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**INFORMATION TECHNOLOGY AND
FRESH PRODUCE: A CASE STUDY USING
STORE LEVEL SCAN DATA TO ANALYZE SALES**

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ABSTRACT

Complications have hampered the adoption of Universal Product Codes (UPCs) for fresh produce until recently. The data being collected using Bar Codes and Price Look-Up Codes (PLUs) have many applications. A case study of carrots demonstrates how analyses of scanning data can show the effects of new items on established products and the customer's willingness to pay for the new products. For precut and organic carrots in a Knoxville area supermarket chain, total carrot volume increased as the new products were introduced while regular (bunch) sales declined sharply. Consumers were willing to pay a premium for the convenience of precut products.

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INFORMATION TECHNOLOGY AND FRESH PRODUCE: A CASE STUDY USING STORE LEVEL SCAN DATA TO ANALYZE SALES

Intense competition has been a driving force in food retailing. The battle for consumers' food dollars is fierce, not only between the food at home and food away from home segments, but also within each area. With respect to food at home, consumers have many choices across a wide variety of retailers from direct outlets to convenience stores to supermarkets to wholesale clubs and hypermarkets. Survival for those involved in the food distribution system depends on providing the foods shoppers want at attractive prices. Competition has prompted retailers to make better use of the scanner technology, which has led to current interest in efficient consumer response, electronic data interchange, cross docking, and just in time delivery.

Several factors have made application of the scanner technology difficult with respect to fresh produce. Complexities stem from the same commodity coming from a large number of growers and suppliers, from the same commodity being sold in a variety of forms (variable weight, fixed weight, variable count, and fixed count), and from the introduction of new packaging (precut). The short shelf life of fresh produce and the associated shrink contribute to the difficulty. Another problem is the shapes of many items are not suitable for affixing bar codes.

Consequently, fresh produce departments have been slower to take advantage of the scanner technology. However, the Produce Electronic Identification Board (PEIB) has introduced a standardized numbering scheme to facilitate the use of scan data to track retail sales by item. Use of these data requires an appreciation of the numbering structure. Further complications include the ways in which retailers have switched to the standardized codes and the introduction of expanded ranges to accommodate new produce items at the retail level.

Store level scan data contain sales information by individual items, which means that one can examine the trade-offs food shoppers make as new products are introduced, as well as to identify trends and seasonal factors. However, to date, no such fresh produce analyses are available. The present paper begins to fill the void. First, it addresses practical problems associated with the use of scan data to track fresh produce. Then, a real world application is presented using store level supermarket scan data to examine the trade-offs among traditional bulk and precut and organic introductions.

Bar Codes and Fresh Produce

Bar codes have two components. One is a sequence of digits that can be seen by a person. The other is a series of bars of varying widths and spacing that can be interpreted by an optical scanner as a series of digits. A universal product code (UPC) is a sequence that follows the standards established by the Universal Code Council (UCC). At the retail level, twelve digits are used in the sequence. Figure 1 is a representation of a retail UPC, where the letters A through L denote the visual sequence.

Starting from the left, position A is called the system character and indicates the type of product. Most UPCs are for manufactured goods, including foods. For such UPCs the digits in positions B through F are assigned by the UCC and are unique. The digits in positions G through K identify specific products of a manufacturer and are left to the respective manufacturer to assign. L is an integer variable based on the preceding 11 digits. This check character serves as a way to ensure the scanner has read the bar code correctly.

Random weight bar codes begin with a 2. The next five digits have been broken into ranges by the UCC. Various commodity groups are responsible for assigning numbers within the ranges.

Figure 1: Universal Product Code Format.



A = system character; where 0, 6, and 7 are for manufactured goods and processed foods; 2 is for variable weight items; 3 is for drugs; 4 is for in-store marking; 5 is for coupons; and 1, 8, and 9 are unspecified.

B through F = identification of specific manufacturers or codes assigned by commodity groups.

G through K = manufacturer's product identification or value of a variable weight/count package.

L = check character.

Position B is fixed at zero, and positions C through F fall within the PEIB bounds. Fresh produce has values from 4000 to 4999, and the PEIB is responsible for assigning the values. Variable weight bar codes have two check characters. Position G is a character check based on the value of the package, found in positions H through K. L continues to function as an overall check character.

