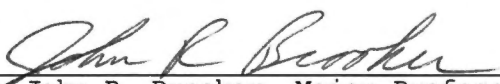
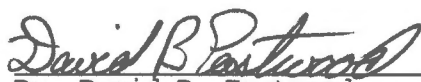


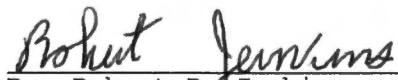
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VERTICAL PRICE LINKAGES IN THE VEGETABLE INDUSTRY:
A CASE STUDY OF EAST TENNESSEE

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Brian T. Carver
August 1995

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ABSTRACT

The purpose of this study was to assemble and analyze retail, wholesale, and shipping point price data relevant to east Tennessee producers and consumers. Specifically, the research focused on the vertical price linkages in the vegetable industry. Contents of this study can be divided into five segments: determination of how upstream prices are transmitted, determination of the degree of symmetry between downstream responses to rising and falling upstream prices, determination of when upstream price adjustments are transmitted, determination of the degree of symmetry between the lag periods used to transmit rising and falling upstream prices, and separately analyzing the pricing relationships of the nine vegetables selected for this study. The data used for this study consisted of average weekly shipping point prices, average weekly wholesale prices for Atlanta, Baltimore, Chicago, and Cincinnati, average weekly retail prices adjusted to wholesale and shipping point quantities, and estimated average weekly truck rates from Knoxville to each of the four wholesale cities and back.

In the first segment of this study, a lagged independent variable model was used to construct an empirical description of the vertical pricing relationships for nine vegetables. The sums of the deltas for both upstream price increases and decreases indicated the magnitude of the downstream price responses. The results seemed to signify downstream pricing adjustments at both the retail and wholesale level were generally not in direct proportion to upstream price movements.

An F-test was then used to compare the estimated levels of downstream responses to both rising and falling upstream prices. The results indicated that the downstream price responses were statistically different for five of the nine vegetables at the retail level and for all of the estimated responses at the wholesale level. These results seemed to indicate the use of inefficient pricing behaviors at both the retail and wholesale levels.

The third part of the study was concerned with determining the time periods in which the downstream pricing adjustments occurred. The estimated coefficients which were statistically significant at the 0.15 level were retained in the model and the used to determine the adjustment periods. The results indicated long but quick retail adjustments to upstream price increases, but short and slow adjustments to upstream price decreases. At the wholesale level, the downstream responses to both upstream price increases and decreases were short and slow.

These adjustment periods were then compared to provide further insight into the pricing behavior of downstream participants. The comparison of retail adjustment periods indicated a preference toward adjusting downstream prices in response to upstream price increases, while the comparison of wholesale adjustment periods indicated no biases.

Finally, the previous four segments of the study were combined and applied to each vegetable in order to determine the separate pricing relationships present for those vegetables. Overall, the pricing relationships were similar, but differences indicated the availability of substitutes for a particular vegetable, differences in elasticities among the vegetables, and differing pricing strategies employed by retailers and wholesalers among the different vegetables.

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CHAPTER I

INTRODUCTION

Production of Fresh Vegetables in Tennessee

For many years, fresh vegetable production consisted of growing vegetables for use at home and for sale at local markets. As urban centers developed, market garden farms began to evolve on the fringe of these cities to supply fresh vegetables during the local growing season. As genetic, transportation and irrigation technology increased, fresh vegetable production began moving from these rural areas located on the fringe of major urban centers to areas where production was more favorable. Over the years, as technology further increased, this trend toward major areas of production has continued. In 1988, California, Florida, Washington, Idaho, Arizona, and Texas accounted for 75.7 percent of United States shipments of fresh fruits and vegetables for domestic and foreign markets, while several other states, including Tennessee, provided the remaining 24.3 percent of U.S. shipments (How).

Although Tennessee is not a major supplier of fresh vegetables, the importance of the fresh vegetable industry in Tennessee is growing. In 1987, 25,426 acres of vegetables were harvested on 1,300 farms. By 1992, the number of acres harvested had increased by 8,843 acres to 34,269, and the number of farms had grown to 1,399 (1992 Census). In 1990, cash receipts from tomatoes, potatoes, snap beans, and other fruits and vegetables totaled \$53,008,000; or 2.6 percent of all cash receipts from farm marketings. In comparison, cash receipts from Tennessee's two leading cash crops, soybeans and tobacco, accounted for 9.4 percent and 9.1 percent, respectively, of all cash receipts from farm marketings (Tennessee Agriculture 1992).

As the vegetable industry in Tennessee grows in importance, so does the popularity of a variety of fresh vegetables. Warm-season crops, such as tomatoes and snap beans, have experienced substantial increases from 1987 to 1992 in acreage harvested and the number of farms; however, not all vegetables have flourished over the same time period. Tennessee's

cool-season crops of broccoli and cabbage have declined in the number of acres harvested. Table 1 presents the increases and decreases in acres harvested and in the number of farms in Tennessee between 1987 and 1992 for selected fresh vegetables.

Table 1. Change in Number of Acres Harvested and in Number of Farms Between 1987 and 1992 for Selected Fresh Vegetables in Tennessee

Fresh Vegetable	Change in Acres Harvested	Percent Change	Change in Number of Farms	Percent Change
Snap Beans	2,947	34.41	71	25.00
Broccoli	-56	-88.89	-8	-29.63
Cabbage	-73	-9.76	45	47.87
Sweet Corn	1160	99.06	183	41.59
Cucumbers	277	139.20	30	22.22
Okra	35	28.93	23	19.83
Peppers	219	47.82	29	23.97
Squash	607	173.93	64	56.14
Tomatoes	896	26.32	60	14.56

Source: 1992 Census of Agriculture

While fresh vegetable production has been moving to concentrated areas of production nationally, the trend can also be seen in Tennessee's fresh vegetable production where growers in only a few counties account for the bulk of the total production. For example, of the 11,512 acres of snap beans harvested in Tennessee in 1992, 6,618 acres, or 57.5 percent were harvested in Cumberland and Fentress Counties. Figures 1 thru 5 display the major production areas of seven of the fresh vegetables listed in Table 1. Data for broccoli and cucumbers are not available.

Description of Marketing Activities

As vegetable production moved from the urban fringe of cities to more concentrated areas of production, marketing operations have become increasingly important. Except for relatively small local production, produce cannot be harvested and delivered to the retail stores in one to two days. Vegetables from the major production areas take as many as five

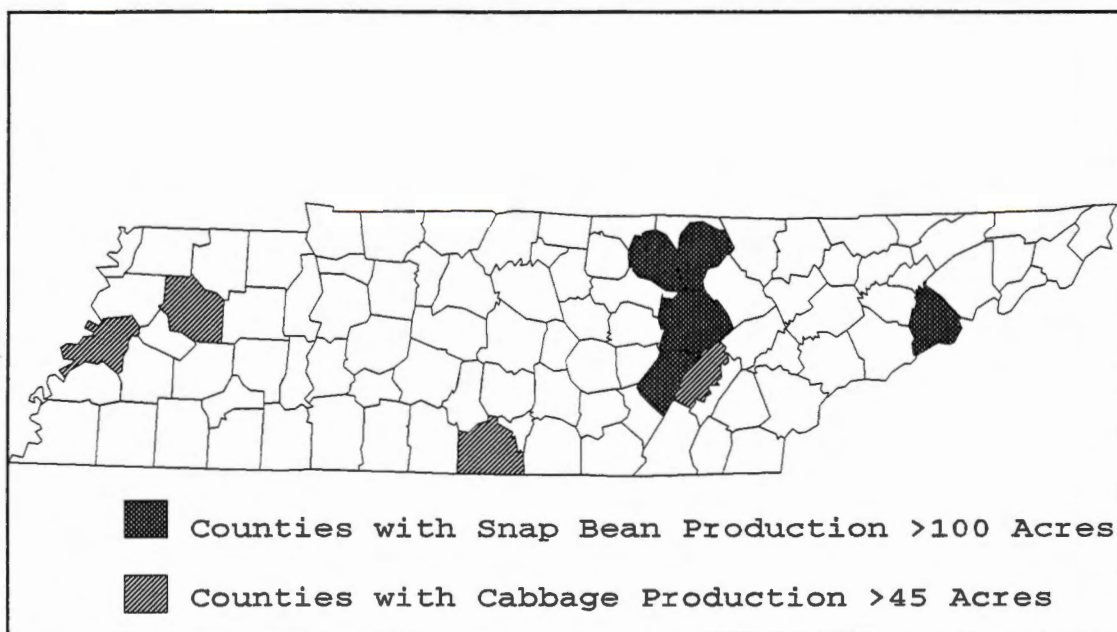


Figure 1. Major production areas of snap beans and cabbage in Tennessee by county, 1992

Source: 1992 Census of Agriculture

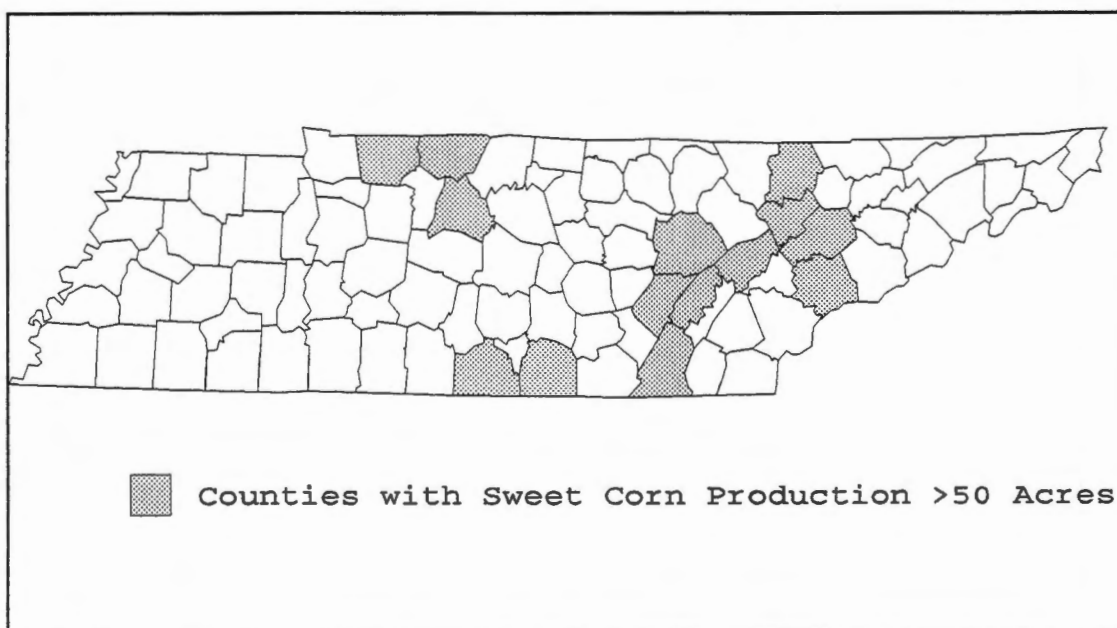


Figure 2. Major production areas of sweet corn in Tennessee by county, 1992

Source: 1992 Census of Agriculture

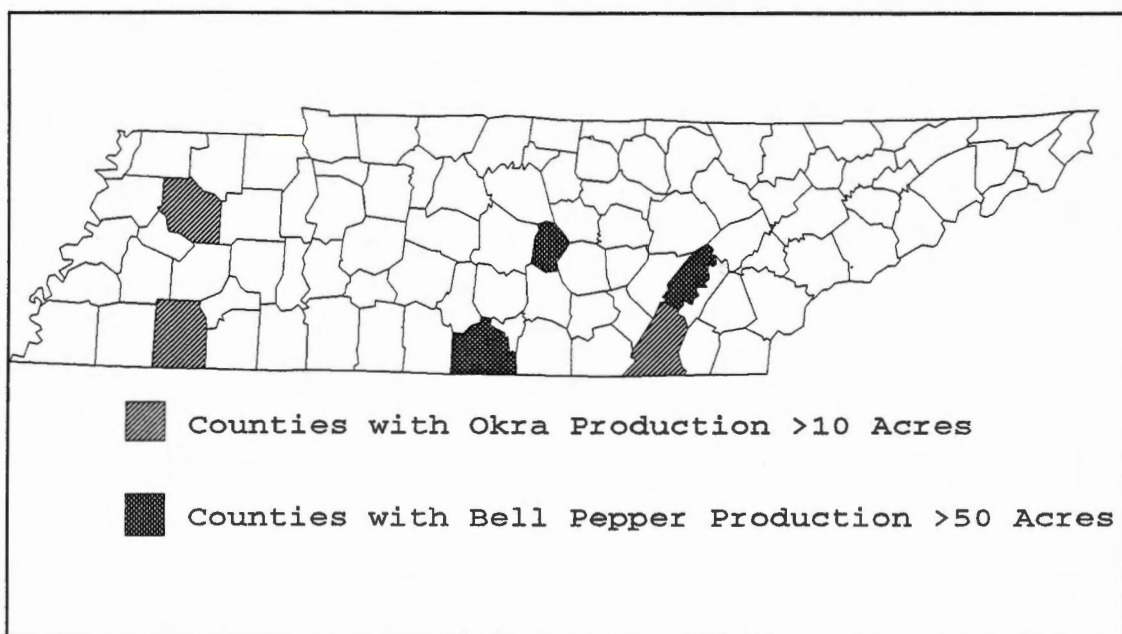


Figure 3. Major production areas of okra and bell peppers in Tennessee by county, 1992

Source: 1992 Census of Agriculture

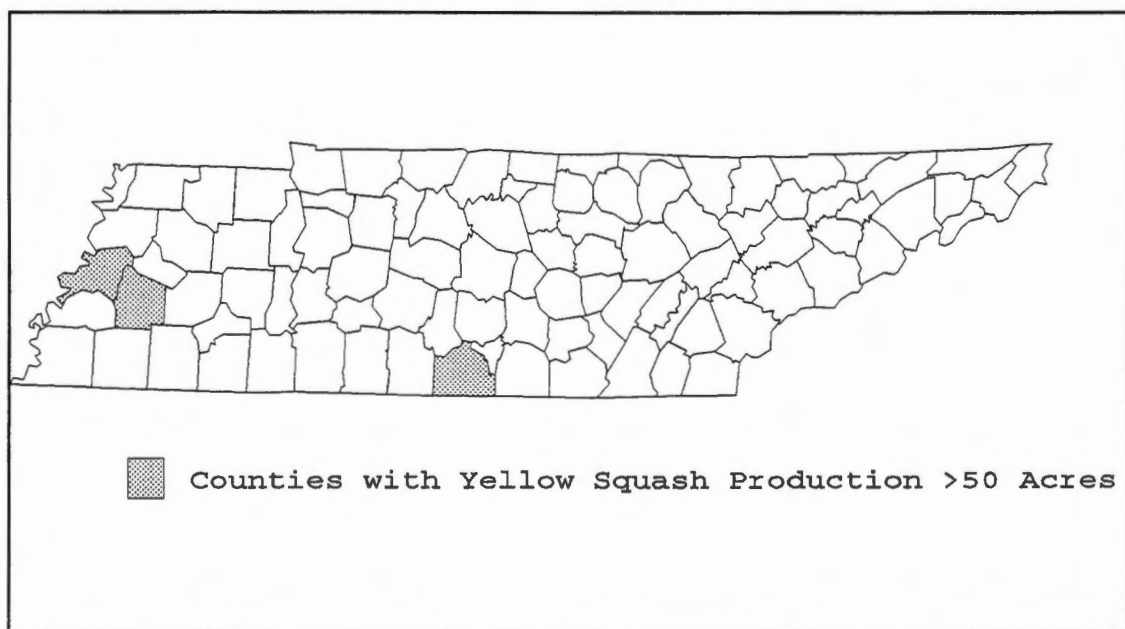


Figure 4. Major production areas of yellow squash in Tennessee by county, 1992

Source: 1992 Census of Agriculture

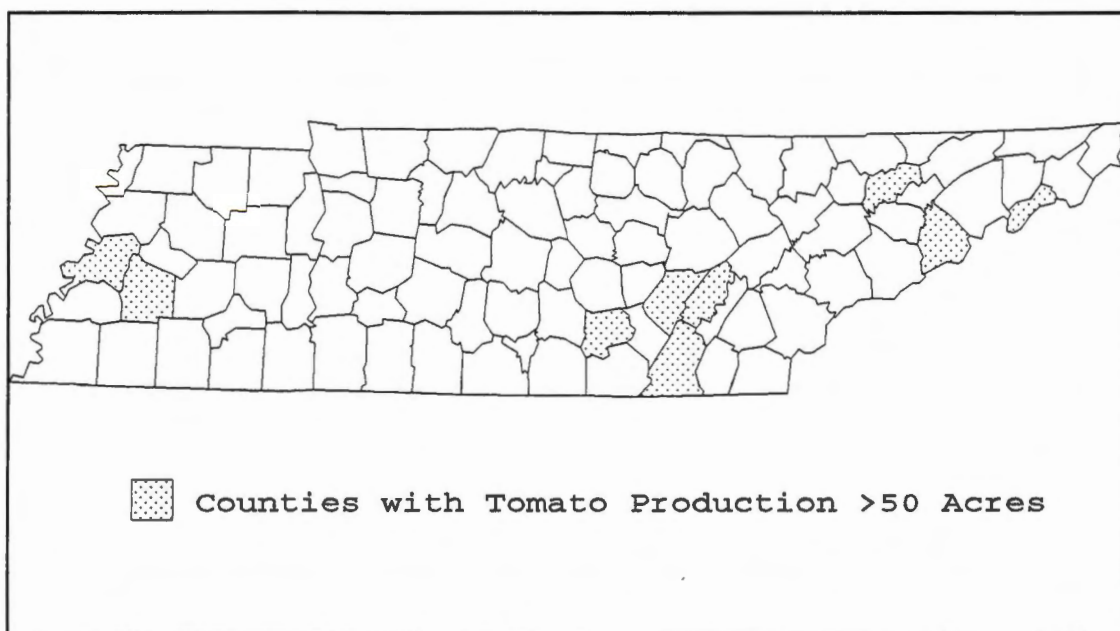


Figure 5. Major production areas of tomatoes in Tennessee by county, 1992

Source: 1992 Census of Agriculture

to seven days to reach retail stores. During this time period, a variety of services must be provided to ensure the preservation of the produce.

Once fresh produce begins to deteriorate the process cannot be reversed; therefore, maintaining the quality of produce from the field to the retail store is critical. Failure to do this will eventually result in lost revenue and lower product prices. By providing a number of marketing services at the shipping point, firms are able to minimize product spoilage and preserve produce quality (How).

Most vegetables are harvested by hand and then delivered to central packing sheds for grading and packing. Upon arrival, pallet boxes of vegetables are emptied into water-filled vats to prevent damage, and the vegetables are then washed. Afterwards, vegetables are graded and sorted

by means ranging from conveyor belts and hand grading to computerized sizing and grading. The vegetables are then packed into containers for shipment and storage. These containers are largely fillerboard cartons and must be able to withstand the rigors of stacking, cooling, shipping, and storage as well as be easy to handle (How).

After being packed, vegetables undergo a cooling process before shipping or storage to remove field heat. This cooling process, or precooling, helps to maintain the quality of fresh vegetables and reduce spoilage. It can be accomplished by several means including hydrocooling, vacuum cooling, air cooling, and package icing (How; Southern Cooperative Series).

After cooling, the packaged vegetables are placed in refrigerated trucks or storage facilities. Specific temperature and humidity conditions vary among vegetables, but the general conditions are similar. Fresh produce is kept in refrigerated storage with temperatures maintained close to the ideal level throughout the storage area to prevent water condensation. The relative humidity of the air is held at high levels throughout the storage area to prevent vegetables from becoming mushy or wilting from moisture loss (How).

In addition to physical marketing operations, support services must be provided at the shipping point level. Shippers must arrange for the sale of fresh vegetables, generally through brokers or sales agents, and for a carrier to transport the vegetables. Once these activities have taken place, the vegetables are ready to be loaded onto refrigerated trucks for transport to terminal markets and retail distribution centers (How).

Shipments of fresh vegetables are received by retail distribution centers and by wholesalers at terminal market facilities. Upon arriving, vegetables may be repackaged, and then held in storage for further ripening. Wholesalers will then resell smaller amounts of produce to a variety of customers, while retail centers will distribute the produce to

its chain stores and sometimes sell to other buyers (How).

Depending on the size of the retail chain, retail stores receive shipments of fresh produce from retail distribution centers or from wholesalers two to three times each week. These shipments usually arrive at night so displays can be built for the morning rush of customers. Perishable produce items are generally displayed in refrigerated cases and leafy vegetables are sprinkled with a mist from time to time. Workers must be careful not to pile displays too high and thus prevent adequate cooling. They must also rotate and cull items frequently to preserve quality and reduce spoilage and revenue losses (How).

Description of Market Conditions for Fresh Vegetables

The fresh vegetable market has undergone vast changes in the post World War II era. From 1945 to 1970, the total use of fresh vegetables experienced a downward trend. New technology in manufacturing and distribution and the increased availability of refrigerators and freezers shifted consumer preferences from fresh vegetables to canned and frozen vegetables. In the early 1970s, however, consumer demand conditions changed drastically to produce an upward trend in the use of fresh vegetables (How).

As the 1970s began, the baby boomer generation entered the work force, the proportion of women working outside the home grew, and the household size declined. As a consequence, families had a larger disposable income that could be spent on food items (How). Over a twenty-seven year period from 1960-1987, disposable income in real terms increased by about two-thirds (How). The 1977-78 National Food Consumption Survey found that, holding socioeconomic and demographic factors constant, a 10 percent increase in income resulted in a 1.5 percent increase in fresh vegetable expenditures (How).

In the late 1960s, the evidence of the association between the diet and health disease began to accumulate. By the early 1970s, health and physical fitness had become a major concern. This led to a change in

lifestyle as well as a change in diet. People began avoiding foods that were high in cholesterol and fat, which led to an increase in the consumption of vegetables (How).

Vast improvements in the supply of fresh vegetables also came about in the early 1970s. Advancements were made in the growing and harvesting of vegetables as well as post-harvest handling. In addition, retail stores improved their displays of fresh vegetables (How). These changes helped to enhance the quality, freshness, and appearance of fresh produce sold at retail stores.

These trends have continued to the present time. Supply activities have continued to improve over the past twenty-five years resulting in higher quality produce being available for the consumer, and, from the demand side, disposable incomes have continued to rise and health concerns have become more important. These trends have resulted in an increase in the per capita consumption of fresh vegetables from 70.9 pounds in 1970-72 to 98.0 pounds in 1985-87. Future projections indicate that expenditures on fresh vegetables will continue to increase. By the year 2020, expenditures, in terms of real dollars, for fresh produce consumed at home are expected to increase from the 1980 level by 72.2 percent (How).

Statement of the Problem

As vegetable production has moved toward centralized areas of production, more marketing activities must be performed. This has logically led to an expansion of the retail-farm price spread. During the same time period, the consumption of fresh vegetables expanded. Like prices for fish, which have also undergone increases in consumption, the average retail price of fresh vegetables increased substantially (How). Average farm prices have also trended upward, but average retail prices have risen faster than have average shipping point prices, resulting in a larger retail-farm spread (Waterfield). This has many participants within the vegetable industry concerned that the retail sector quickly responds with higher prices when faced with declining product supply, but, when

product supply is increasing and grower returns are declining, retailers are less responsive in retail price adjustment (Waterfield).

For many agricultural products, a considerable amount of transformation is required before the final product reaches the ultimate consumer. Since these consumer products are rarely in the same form as when they leave the farm, price relationships between producer prices and retail prices become unclear and increasingly difficult to evaluate. For these reasons, a weak price linkage among exchange points is expected to prevail (Ward). In other words, adjustments in the farm level price of an agricultural product is expected to have a minimal effect on the prices of retail products for which that agricultural product is a component.

Unlike agricultural products that are inputs to a manufacturing process, fresh vegetables require little transformation before they reach the consumer. For this reason, fresh vegetables are expected to show stronger price linkages between retail and farm levels (Ward). As a result, a price adjustment in the fresh vegetable market at one exchange point should have a more profound effect on prices at other exchange points than the same adjustment for a highly processed agricultural product.

Past studies have tried to explain price movements within the vegetable industry in order to allow vegetable producers, wholesalers, and retailers to make more precise production, pricing, and inventory decisions. However, a major weakness of these studies has been the use of average monthly prices to determine how prices throughout the marketing channel adjust to a change in price at one exchange point. Using monthly price averages has led to imprecise results; the inexactness of which is compounded by the perishability of fresh vegetables. Due to their short shelf-lives, the fresh vegetable planning horizons for retailers are much less than one month, which leads to a change in pricing and inventory strategies more than once each month. While monthly data are only able to record price and inventory averages, weekly data are more in line with

planning horizons and better able to record each movement in prices and inventory (Brooker, et al.). With the advent of retail scan data technology, weekly price data can now be tracked and gathered at selected locations.

Analysis of weekly fresh vegetable price movements at the selected stages of the marketing channel provide a more appropriate time horizon for the pricing behaviors of wholesalers, retailers , and consumers and the expanding retail-farm price spread. In addition, market participants may be able to predict price movements better at one stage of the market based on a change in price at another stage of the market using weekly data. This could lead to more efficient production, purchasing, and inventory management decisions. Even if growers and other market participants are unable to predict price movements because of supply variability, they could at least understand or expect certain adjustments in grower returns and retail prices when shifts occur in the short-run supplies.

Objectives

The overall goal of this project was to provide vegetable producers and other industry participants with insight about the pricing behavior of wholesalers and retailers and the resulting retail-farm price margin. Included in this overall goal were seven particular objectives:

- 1) determination of downstream price increases in relation to upstream price increases,
- 2) determination of downstream price decreases in relation to upstream price decreases,
- 3) determination of the degree of symmetry between downstream responses to rising and falling upstream prices,
- 4) determination of the lag periods in which upstream price increases are transmitted,

- 5) determination of the lag periods in which upstream price decreases are transmitted,
- 6) determination of the degree of symmetry between the lag periods used to transmit rising and falling upstream prices, and
- 7) separately analyzing the weekly pricing relationships of nine vegetables.

CHAPTER II

REVIEW OF LITERATURE

Analysis of the Retail-Farm Spread

Over the years, the retail-farm margin has become an important issue to those involved with the vegetable industry. However, in recent years, the retail-farm spread has become a focal point for many producers. This is a result of the difference between shipping point and supermarket prices widening. Many producers are concerned that retailers are profiteering by not adjusting their prices down as wholesale and shipping point prices fall. However, as the concern about the expanding retail-farm spread grows, "so does the gulf of misunderstanding between grower-shippers and retailers (Waterfield, p. 1A)."

In an effort to analyze the retail-farm spread, George and King began examining the elasticity of price transmission and derived farm-level elasticities. They concluded that for the majority of 32 commodities, which included five fresh vegetables, three canned vegetables, and dried vegetables, the elasticity of price transmission, or "the ratio of relative change in retail price to the relative change in the farm-level price, (George and King, p. 61)" was less than 1.0. The implication of this was that if producer prices rose, holding quantity processed and input prices for processors constant, the relative change in retail price would not exceed the relative change in farm prices.

George and King then used the elasticities of price transmission along with retail elasticities to determine farm level elasticities. The resulting farm level elasticities were less than the retail elasticities. These results, however, may not be very accurate, because the data were quarterly and yearly averages, and, as Gardner points out, no distinction was made between product quantities at retail and farm levels when using the price transmission elasticities to derive farm level elasticities.

Gardner, unlike George and King, used two equations to determine the elasticity of price transmission. If price changes are a result of a shift in the supply of agricultural commodities, then one equation will be

used and the elasticity will be less than 1.0. When price changes are a result of a shift in food demand, the other equation is used and elasticity results will be closer to unity, or will exceed 1.0, if "marketing inputs are more nearly fixed in supply than are farm products (Gardner p. 404)." The determination of the size of farm level elasticity of demand relative to the retail elasticity of demand is then dependent on the relative size of the elasticity of substitution between agricultural commodities and other marketing inputs and the absolute value of the retail elasticity of demand for food. The derived demand function for agricultural products "will be less elastic than the retail demand function if and only if" the elasticity of substitution is less than the absolute value of retail elasticity (Gardner, p. 405).

Gardner also investigated how other shifts in retail demand, farm commodity supply, and marketing input supply affect the retail-farm spread. An increase in retail demand will reduce the retail-farm spread if the supply of marketing inputs is more elastic than that of farm commodities, and it will increase the spread if the supply of marketing inputs is less elastic. An increase in the supply of farm products will increase the retail-farm spread, while an increase in the supply of marketing inputs will decrease the spread. If the elasticity of supply of farm commodities is less than that of marketing inputs, then an effective price ceiling on retail prices will reduce the price of farm products and increase the retail-farm spread. Finally, if the price of farm commodities is supported above the market equilibrium, the retail-farm spread will be reduced. The model used by Gardner, however, has two limitations. The model assumes competition exists, and it places all marketing activities into a single production function and "all nonfarm marketing inputs into one quantity (Gardner, p. 407)."

Holloway felt that the assumption of pure competition was too stringent a limitation on the model and, therefore, worked to develop a noncompetitive model that fits the food industry better. In the

development of this model, Holloway included the assumptions of homogeneity, of instantaneous adjustments to equilibria, and that these adjustments would occur in a closed economy void of government intervention. Empirical results led to the conclusion that between 1955 and 1983 outcomes obtained under perfect competition and the observed outcomes were not significantly different. The results of a study conducted by Wholgenant also support this idea of competitive marketing group behavior.

Factors Affecting the Retail-Farm Spread

As Brorsen, et al. point out, price uncertainty can also affect the marketing margin. In their examination of the U.S. wheat market, they found that an increase in output price uncertainty led to an increase in both the wholesale-farm and retail-wholesale margins. This suggests "that decision makers within the wheat marketing channel are risk averse (Brorsen, et al., p. 526)." In addition, they discovered that an increase in the quantity marketed and increases in milling and marketing costs led to an increase in both of these margins. These results further support the idea of decreasing absolute risk aversion behavior. These results indicate that not only do producers and/or consumers benefit from price stabilization policies, but marketing firms, which are risk averse, will also benefit. Although stark differences exist between the wheat and vegetable industries, important observations about the effect of risk averse behavior on the marketing margin can be made.

Quality characteristics of farm products also have an effect on the retail-farm spread. In their model, Parker and Zilberman use a hedonic framework to examine the California fresh peach industry, including data on peach prices and characteristics at both the retail and farm level. They assume that losses due to handling, transportation, and spoilage will increase as levels of characteristics increase. This is a reasonable assumption, however, if these quality characteristics are accurately defined, because greater maturity is associated with higher quality in

fresh produce. This led to the conclusion that as quality increases, marketing cost increase, and, therefore, the retail-farm spread increases.

Parker and Zilberman also held quality characteristics constant to determine how time-within-season effects the marketing margin. They found that as the season progresses, the retail price falls for the typical summer fruit due to the availability of seasonal substitutes, the decline of the early season novelty effect, and rises in production acreage. This led to the conclusion that the retail-farm margin converges as the season advances.

Technological change has also been linked to changes in the retail-farm spread. Miedema explored this relationship, and results from his study indicated that the marketing margin generally declined when neutral technological change was present and when agriculturally biased technological change occurred. For the retail-farm price ratio to increase in the presence of neutral technical change, an extremely limited substitution between agricultural products and marketing inputs and an inelastic demand at the retail level would have to exist.

Later, Fisher explored how exogenous changes in marketing charges affected both producers and consumers. The model first developed by Fisher assumed that the elasticity of substitution was zero, but this assumption can be relaxed when a competitive model, such as Gardner's model, is used. This is an important relaxation of assumptions because the results provided by Fisher's model are sensitive to the value of the elasticity of substitution. Parameter values for the Sydney beef market were used to determine the burden of a change in marketing charges borne by producers and retailers. The results showed that a greater portion of these new charges would be passed on to the producer. Therefore, farmers "have a strong economic interest in promoting efficiency in the service sector (Fisher, p. 263)."

An early work by Buse and Brandow tried to determine the relationship of volume, prices, and cost to the retail-farm spread. They

found that processing and distribution costs were the main determinants of the margin and that adjusted retail price, change in price, and volume were minor components of the margin. These results, however, may lack a great deal of accuracy. All of the data used by Buse and Brandow were either quarterly or annual data, and they felt that their simple model probably did not accurately reflect complex relationships that existed in the markets for some foods. In addition, when the Durbin-Watson test was applied to annual and quarterly equations in the model, the possibility of serial correlation arose.

Analysis of Vertical Price Linkages

By examining the relationship between exchange points in the market, the vertical price linkages between markets can be determined and used to explain how prices move in relation to a change at one of the exchange points. In an effort to determine these price linkages, Ward used Granger's causality test, which presumes that causality may flow in either direction between two variables, and the appropriate F-test to determine if wholesale prices tend to lead both retail and shipping point prices. Ward's results were consistent with those produced by Heien, who studied the wholesale-retail price relationship with a dynamic model of the food industry. Heien's results were also consistent with Hansmire and Willett, who studied price transmission in the apple industry.

Using this information, Ward and Zepp began estimating symmetry conditions for each relationship using Wolffram's asymmetric models to accomplish their objectives. One would expect prices to move in a parallel manner with a lagged difference at the retail level, or for symmetry to exist; however, in their study of price relationships, Ward and Zepp found that asymmetric relationships, or price movements that may or may not be related to a change in price by the price leader, existed at both the wholesale-farm level and the wholesale-retail level. As wholesale prices rise, retailers are reluctant to increase their prices for fear of an inability to move the perishable items. Producers also

experience such "stickiness" in the upward movement of the price they receive for fresh vegetables. On the other hand, as wholesale prices fall, retailers move quickly to pass their savings on to consumers, and producer prices fall at a more accelerated rate than producer prices rise when wholesale prices are increasing.

These results are contradicted by Hansmire and Willett, who found that rising wholesale prices of apples strongly influenced retail prices, whereas falling wholesale prices exhibited little influence on retail prices. They are also refuted in an article by Waterfield who found grower prices for Washington red delicious apples had increased 6 cents per pound over the previous 10 years while retail prices increased 20 cents per pound, and retail prices had remained constant as grower prices for apples fell due to the alar scare in February 1989.

Although much of the effects of price changes at the wholesale level are felt in the same month, some lags of up to two months may occur. These lags will seldom exceed one to two months, however, due to the perishability of fresh vegetables (Ward and Zepp). This view is contradicted by Hansmire and Willett who found the use of monthly data lacked "sufficient periodicity to determine price lags for fresh apples (Hansmire and Willett, p. 9)." Because of this condition, they hypothesized that the lag period was sometime less than a month.

