato sales respond dramatically to price changes. Third, in the weeks immediately following a surge in purchases, sales did not fall back below their recent trend line. That is, potato shoppers apparently did not reduce their average purchases due, for example, to larger home inventories of potatoes. Seemingly, reduced prices did not simply shift weekly sales levels, but actually induced consumption increases.

Latin Square Experimental Results

Responses to the four-week experimental prices are shown in the highlighted areas on Figure 1. Several alternative applications of ANOVA were used to analyze the data. Using the unsmoothed data, price effects were statistically significant at approximately the 5 percent level (Table 2). That purchases were not influenced even more may be explained by the sizable residual sum of squares resulting, in part, from the very sharp response to the $.49 price in store #1 (378 pounds per 100 customers were purchased). When this value was replaced with the group mean for the $.49 price, price effects became highly significant, at about the .001 level.

Table 2

Analysis of Variance Results of Latin Square Potato Pricing Experiment

Dependent Variable: Pounds

Source	DF	Sum of Squares	Mean Square	F Value
Model	15	82495.616	5499.708	1.99
Error	16	44185.311	2761.582	
Corrected Total	31	126680.928		

Source	DF	Type I SS	F Value	PR > F	DF
Week	3	26641.094	3.22	0.051	3
Price	3	26542.374	3.20	0.052	3
Week*Price	9	29312.148	1.18	0.370	9