Fresh produce has several features that complicate the use of UPCs. First, there are both fixed and variable weight items (e.g., a three pound bag of oranges and oranges priced by the pound). Second, some items are sold by count (e.g., cabbage). Third, the shapes can preclude putting the entire UPC on (e.g., broccoli). Fourth, there are many suppliers of the same produce (e.g., gala apples). Fifth, new products are constantly being introduced.¹

¹Fruits and vegetables had 552 new product introductions during 1996 alone (Food Institute).

The first four complications have been addressed by creating related coding schemes. One is for variable weight/count produce, and one is for fixed weight/count packages. Variable weight/count produce items are marked with an abbreviated number, without the corresponding bars. These shortened codes are called price look-up codes (PLUs). The number is the commodity designation assigned by the PEIB in positions C through F. The checkout clerk types in the number. For variable weight items, the clerk weighs the produce, and the software calculates the cost. For variable count produce, the clerk types in the number of units, and the software calculates the cost. Standardized weight and fixed count produce use UPCs that begin with a 0 in position A. Positions B through F are assigned as 33383, and G through K describe the item according to the system created by the PEIB. L continues to function as the check character.

New produce introductions have necessitated the expansion of the 4000 to 4999 PLU range. Currently, a 3000 range is being created. Unfortunately, these codes will not match the corresponding random weight UPCs (positions C-F).

Two other modifications of PLUs entail organically grown and genetically engineered produce. The former is designated by a 9 preceding the four digits. For example, small Braeburn apples are 4101 and organically grown small Braeburn apples are 94101. Genetically engineered commodities are designated by replacing the 9 with an 8.

Bar codes provide the capability for tracking the sales of every product sold by a retailer. However, the volume of products available in supermarkets and the intricacies of the numbering system create a very complex data base. From category management and demand analysis perspectives, drawing off correct records can be tricky. There is no sequencing of UPCs and PLUs that allows one to find a specific commodity. In addition the discretionary ranges allow for chain and

store specific numbers to be assigned to produce items. Examples are the PEIB has set aside the variable weight range 4153-4217 for retailer assigned apples and 00793-00799 for retailer assigned fixed weight/count Washington red delicious apples. Tracking sales of specific commodities, then, entails knowledge of all the UPCs and PLUs that have been used for the respective item.²

A Scan Data Base

The data used in this descriptive analysis are scan data covering the weeks ending May 14, 1988 through March 16, 1996 for five supermarkets in the Knoxville area that are part of the same chain. Stores are located in separate neighborhoods that are average to above average income and are relatively homogeneous with respect to race and age distribution. Weeks represent seven day periods that begin Sunday morning and end Saturday night. The pricing period matches the seven day data accumulation week. Price is the price per pound for produce sold by weight, price per item for produce sold by count, and price per package for standardized weights and counts.

Quantity is measured as item movement, which is the number of times the scanners read the respective code. Item movement is considered to be a proxy for units sold assuming there is little variation in the distributions of weights/counts sold from week to week. Customer counts are the number of times the register drawers are open. Item movement was converted into item movement per thousand customers.

Altogether 410 weeks were included, but there were three weeks for which technical difficulties led to no data transfer from any of the five stores to the corporate management

²Other caveats associated with using scan data are described in Eastwood.

information system. There were also a few instances where the item movement per thousand customers data were at least three times their standard errors and were considered to be outliers.

This data base provides the opportunity to examine long-run trends, seasonality, and the effects of new produce introductions. The case in point is carrots. At the start of period, they were for sale in bunches wrapped in plastic or banded together. During the period precut carrot packages and organic labeling were introduced. Carrots are a major fresh produce commodity, and precut packages have been well received by food shoppers. According to A. C. Nielsen data, precut vegetable sales for the 52 week period ending February 22, 1997 were \$689.5 million of which \$481.1 million was precut carrots, and prepackaged salad, a separate category, amounted to \$836.0 million for the 52 weeks ending January 25, 1997 (Vance).