Many of the same results can be found in another study conducted by Ward, but the completed analyses were limited by the data sources used to test the hypotheses. The data used in the analyses were based on monthly averages. The problems with this data are two-fold. Monthly data are inconsistent with the planning horizons of most businesses, and monthly averages tend to conceal valuable information about price fluctuations.

Hansmire and Willett conducted a similar type of study that examined the price transmission process of the apple industry. They examined price lags and the existence of pricing asymmetry within the industry. In the development of the model, Hansmire and Willett assumed causality occurred

in an upward direction from the farm to the retail level, and they chose to use a markup model which assumes Lontief production technology, which implies the use of farm and marketing service inputs in fixed proportions, constant returns to scale (CRTS), and competitive markets. In addition, price series were not deflated because the purpose was to examine the behavior of nominal prices. A distributed lag formulation was used to examine the role of lagged prices in the apple industry. The results of their study show 1) an asymmetric relationship to exist in the wholesale-retail price spread; 2) inconclusive results in the shipping point-wholesale price spread possibly due to the assumption of upward causality moving through the marketing channel; and 3) indeterminate price lags due to monthly data being used.

Likewise, Kinnucan and Forker studied price transmission in the dairy industry. They also chose a markup pricing model assuming competitive conditions, constant returns to scale, and Lontief production technology. Lontief production technology and CRTS were found to be reasonable assumptions, while the assumption of competition was justified by the hypothesis that its violation would not produce significantly different results. In addition, a unidirectional-upward causal relationship was assumed because the test developed by Granger and Sims to determine the direction of causality were "ambiguous, unreliable, and heavily influenced by lack of variability in the data (Hansmire and Willett, p. 3)." Like Ward and Zepp, Kinnucan and Forker found pricing asymmetry to exist, but contrary to Ward and Zepp, their results indicate that the overall effect on retail dairy prices of a farm level price increase was greater than the overall effect of a price decrease. They were also able to reject the null hypothesis of symmetry in pricing at the 10 percent level or lower for all dairy products examined. Moreover, the mean lags for price increases were smaller for all products examined than the mean lag for price decreases. Furthermore, Kinnucan and Forker found long run rising-price elasticities to be larger than corresponding

falling-price elasticities. Thus, they concluded that farm level price increases are more fully passed through to the consumer than are farm level price decreases.

The most recent study, which was conducted by Powers, was selected as the basis for this study and is reviewed in the next chapter.

CHAPTER III

METHODOLOGY AND PROCEDURES

Analysis of Price Linkage Model

If firms are competitive, fresh vegetables are produced by "combining the farm commodity with marketing inputs in fixed proportions". The marginal cost of producing the fresh vegetables, then, remains constant regardless of the amount produced, and "the rule linking each city's wholesale price to the FOB price is:

$$(1) \quad W = a_1 S + a_2 X,$$

where W is the city's wholesale price, S is the FOB shipping point price, X is the price of marketing inputs, and a_1 and a_2 are coefficients representing the marketing technology (Powers, p. 2-3)." Coefficient a_1 indicates the number of units of a vegetable at the shipping point level it takes to produce one unit of the same vegetable at the wholesale level. Since vegetables are perishable, a_1 will exceed 1. Coefficient a_1 also indicates the amount the wholesale price would change based on a one unit change in the shipping point price (Powers).

Equation 1 expresses downstream prices as a function of upstream prices. If operating in an efficient market, this does seem correct. Price responses to shifts in supply or demand should travel through the marketing system with the produce as lagged by transportation and storage. These lags should not, however, exceed the time required to move the produce between stages, which in total is generally between one and seven days (Powers).

The vertical relationship in equation 1 is based on three assumptions. First, firms are competitive. This seems to be a reasonable assumption for growers, packers-shippers, and wholesalers. Because of their large numbers and the lack of a government program to limit production or shipments, growers and packer-shippers are unable to manipulate the FOB price of vegetables. Terminal markets are "dominated by many small-volume buyers and sellers with diverging interest," which prevents any group of wholesalers from exerting any control over a city's

wholesale price (Powers). While retailers do not seem to operate in a competitive environment, Holloway found that retail market deviations from competitiveness from 1955-83 have been relatively insignificant. The second assumption is that fresh vegetables are combined with fixed proportions of marketing inputs. The lack of substitutability of marketing inputs in the short run and the relatively fixed nature of technology for marketing and distributing fresh vegetables supports the validity of the second assumption. Finally, the third assumption is that marginal marketing costs are constant. Since fees for cooling, packing, and selling remain constant during the year this assumption seems to be feasible (Powers). In addition, Kinnucan and Forker found empirical evidence to support this assumption in their analysis of dairy prices.

Although the total response of downstream prices to upstream prices is probably nearly symmetrical in the long run, initial price responses may be asymmetrical or price changes may not fully pass through during the week in which they occur. To accommodate this, equation 1 can be revised to allow for asymmetric price responses and gradual price adjustment by using Houck's approach for specifying nonreversible functions and including lags of increases and decreases in upstream prices and hauling cost. The resulting equation, which specifies the increases and decreases in FOB prices (SP) and hauling cost (HC) is:

$$(2) \quad WP_t = \sum_{j=0}^{m1} \delta_{1,-j} SPR_{t-j} + \sum_{j=0}^{m2} \delta_{2,-j} SPF_{t-j} + \delta_3 HCR_t + \delta_4 HCF_t + e_t,$$

where $WP_t = W_t - W_0$,

$$SPR_t = \sum_{i=0}^t \Delta SP_i,$$

$\Delta SP_i = SP_i - SP_{i-1}$ if $SP_i > SP_{i-1}$ and 0 otherwise,

$$SPF_t = \sum_{i=0}^t \Delta SP_i,$$

$\Delta SP_i = SP_i - SP_{i-1}$ if $SP_i < SP_{i-1}$ and 0 otherwise,

$$HCR_t = \sum_{i=0}^t \Delta HC_i,$$

$\Delta HC_i = HC_i - HC_{i-1}$ if $HC_i > HC_{i-1}$ and 0 otherwise,

$$HCF_t = \sum_{i=0}^t \Delta HC_i,$$

$\Delta HC_i = HC_i - HC_{i-1}$ if $HC_i < HC_{i-1}$ and 0 otherwise.

WP_t is the difference between the city's wholesale price in week t and the price in week 0, the initial week; SPR_t is the sum of all week-to-week increases in the FOB price from its initial value in week 0 to week t ; SPF_t is the sum of all week-to-week decreases in the FOB price from its initial value in week 0 to week t ; HCR_t is the sum of all week-to-week increases in truck hauling costs from its initial value in week 0 to week t ; HCF_t is the sum of all week-to-week decreases in hauling costs from its initial value in week 0 to week t ; $m1$ is the lag length for SPR ; $m2$ is the lag length for SPF ; $\delta_{1,j}$ ($j=0,1,2,\dots,m1$) are the $m1 + 1$ estimated coefficients corresponding to the $m1 + 1$ SPR_j 's; $\delta_{2,j}$ ($j=0,1,2,\dots,m2$) are the $m2 + 1$ estimated coefficients corresponding to the $m2 + 1$ SPF_j 's; δ_3 is the estimated coefficient for HCR ; δ_4 is the estimated coefficient for HCF ; and e_t is the random error term. Because every variable appears as a deviation from its previous or initial value, the intercept term drops out of equation 2. Initially, Powers included lags of hauling costs and average U.S. hourly earnings for nonsupervisory workers in wholesale grocery and related products, but neither factor explained any additional variation in wholesale prices; therefore, they were omitted from the model.

For each wholesale city's equation, $m1$ and $m2$ were found by specifying lag lengths of seven weeks and estimating the equation. The last lag was then eliminated if its estimated coefficient was not

statistically different from zero at the .20 level, and the equation was re-estimated. This procedure was followed until the last lag remaining in the equation was statistically different from zero. A longer lag period indicates that price changes are distributed over a longer period of time (Powers).

$\sum_{j=0}^{m1} \delta_{1,-j}$ and $\sum_{j=0}^{m2} \delta_{2,-j}$ represent the total response of a city's

wholesale price to an increase or decrease, respectively, in the price at the shipping point. Because of product shrinkage, these values should slightly exceed one for the price changes to be fully passed through. If these values greatly exceed one, price changes at the FOB level more than fully pass through, and, if these values are less than one, price changes are only partially passed through. If $\sum_{j=0}^{m1} \delta_{1,-j} = \sum_{j=0}^{m2} \delta_{2,-j}$, then a city's

wholesale price response to rising and falling FOB prices is symmetrical. Similarly, if $\delta_3 = \delta_4$, then price responses to increases or decreases in hauling cost are symmetrical. An F-test was constructed to assess these conditions (Powers).

In order to explain the relationship between wholesale prices and retail prices, equation 2 must be slightly modified. Unlike Powers's approach, this study does not use retail prices of the cities with wholesale markets, so hauling costs were included in the wholesale-retail price transmission model. The result is:

$$(3) \quad RP_t = \sum_{j=0}^{m1} \delta_{1,-j} WPR_{t-j} + \sum_{j=0}^{m2} \delta_{2,-j} WPF_{t-j} + \delta_3 HCR_t + \delta_4 HCF_t + e_t$$

where RP_t is the difference between the retail price in week t and this price in week 0, the initial week. Adjusting equation 2 to reflect the

retail-shipping point price transmission resulted in:

$$(4) \quad RP_t = \sum_{j=0}^{m1} \delta_{1,-j} SPR_{t-j} + \sum_{j=0}^{m2} \delta_{2,-j} SPF_{t-j} + \delta_3 WHCR_t + \delta_4 RHCR_t + \delta_5 WHCF_t + \delta_6 RHCF_t + e_t$$

where WHC is the cost of transporting produce from the FOB shipping point to the wholesale market, and RHC is the cost of transporting produce from the wholesale market to the terminal market (Powers).

Data Collection

The fresh vegetables selected for this study were green beans, broccoli, cabbage, sweet corn, cucumbers, okra, green peppers, squash, and tomatoes. These vegetables were chosen based on their ability to be produced in Tennessee and the availability of shipping point, wholesale, and retail price data.

Shipping point price data were collected from a grower cooperative and reflect the average weekly price received by the member producers. These data provide accurate reflections of prices received by vegetable producers in east Tennessee, but, due to the relatively short harvest season for this region, the data have a small number of observations.

Price data for wholesale markets were acquired from the Market News Service (U.S.D.A. 1988-1993) for four markets considered important to Tennessee producers (Best and Brooker 3). The weekly range of reported wholesale market prices in Atlanta, Baltimore, Chicago, and Cincinnati were used to calculate average weekly wholesale market prices for the selected vegetables at each location. An average of the weekly range of wholesale prices for each city is the best estimate of the actual average weekly wholesale price, because the quantities of vegetables sold within the price ranges are not known.

Weekly retail prices and product movement were obtained from five Knoxville area retail grocery stores that are part of a national supermarket chain. The weekly retail price for each vegetable was multiplied by its volume movement for each store and, then, were summed

across the five stores. This was then divided by the total volume movement for that vegetable for the five stores to yield the average weekly retail price. Since vegetables are sold in different quantities at the retail and wholesale levels, the average weekly retail prices were then adjusted to reflect the price charged for wholesale quantities (U.S.D.A. Statistical Bulletin No. 616). The data are an accurate reflection of retail prices in the Knoxville area since the retail prices and product movement are taken directly from the retail scanner tapes and this supermarket chain controls the largest market share in Knoxville.

The truck rates for mixed vegetables from the central and southern San Joaquin Valley to Atlanta were acquired from Fruit and Vegetable Truck Rate and Cost Summary (U.S.D.A. 1988-1993). An index was then created by determining the weekly percentage change in those truck rates. Present period forward and back hauling truck rates between Knoxville and each of the terminal market cities were obtained from a Knoxville-based trucking company. These rates were then adjusted by the index to determine the estimated weekly truck rates for a truckload of vegetables between 1988 and 1993. These estimated truck rates were then divided by the number of packaged items in a truckload for each vegetable to determine the per unit hauling cost for each vegetable (Appendix Figures 109-111). Neither the prices nor the hauling cost were adjusted for inflation since the focus of this study was to examine nominal prices rather than real prices.

The average weekly wholesale prices for each vegetable for the 1988 through 1993 period were graphed by year. Along with these plots, the adjusted average weekly retail prices and the average weekly prices received by area producers of the selected fresh vegetables were generated. These graphs were then compared to reveal overall patterns in the price margins and their consistency. While a graphical analysis does not provide any statistical evidence of price transmissions, it does produce a "feel" for the existing pricing relationships.

These price data, along with hauling cost were then used to

construct an empirical description of vertical pricing relationships. The model developed by Powers and adapted from Heien; Kunnucan and Forker; Pick, Karrenbrock, and Carman; and Ward was used to examine the vertical price relationships.

CHAPTER IV

RESULTS OF THE STUDY

Results of the Graphical Analysis

In order to provide a proper perspective for the pricing relationships between retail, wholesale, and shipping point prices, it was necessary to examine these prices in a graphical setting. Figures 6-11 detail the pricing relationships for yellow squash, which are generally consistent with the pricing relationships present for all other vegetables used in this study except okra.

A comparison of shipping point prices and the average wholesale price of squash reveals a close pricing relationship in which price movements at the shipping point are transmitted quickly and fully. A closer examination of all four wholesale markets, however, reveals some variability in prices that may indicate less easily defined pricing relationships.

A much less defined pricing relationship is present between the retail and wholesale levels. While the average wholesale price of squash shows a good deal of volatility, the retail price displays a more constant price. This is characteristic of a pricing strategy in which the retailer uses a threshold price at the wholesale level to initiate price changes at the retail level. In addition, the retail prices appear to be less responsive to price downturns than upswings in the price of squash at the wholesale level. These price changes, however, appear to occur in a logical simultaneous to four week time period. All of the nine vegetables follow this same general pattern except okra. However, beans, broccoli, corn, and peppers display slightly more volatility than squash in their retail prices. Similar pricing relationships exist between the retail and shipping point prices for all vegetables other than okra.

The pricing relationship between the retail and average wholesale price for okra is much less defined than that for other vegetables. Wholesale prices for okra exhibit a wide range of prices for a given week with price movements being in opposite directions at times. Therefore,

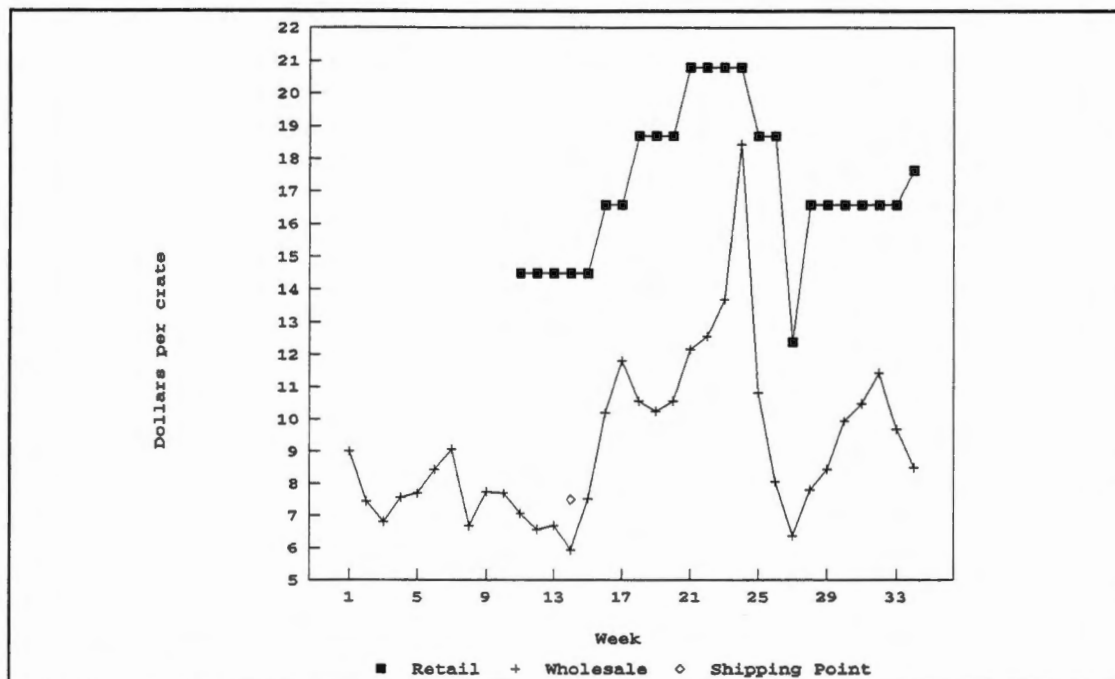


Figure 6. Yellow Squash: Retail, average wholesale, and shipping point prices, 1988

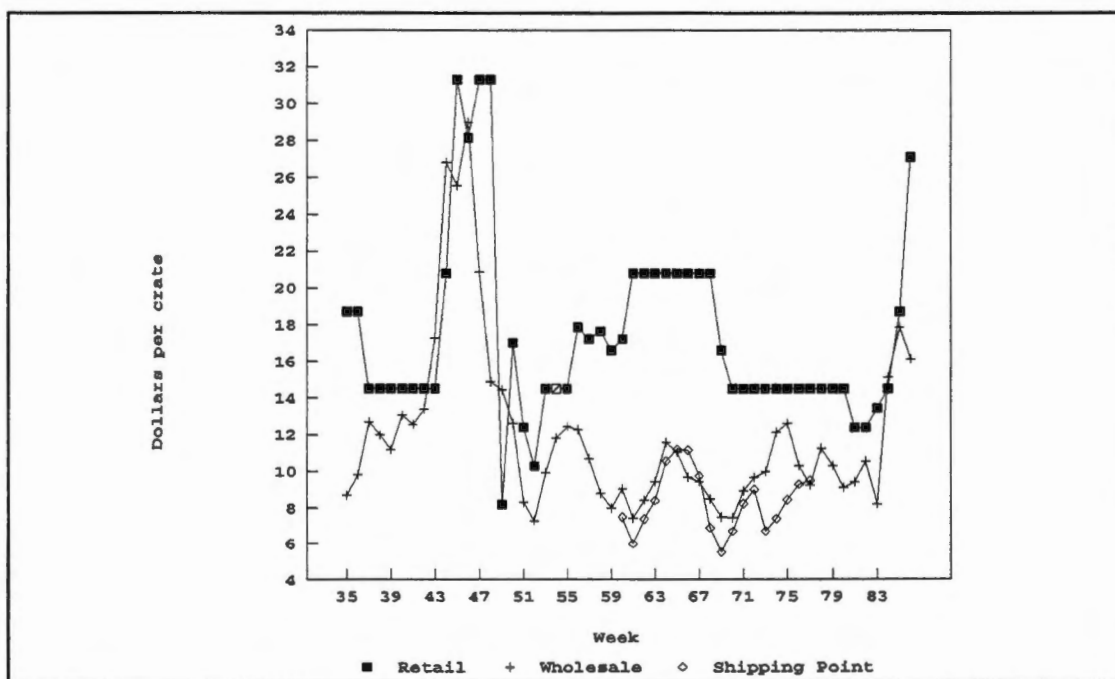


Figure 7. Yellow Squash: Retail, average wholesale, and shipping point prices, 1989

Note: For a complete explanation of graphs please see the Appendix.

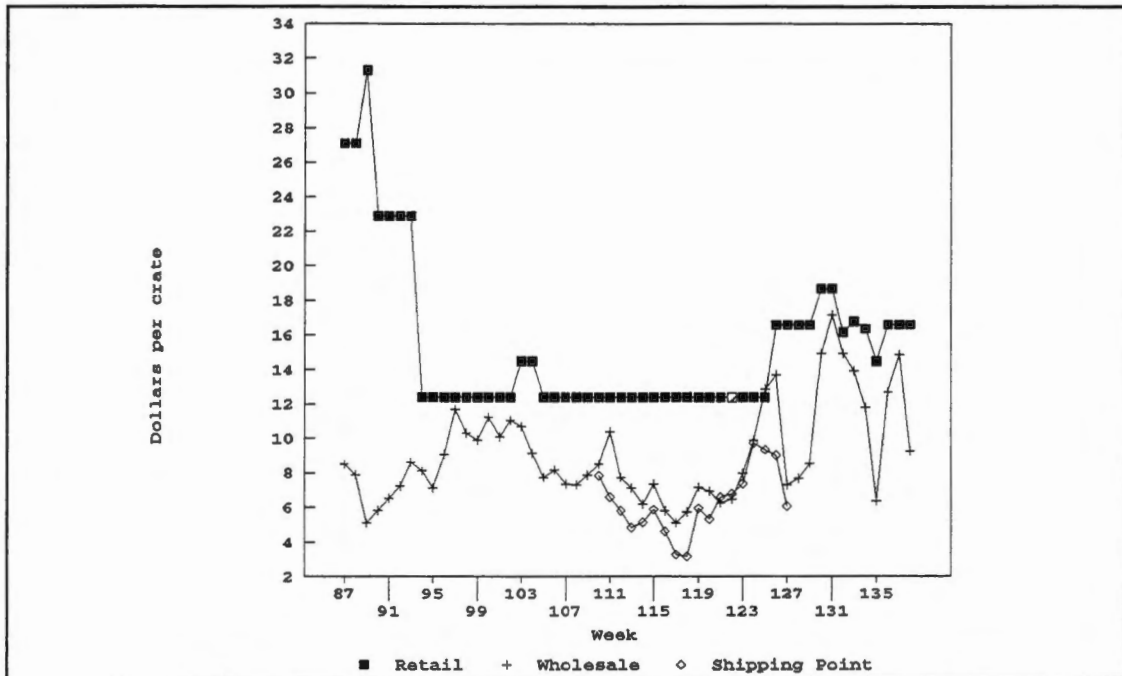


Figure 8. Yellow Squash: Retail, average wholesale, and shipping point prices, 1990

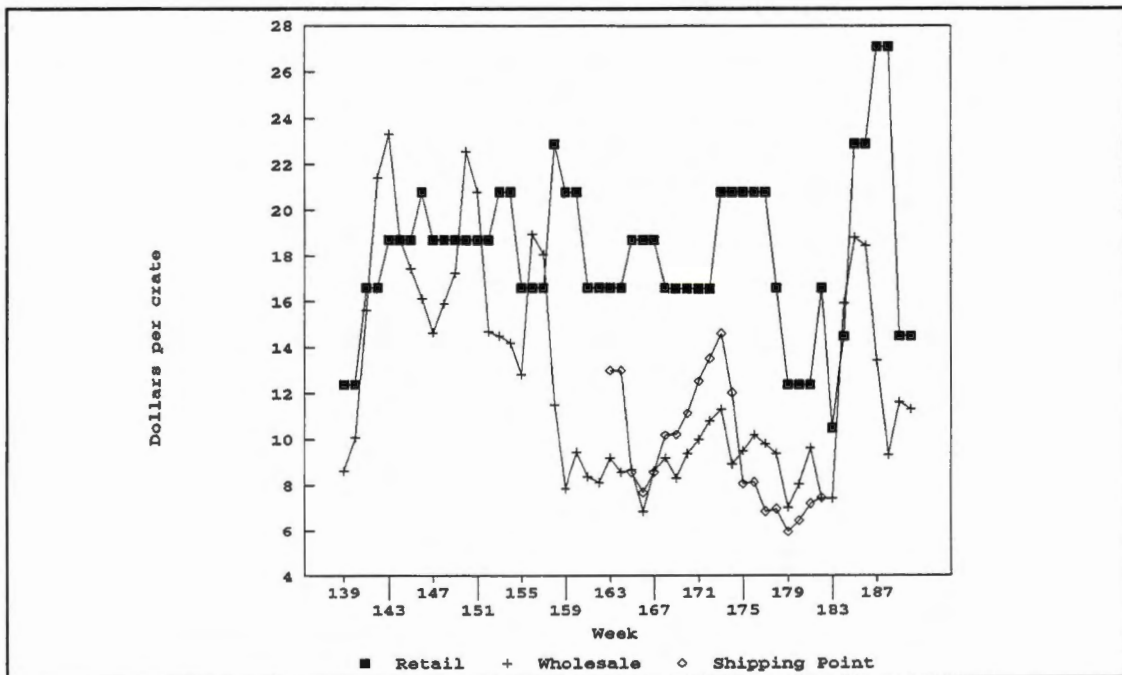


Figure 9. Yellow Squash: Retail, average wholesale, and shipping point prices, 1991

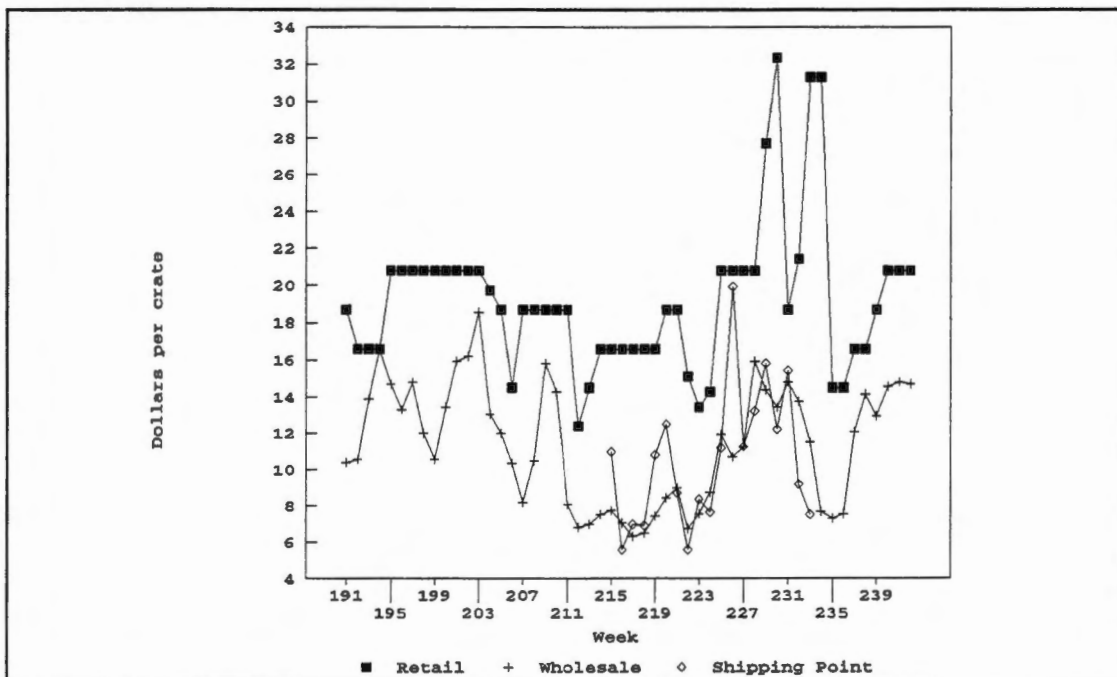


Figure 10. Yellow Squash: Retail, average wholesale, and shipping point prices, 1992

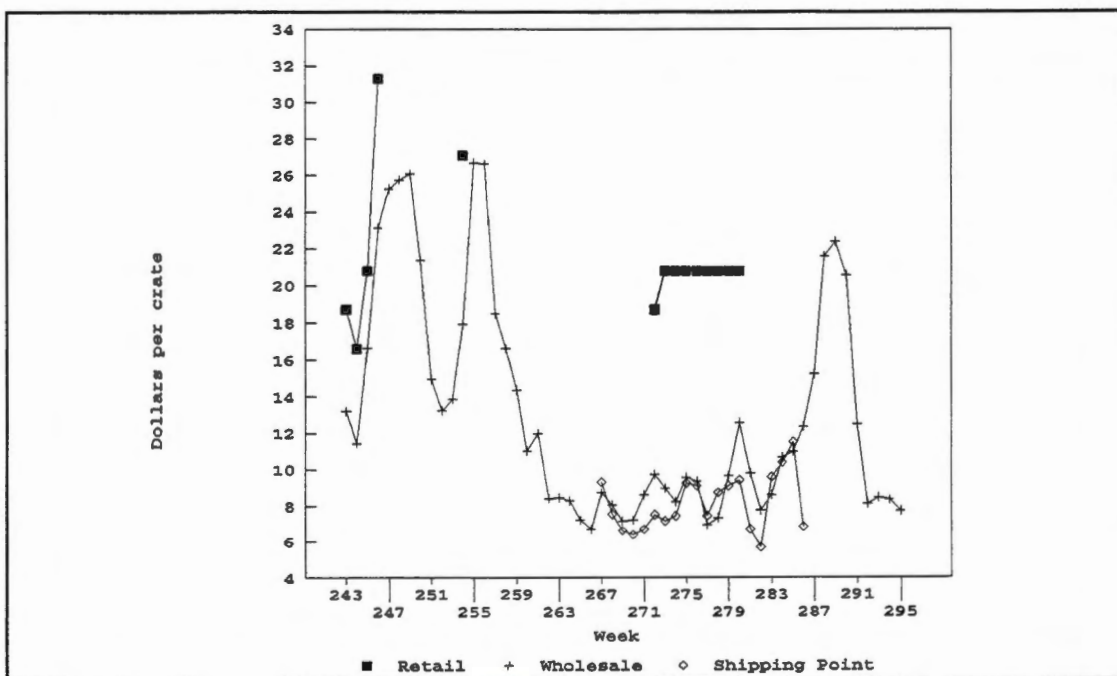


Figure 11. Yellow Squash: Retail, average wholesale, and shipping point prices, 1993

some price movements at the retail level may be directly opposite a price movement at the wholesale level.

Appendix Figures 1-108 provide a complete graphical presentation of the retail, wholesale, and shipping point prices for the nine vegetables included in this study.

Results of the Statistical Analysis

Modeling Alterations

The first estimation of the model and attempt at determining the appropriate lag lengths produced results that were inconsistent with the graphical analysis and with previous findings. Beginning with lag periods of seven weeks, the last lag period was eliminated if the p-value was greater than 0.20 and the equation was re-estimated. This process continued until the last lag period was statistically different from 0. Since the lag periods of seven weeks were different for zero at the 0.20 level, longer lags were used until the last lag period had a p-value larger than 0.20. This resulted in vegetables such as corn, cabbage, and cucumbers producing lag lengths of as many as 15 weeks for a price movement in one direction and lag lengths of as few as two to three weeks for a price movement in the other direction. A common characteristic of these vegetables was an initial retail price that was one of the highest or lowest prices in the time period studied. One of the limitations to the model used is that the results may be substantially distorted if the initial values are in error (Powers). In an attempt to correct this problem, the average retail price for each vegetable was used as its initial price. For some vegetables, such as beans, the findings changed little, but a marked difference was noticed for those vegetables whose initial price was the smallest or largest price in the data set. This may be an indication that the retailer is reacting more to an average price than to present upstream pricing movements. In other words, retailers seem to be most concerned about how consumers react to price movements,

hence the relatively infrequent adjustments in price when compared to the frequency of adjustments at the wholesale level.

The estimation of the models using these average retail prices as its initial price produced lag lengths that were consistent with the previous analysis, but the sums of the estimated beta coefficients for rising prices and for falling prices were of the inappropriate sign and over or understated, based on previous findings. A stepwise regression procedure, with a reduced target p-value of 0.15, was then employed to eliminate those lag periods that were having no effect on the dependent variable. After analyzing the data, it was determined that lags of five periods should be used in the stepwise procedure. Although the stepwise procedure is criticized for its high probability of making a Type I or Type II error, the estimated coefficients improved enough to warrant its use.

Although the results had improved with the stepwise regression, some of the sums of the deltas were still of the inappropriate sign and over or under stated. A closer examination of the deltas for rising and for falling transportation prices revealed inappropriate signs and a possible correlation with the price data. Since the direction of this study dealt with the response of downstream prices to upstream price movements, and the estimated transportation data could have substantial errors, the decision was made to exclude the transportation price changes from the model. Results from this modified model were more consistent with the previous analyses and with expectations. Although some of the signs of the remaining coefficients were still inappropriate, these coefficients were small and may be consistent in the presence of other pricing strategies employed by the retailer.

Retail-Wholesale Price Linkage

Retail prices adjusted more fully to a rise in the wholesale price than to a fall in the wholesale price (Table 2). For example, the sum of the deltas for rising wholesale prices for broccoli from Atlanta was 1.50

Table 2. The Response of Knoxville Retail Prices to Changes in the Wholesale Price for Four Cities and Nine Vegetables

	Atlanta			Baltimore		
	Increase	Decrease	R ²	Increase	Decrease	R ²
Beans	1.99 ^{ab}	1.78 ^b	0.13	1.04 ^b	0.89 ^b	0.09
Broccoli	1.50	0.87	0.17	1.12	0.59	0.16
Cabbage	3.85	0.75	0.35	1.74	-0.59	0.27
Corn	2.45 ^b	1.41 ^b	0.12	3.43 ^b	2.47 ^b	0.18
Cucumbers	1.17	0.36	0.08	0.75 ^b	0.23 ^b	0.05
Okra	-0.46	N/A	0.01	0.66 ^b	-0.58 ^b	0.04
Peppers	3.76	1.58	0.30	2.26	0.21	0.31
Squash	1.39 ^b	1.03 ^b	0.23	1.09 ^b	0.69 ^b	0.11
Tomatoes	N/A	0.33	0.00	1.57	-0.88	0.08

	Chicago			Cincinnati		
	Increase	Decrease	R ²	Increase	Decrease	R ²
Beans	2.14 ^b	1.70 ^b	0.31	1.64 ^b	1.58 ^b	0.11
Broccoli	1.32	0.65	0.23	1.36	0.45	0.19
Cabbage	2.08	-0.18	0.23	2.29	-0.16	0.27
Corn	2.92	1.83	0.18	3.18 ^b	2.09 ^b	0.18
Cucumbers	0.32	-0.28	0.03	0.75 ^b	0.18 ^b	0.05
Okra	1.13	N/A	0.04	-0.54	N/A	0.01
Peppers	1.77	-0.24	0.23	2.76	0.88	0.27
Squash	0.91 ^b	0.49 ^b	0.15	1.19 ^b	1.17 ^b	0.14
Tomatoes	0.73	-0.88	0.05	2.31	-0.83	0.08

^aA response of 1.99 is interpreted to mean that a 1 percent increase in the wholesale price results in a 1.99 percent increase in the price at the retail level.

^bDenotes that a pair of responses for a city are not significantly different at the .01 level.

while the sum of the deltas for falling wholesale prices was 0.87. These results are interpreted to mean a one percent rise in the wholesale price would lead to a 1.50 percent increase in the retail price, whereas, a decrease in the wholesale price of one percent would lead to a 0.87 percent decrease in the retail price. Overall, most of these differences varied from .20 to .70, but, in some instances, the retail price adjusted upward by as much as three times more than the adjustment downward, such as for cabbage from Atlanta, which had a coefficient for rising wholesale prices of 3.85 and a coefficient for falling wholesale prices of 0.75. Of the thirty-six sums of deltas for price decreases at the wholesale level, twenty-two were less than one. In other words, a price decrease at the wholesale level generally resulted in a decrease in retail prices, but of a smaller magnitude. In nine of those twenty-two cases, the sum of the deltas was less than zero. These values were unexpected, but may indicate the retailer is basing downward price adjustments for those vegetables on other things such as advertising or competitors' prices. For twenty-six of the thirty-six sums of deltas for wholesale price increases, the sum of the deltas was greater than one. This indicated that wholesale price increases are being fully passed through to the retail level and in some cases these increases are being passed through two and three times.