Figure 1

Sales of Ten-Pound Bags of Round White Potatoes in Two Test Stores

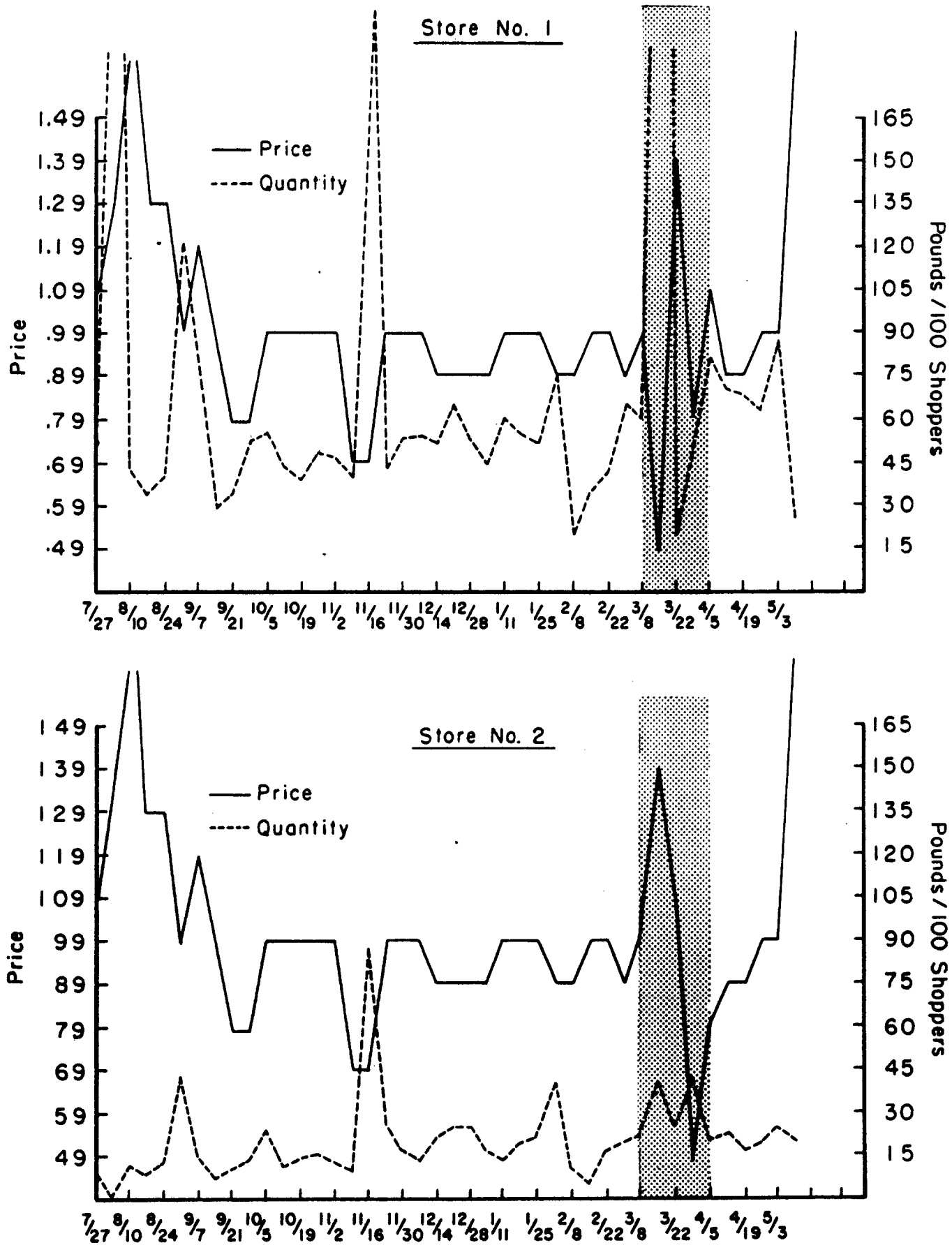


Table 3 presents the mean sales associated with each price and the results of Tukey's Studentized Range Test for contrasts among the variables. Tukey's test indicates that the sales level associated with the $.49 price is significantly higher than the other three mean levels and, similarly, the sales produced by the $1.39 price are significantly lower than the other three. Of equal interest, however, is the mean sales generated by the two intermediate prices. The lower price $.79, actually produced a mean sales value (57.7 pounds per 100 customers) that was marginally lower (but not statistically significant) than that produced by the higher price, $1.09 (58.9 pounds per 10 customers).

Table 3

Four-Store Mean Weekly Potato Sales Associated With Four Prices, Per 100 Customers

Price ($)	Mean Sales* Per 100 customers
1. .49	115.42
2. .79	57.72
3. 1.09	58.92
4. 1.39	38.30

*One is statistically different from 2, 3 and 4, and 4 is statistically different from 1, 2 and 3. Otherwise means are not statistically different at the 5 percent level using Tukey's test.

These findings are contrary to general expectations and much empirical analysis which generally conclude that potatoes are price inelastic. This study indicates that potato sales can be quite responsive to price changes; that is, they are price elastic, at least on an individual store basis. However, the sales data from store #1 suggests that the level of statistical substantiation for this conclusion is limited. Individual retailers need also to consider the effects of competition in the longer term. Competition tends to make the store-level demand more elastic as shoppers exercise the option of cross-store shopping. Since the price reductions in this study were short-term and not advertised, however, it is likely that sales shifts due to cross shopping were insignificant. Thus the elasticity estimates here appear to be true representations of underlying demand relationships, within the appropriate confidence intervals.

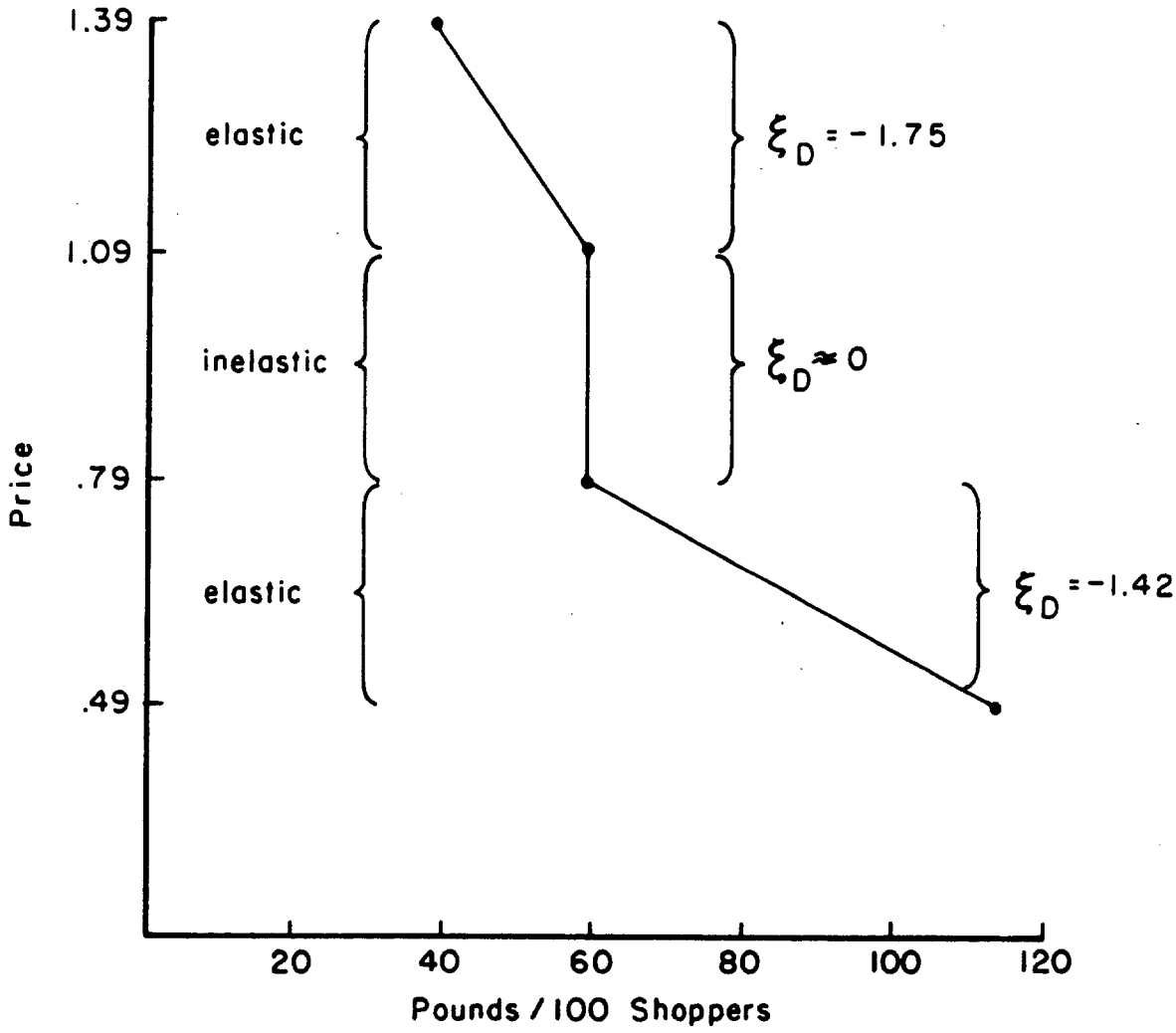
The experimental data from this study suggest, in fact, a rather unique demand curve (Figure 2). The expected monotonic downward slope is interrupted by a nearly vertical, or discontinuous, portion; between the $1.09 and $.79 prices there is virtually no quantity response to price changes. That is, when price was varied by modest increments around the prevailing price of $.99, sales did not fluctuate.