Two factors complicated drawing off carrots from the scan data base. First, the start of the time period predates the PEIB's standards. Thus, the chain used its own PLUs during this subperiod. Second, the chain altered the departmental numbering system (i.e., the numerical designations of departments, subdepartments, and commodities). Consequently, it was necessary to draw off the fresh produce bar codes each week by department and create a master list of all unique produce codes. Then, produce commodities could be associated with each bar code number. The sorting resulted in the identification of 1566 fresh produce codes of which 49 were carrots. Some of these represented the same item, but PLUs defined by the PEIB replaced store numbers. The codes were separated into regular (traditional forms in which fresh carrots are sold), precut, and organic. There were 18 regular carrot bar codes, 22 precut carrot bar codes, and 9 organic carrot bar codes.

Item movement per thousand customers and average prices were created for each subgroup. The weekly item movements by bar code were added together across reporting stores and divided

by the customer counts of the reporting stores. These were then aggregated by subgroup to obtain carrot sales per thousand customers for regular, precut, and organic. Average prices are weekly weighted averages where the weights are the item movements of the PLUs included in the carrot type.

Regular, Precut, and Organic Fresh Carrots

Regular carrots were available during the entire period. Precut carrots were introduced the week ending June 15, 1991, but their sales were sporadic until February 29, 1993 when they became consistently available for the rest of the period. Organic bar codes and sales started with the week ending January 28, 1995 and have been available during the subsequent weeks.

Table 1 presents descriptive statistics by subgroup for item movements per thousand customers and average prices. Regular carrots were available for the entire period, and the average weekly item movement was 26.52. Precut, following its introduction had an average item movement of 30.05 per thousand customers per week. Organically labeled carrots had an average item movement of 3.82. Regular carrots had the highest coefficient of variation (70.04), followed by precut (50.54), then organic (43.67).³ On average, regular carrots had the lowest price (\$.91). Precut's average price was \$1.32, and organic's was \$1.74. Precut's price had the highest coefficient of variation (21.83), which was almost twice that of regular (12.70), and organic's was 11.85.

Correlations between item movements, prices, and item movements and prices are displayed in Table 2. Over the period during which both regular and precut carrots were available, the pairwise

³The coefficient of variation is the standard deviation divided by the respective mean. Because it is a pure number, as the units of measurement cancel, it provides a way to compare dispersion across variables. The higher the coefficient, the higher the standard deviation relative to the mean, or higher relative variability.

Table 1. Descriptive Item Movement and Price Statistics: May 14, 1988 through March 16, 1996.

	<u>Number of Weeks</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Coefficient Variation</u>
Item Movement				
Regular	400	26.52	18.57	70.04
Precut	216	30.05	15.19	50.54
Organic	55	3.82	1.67	43.67
Price				
Regular	400	\$.91	.12	12.70
Precut	216	\$ 1.34	.29	21.83
Organic	55	\$ 1.74	.28	11.85

item movement correlation was $-.69$, suggesting a switching from regular to precut carrots. The correlation for regular versus organic was also negative, but much smaller ($-.19$), which indicates a smaller trade-off, but organic so far seems to be a niche market given the small average item movement. Precut and organic item movements' correlation is positive, suggesting that both increased vis-a-vis regular.

A positive cross-price correlation between regular and precut indicates a tendency for these prices to change in the same direction approximately 30 percent of the time. Regular and organic prices seem to be fairly independent ($-.05$). Precut and organic prices change in the opposite direction in approximately two-thirds of the weeks during which both were available. These results suggest pricing decisions between traditional packs of carrots and the newer forms are fairly independent.

Own-price versus item movement correlations were negative for regular and organic carrots, although the latter is very small. Regular item movement's negative correlation with the price of precut is consistent with food shoppers switching to the newer product and the retailer being able

Table 2. Item Movement and Price Correlations by Package Type.