Of the nine vegetables, beans, corn, cucumbers, and squash produced sums of deltas for increasing and decreasing wholesale prices that were not significantly different at the 0.01 level. However, at the 0.05 level, beans were the only vegetable to consistently produce indifferent price adjustments. These results indicate that the retailer is not transmitting wholesale price increases to the retail level differently than wholesale price decreases, although the sums of the deltas may show mild differences, and they may be an indication of the availability of ready substitutes for fresh snap beans. At the 0.01 level, the sums of deltas for both beans and squash were not different for each of the four cities, while, for corn, the sums of deltas were different for Chicago

and, for cucumbers, they were different for Chicago and Atlanta. These are indications the customers can expect the same relative price decrease in the presence of falling wholesale prices as a relative price increase in the presence of rising wholesale prices for both beans and squash and probably for corn. The pricing strategy for cucumbers, however, is mixed, and seems to hinge upon the city in which retail produce was bought at the wholesale level.

The sums of deltas for rising and falling wholesale prices for broccoli, cabbage, peppers, and tomatoes were all significantly different from each other at the .01 level for all four cities. Since, for all four vegetables, the sum of the deltas for rising wholesale prices is greater than the sum of the deltas for falling wholesale prices, the inference is the retailer is passing wholesale price increases through more fully than wholesale price decreases. In other words, customers can expect retail prices to increase more in the presence of rising wholesale prices than they can expect them to decrease in the presence of falling wholesale prices. For cabbage and peppers, the differences were quite significant with large sums of deltas for the rising wholesale prices. These results do appear to be consistent with the graphical analysis of the data and imply a greater willingness to increase the retail prices of cabbage and peppers in the presence of rising wholesale prices than with the other vegetables.

The pricing strategy for okra was not able to be determined, since estimations produced significant deltas only for rising wholesale prices for three of the four cities. These inconclusive results may be due to a wide range of variability in the wholesale data, and a lack of variability in the retail price data, which implies a retail pricing strategy based on factors other than price.

Retail price adjustment lag periods also exhibited a pattern of favoring retail price increases based on wholesale price increases (Table 3). The retailer rarely used the simultaneous week to pass wholesale

Table 3. Lag Periods Used at the Retail Level for Rising and Falling Wholesale Prices for Four Cities and Nine Vegetables

	Atlanta		Baltimore	
	Increase	Decrease	Increase	Decrease
Beans	1 2 3 4	1 2 3 5	1 2	3 4 5
Broccoli	1 2 3	3 4 5	1 2 3 5	0 3 4 5
Cabbage	1 2 3 4 5	3	1 2 3 4	0
Corn	2 4	4 5	1 2 3 4	1 2 5
Cucumbers	1 2 3	5	1 2	5
Okra	0	N/A	2	2
Peppers	1 2 3	1 2 4	0 1 2 3	0 2 3 4
Squash	2 3 4	1 2 5	2 3 4	1 5
Tomatoes	N/A	4	4 5	5

	Chicago		Cincinnati	
	Increase	Decrease	Increase	Decrease
Beans	1 2 4 5	2 3 4 5	2 3 4 5	1 2 3 5
Broccoli	1 2 3	0 2 3 4	1 2 3	0 3 4
Cabbage	0 2 3 4	0 1 5	2 3 4	0 1
Corn	1 2 3 4	2 4 5	1 2 3 4	1 3 5
Cucumbers	2	0	1 2	2
Okra	0 1 2	N/A	0	N/A
Peppers	1 2	0 3	1 2 3	1 4
Squash	1 2	5	1 2 3	2 4 5
Tomatoes	4	0	3 5	5

price increases through, but these price increases were almost always passed through in lag periods 1, 2, 3 and 4. Wholesale price decreases, on the other hand, were transmitted in lag periods 2, 3, 4, and 5.

The number of lag periods, on the other hand, favored wholesale price decreases. In fourteen of the thirty-six lag periods, the significant lag periods for falling wholesale prices were fewer than the significant lag periods for rising wholesale prices, in only three of the thirty-six lag periods were the number of significant lag periods for rising wholesale prices fewer than those for falling wholesale prices. This implies that the transmission of wholesale price increases to the retail level are spread over more weeks than is the transmission of wholesale price decreases.

Tomatoes were the one major exception to the general pattern of faster rising than falling prices. For Baltimore, Chicago, and Cincinnati wholesale price increases, the average lag period was 4.2 weeks. The retailer consistently responded to falling wholesale prices, although, by raising retail prices in week 5 for Baltimore and Cincinnati and week 0 for Chicago. While the longer lag periods do appear consistent with the graphical analysis, a lag period of 0 for the falling price was unexpected. The longer lag periods may be explained by the popularity and volume movement of tomatoes and the moderate to large adjustments to rising wholesale prices combined with the counter adjustments to falling wholesale prices. Cabbage, in contrast to tomatoes, had overall counter adjustments to falling wholesale prices but experienced a large counter adjustment in the simultaneous week and small adjustments downward in the weeks to follow instead of a single counter adjustment followed by no downward trend in the retail price.

Cucumbers displayed a deviation from the general pattern of consistent slow adjustments to falling prices. Falling price adjustments for Atlanta and Baltimore occur in week 5, while the adjustments for Chicago and Cincinnati occur in week 0 and week 2, respectively. These

results are somewhat consistent with the graphical analysis of the data which seems to display the full downward trends for Atlanta and Baltimore occurring slightly before those for Chicago and Cincinnati. This, however, is not consistent with three to five week lag differences.

Wholesale-Shipping Point Price Linkage

The wholesale-shipping point price linkages are more difficult to determine due to the small number of shipping point observations. In addition, since shipping point sales occurred on Friday of each week, wholesale sales on Monday, and retail adjustments on Saturday, the simultaneous week shipping point sales were not included in the model. As a result, beans, broccoli, corn, and okra do not have enough shipping point observations to estimate a model, while cabbage, cucumbers and peppers each contain between ten and forty observations. With the available data, pricing relationships were calculated for cucumbers, peppers, and tomatoes (Table 4). In stark contrast to the retail-wholesale linkage, the wholesalers were willing to transmit shipping point price decreases for cucumbers and peppers much more fully than price increases. The sum of the deltas for rising shipping point prices were negative, implying the wholesale prices declined in the presence of falling shipping point prices. For example, Baltimore peppers had a sum of the deltas for falling shipping point prices of 5.53 and a sum of deltas for shipping point price increases of 2.14. These are interpreted to mean a one percent fall in the shipping point price leads to a 5.53 percent decline in the wholesale price while a one percent increase in the shipping point price results in a 2.14 percent increase in wholesale prices. These results as well as the unusual negative sum of the deltas for rising shipping point prices for cucumbers may be attributed to a generally declining shipping point data set (see Appendix figures 49-60 and 73-84).

Tomatoes, on the other hand, followed the general pattern of more fully increasing prices in relation to an upstream price increase as

Table 4. The Response of Atlanta, Baltimore, Chicago, and Cincinnati Wholesale Prices to East Tennessee Shipping Point Price Changes

	Atlanta			Baltimore		
	Increase	Decrease	R ²	Increase	Decrease	R ²
Beans	N/A	N/A	N/A	N/A	N/A	N/A
Broccoli	N/A	N/A	N/A	N/A	N/A	N/A
Cabbage	1.85 ^a	N/A	0.02	N/A	0.33	0.01
Corn	N/A	N/A	N/A	N/A	N/A	N/A
Cucumbers	N/A	2.70	0.39	-4.30	2.63	0.61
Okra	N/A	N/A	N/A	N/A	N/A	N/A
Peppers	0.90	1.56	0.56	2.14	5.53	0.91
Squash	4.73	N/A	0.11	0.02	N/A	0.01
Tomatoes	5.49	2.56	0.59	4.22	1.59	0.48

	Chicago			Cincinnati		
	Increase	Decrease	R ²	Increase	Decrease	R ²
Beans	N/A	N/A	N/A	N/A	N/A	N/A
Broccoli	N/A	N/A	N/A	N/A	N/A	N/A
Cabbage	N/A	3.10	0.38	N/A	0.50	0.07
Corn	N/A	N/A	N/A	N/A	N/A	N/A
Cucumbers	-5.02	4.36	0.77	-2.77	5.02	0.88
Okra	N/A	N/A	N/A	N/A	N/A	N/A
Peppers	1.97	5.41	0.89	1.97	6.97	0.85
Squash	N/A	N/A	N/A	1.09	N/A	0.02
Tomatoes	5.72	1.82	0.60	5.32	N/A	0.04

^aA response of 1.85 is interpreted to mean that a one percent increase in the shipping point price results in a 1.95 percent increase in the price at the wholesale level.

compared to cutting prices in the presence of declining shipping point prices. The abnormally large sums of the deltas for rising shipping point prices, when viewed with counter price adjustments at the retail level to wholesale price decreases, may imply a certain degree of demand inelasticity for tomatoes. On the other hand, these large sums of the deltas along with the large sums of the deltas for downward adjustments for cucumbers and peppers may be an indication that wholesalers are more concerned with upstream prices than retailers. This would seem logical since wholesalers must make a profit on a narrow range of products in order to continue to operate as opposed to a supermarket's range of foods.

Unfortunately, squash, like cabbage, failed to show a pricing relationship in which both rising and falling shipping point prices had an effect on the wholesale price. These results for squash were unexpected since it had the most shipping point observations, but they may be partially explained by the variability of the wholesale prices over certain ranges and in particular the deviations of the Atlanta wholesale prices from the general pattern exhibited by wholesale prices at the other three cities (Appendix Figures 85-96). The lack of a pricing relationship for cabbage, however, was expected due to the small number of observations.

The lag periods of cucumbers, peppers, and tomatoes exhibited consistently moderate to slow wholesale price adjustments for both rising and falling shipping point prices (Table 5). This is in contrast to the retail-wholesale price linkages in which adjustments to rising wholesale prices tended to be passed through more quickly. These longer lag periods may indicate that wholesalers are trying to counteract inefficient pricing behavior with longer pricing adjustment periods.

Retail-Shipping Point Price Linkage

Estimates of the retail-shipping point price linkages are hampered by the lack of data at the shipping point level and a lack of volatility in the retail prices. Shipping point prices did not normally experience

Table 5. Lag Periods Used at the Wholesale Level for Rising and Falling Shipping Point Prices for East Tennessee and Nine Vegetables

	Atlanta		Baltimore	
	Increase	Decrease	Increase	Decrease
Beans	N/A	N/A	N/A	N/A
Broccoli	N/A	N/A	N/A	N/A
Cabbage	1	N/A	N/A	3
Corn	N/A	N/A	N/A	N/A
Cucumbers	N/A	1 3	4	4
Okra	N/A	N/A	N/A	N/A
Peppers	4 5	2 4	3 4 5	1 2 3 5
Squash	1 2 3 4 5	N/A	1 2	N/A
Tomatoes	1 3 4	2 4 5	1 3 4	2 5

	Chicago		Cincinnati	
	Increase	Decrease	Increase	Decrease
Beans	N/A	N/A	N/A	N/A
Broccoli	N/A	N/A	N/A	N/A
Cabbage	N/A	1 2 3	N/A	1 3
Corn	N/A	N/A	N/A	N/A
Cucumbers	4 5	2 4	5	1 5
Okra	N/A	N/A	N/A	N/A
Peppers	1 3 4 5	1 2 3 5	4 5	1 2 3 5
Squash	N/A	N/A	2 3 4	N/A
Tomatoes	2 3 4 5	1 5	1 2 3 4	N/A

large week to week price increases or decreases, therefore, when a threshold pricing strategy is employed, retail prices do not adjust to these small changes. Of the nine vegetables, only cabbage and cucumbers produced sums of deltas for both rising and falling shipping point prices (Table 6). The retail price of cabbage rose 1.11 percent in response to a one percent price increase at the shipping point level, but retail prices also rose .51 percent in relation to a one percent price decrease. These estimations, however are not significantly different from each other indicating the retailer is adjusting his prices evenly in comparison to

Table 6. Sum of Deltas and Lag Periods for the Retail-Shipping Point Price Linkage

	Sums of Deltas		R ²	Lag Periods	
	Increase	Decrease		Increase	Decrease
Beans	N/A	N/A	N/A	N/A	N/A
Broccoli	N/A	N/A	N/A	N/A	N/A
Cabbage	1.11 ^{ab}	-0.51 ^b	0.03	4	3
Corn	N/A	N/A	N/A	N/A	N/A
Cucumbers	-3.35 ^b	1.09 ^b	0.18	5	5
Okra	N/A	N/A	N/A	N/A	N/A
Peppers	N/A	2.10	0.21	N/A	5
Squash	0.95	N/A	0.03	4	N/A
Tomatoes	N/A	8.25	0.25	N/A	4 5

^aA response of 1.11 is interpreted to mean that a one percent increase in the shipping point price results in a 1.11 percent increase in the price at the retail level.

^bDenotes that a pair of responses are not significantly different at the .01 level.

shipping point price changes. The same scenario of indifferent coefficients for rising and falling shipping point prices holds for cucumbers, although the retailer adjusts prices downward in relation to both increasing and decreasing shipping point prices. In addition, the same slow adjustment period as seen in the wholesale-shipping point price linkage is present.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, LIMITATIONS, AND RECOMMENDATIONS

Summary of the Study

The primary purpose of this study was to assemble and analyze retail, wholesale, and shipping point price data relevant to east Tennessee producers and consumers. Specifically, this analysis focused on the vertical price linkages in the vegetable industry. Methodology and procedures were oriented toward answering concerns of vegetable producers and consumers who have considered retail vegetable prices to be trending upward while the shipping point prices remained stable. Seven specific objectives of this study were to:

- 1) determine the downstream price increases in relation to upstream price increases,
- 2) determine the downstream price decreases in relation to upstream price decreases,
- 3) determine the degree of symmetry between downstream responses to rising and falling upstream prices,
- 4) determine the lag periods in which upstream price increases are transmitted,
- 5) determine the lag periods in which upstream price decreases are transmitted,
- 6) determine the degree of symmetry between the lag periods used to transmit rising and falling upstream prices, and
- 7) separately analyze the pricing relationships of the nine vegetables selected for this study.

A lagged independent variable model developed by Powers was used to achieve the objectives of this study by constructing an empirical description of the vertical pricing relationships for nine vegetables. The estimated coefficients of the model provide insight to the amount of price transmission occurring while the significant lags indicate the adjustment period for price transmissions.

Objectives one and two examined the magnitude of downstream price adjustments in relation to upstream price adjustments. The sum of the deltas for an upstream price increase indicate how fully that increase was passed through to the consumer. Likewise, the sum of the deltas for an upstream price decrease indicate how fully it was transmitted at the retail level. Values for the sums of the deltas which were greater than one indicated the upstream adjustments were being passed through more than fully, while values less than one indicate the upstream adjustments were less than fully passed through.

Objective three attempted to provide information about the general pricing strategies of both retailers and wholesalers. The sums of the deltas for upstream price increases were compared to the sums of the deltas for upstream price decreases to determine if the two were significantly different. If so, asymmetrical price adjustments were occurring. Therefore, knowledge of the degree of symmetry is essential in understanding the general pricing behavior of downstream industry participants.

The fourth and fifth objectives were concerned with determining the time periods in which the downstream pricing adjustments occurred. Short, quick lag periods indicate a willingness of the downstream market participant to adjust prices in relation to upstream adjustments, while long or slow adjustment periods indicate a reluctance of the market participant to transmit upstream adjustments.

The sixth objective attempted to provide further information about the pricing strategies of retailers and wholesalers by comparing the lag periods in which downstream price adjustments occur. Unequal lag periods or mistimed lag periods implied a preference of downstream participants to adjust prices in response to either an upstream price increase or decrease. Therefore, a knowledge of the lag periods were also important in understanding the pricing relationships present.

The final objective was directed at applying each of the previous six objectives to each vegetable and determining the separate pricing relationships present for those vegetables. Overall, the pricing relationships for vegetables are similar, but differences indicate the availability of substitutes for a particular vegetable, differences in elasticities among the vegetables, and differing pricing strategies employed by retailers and wholesalers among the different vegetables.

Each of the objectives of this study addressed questions related to the understanding of retail and wholesale pricing strategies. The first two objectives attempted to determine how upstream price adjustments were transmitted downstream, and the third objective then tried to determine if those adjustments were equal. The fourth and fifth objectives dealt with determining when upstream price adjustments were transmitted downstream, while the sixth objective compared these adjustment periods to determine if differences existed. Finally, the seventh objective combined the first six to analyze the pricing relationship present for each individual vegetable.

Conclusions and Implications of the Analysis of the Retail-Wholesale Price Linkage

Differing pricing strategies for the nine vegetables in this study were revealed in the analysis of retail-wholesale price linkage. The magnitudes of upward and downward retail price adjustments for snap beans are statistically different, and the number of lag periods required for transmission of the price changes is relatively the same. However, upward price adjustments occur more quickly than do downward adjustments. Both corn and squash experience the same indifferent levels of retail price adjustments and slower adjustments to decreasing wholesale prices, but upward adjustments are transmitted over more weeks than are downward adjustments. In contrast, wholesale price increases for broccoli, cabbage, and green peppers are transmitted more fully than are wholesale price decreases. In addition, these upward adjustments are passed through over longer periods of time. The upward retail price adjustments for

broccoli and peppers do begin quicker than downward adjustments, but downward retail price adjustments occur more quickly for cabbage. Tomatoes also respond more fully to wholesale price increases, but price adjustments are passed through in the same number of periods. These adjustments, however, are slow for both wholesale increases and decreases. Cucumbers and okra, on the other hand, do not display distinctive pricing strategies. Depending on the city, cucumbers experience both different and comparable levels of retail price adjustments and both slow and quick responses to decreasing wholesale prices, however, the number of lag periods required for upward adjustments is consistently longer than for downward adjustments. Retail price adjustments for okra are hardly even linked to wholesale price changes with R-square figures ranging from 0.0087 to 0.0436. Knowledge of these retail pricing strategies is essential to understanding the reaction of a retailer to upstream price changes and the development of consumer expectations in response to upstream changes.

While the reaction of the retailer to upstream price changes has been of considerable importance to producers and consumers alike, it is not the only determinant of retail price adjustments. With the exception of okra, The R-squares generally ranged from 0.10 to 0.30, indicating that retailers are considering other factors in adjusting prices. As indicated before, transportation cost do affect retail vegetable prices, but were excluded in order to determine the true effect of upstream price changes. In addition, retailers may run advertisements in which vegetables are "loss leaders." In such cases, the current weekly price will not reflect previous changes in the upstream price. Retailers may also include changes in labor, energy, advertising, and other variable costs in their pricing decisions. Although the results of this study seem to indicate that retailers are exhibiting monopolistic pricing behavior, one should remember that the retailer is also adjusting prices based on additional factors not included in this study. Therefore, all factors of adjustment

must be considered in assessing the level of pricing efficiency within the commercial fresh vegetable marketing channel.

Conclusions and Implications of the Analysis
of the Wholesale-Shipping Point Price Linkage

Due to a lack of shipping point data, establishment of the wholesale-shipping point price linkage was difficult. Either no shipping point observations or too few observations resulted in no results for snap beans, broccoli, sweet corn, and okra. A lack of observations also led to inconclusive results for cabbage. Although sufficient data existed to obtain results for squash, these results were also inconclusive. Based on the results obtained, both cucumbers and peppers produced pricing strategies which were inconsistent with previous analyses. The wholesale price adjusted to shipping point price decreases more fully than price increases, with the upward and downward wholesale adjustments both being slow. Shipping point price changes for cucumbers were transmitted in the relative same number of periods, while the transmission of shipping point price decreases occurred quicker. The wholesale shipping point price linkage for tomatoes, on the other hand, exhibited a pattern closer to that of the retail-wholesale price linkage for tomatoes. Shipping point price increases, however, were passed through even more fully than for the retail-wholesale linkage, and the number of periods for shipping point price decreases to be transmitted were less than for price increases.

The inconsistencies of cucumbers and peppers may be explained by a small number of observations and a general downward trend of shipping point prices over the available range. While tomatoes display the expected general wholesale pricing strategy, the sums of the deltas were much larger than expected. Although the same patterns for wholesale-shipping point and retail-wholesale price linkages may be an indication of the degree of inelasticity of demand for tomatoes, the problems it experiences and those of cucumbers and peppers may be corrected with a more complete set of shipping point data.

The results provide some information on the wholesale-shipping point price linkage. A closer relationship between wholesale price adjustments and upstream price changes was discovered. While the data provided fewer observations than desired, R-squares for many of the regressions fell in the range of 0.60 to 0.90. This is logical, since wholesalers are not engaged in the costly marketing activities of retailers. In addition, the estimated pricing relationships indicated inefficient pricing strategies of wholesalers. This appears logical because vegetable sales are the wholesaler's livelihood and wholesale markets are considered to possess more market information than the other market participants.

Conclusions and Implications of the Analysis of the Retail-Shipping Point Price Linkage

The analysis of the retail-shipping point price linkage provided little insight to the actual relationship between price movements at the shipping point level and price adjustments at the retail level. Only cabbage and cucumbers produced results for which the rising as well as falling shipping point prices provided significant adjustments at the retail level. These, however, were not statistically different with the range between the two pairs of estimated coefficients being 1.62 and 4.44. These problems can be attributed to a lack of data at the shipping point level and a lack of variability in the retail prices. The inability of this study to define a relationship between the retail and shipping point level is unfortunate, since that relationship provides valuable and needed information on the correlation of producer and consumer prices for vegetables.

Limitations and Recommendations

As Powers had stated in his article, substantial errors may exist if the initial prices used are in substantial error. As this study progressed, it became apparent that, if the initial values were among the highest or lowest prices in the data set, substantial problems existed. Once retail data-set averages for each vegetable were used as the initial values, findings for those vegetables which had initial values that were

suspected to be in error changed, while findings for the other vegetables were altered little.

Examination of the retail data revealed a possible pricing strategy of increasing or decreasing the retail price once the wholesale price reached a threshold level. Such a pricing strategy may conceal the actual correlation between retail price adjustments and upstream price changes, since wholesale prices are allowed to exhibit a small degree of volatility over a given price range without the retail price adjusting. Such a pricing strategy would not be inconsistent with logic, since weekly adjustments of prices may be more costly and bothersome than allowing per unit profits to vary from week to week when the wholesale price is moving with a certain price range.

Conducting a similar study with a more complete shipping point data set would allow for a more complete and accurate examination of the wholesale-shipping point price linkage and the retail-shipping point price linkage. In addition, using a more accurate representation of transportation costs could lead to more concise results.

Finally, autocorrelation was present in the data used for this study. While this was expected with the use of lagged period independent variables, measures were taken to correct for the autocorrelation problem. First, outlier prices were eliminated from the data set. This resulted in significantly different deltas and lag periods, while improving autocorrelation measures little. Next, dummy variables were used to identify the positive and negative outliers and their effect on the model estimates. This resulted in the dummy variables being significant, but drastically changed deltas and lag periods. Since both procedures significantly altered the results of the study without fully correcting the autocorrelation problem, neither procedure was used in generating final estimates. A transformation of the data was then considered as a possible solution to this problem, but such a procedure carries potential statistical risks from making inferences about transformed data rather

than the actual data. Although leaving the data unchanged also carries potential statistical risks, this course of action was chosen based on the forecasting nature of this study.

In summary, the analysis of the retail-wholesale price linkage provides the only viable results, which indicates a willingness of the retailer to increase prices in relation to wholesale price increases. Although these results seem to indicate imperfect pricing efficiency, low R-square values indicate the presence of other factors involved in the decision-making process.

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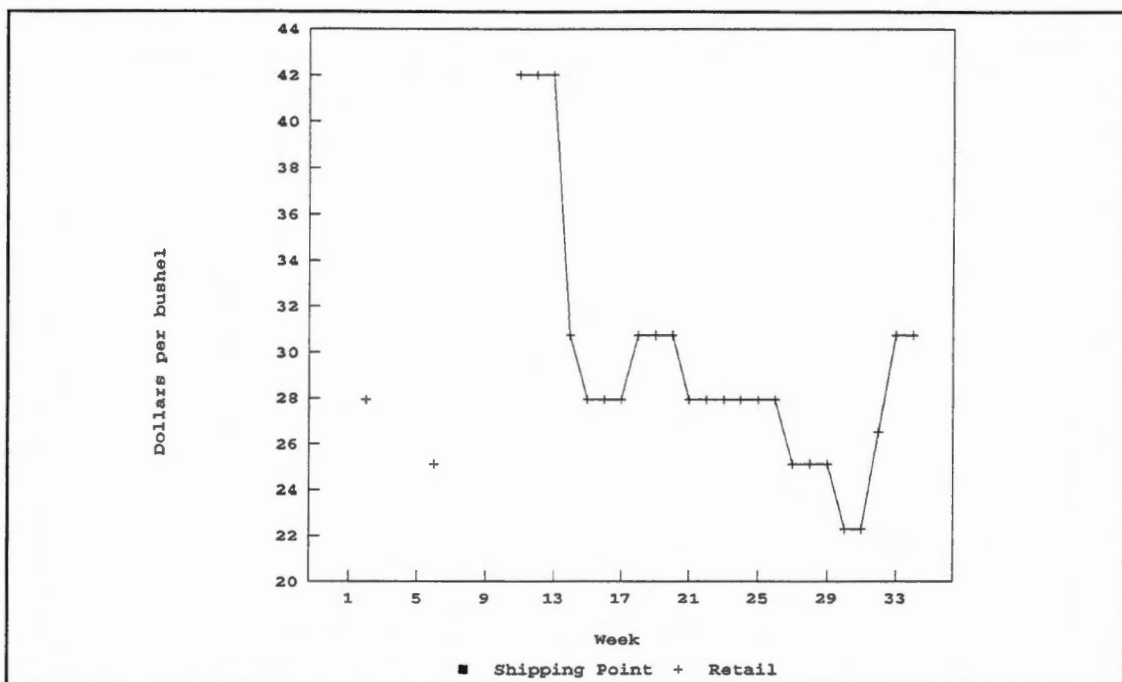
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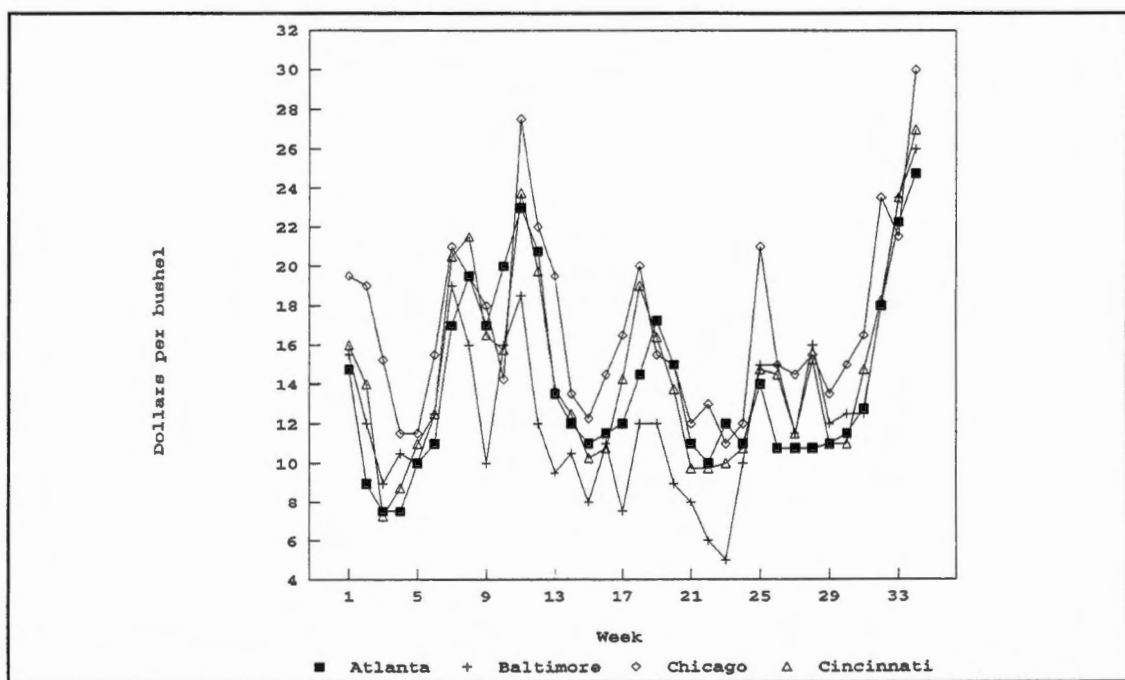
APPENDIX

EXPLANATION OF APPENDIX FIGURES

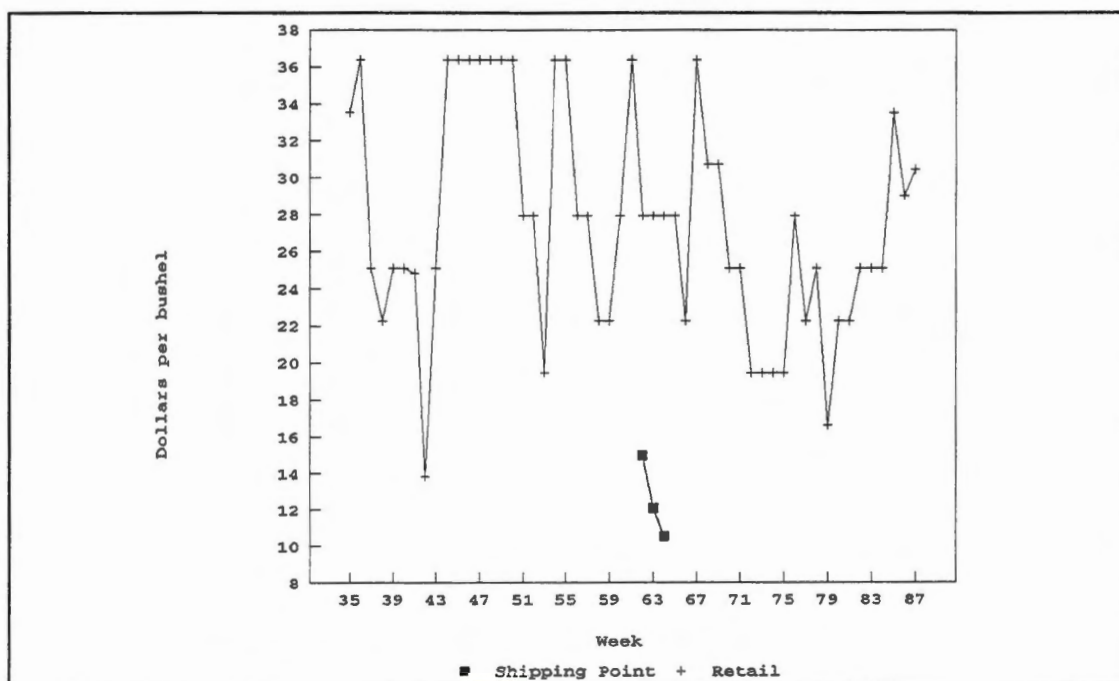
Figures 6-11 and the figures contained in this Appendix possess consecutively numbered weeks. Week 1 is the week ending May 14, 1988, and, therefore, the 1988 figures contain only 34 weeks. Each of the 1989-1993 figures contain 52 weeks numbered in succession from 34 to 295.