Substantial research demonstrates that such a lack of response is often explained by consumers' inability to perceive variations in stimuli over a limited range (see Assael, 1983, p. 130, for a review). That is, consumers are not able to detect variations at levels below their "differential threshold." In this experiment, such a consumer threshold appears to have existed between $.79 and $1.09 for ten-pound bags of potatoes. However, when price was changed to levels beyond this threshold, specifically to $.49 or $1.39, consumers reacted in a way consistent with conventional price theory.

The price and volume data collected during the test period allow the computation of approximate mid point elasticities (Figure 2). The elasticity estimates thus derived tend to support the above conception of perception thresholds. When price is lowered from $1.09 to $.79, pounds purchased per customer barely change, thus total revenue is naturally reduced, indicating a highly inelastic (nearly vertical) demand in this range. However, when the price is raised (lowered) outside this range, total returns to the retailer decreases (increases), suggesting a price elastic demand. For the aggregate data these elasticities ranged between -1.42 and -1.75. These data then suggest that price changes large

Figure 2

Mean Sales and Total Revenue Associated with Four Price Levels
For Round White Potatoes



enough to be detected by consumers lead to relatively elastic demand at the aggregated store level. However, computed elasticities at the individual store level varied considerably, from -4.94 at the most elastic store (Store #1, Figure 1), to, surprisingly, 2.65 at the "least elastic" demand store (not shown). This detail emphasizes the desirability of making pricing decisions at the store, rather than the price zone, level.

Consumer Response

The consumer survey responses allowed testing the hypothesis that a majority of consumers, even regular potato shoppers, would not perceive the rather radical experimental price changes. This hypothesis could not be rejected at the 5 percent level. When asked whether any recent changes had been noticed in the produce department, only one shopper (out of 441) mentioned "potato price changes." Even when asked specifically about changes in potato prices, consumers, on average, either reported "no change observed" or, often, indicated an incorrect direction of price change. Weekly potato purchasers were no more accurate in their recollection of the direction of change than were monthly buyers.

Although these consumer responses uphold the contention that consumers are insensitive to, or do not perceive, price changes in potatoes, several qualifications to such a conclusion must be considered. First, consumers were questioned regarding "all potatoes," not specifically about ten-pound bags of round white potatoes. Second, it happened that store #1 (Figure 1), which consistently has the largest sales responses to price changes, was not selected as an interview site in the random selection process. It may well have been that potato shoppers in this store would have reported noticing the potato pricing changes more accurately.

Implications for Food Distribution

The recent availability of scanning data provides potato marketers, among others, with the potential of incorporating store-specific demand differences in pricing decisions. This pilot research suggests that retail potato sales demonstrate substantial variability through time and across stores. Furthermore, the study produced some statistical evidence that, on average, consumer response to large price changes is relatively elastic. For food retailers this implies not only that total (round white) potato sales may increase with substantial price reductions, but also that pricing according to individual stores, rather than according to historical price zones, may be an appropriate profit-maximizing strategy. Localized pricing may become increasingly feasible as retailers incorporate the newly available information from demographic databases into their pricing plans. Retailers could make use of store-specific elasticities to assess impacts of promotional activity, to determine optimal space allocation and to develop improved sales management models. Before such pricing approaches can be recommended, however, further replications of these tests are needed.

Applying these results also necessitates an effective identification of the response level of shoppers. That information must be collected from observed purchase behavior, as interviewed shoppers in this study were not able to identify correctly the magnitude, or even the direction, of experimental price changes. At a more aggregate level, this pilot project, while leaving many questions unanswered, suggests that scanning data hold great promise for developing new insights into both applied and theoretical research. Moreover, pricing experiments appear plausible in the supermarket with modest efforts and costs. Finally, consumers do not seem as upset by frequent, and even dramatic, price changes, at least in the produce department, as retailers often fear.

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