<u>Item Movement</u>	<u>Item Movement</u>		
	<u>Regular</u>	<u>Precut</u>	<u>Organic</u>
Regular	1.00		
Precut	-.69	1.00	
Organic	-.19	.55	1.00

<u>Price</u>	<u>Price</u>		
	<u>Regular</u>	<u>Precut</u>	<u>Organic</u>
Regular	1.00		
Precut	.30	1.00	
Organic	-.05	-.64	1.00

<u>Price</u>	<u>Item Movement</u>		
	<u>Regular</u>	<u>Precut</u>	<u>Organic</u>
Regular	-.35	.14	-.19
Precut	-.69	.60	.17
Organic	.33	.10	-.03

to raise the price, once the switching began. A complementary (positive) regular item movement-organic price correlation is observed. Precut item movement has a small positive correlation with regular's price. An interpretation is that above average regular prices prompted some shoppers to switch to precut. The positive own-item movement-price correlation for precut is consistent with the introduction of a new product at a lower price and then raising the price as consumers adopt the new introduction. The negative organic item movement-regular price correlation suggests a tendency for regular carrot prices and organic item movement to change in the opposite directions, whereas the positive precut price-organic item movement correlation suggests some substitution occurred.

The numbers of distinct carrot products tracked by the scanners within each of the three groups over the time period are shown in Figure 2. During the first three years, the chain carried two

or three types of traditional packaging, occasionally there were four. This range persisted in most weeks following the introduction of precut, with two notable changes. One is an increase in variability of the number of regular bar codes, and the other is a tendency, especially in the later weeks, to more selection in terms of the number of distinct packages (i.e., more suppliers and package sizes).

At first only one precut carrot package was available, followed by a period of increased package variety in the displays. The number of bar codes leveled off in 1995, with the outlets offering between seven and nine package types. Organic carrots became available at the start of 1995, and the chain has carried from one to six types of packs. Approximately twice as many precut packs are displayed than either the regular or organic packages during the last two years of the time period.

Prices of the three types of packaging are graphed in Figure 3. Regular prices over the long run have remained fairly constant. The chain introduced precut at prices considerably above regular's, lowered them to regular's, and even sold precut for a few weeks at prices below regular carrots. Then, an extended period of rising precut prices (especially relative to regular) occurred until organically labeled carrots became available.

Carrot sales per thousand customers are displayed in Figure 4. With respect to regular carrots, a seasonal pattern is seen during the subperiod prior to the introduction of precut. When precut carrots were introduced, management also began to change its numbering scheme to identify departments within the outlets, and the PLUs that had been used for regular carrots and other fresh produce began to change toward the formats that were being considered by PEIB. These factors resulted in a period of highly erratic item movement data.

Figure 2.