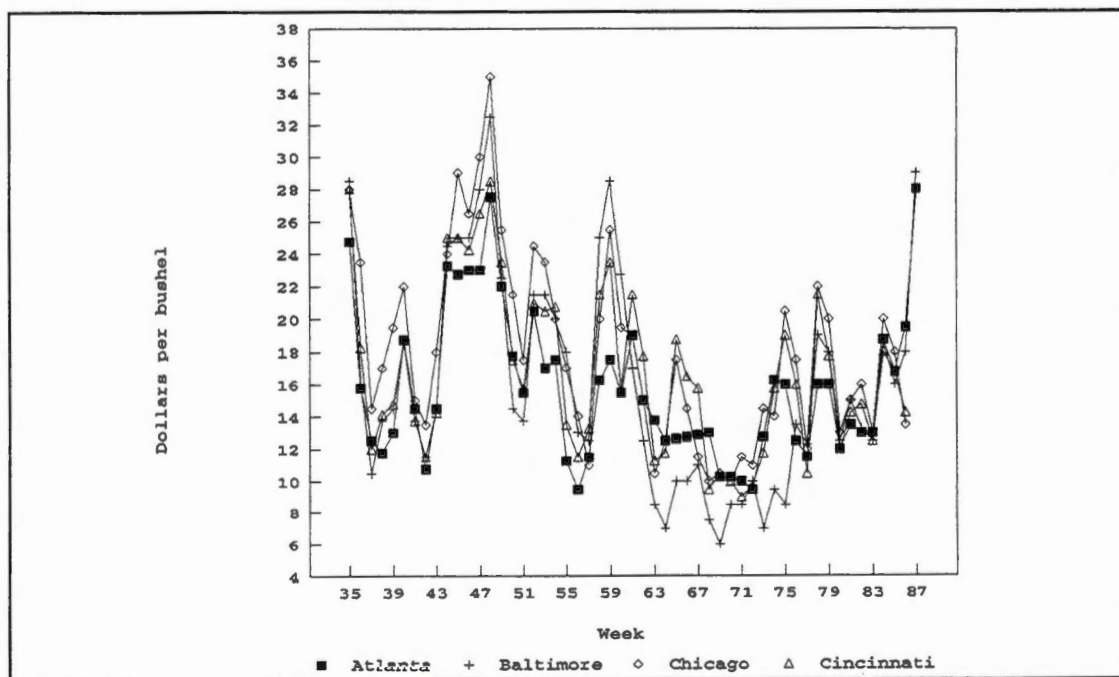
Appendix Figure 1. Snap Beans: Retail and shipping point prices, 1988



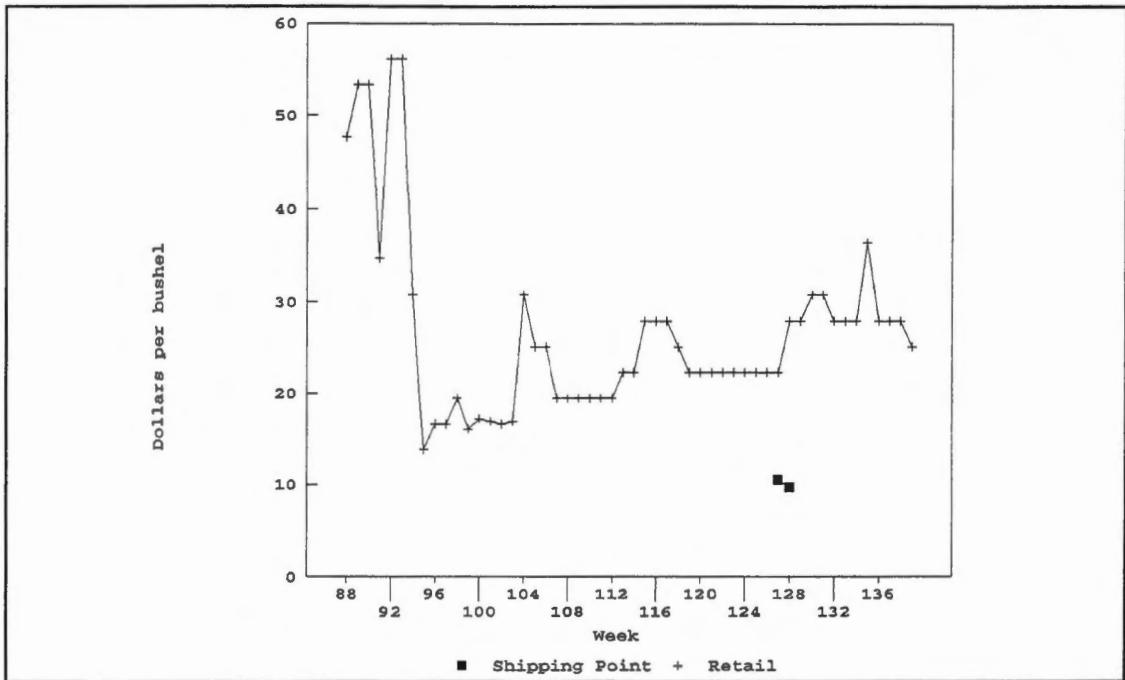
Appendix Figure 2. Snap Beans: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1988



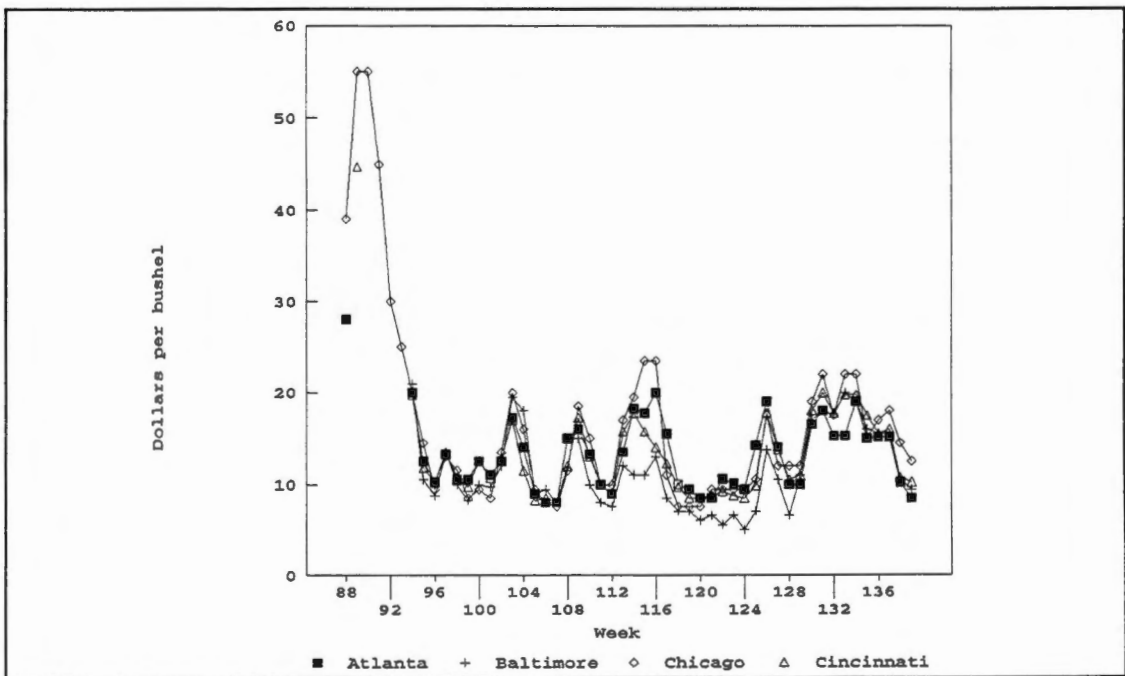
Appendix Figure 3. Snap Beans: Retail and shipping point prices, 1989



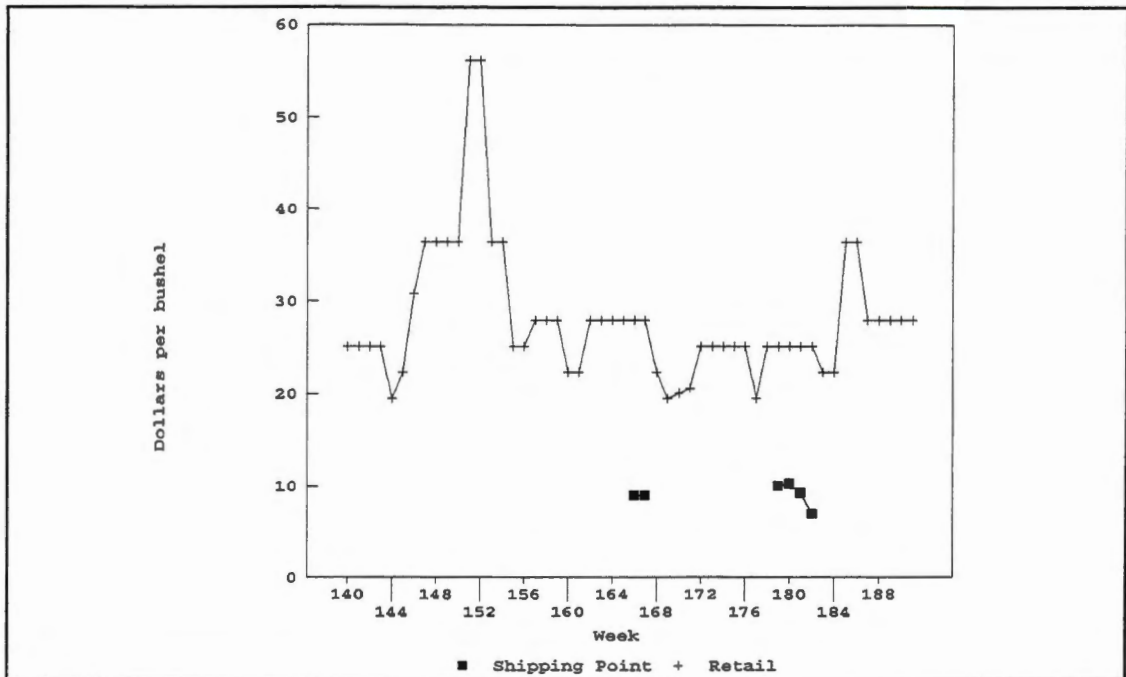
Appendix Figure 4. Snap Beans: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1989



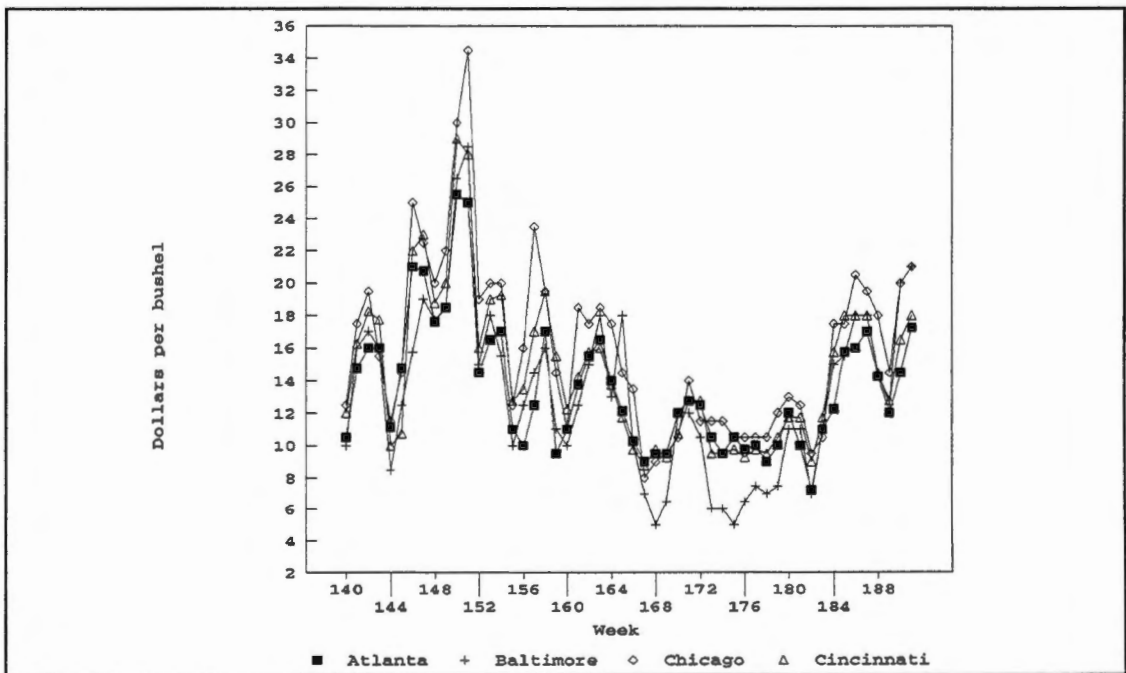
Appendix Figure 5. Snap Beans: Retail and shipping point prices, 1990



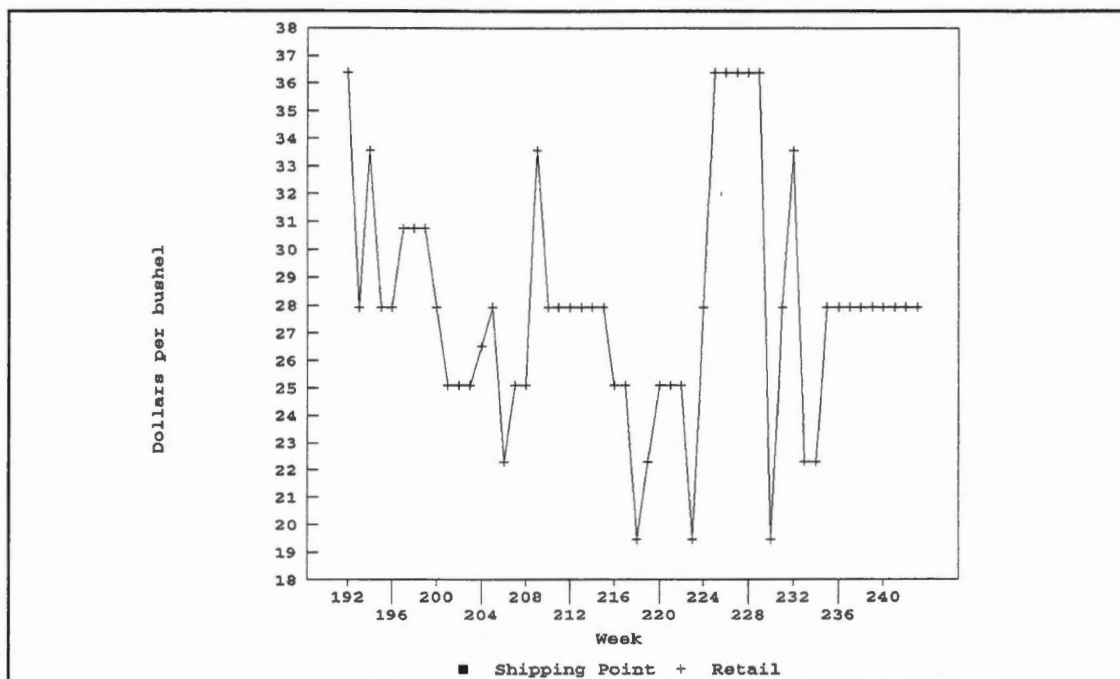
Appendix Figure 6. Snap Beans: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1990



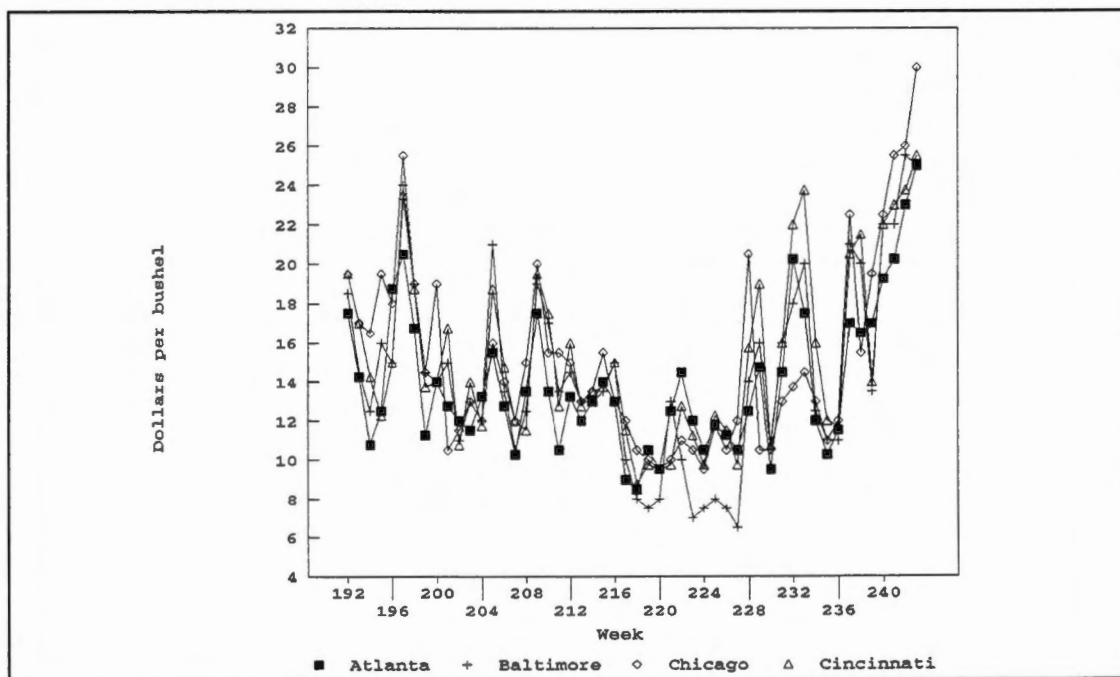
Appendix Figure 7. Snap Beans: Retail and shipping point prices, 1991



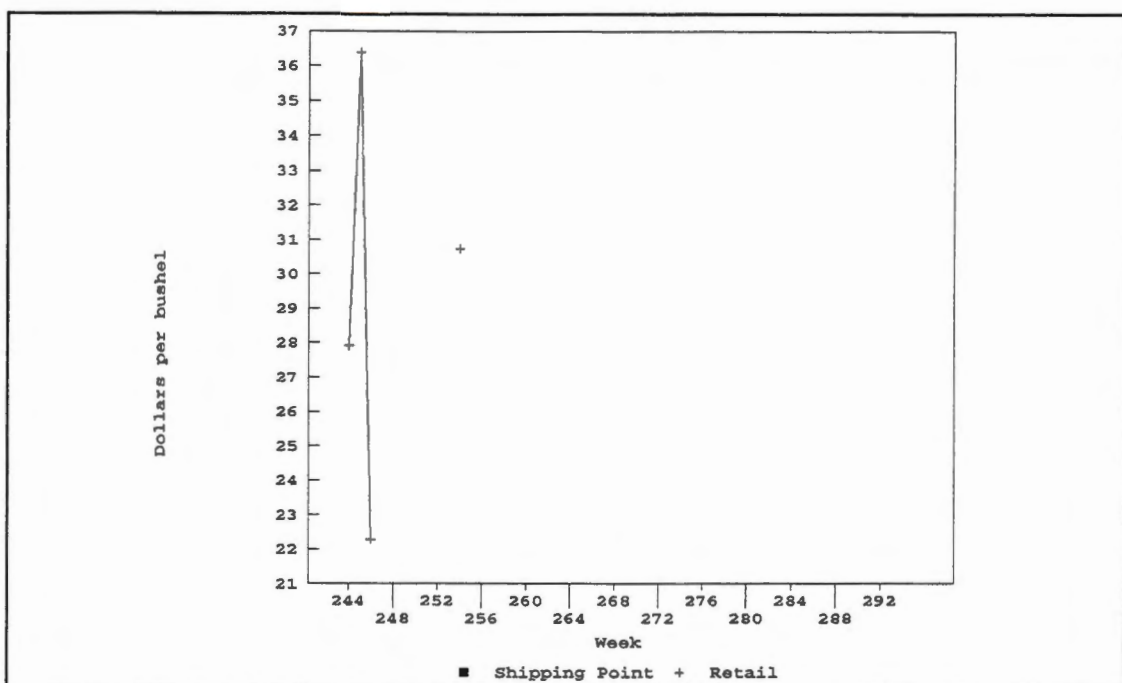
Appendix Figure 8. Snap Beans: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1991



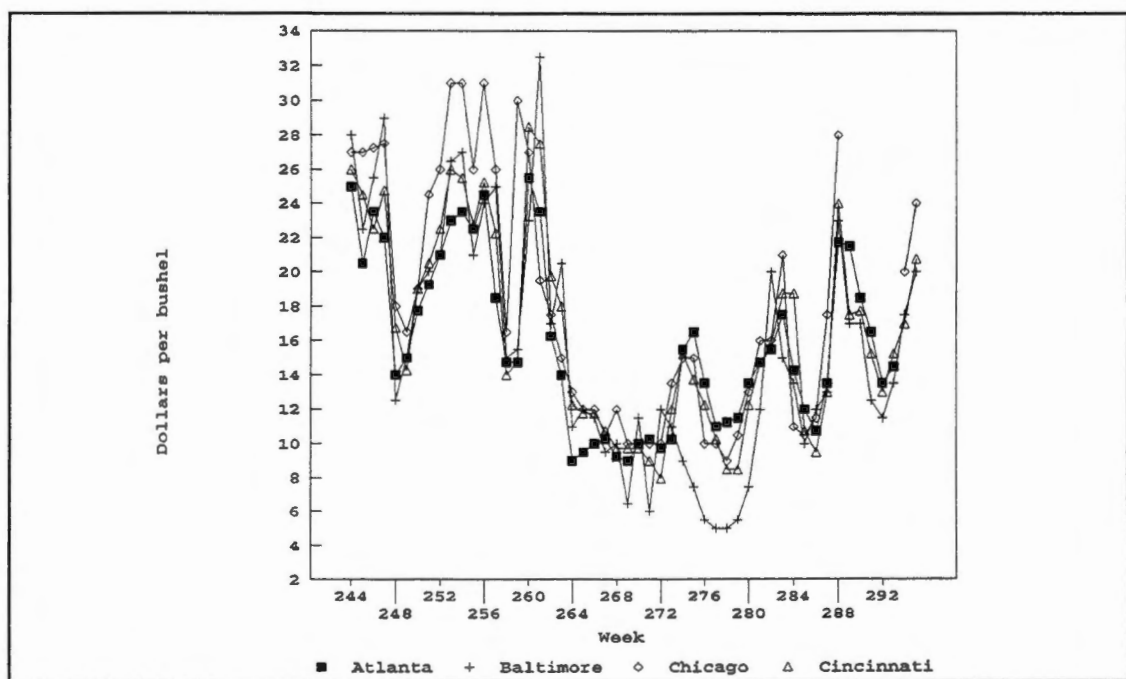
Appendix Figure 9. Snap Beans: Retail and shipping point prices, 1992



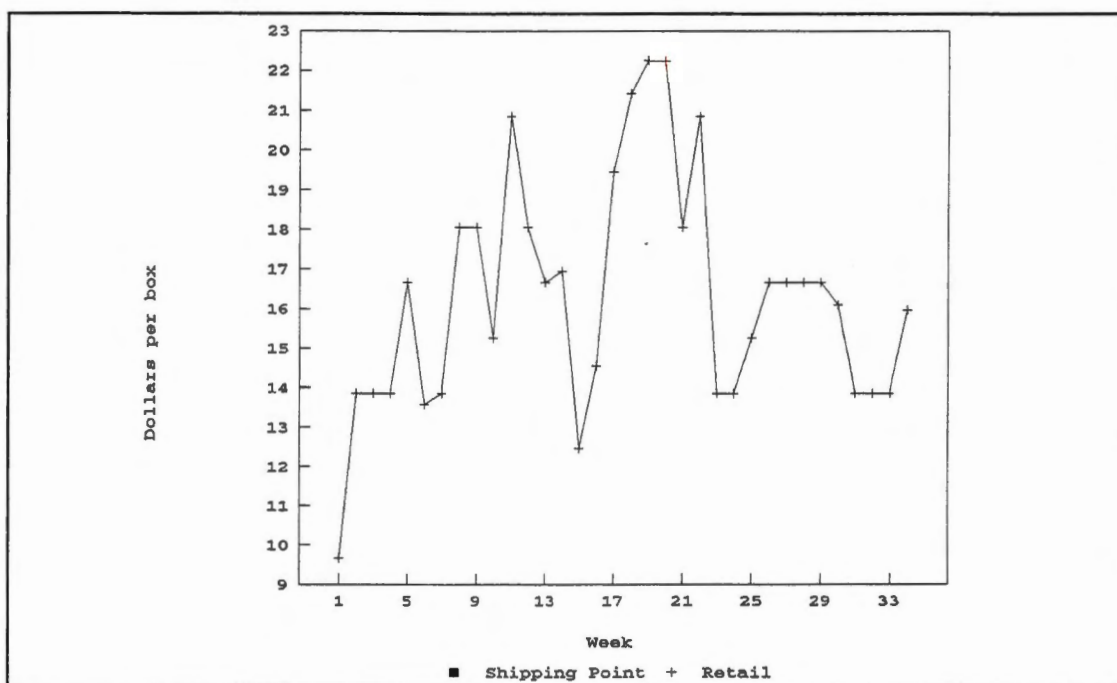
Appendix Figure 10. Snap Beans: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1992



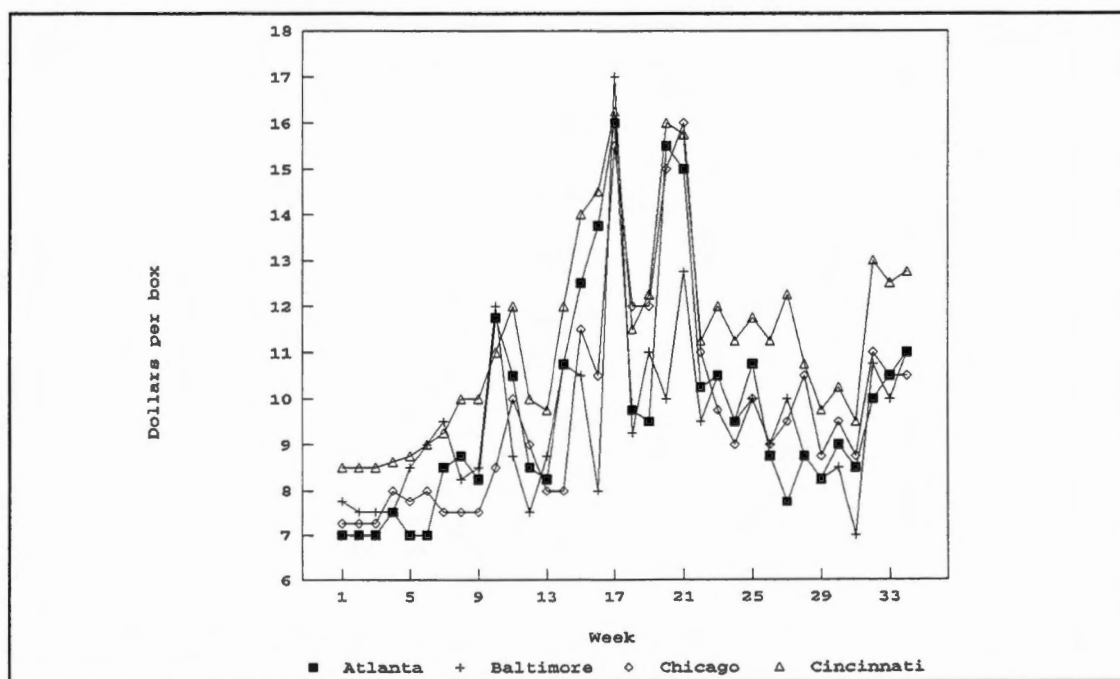
Appendix Figure 11. Snap Beans: Retail and shipping point prices, 1993



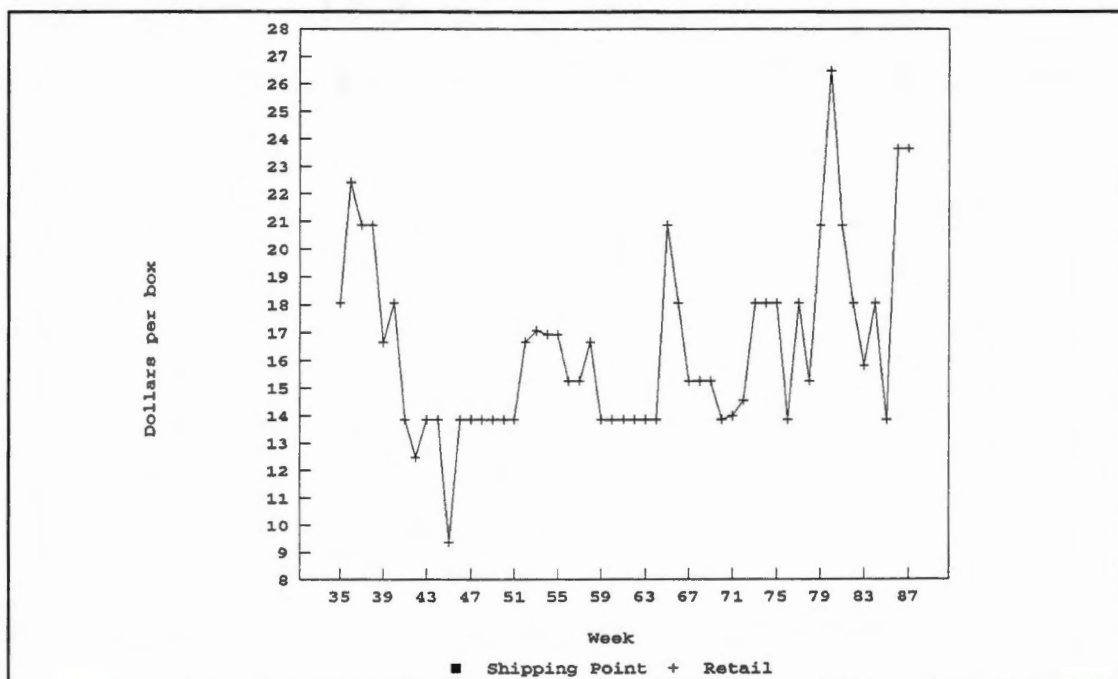
Appendix Figure 12. Snap Beans: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1993



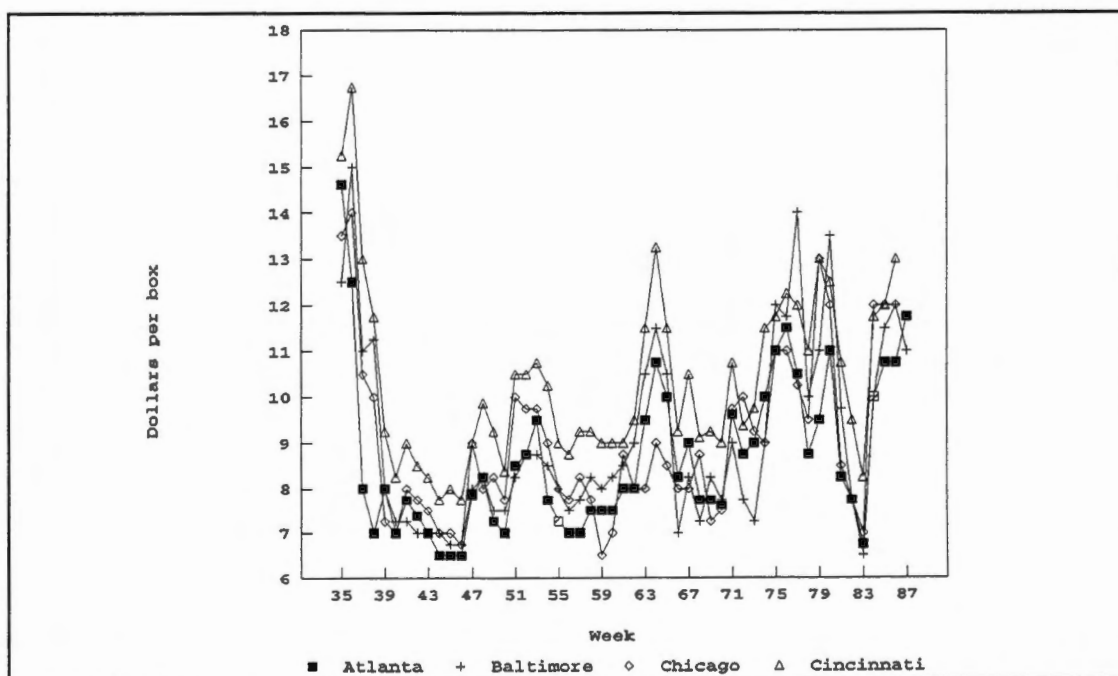
Appendix Figure 13. Broccoli: Retail and shipping point prices, 1988



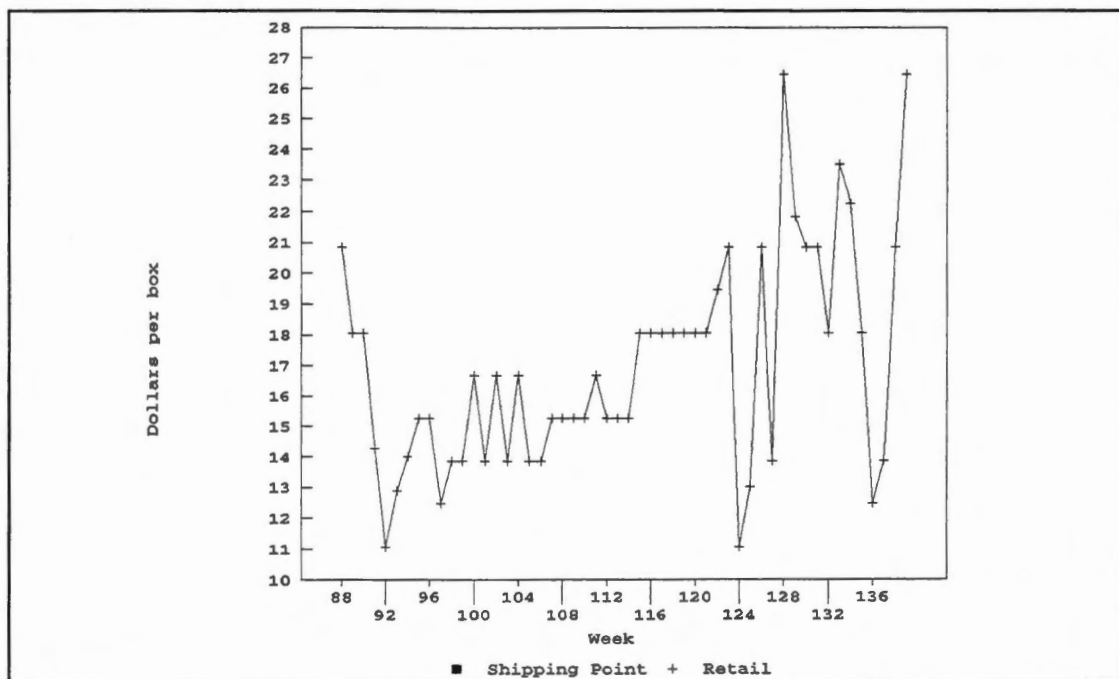
Appendix Figure 14. Broccoli: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1988



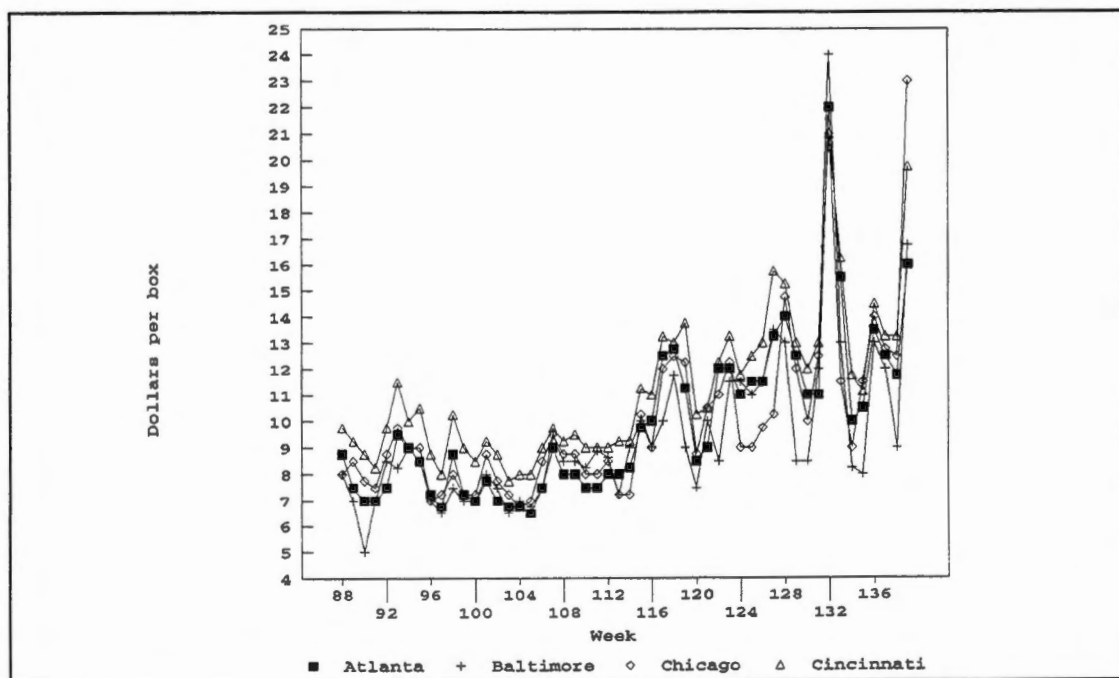
Appendix Figure 15. Broccoli: Retail and shipping point prices, 1989



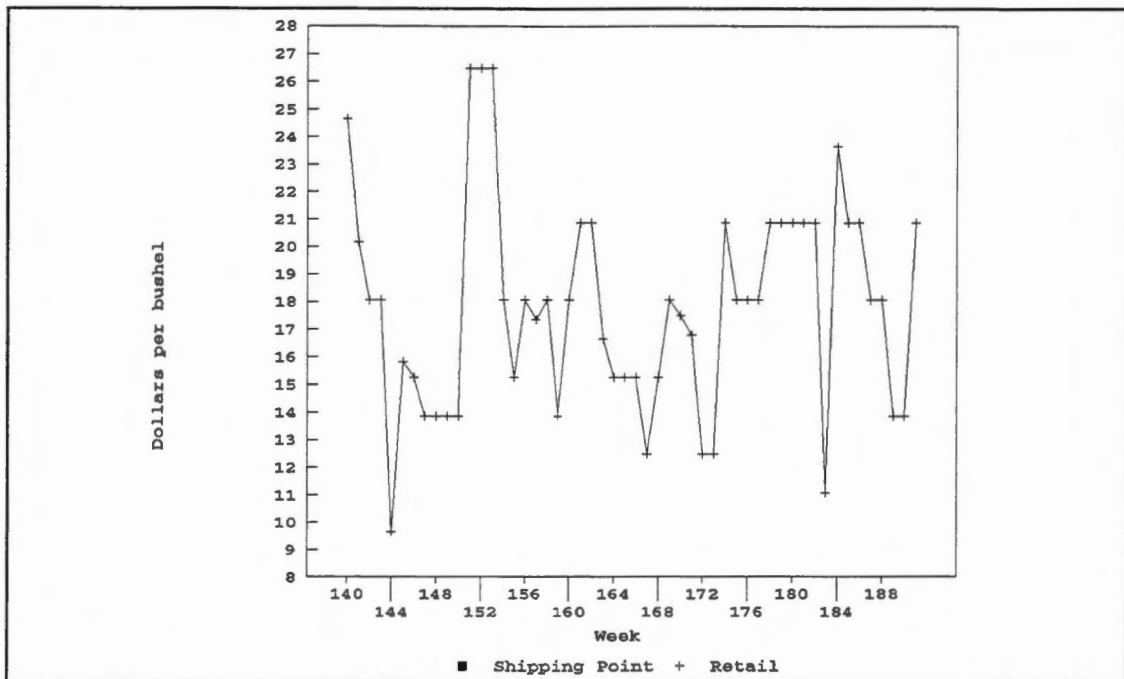
Appendix Figure 16. Broccoli: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1989



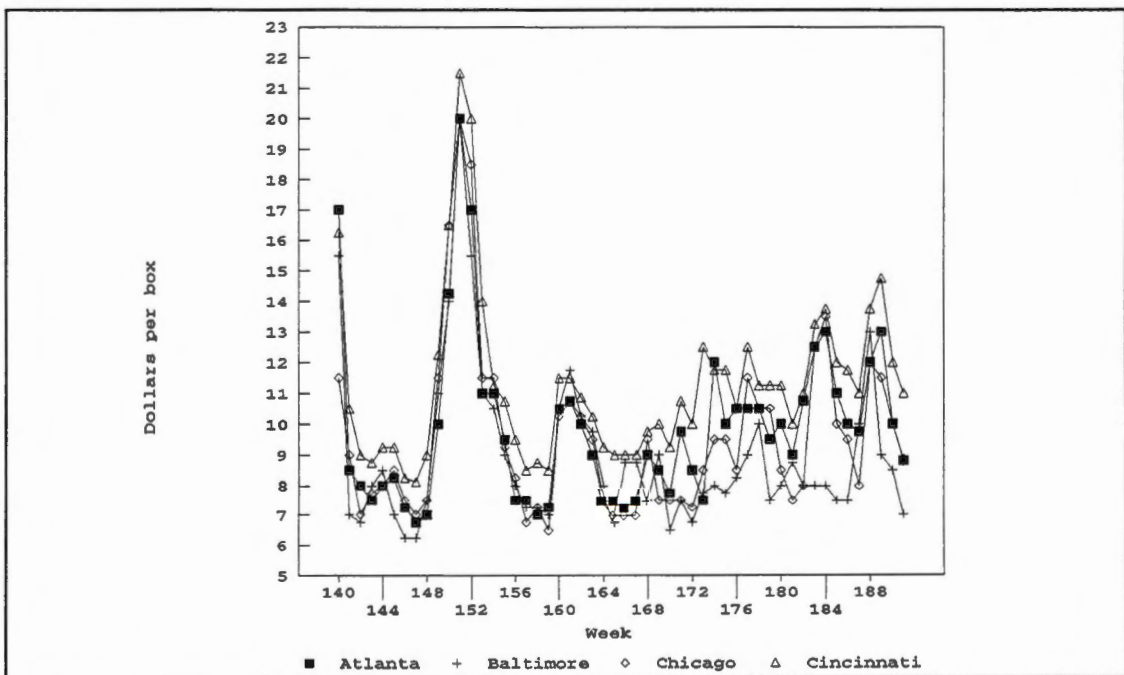
Appendix Figure 17. Broccoli: Retail and shipping point prices, 1990



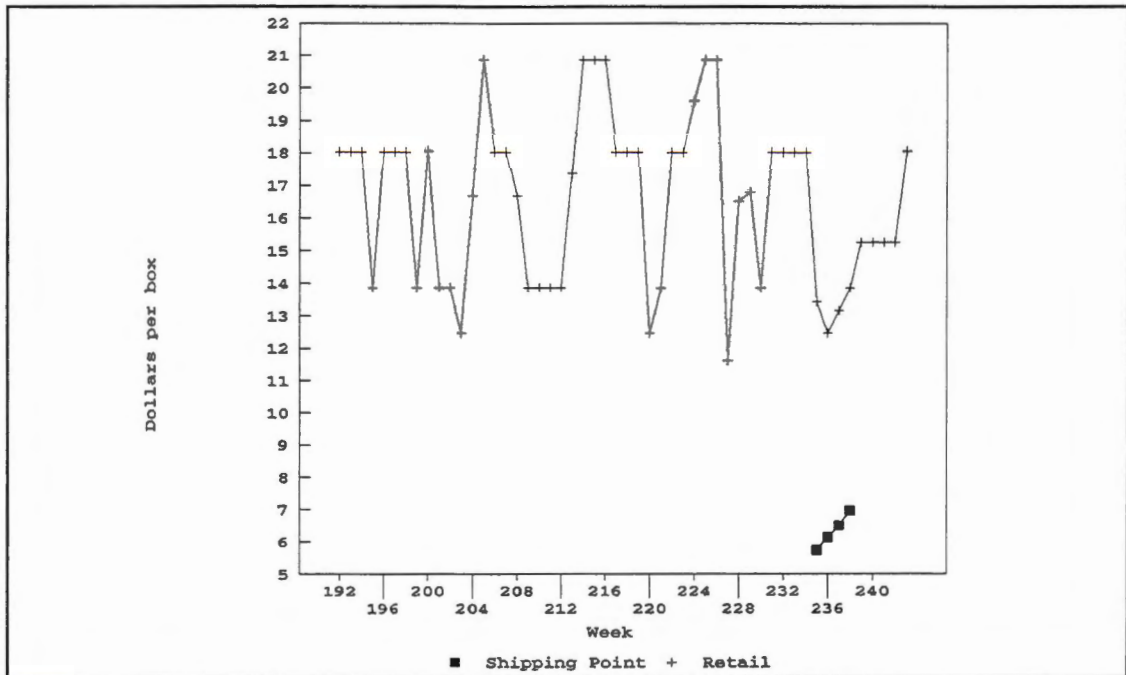
Appendix Figure 18. Broccoli: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1990



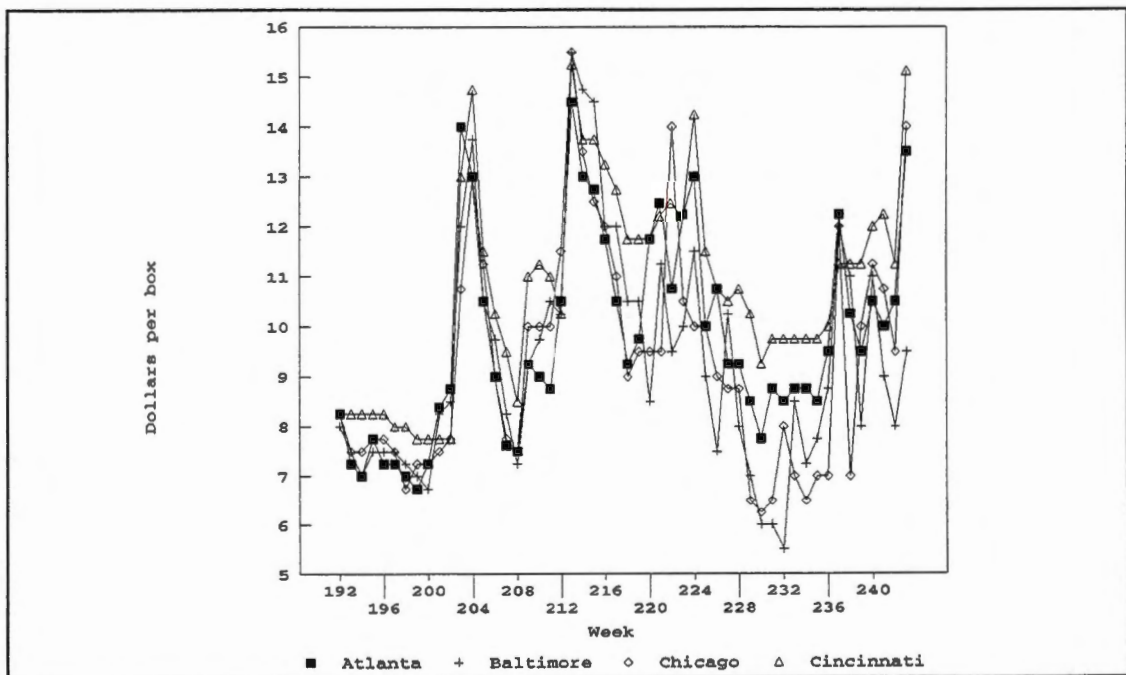
Appendix Figure 19. Broccoli: Retail and shipping point prices, 1991



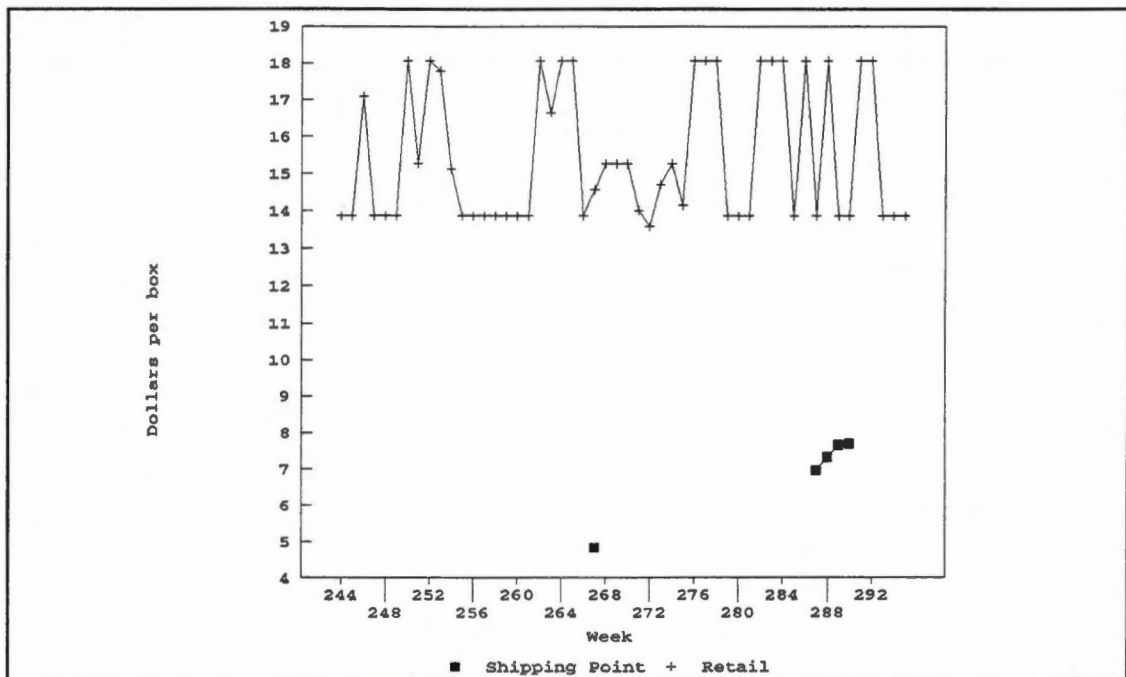
Appendix Figure 20. Broccoli: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1991



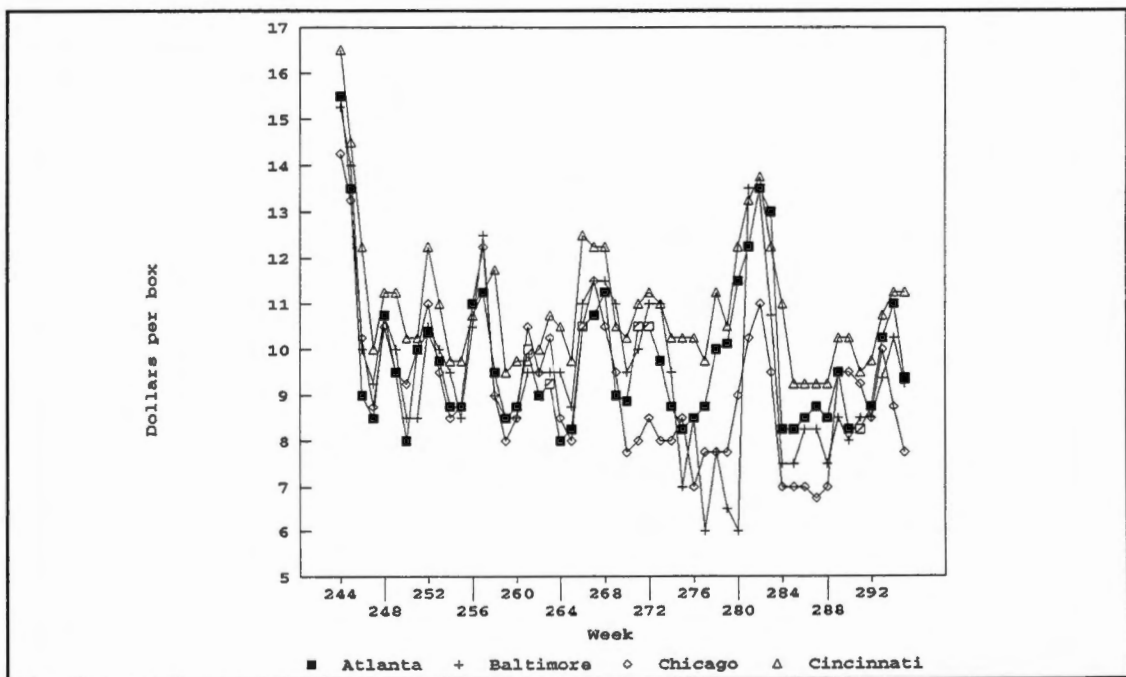
Appendix Figure 21. Broccoli: Retail and shipping point prices, 1992



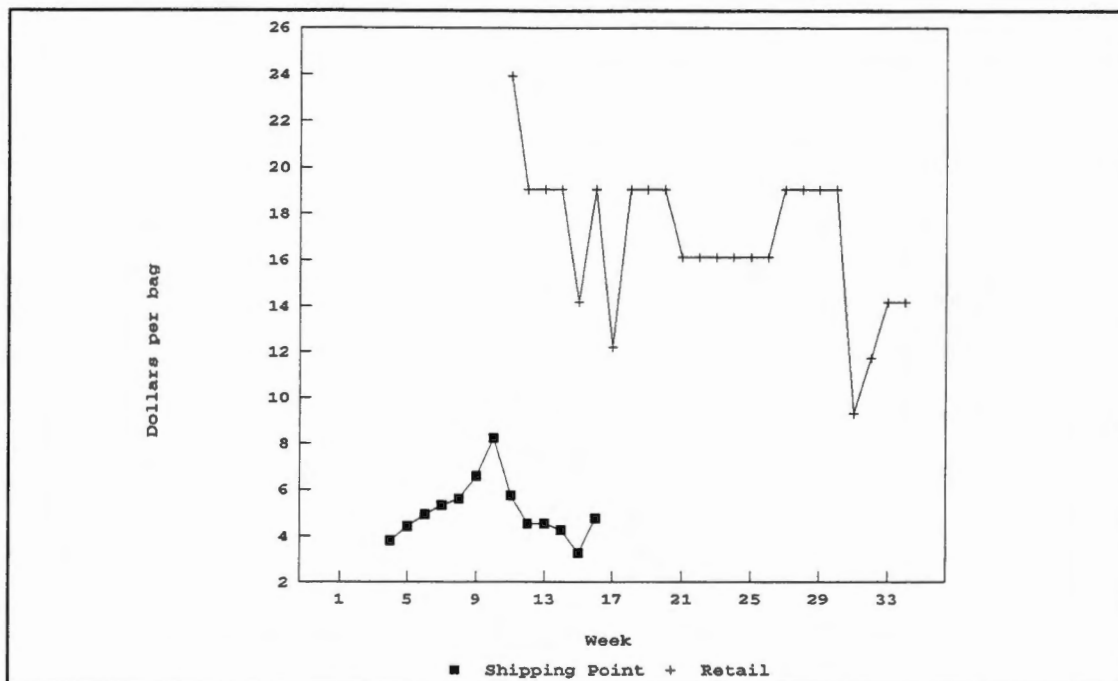
Appendix Figure 22. Broccoli: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1992



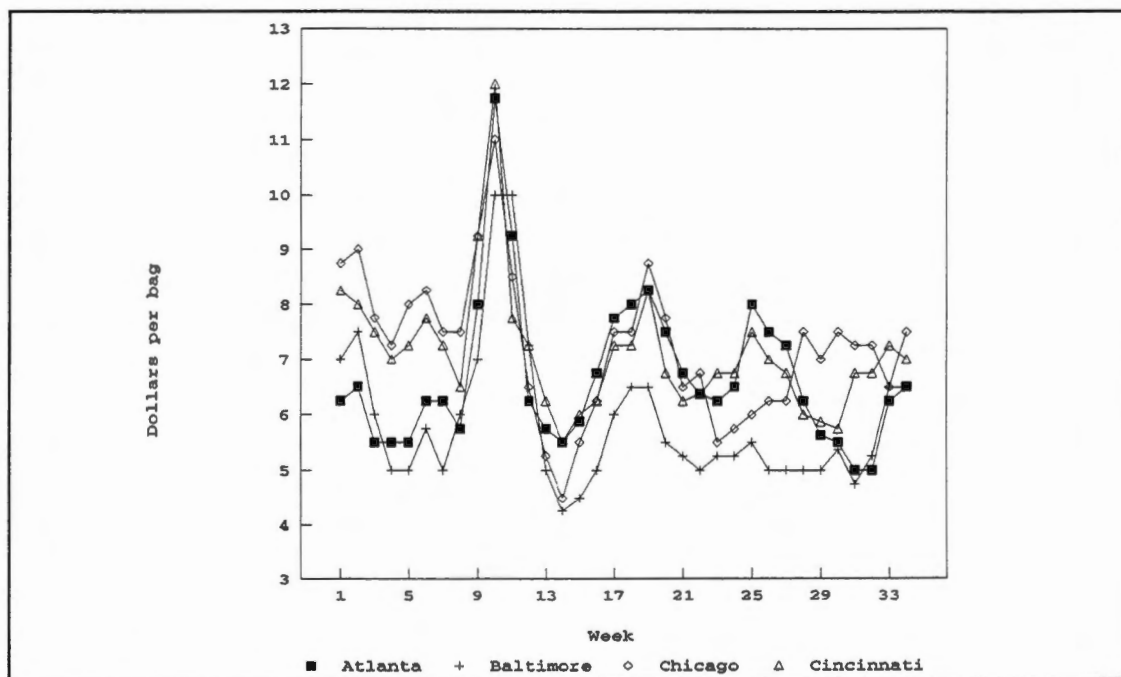
Appendix Figure 23. Broccoli: Retail and shipping point prices, 1993



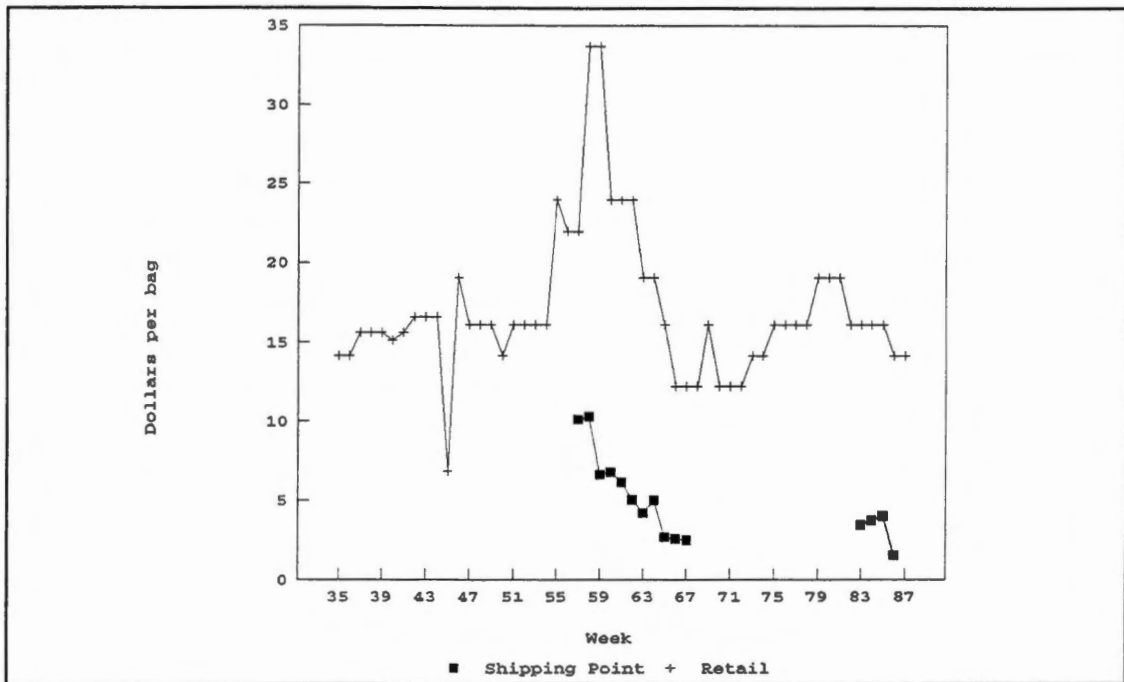
Appendix Figure 24. Broccoli: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1993



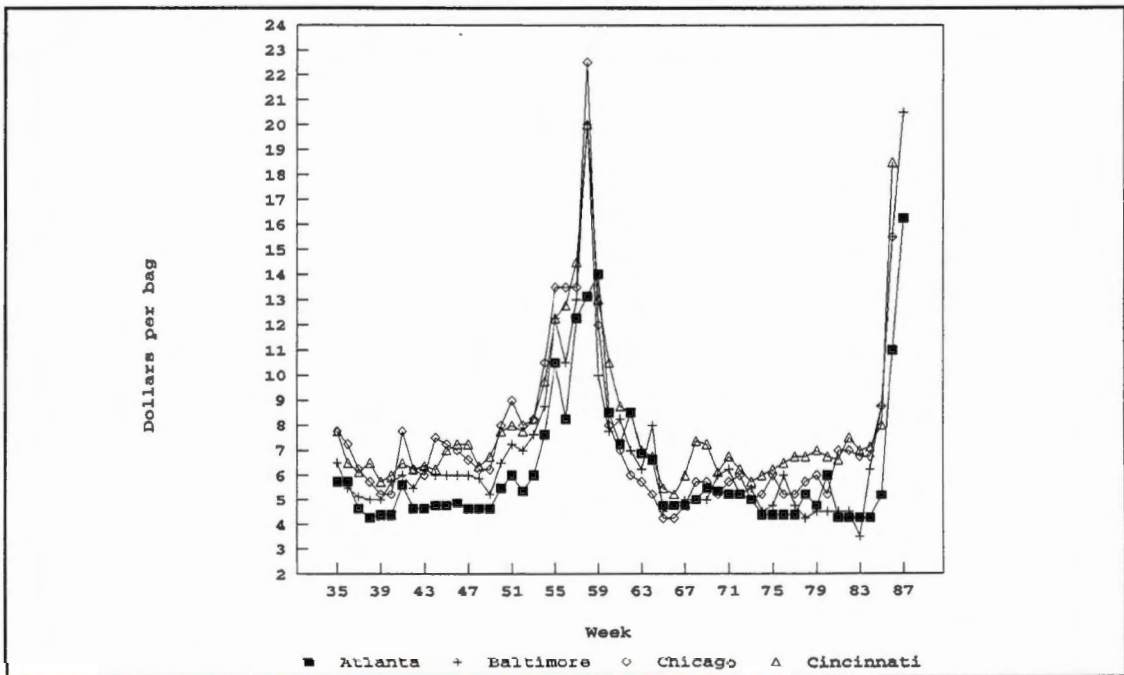
Appendix Figure 25. Cabbage: Retail and shipping point prices, 1988



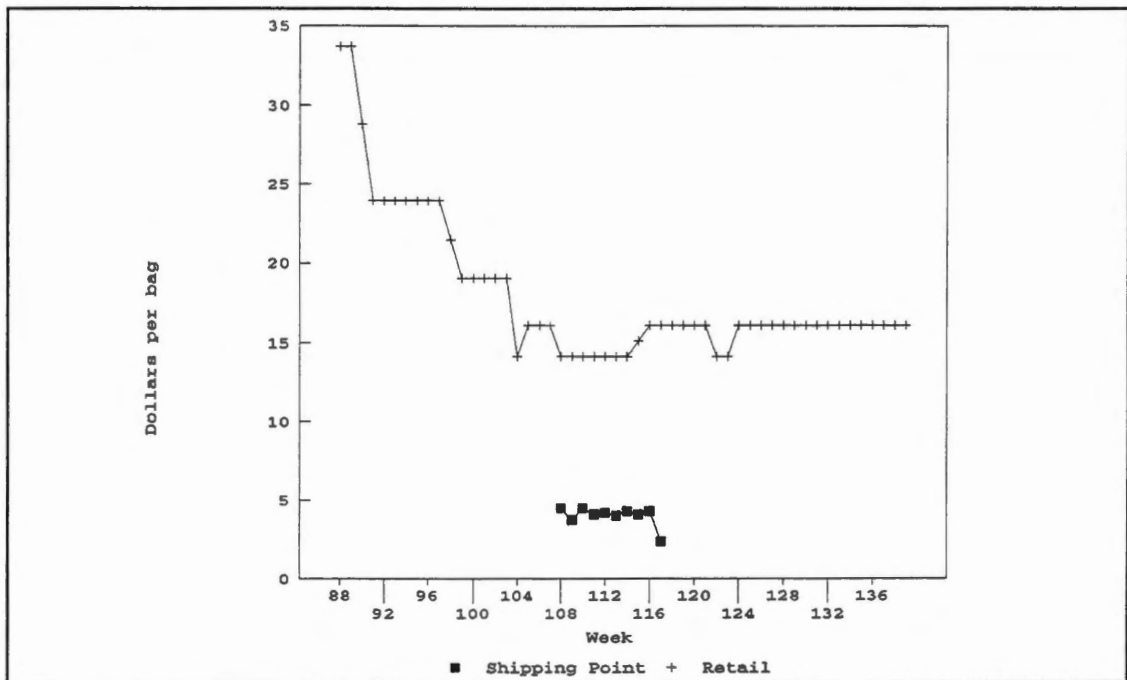
Appendix Figure 26. Cabbage: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1988



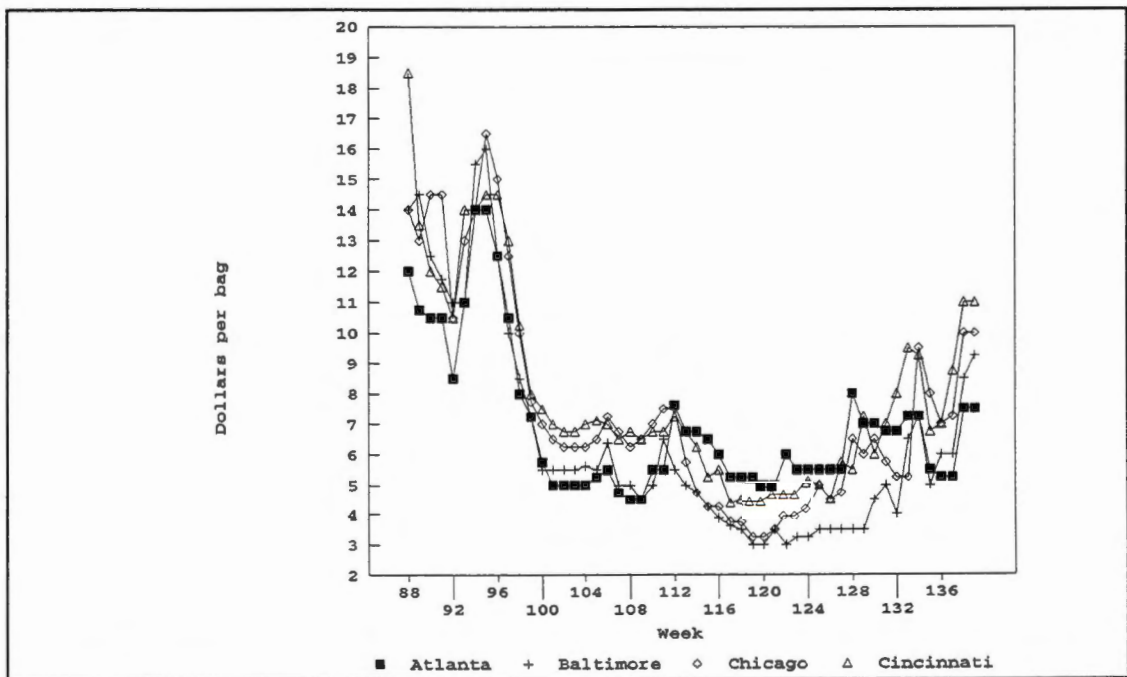
Appendix Figure 27. Cabbage: Retail and shipping point prices, 1989



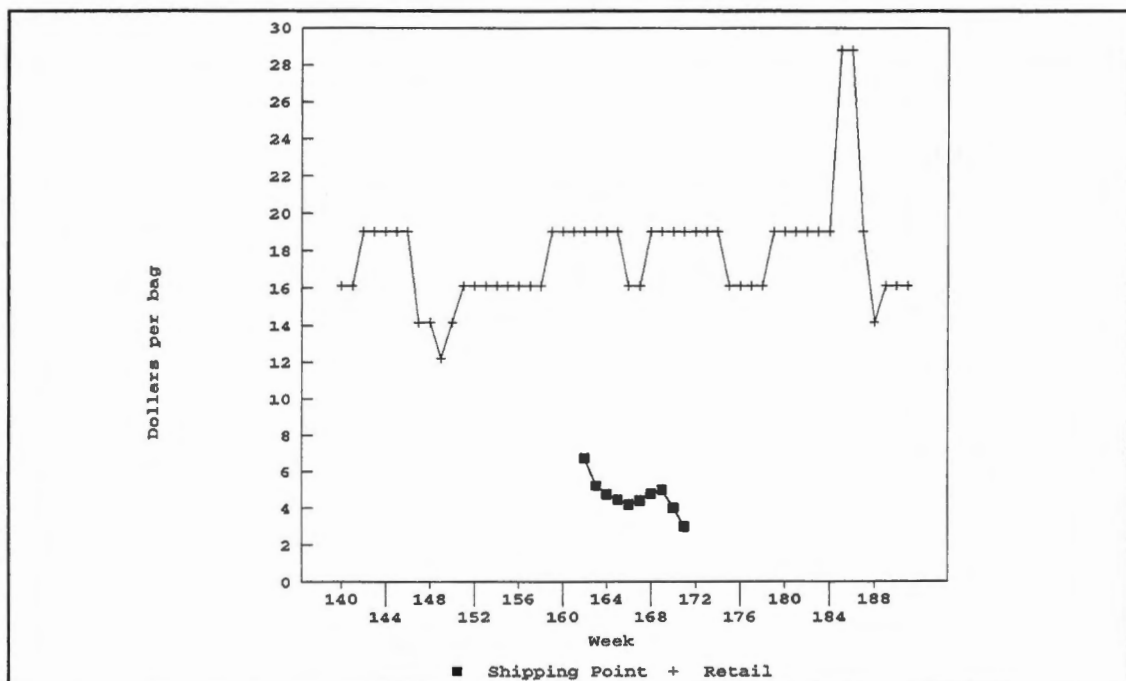
Appendix Figure 28. Cabbage: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1989



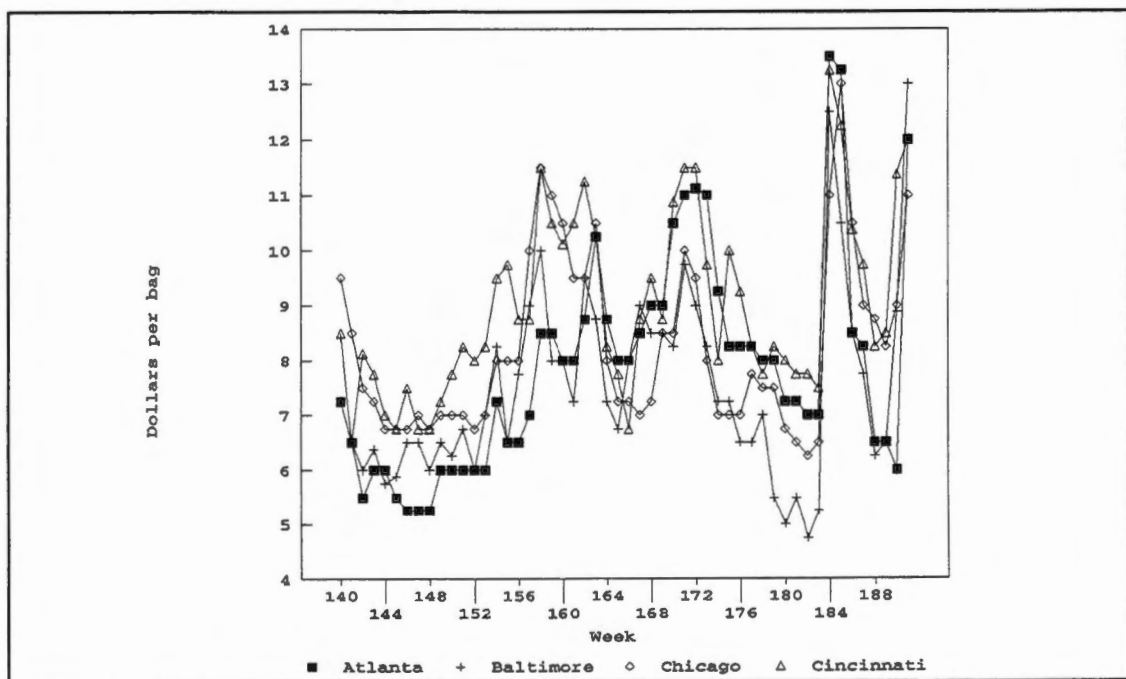
Appendix Figure 29. Cabbage: Retail and shipping point prices, 1990