Frequencies of Carrot PLUs by Group

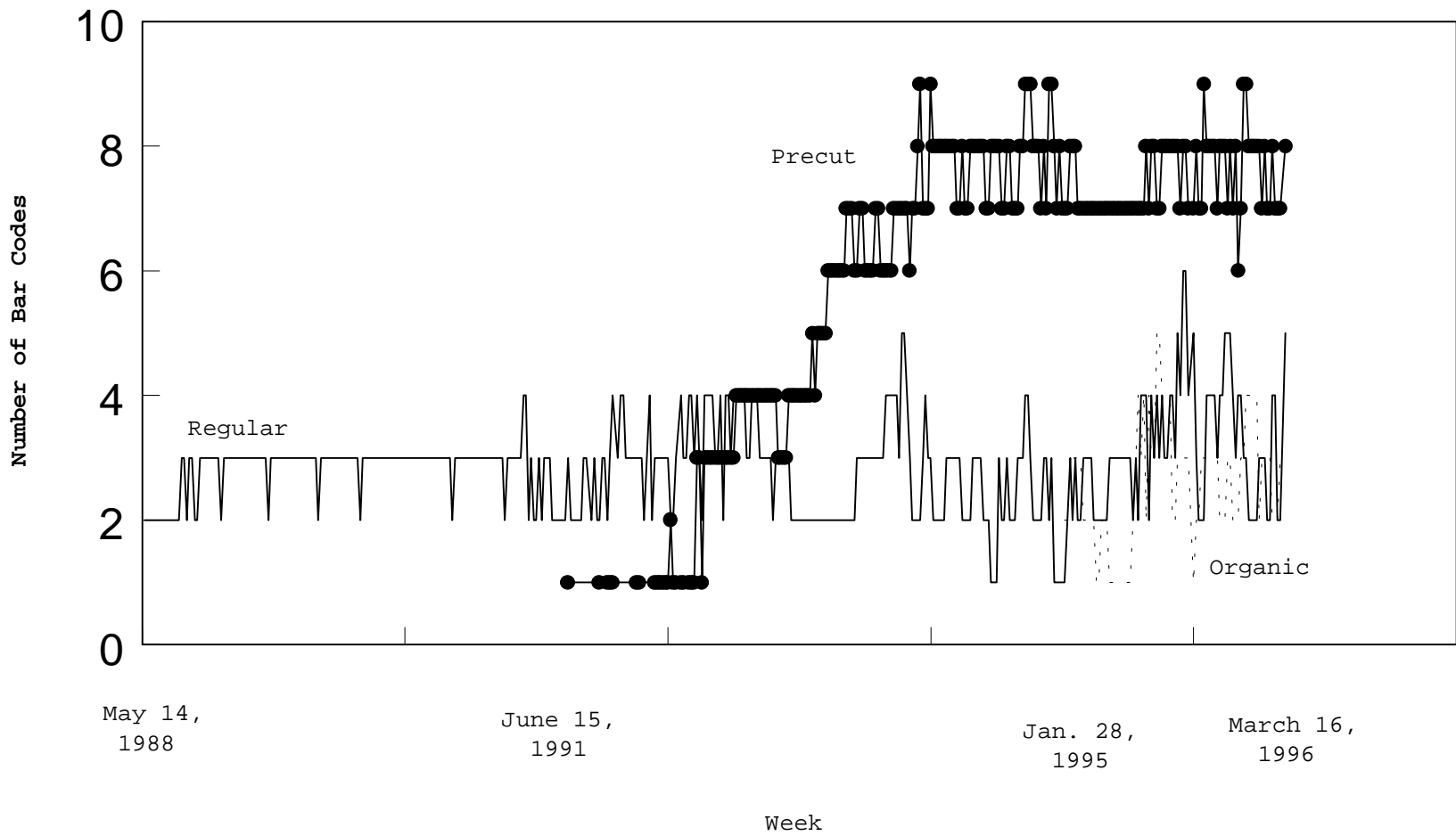


Figure 3.