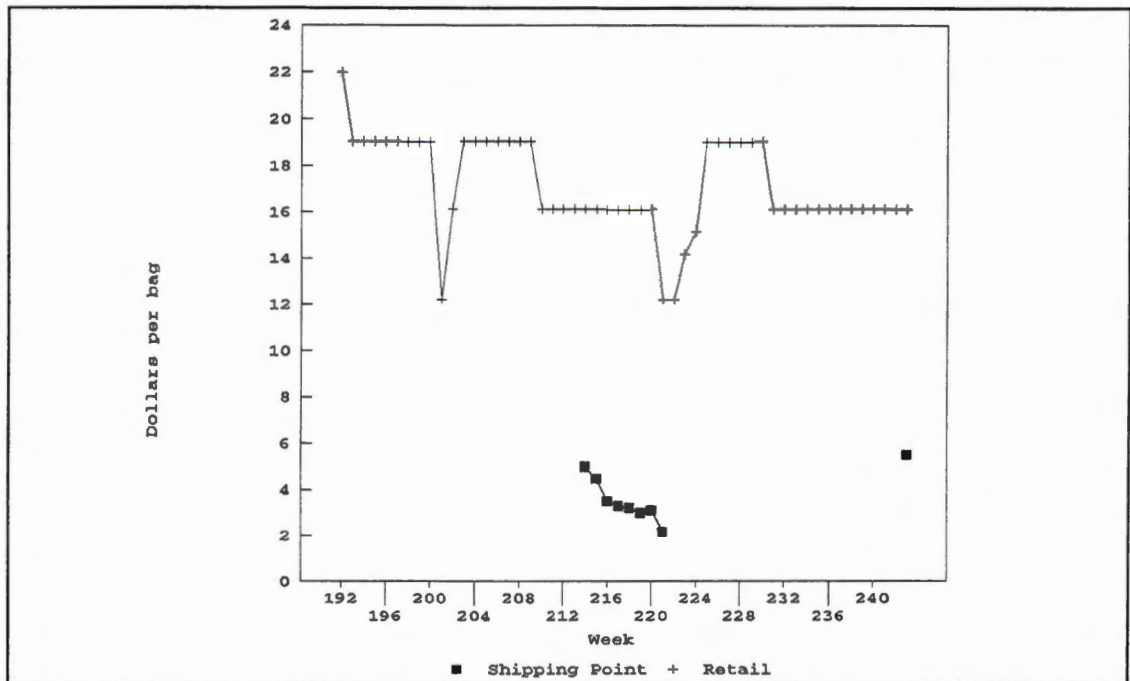
Appendix Figure 30. Cabbage: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1990



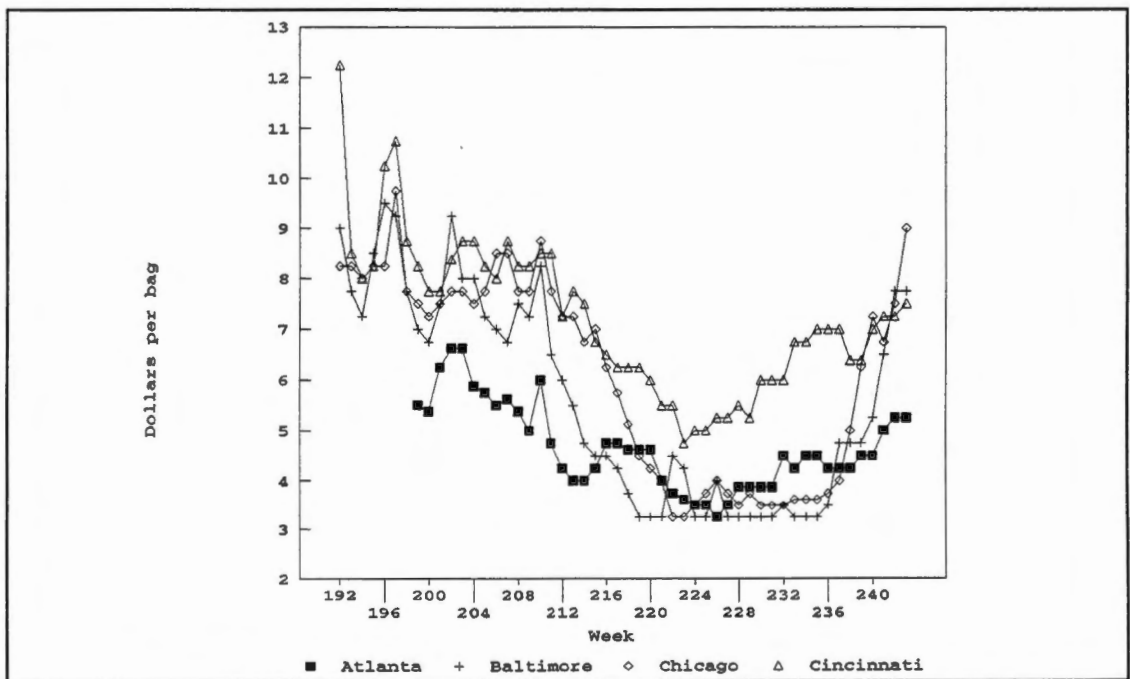
Appendix Figure 31. Cabbage: Retail and shipping point prices, 1991



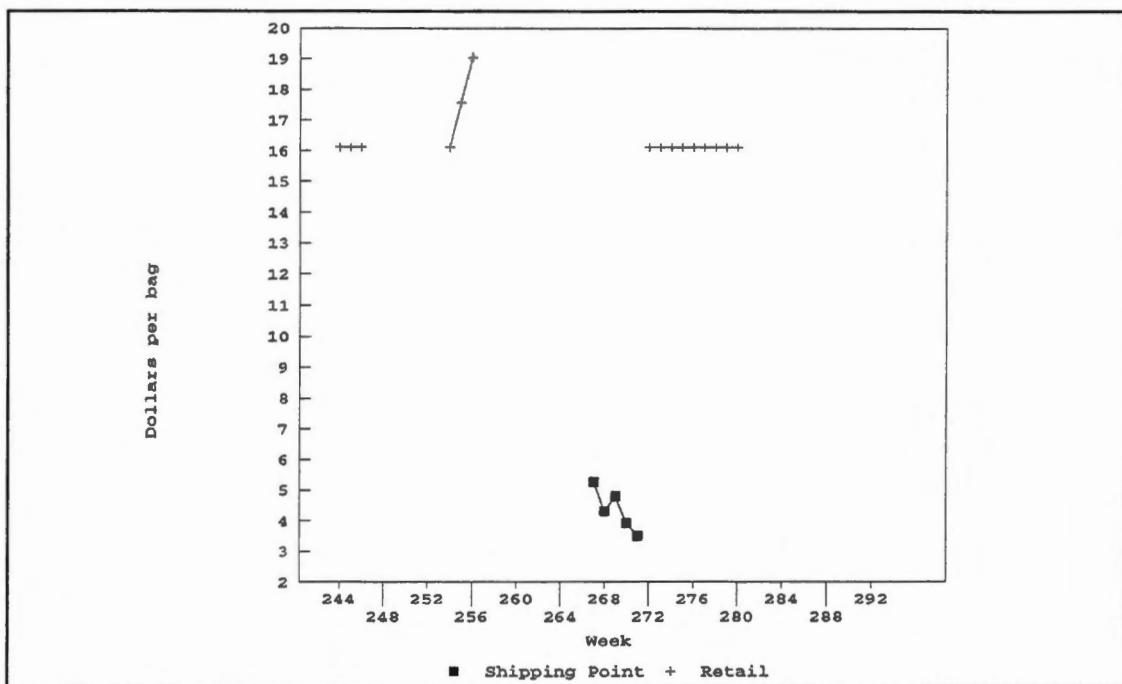
Appendix Figure 32. Cabbage: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1991



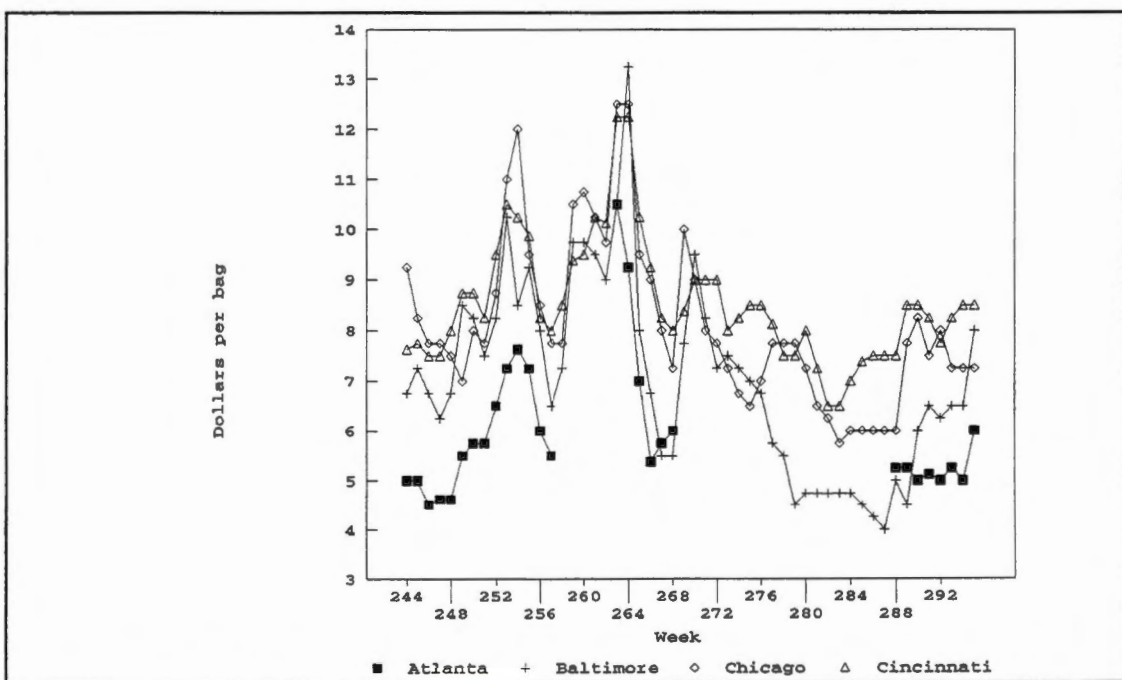
Appendix Figure 33. Cabbage: Retail and shipping point prices, 1992



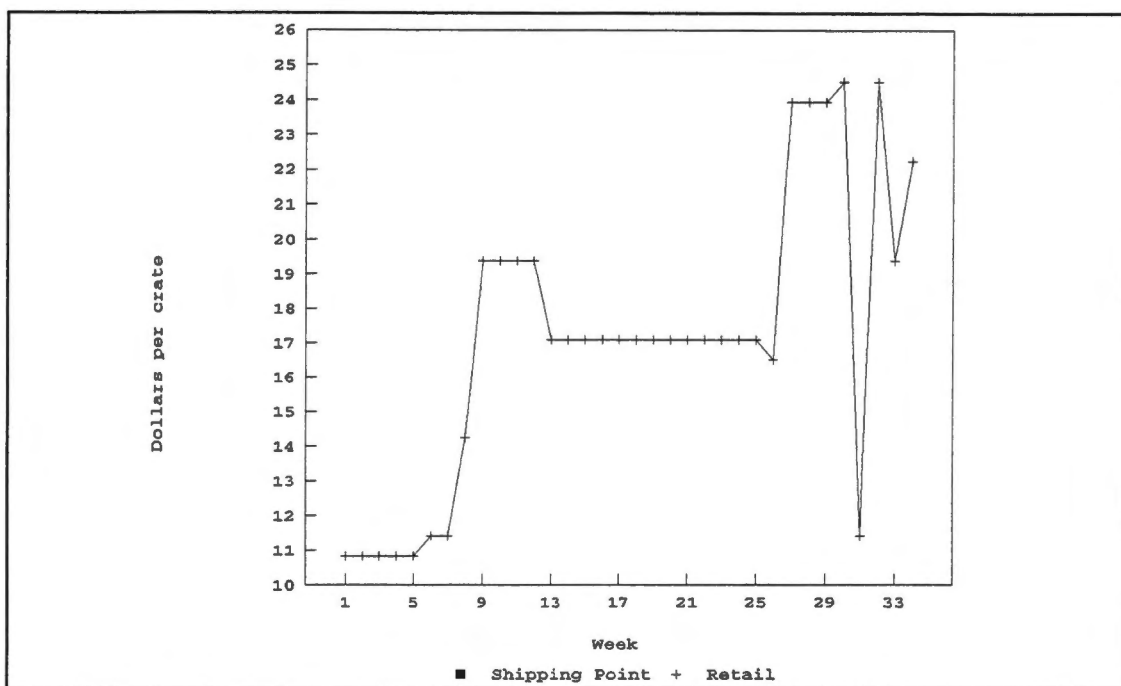
Appendix Figure 34. Cabbage: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1992



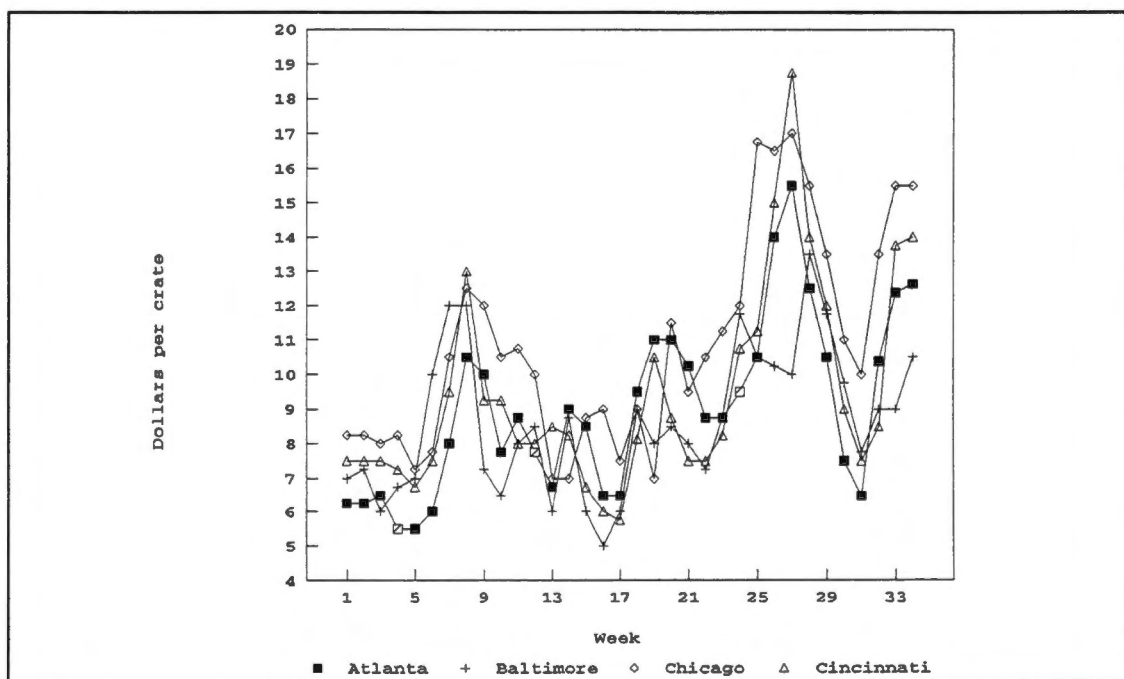
Appendix Figure 35. Cabbage: Retail and shipping point prices, 1993



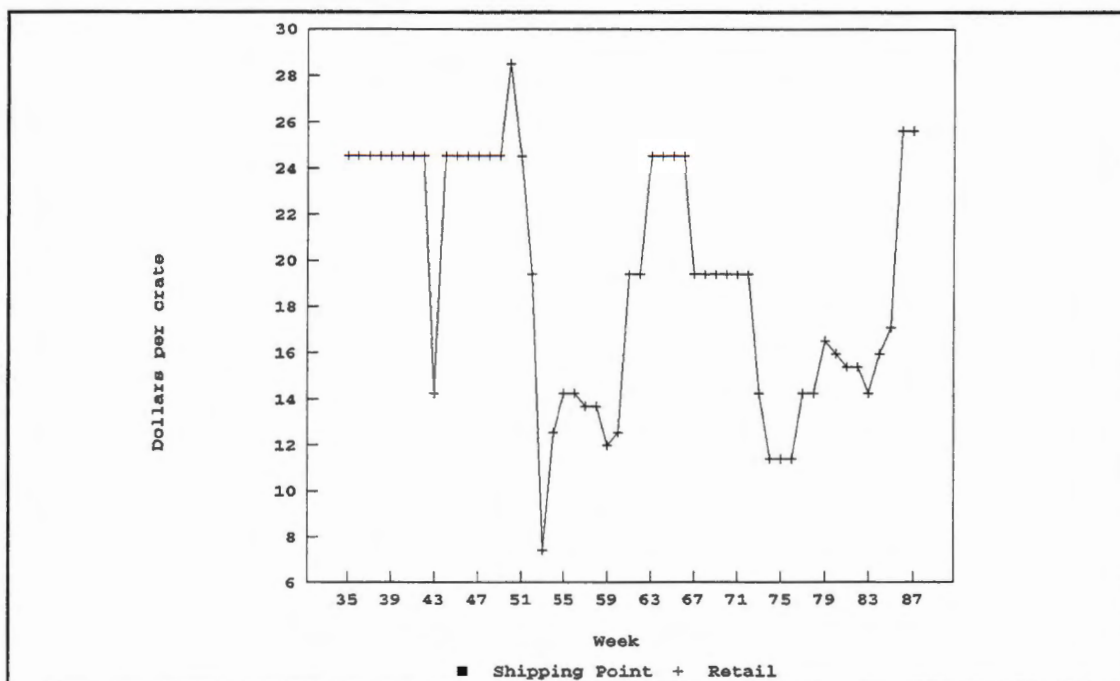
Appendix Figure 36. Cabbage: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1993



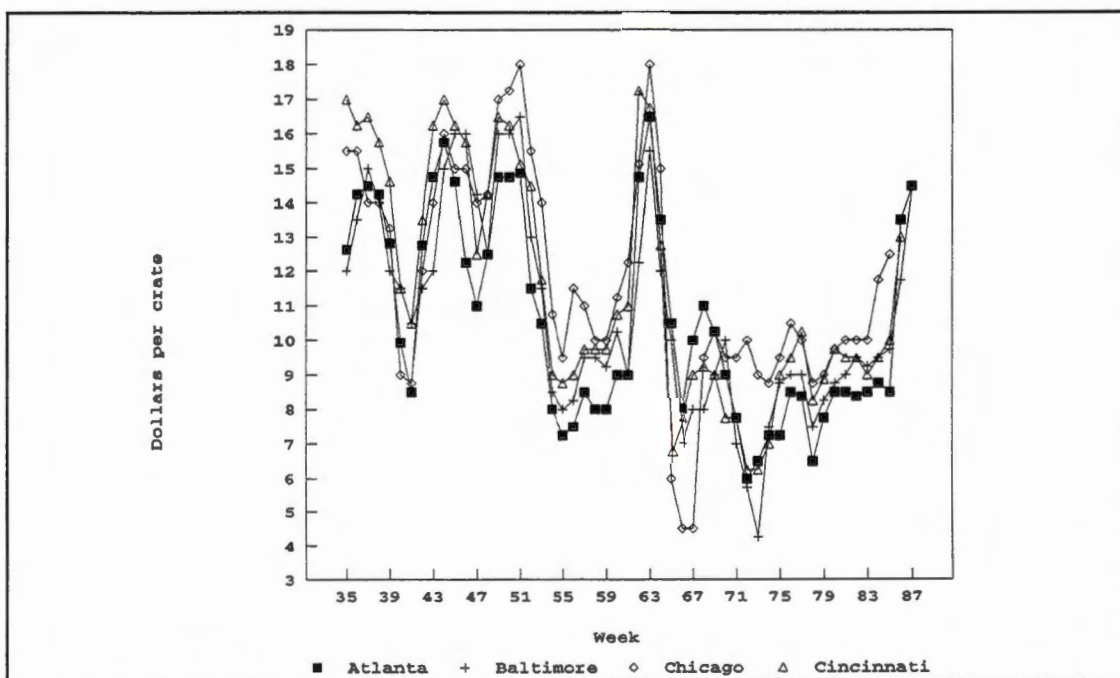
Appendix Figure 37. Corn: Retail and shipping point prices, 1988



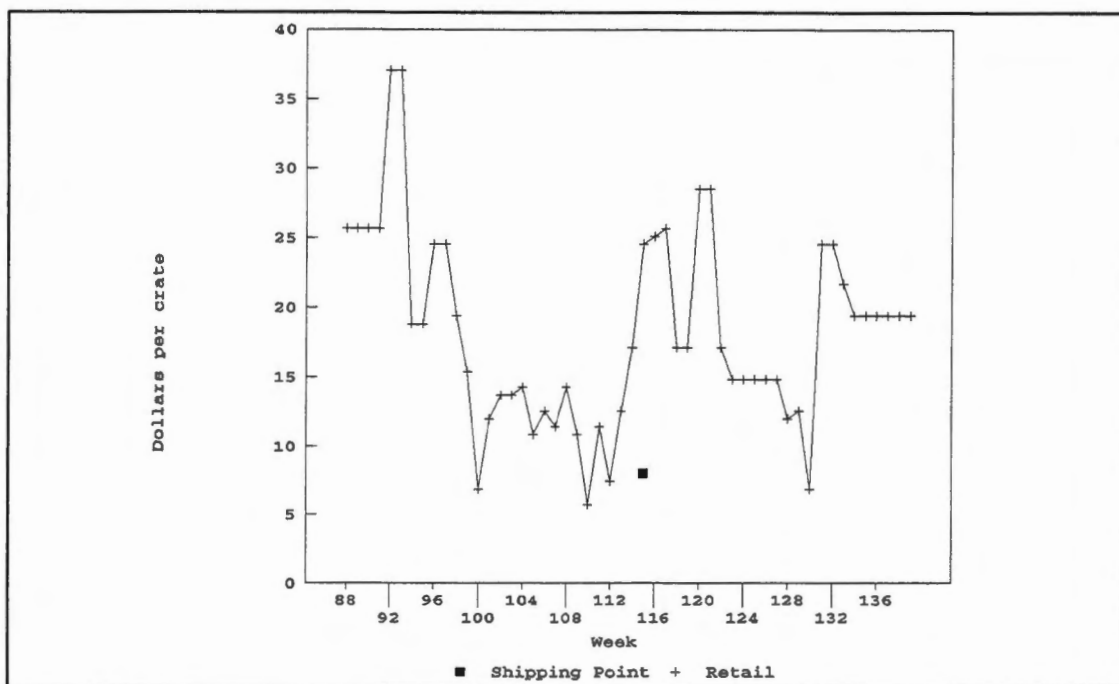
Appendix Figure 38. Corn: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1988



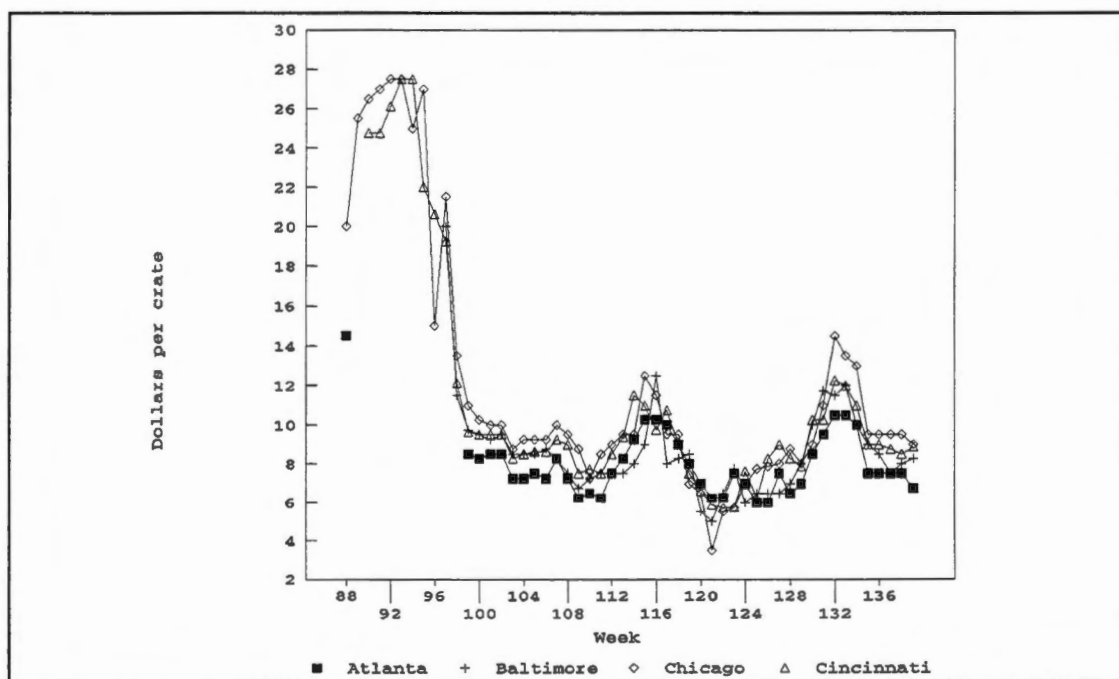
Appendix Figure 39. Corn: Retail and shipping point prices, 1989



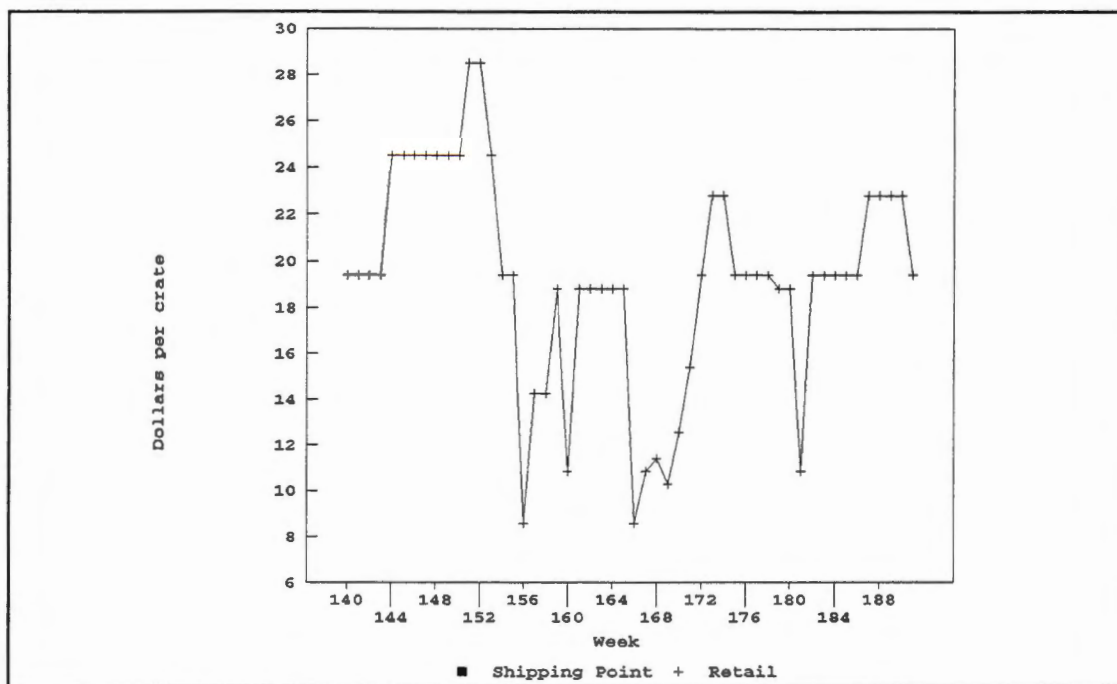
Appendix Figure 40. Corn: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1989



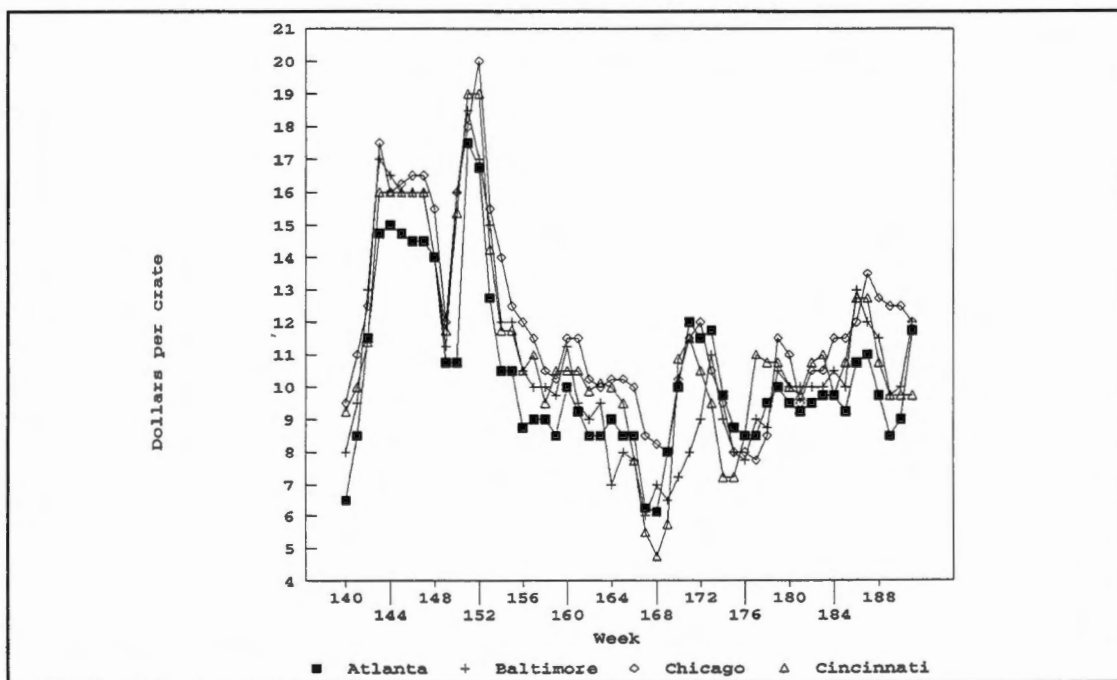
Appendix Figure 41. Corn: Retail and shipping point prices, 1990



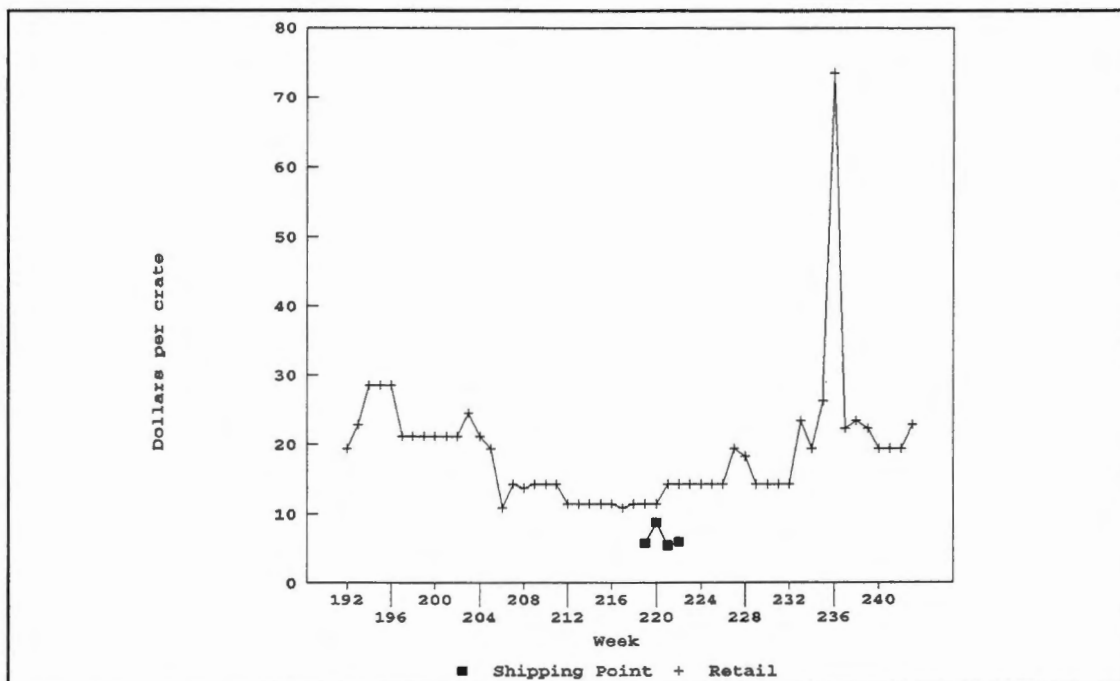
Appendix Figure 42. Corn: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1990