Average Carrot Prices by Type

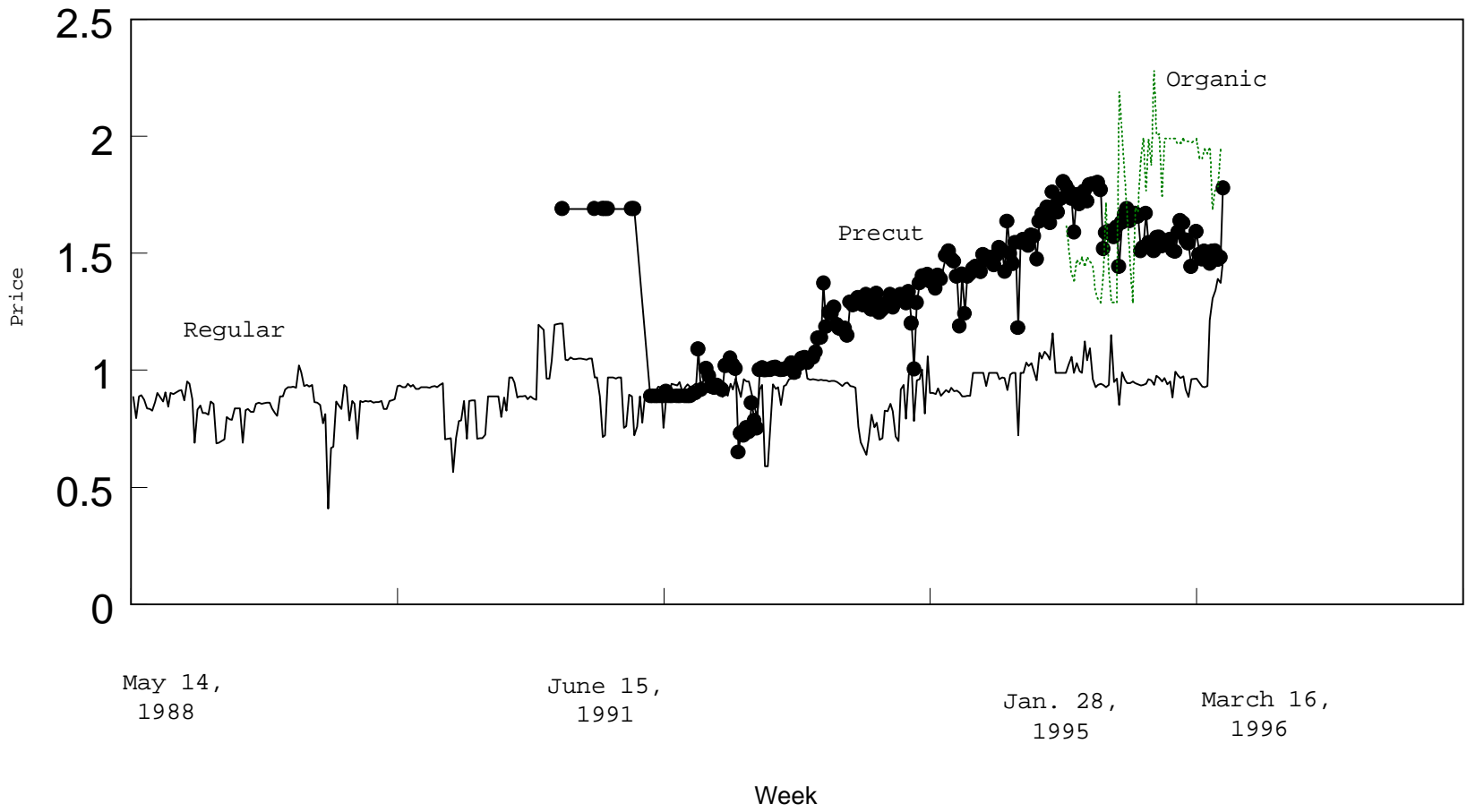
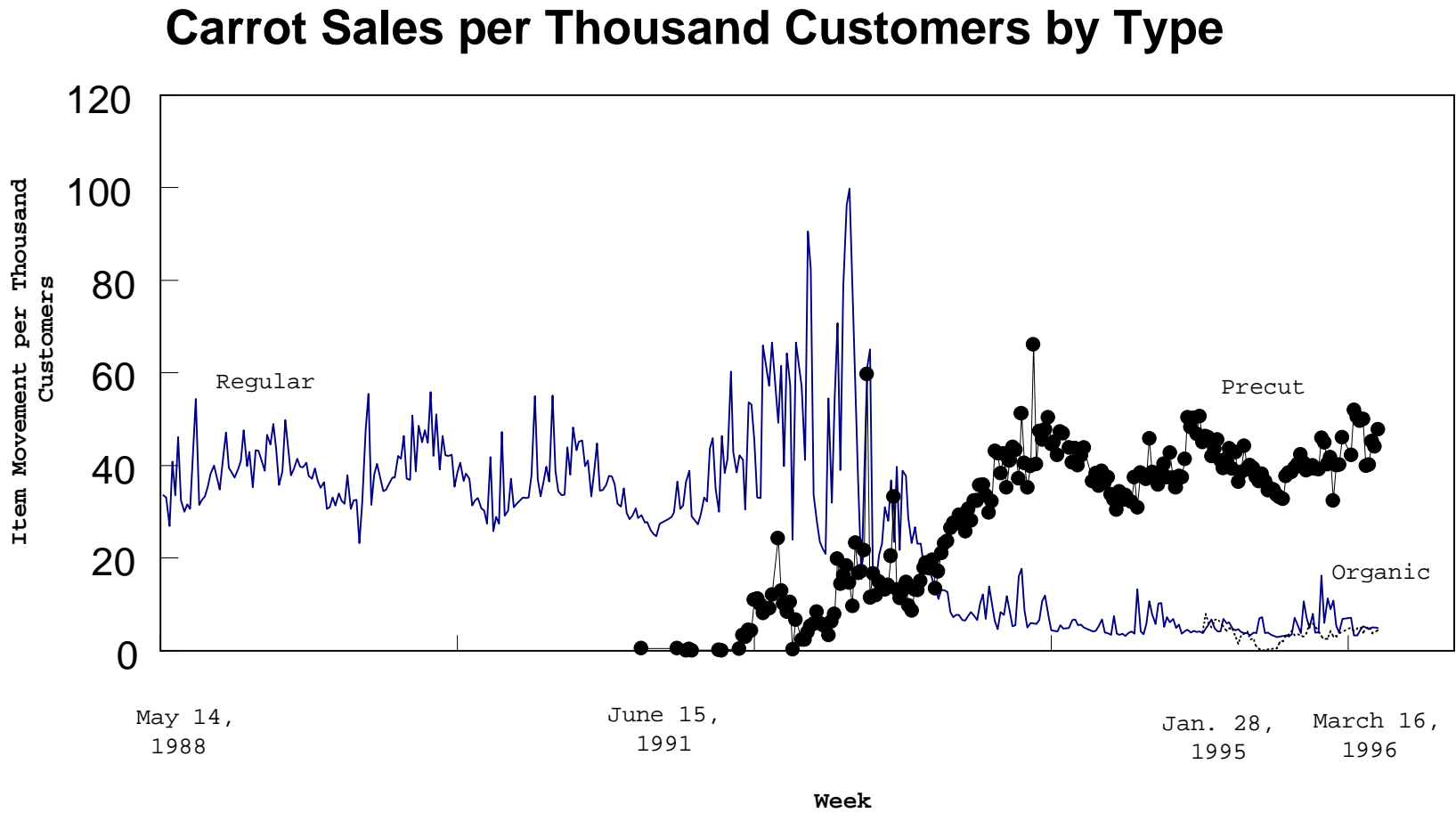


Figure 4.



January typically is a peak period of carrot sales. Inspection of the chain's weekly newspaper supplements for January revealed that only regular carrots were promoted, and this occurred in only four weeks, which were in different years. Furthermore, inspection of the weekly television and radio advertising records indicated that regular, precut, or organic carrots had not been included in these media for any January week. These results suggest that the seasonal pattern is not due to a program of regular promotion during the winter.

Precut carrot sales started off at very low levels. In light of Figure 3, the initial price was too high for many food shoppers to try the new products. Sales increased somewhat with the first price reduction, but the second time prices were lowered in the fall of 1991, consumer acceptance started to increase dramatically, which occurred at the expense of regular carrot sales. Following the period of introduction, the cyclical pattern that had been present in regular sales prior to June, 15, 1991 became visible in precut. Regular carrot sales per thousand customers have declined to such an extent that they are now comparable to organic's sales.

Further insight is associated with Figure 5. Prior to the introduction of precut, regular carrot sales appear to have no long-run trend. Following the weeks when the bar codes were changed and precut is available, the cyclical pattern reappears, but now there is a slightly positive long-run trend in total sales. This suggests that the introduction of precut has led to a somewhat increased market for carrot consumption.

Implications

The descriptive analysis of carrot scan data show food shoppers have switched from traditional packs to precut. Furthermore, the higher price (on average \$.41) indicates that people are willing to pay a premium for the increased convenience of precut. Continued improvements in

package technology and increased time allocation pressures on consumers will strengthen preferences for precut, although the sales data suggest that the period of rapid growth following precut's introduction has leveled off, and a small positive long-run trend seems to be present in the last two years for which data are available.