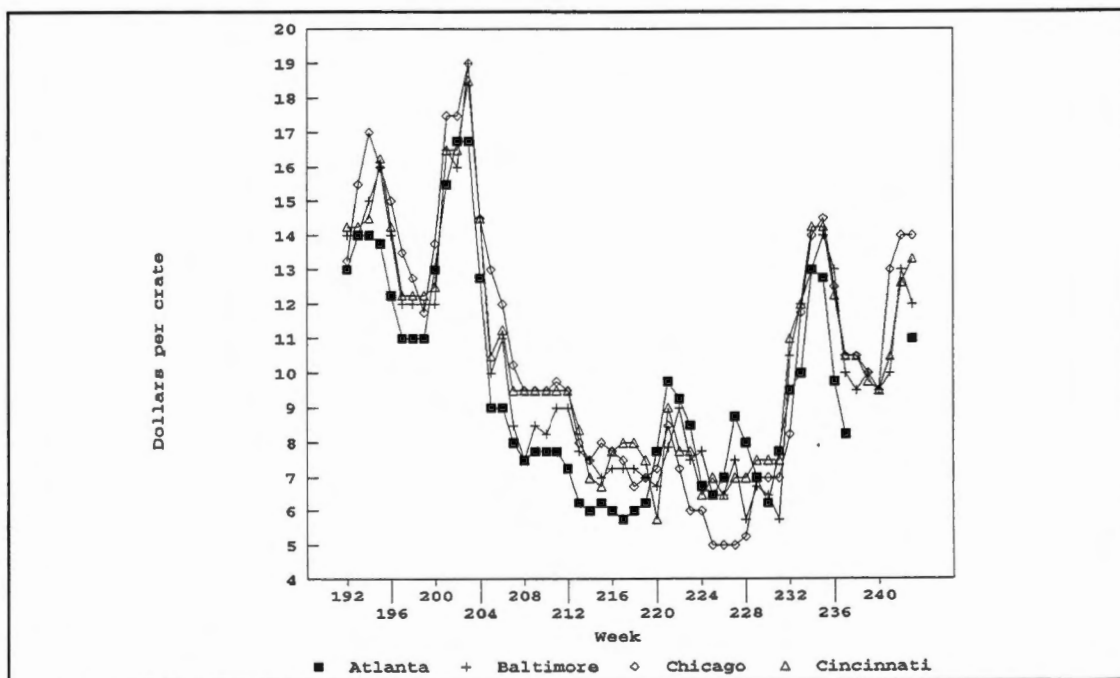
Appendix Figure 43. Corn: Retail and shipping point prices, 1991



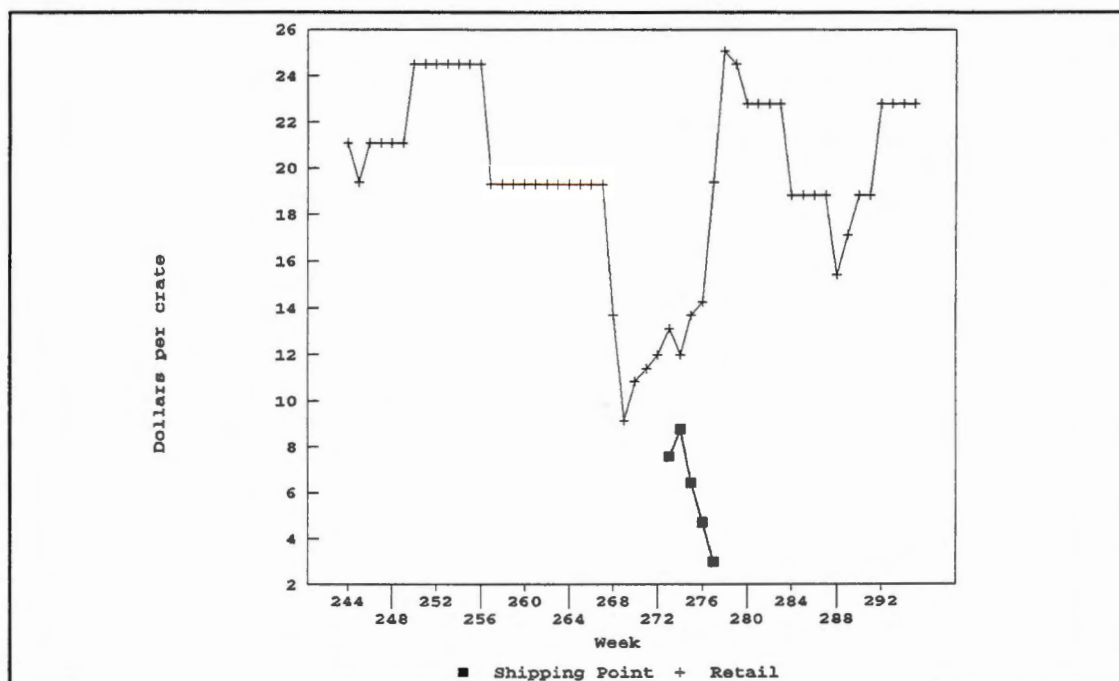
Appendix Figure 44. Corn: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1991



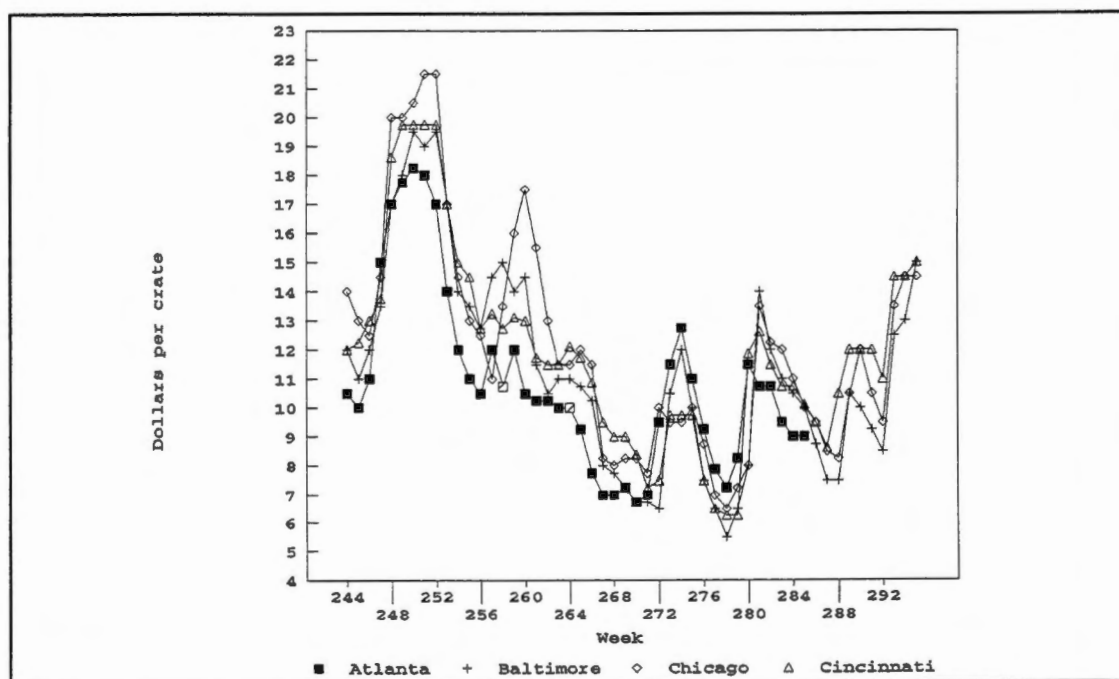
Appendix Figure 45. Corn: Retail and shipping point prices, 1992



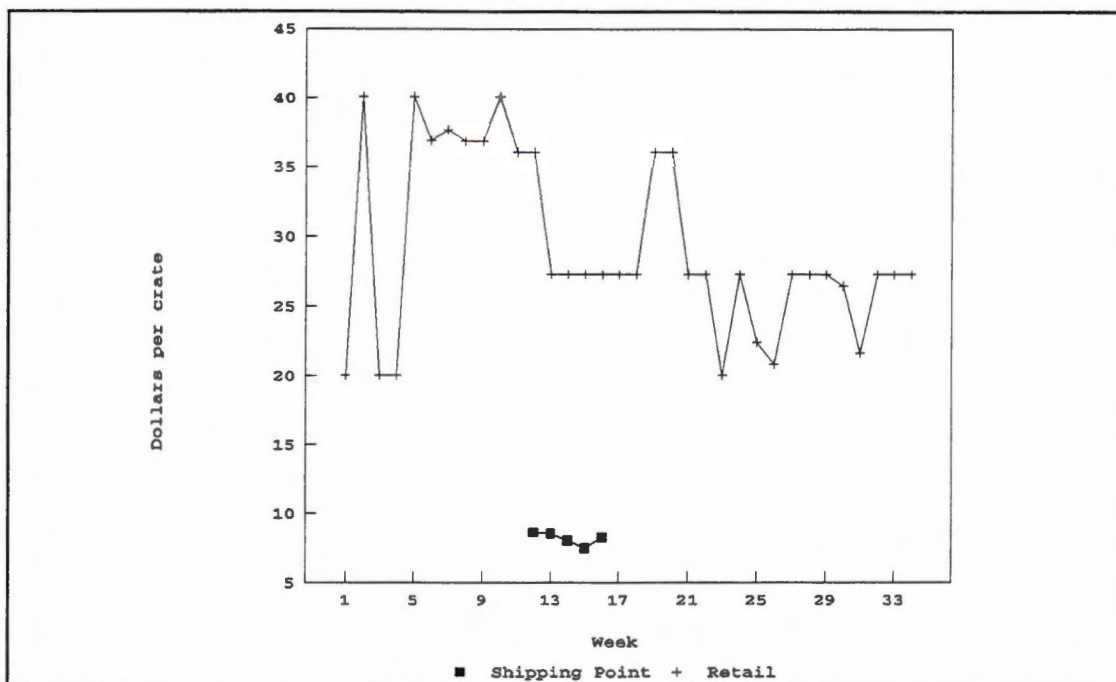
Appendix Figure 46. Corn: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1992



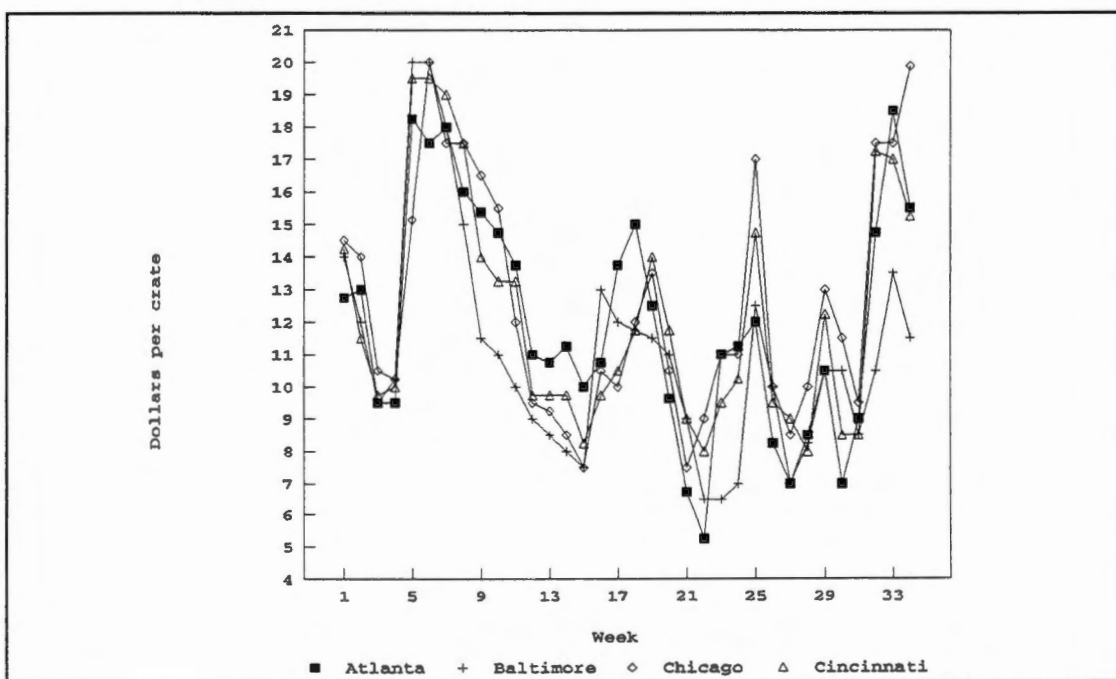
Appendix Figure 47. Corn: Retail and shipping point prices, 1993



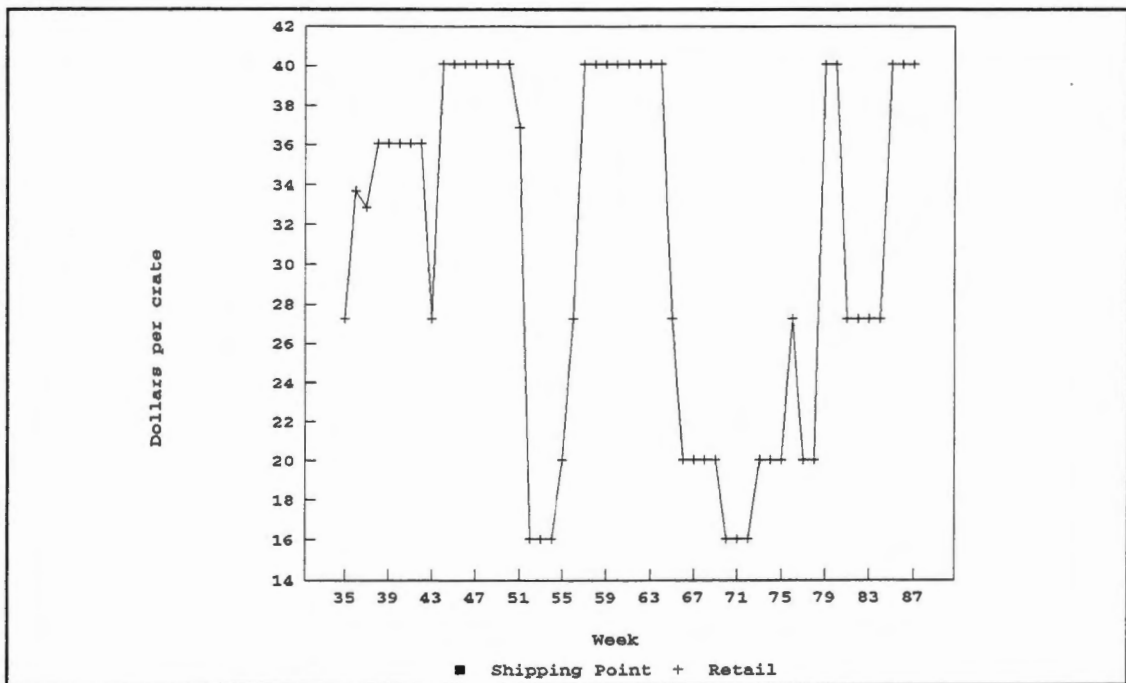
Appendix Figure 48. Corn: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1993



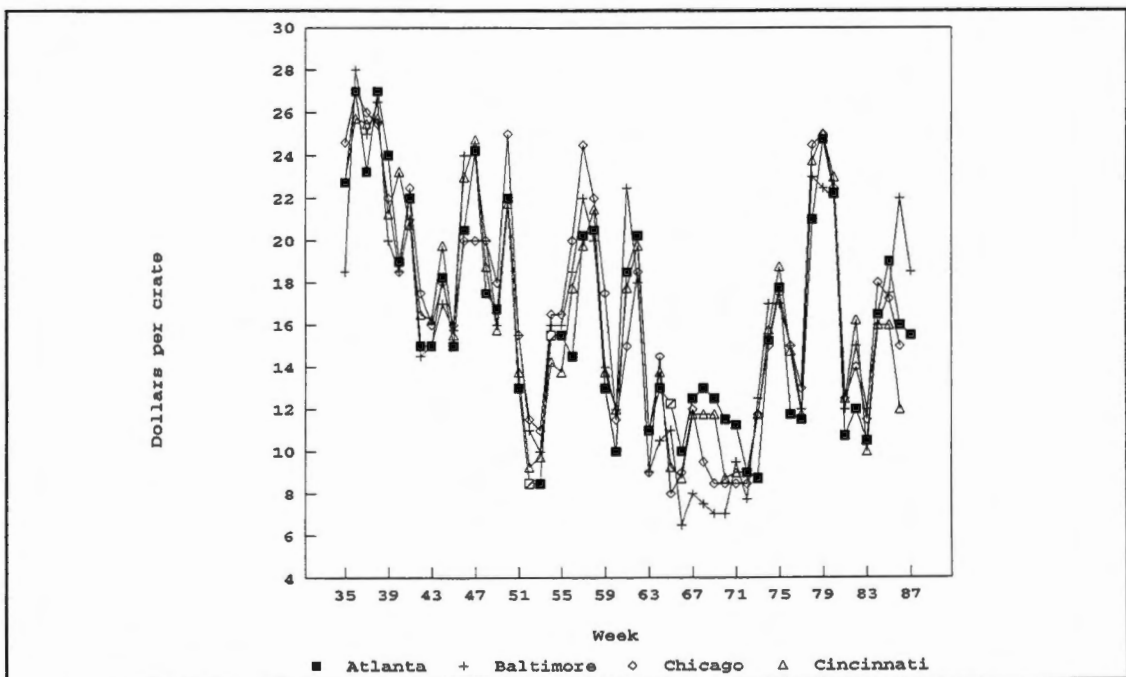
Appendix Figure 49. Cucumbers: Retail and shipping point prices, 1988



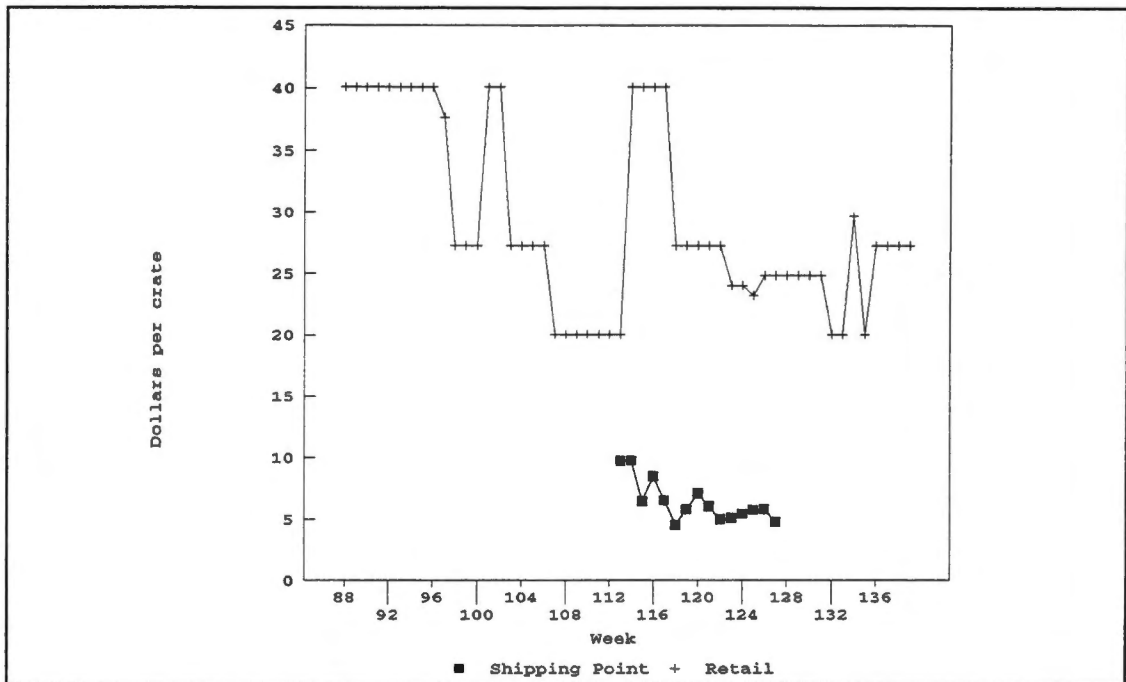
Appendix Figure 50. Cucumbers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1988



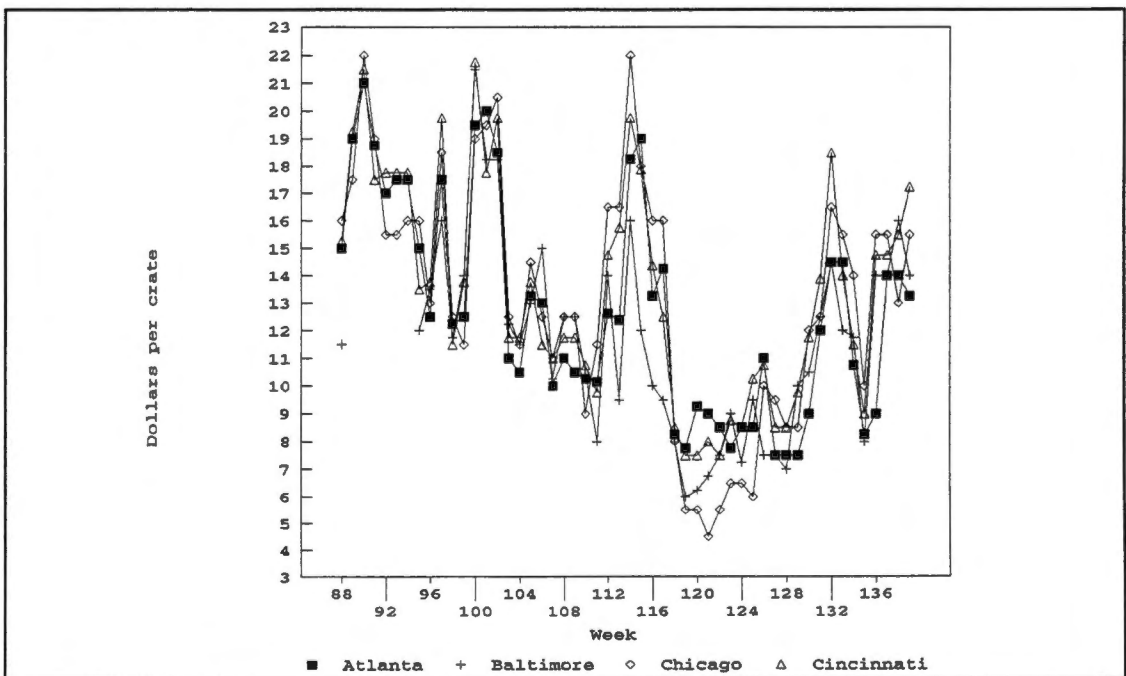
Appendix Figure 51. Cucumbers: Retail and shipping point prices, 1989



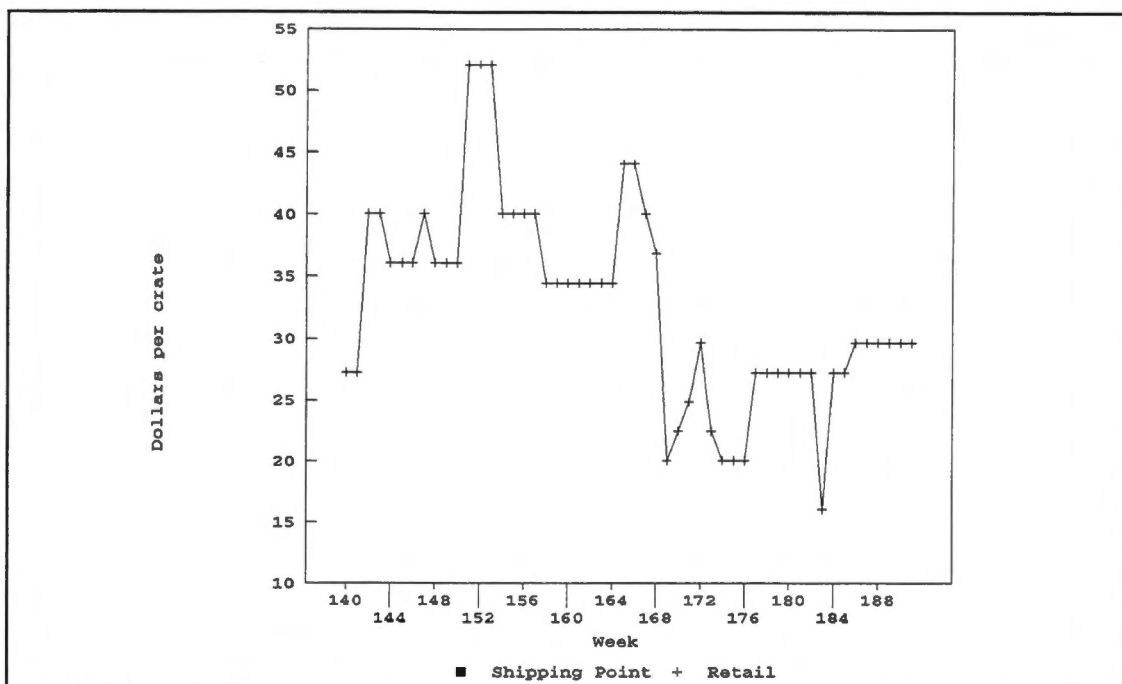
Appendix Figure 52. Cucumbers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1989



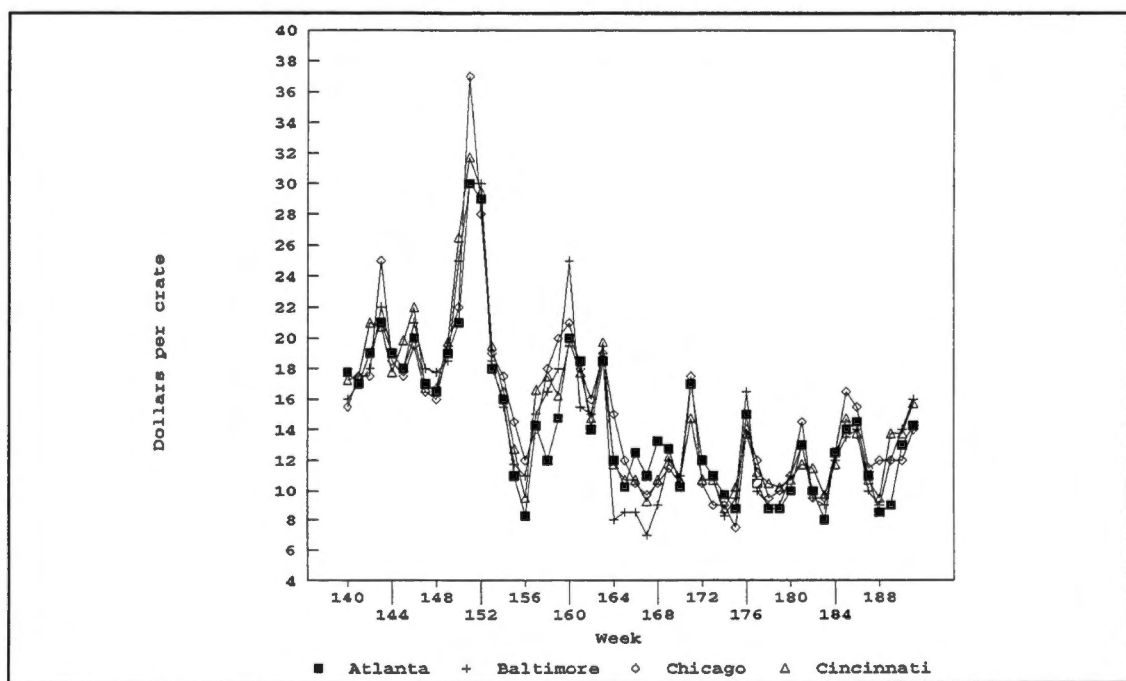
Appendix Figure 53. Cucumbers: Retail and shipping point prices, 1990



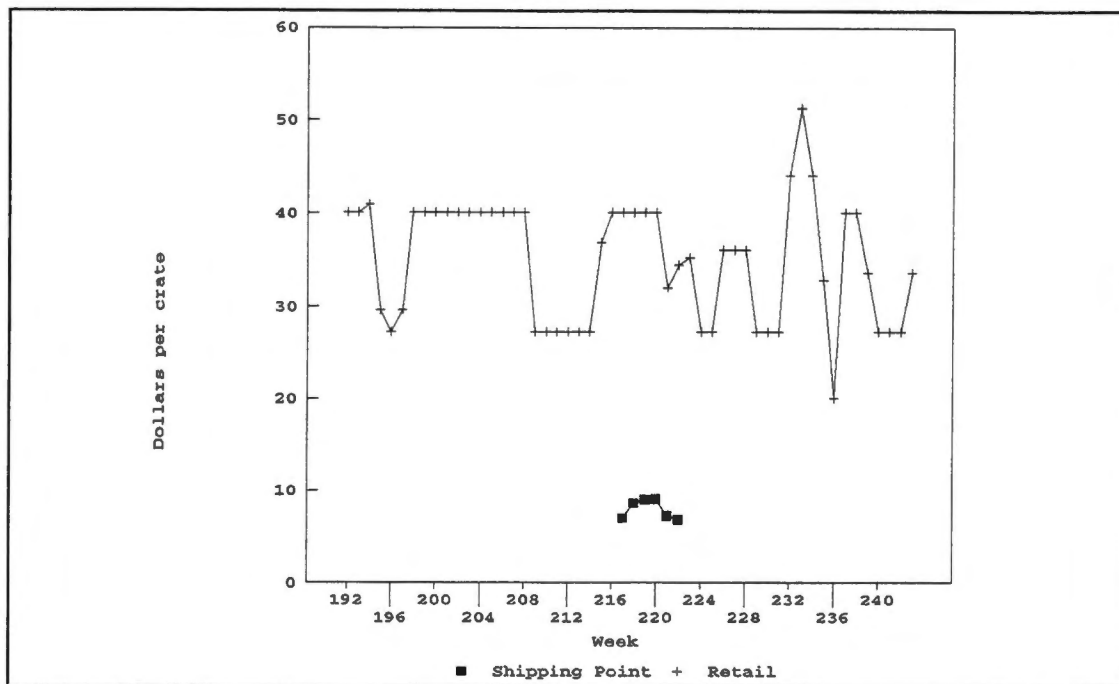
Appendix Figure 54. Cucumbers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1990



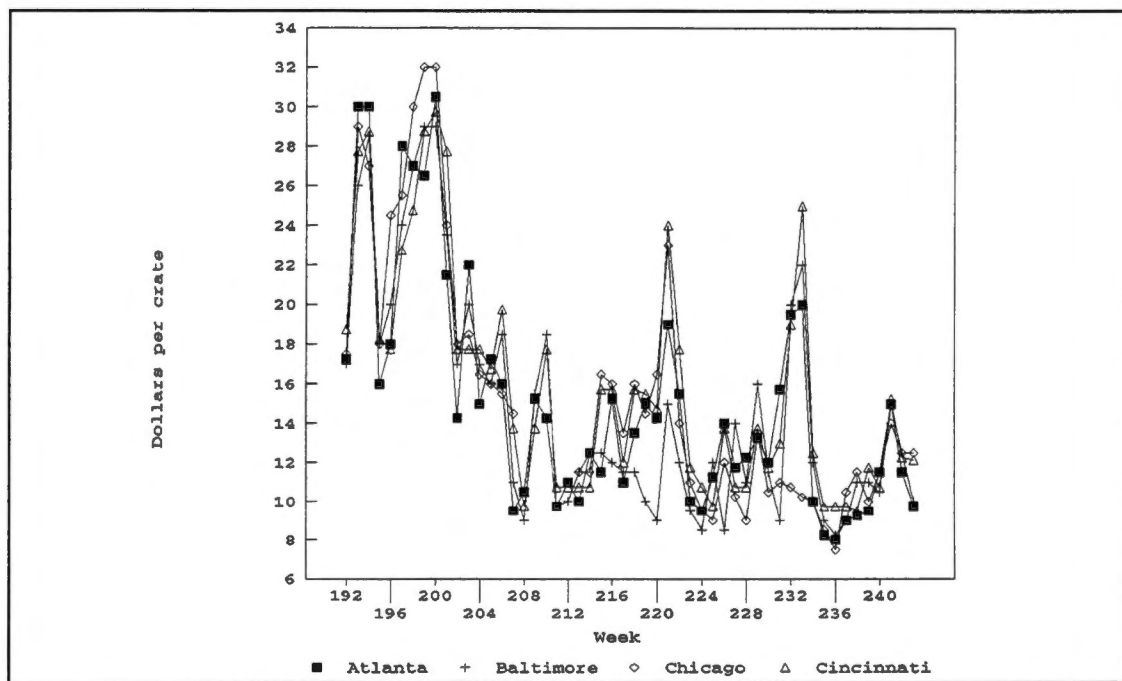
Appendix Figure 55. Cucumbers: Retail and shipping point prices, 1991



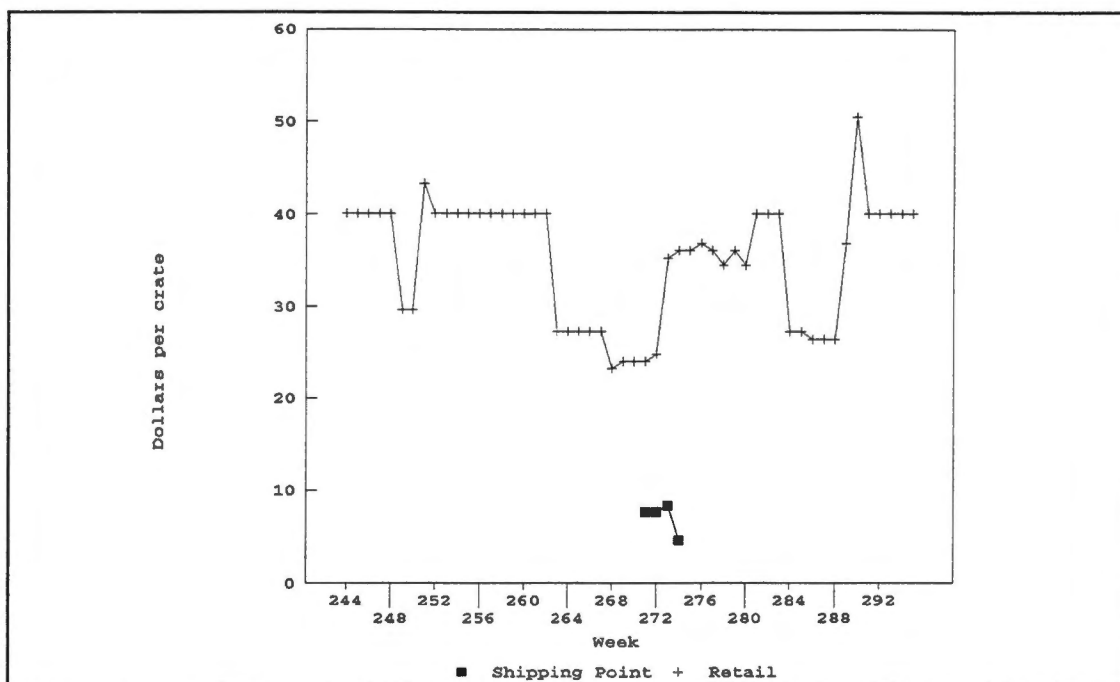
Appendix Figure 56. Cucumbers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1991