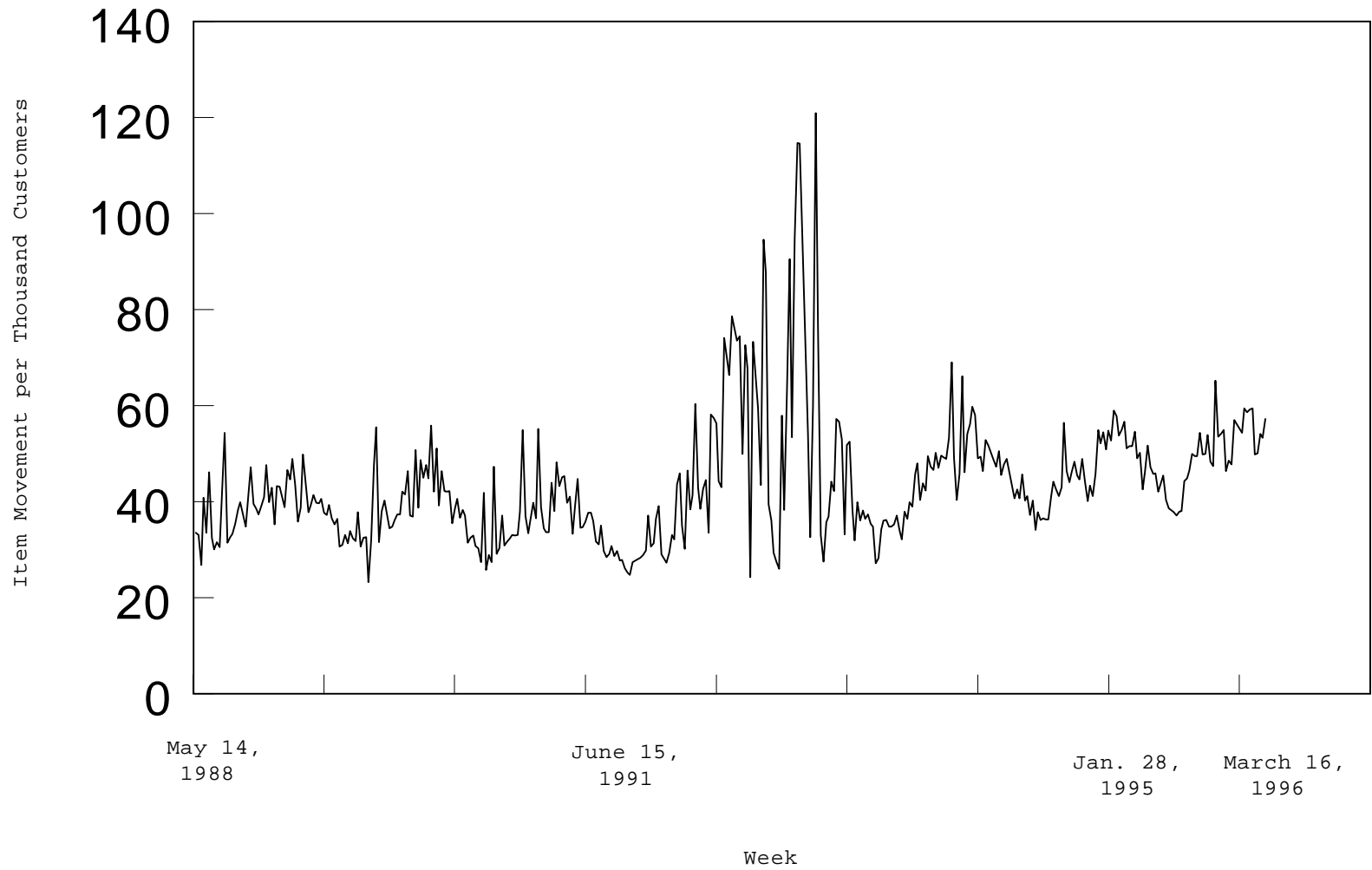
Some problems within the food distribution system are the result of the successful introduction of precut. For retailers shelf space continues to be limited. More varieties of fresh produce are becoming available at the same time more enterprises are getting into precut, and these new entrants as well as established firms are adding more types of packs (sizes and product mixes within the packages). At the same time branding on the part of larger processors and retailers is taking place. This means it will be difficult for many processors to find shelf space in the larger chains. Independent retailers and convenience stores may become viable outlets for smaller processors.

Growers also need to be responsive to precut produce, especially given the decline in regular package sales. As new varieties are developed that are more suitable for precut, producers need to be willing to try them. In addition growers need to develop relationships with brokers and precut processors who are aggressively working the precut segment.

Organically grown carrots (and other produce) have attracted a small segment of consumers who are willing to pay a premium over precut as well as regular packs. Further expansion of this market niche may depend on developing more precut packaging.

Figure 5.

Total Carrot Sales per Customer



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