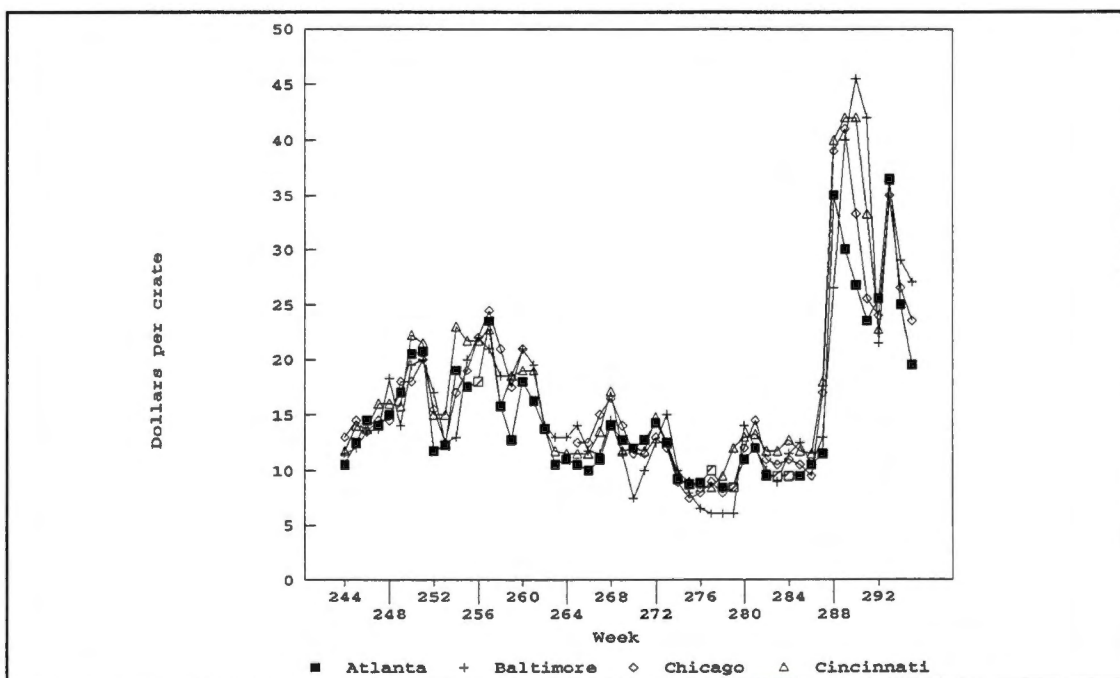
Appendix Figure 57. Cucumbers: Retail and shipping point prices, 1992



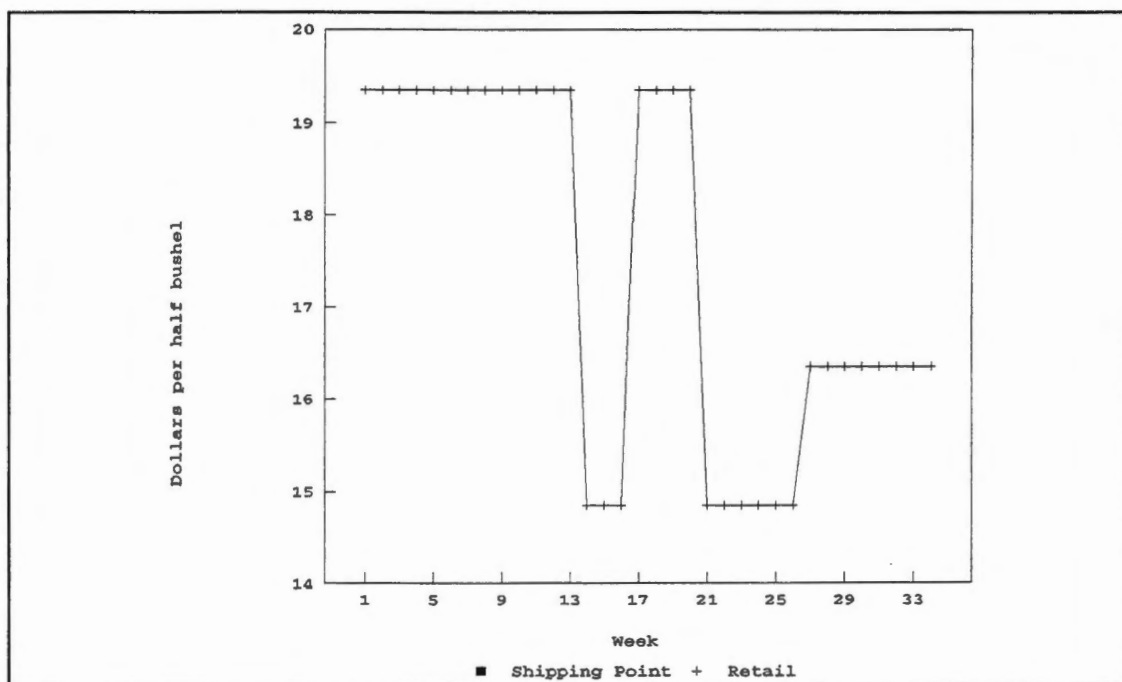
Appendix Figure 58. Cucumbers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1992



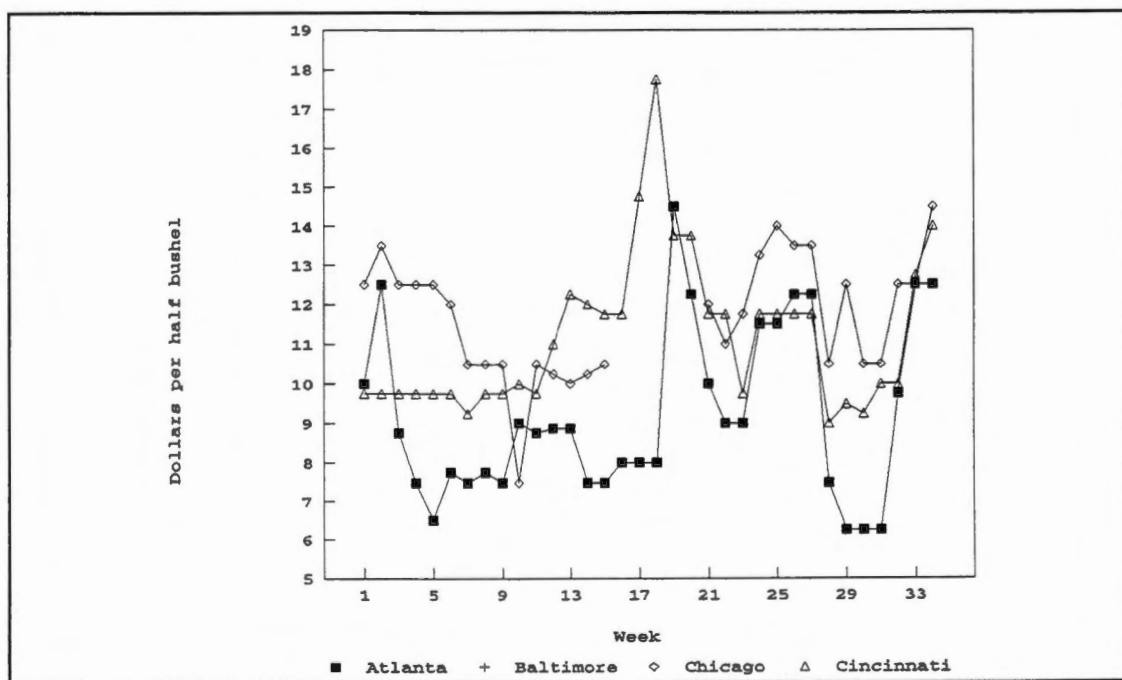
Appendix Figure 59. Cucumbers: Retail and shipping point prices, 1993



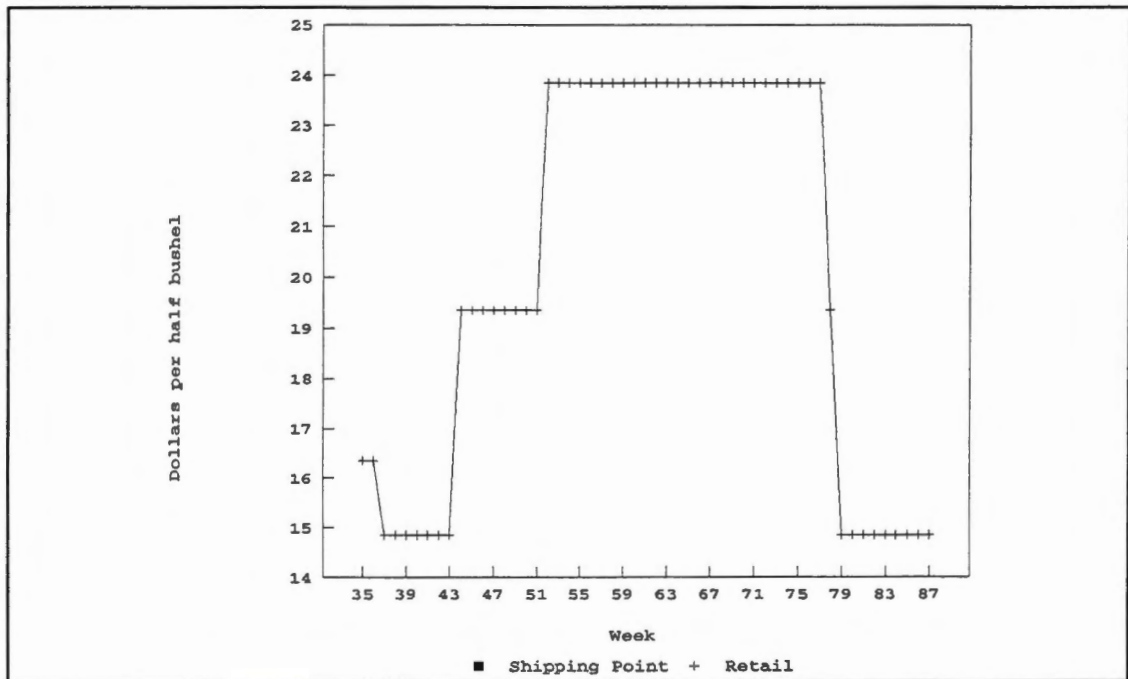
Appendix Figure 60. Cucumbers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1993



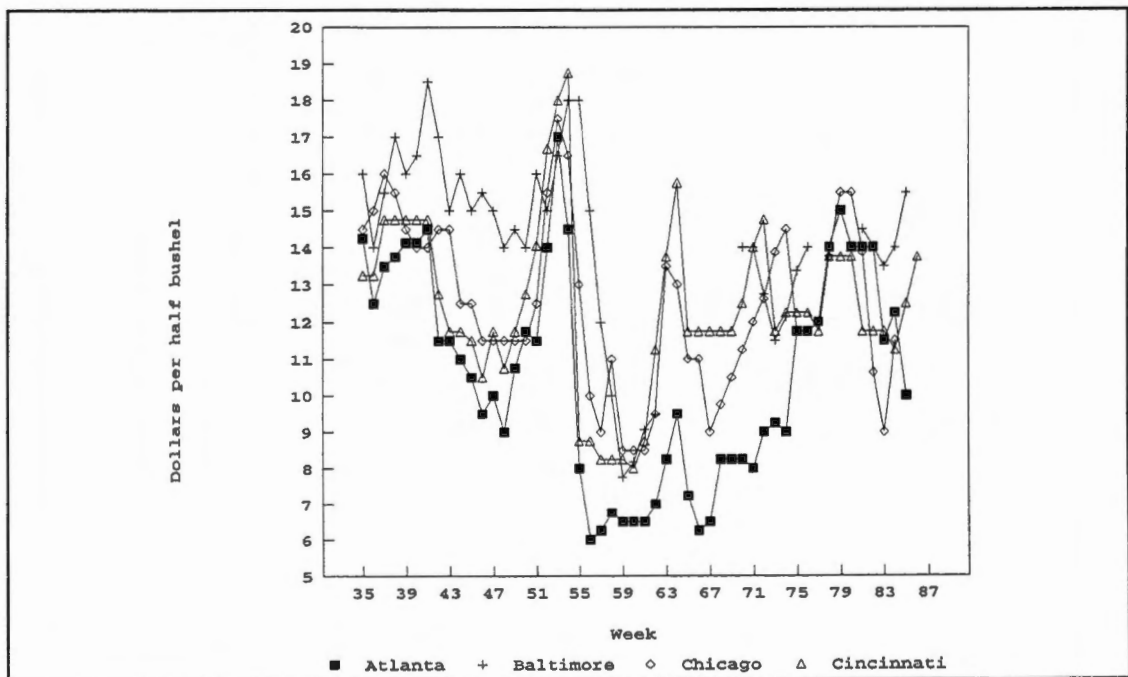
Appendix Figure 61. Okra: Retail and shipping point prices, 1988



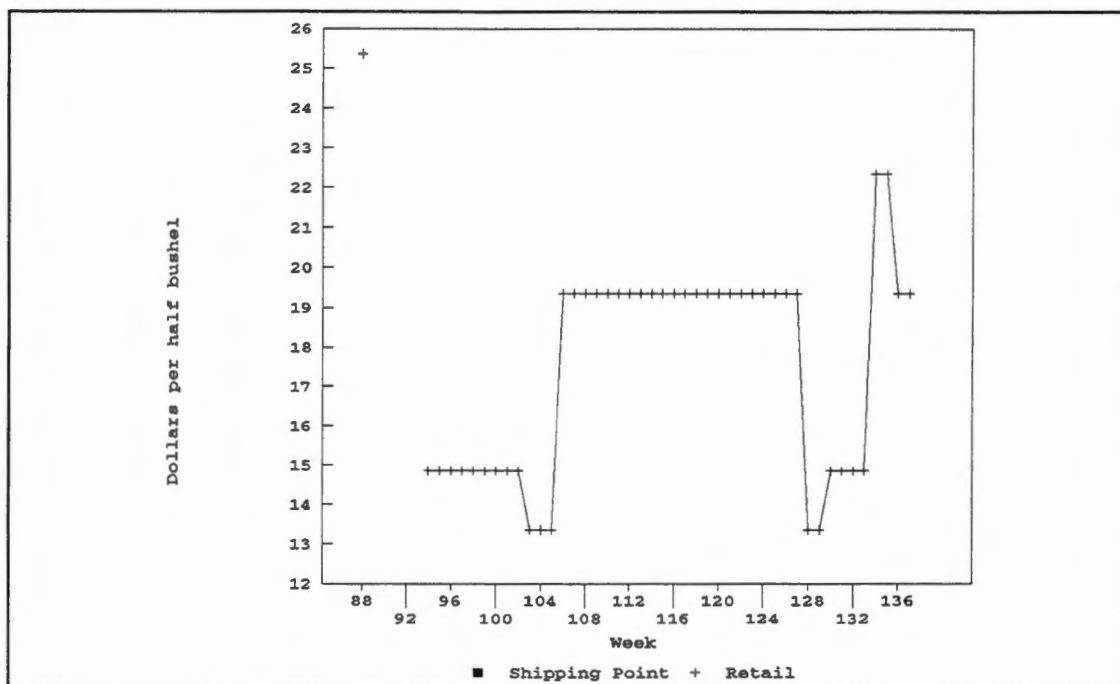
Appendix Figure 62. Okra: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1988



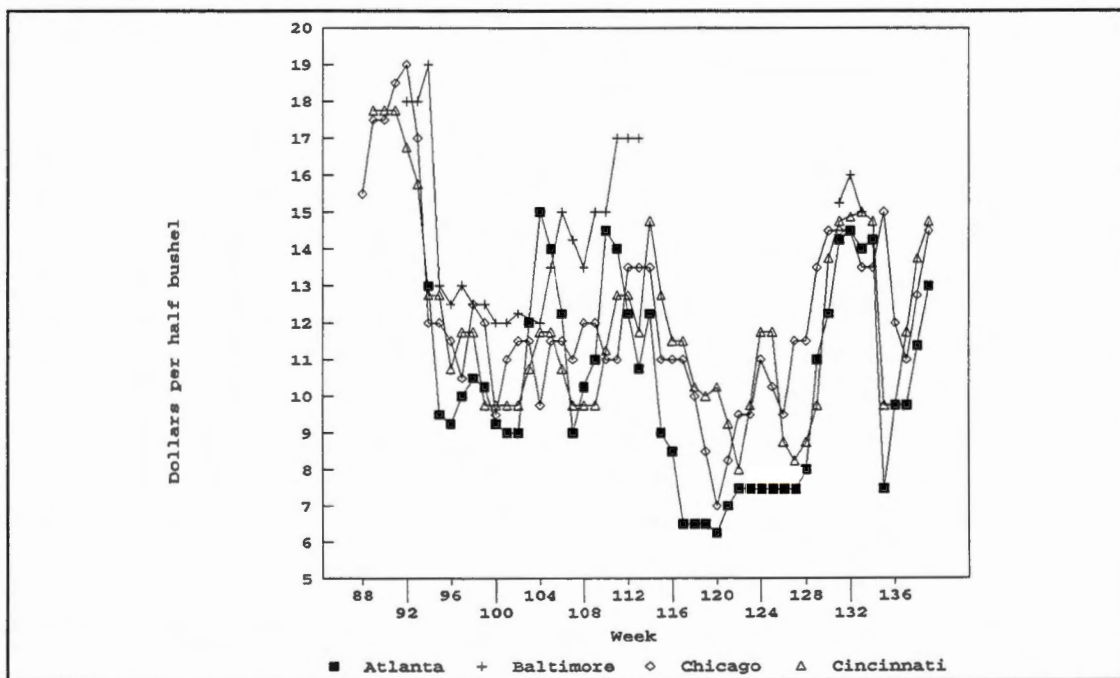
Appendix Figure 63. Okra: Retail and shipping point prices, 1989



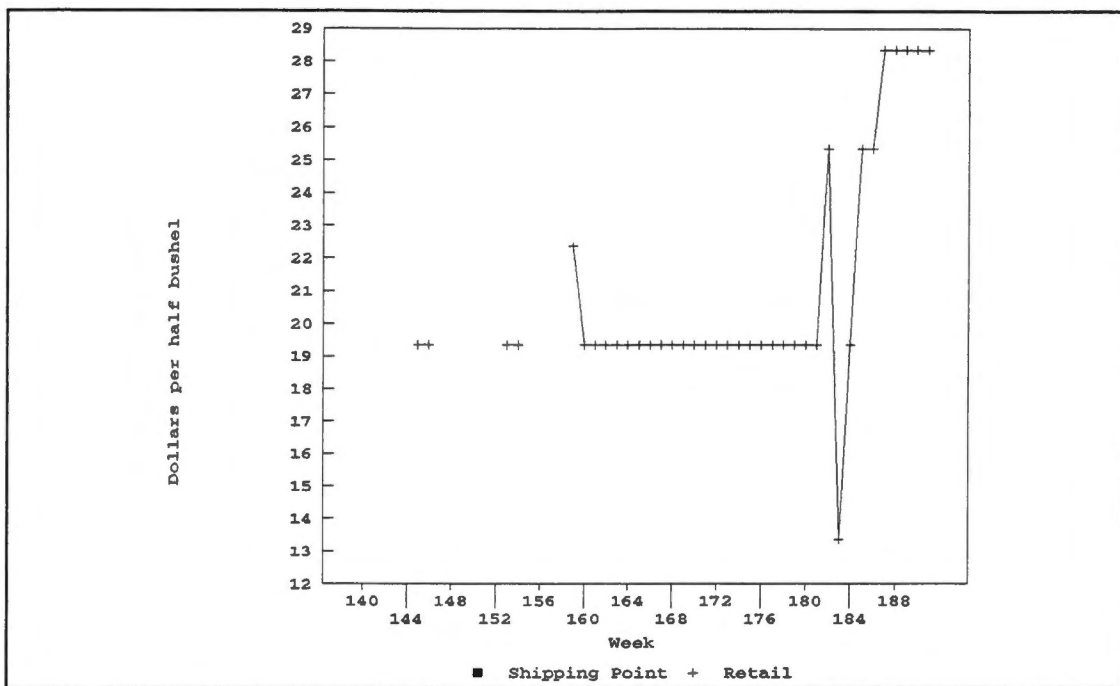
Appendix Figure 64. Okra: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1989



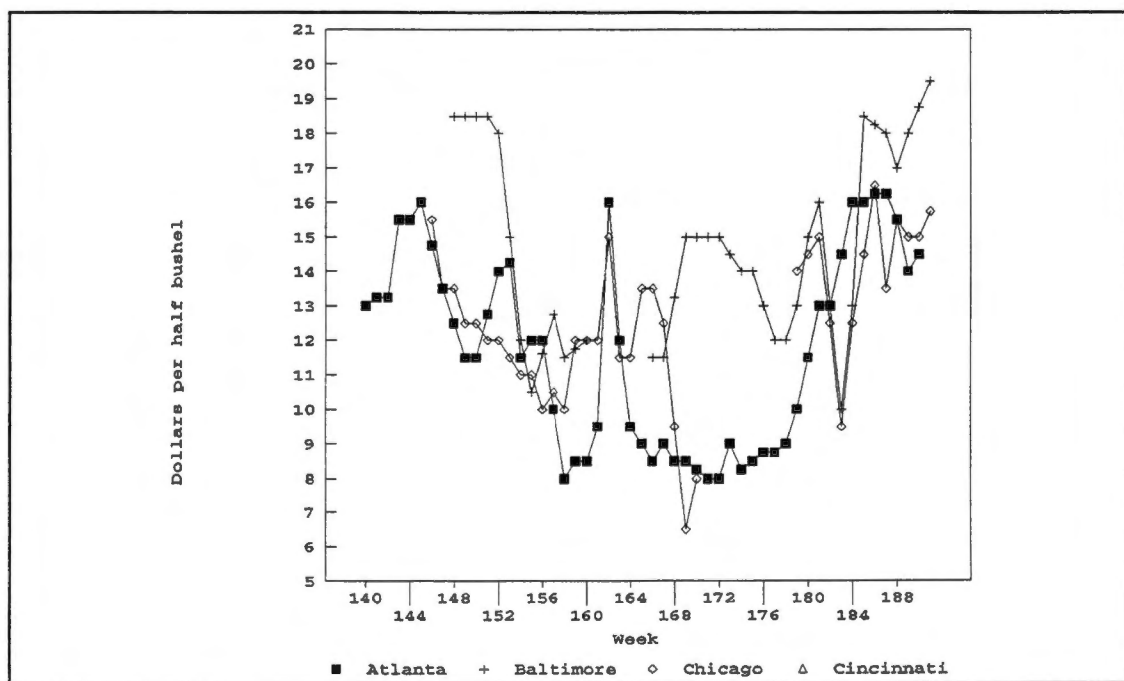
Appendix Figure 65. Okra: Retail and shipping point prices, 1990



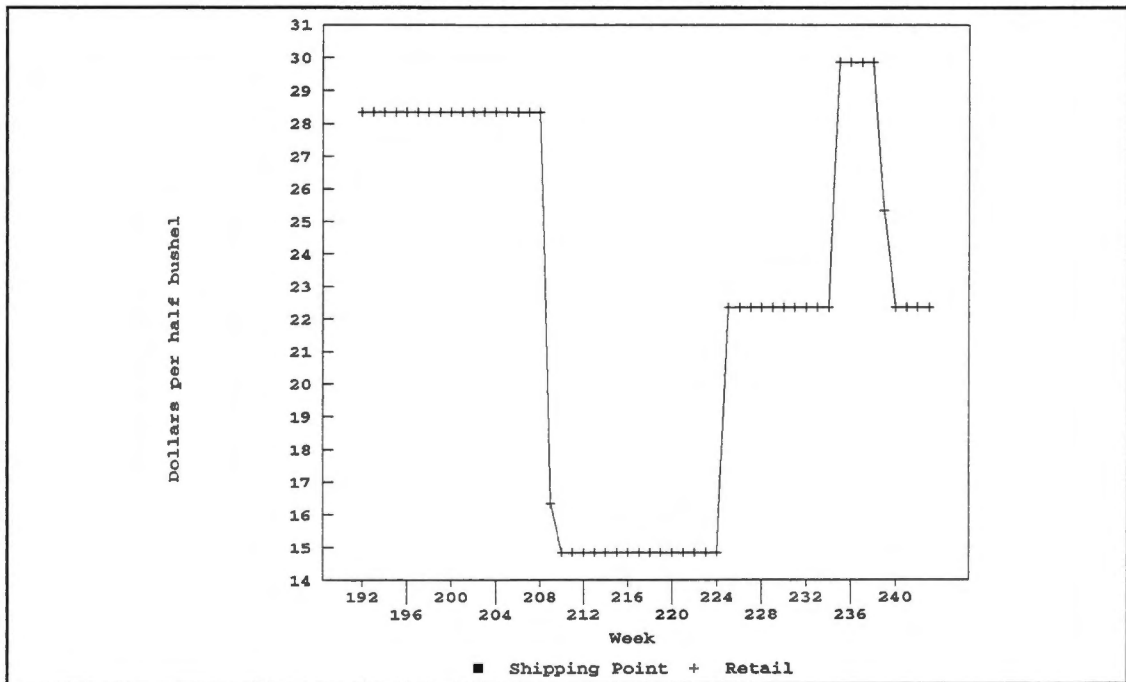
Appendix Figure 66. Okra: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market price, 1990



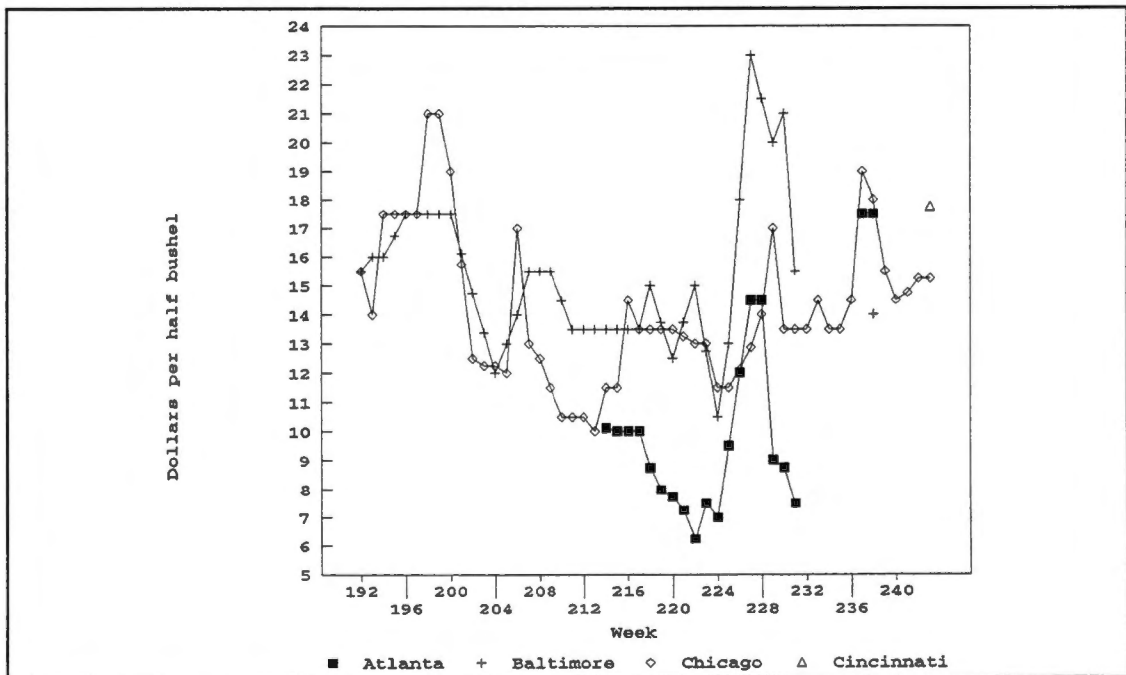
Appendix Figure 67. Okra: Retail and shipping point prices, 1991



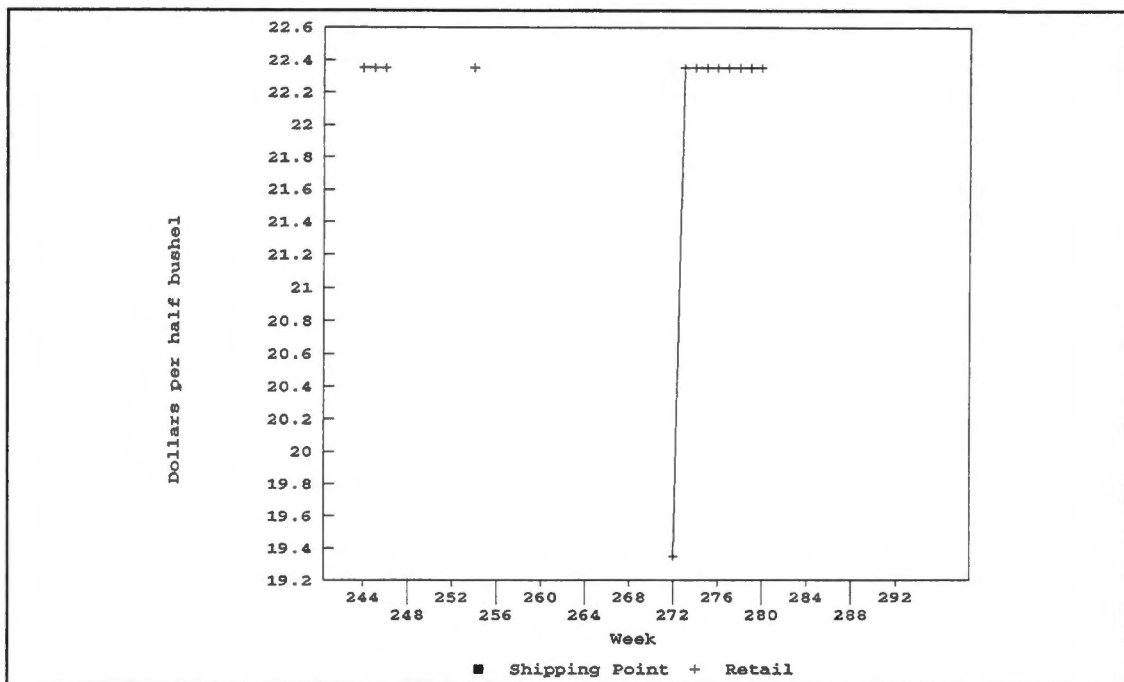
Appendix Figure 68. Okra: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1991



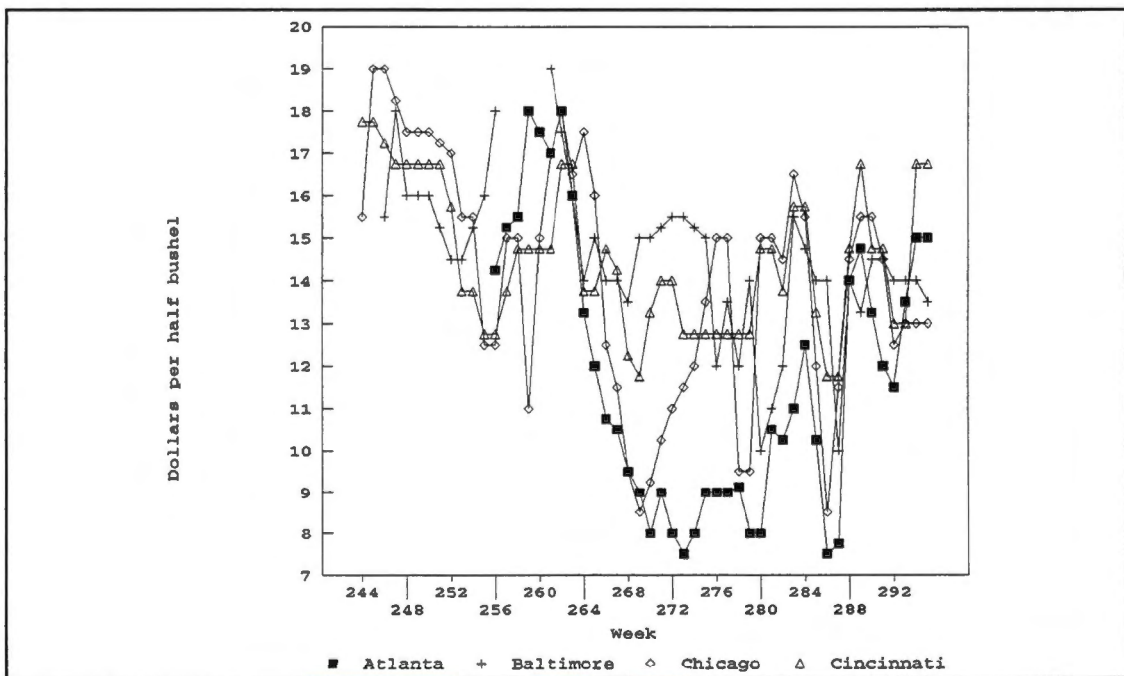
Appendix Figure 69. Okra: Retail and shipping point prices, 1992



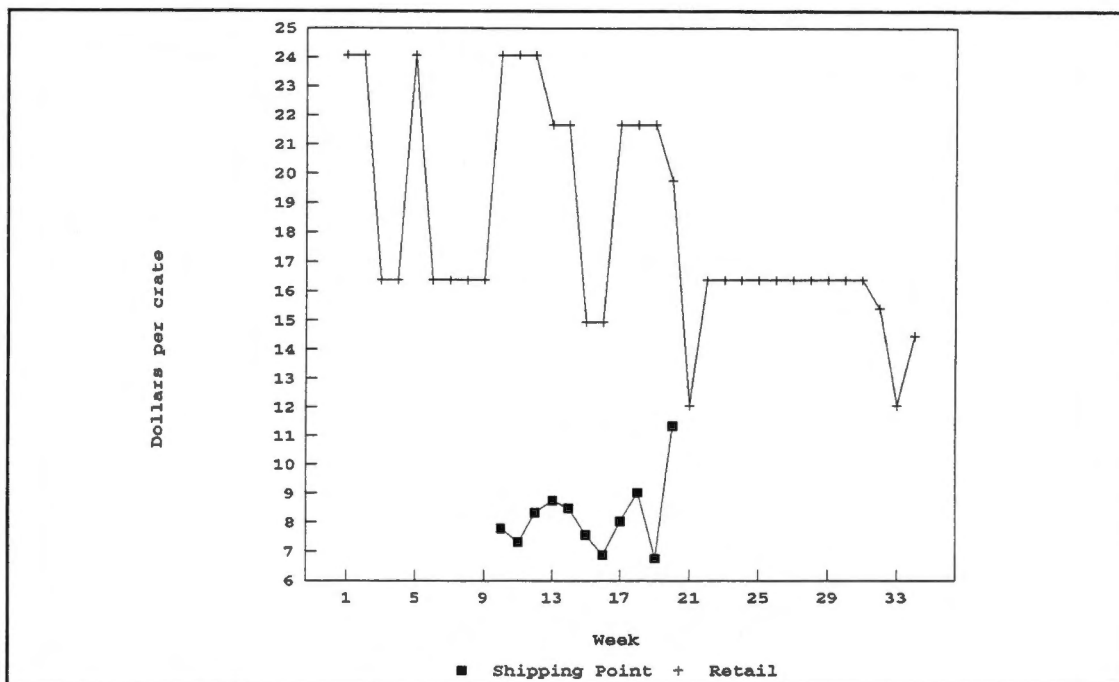
Appendix Figure 70. Okra: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1992



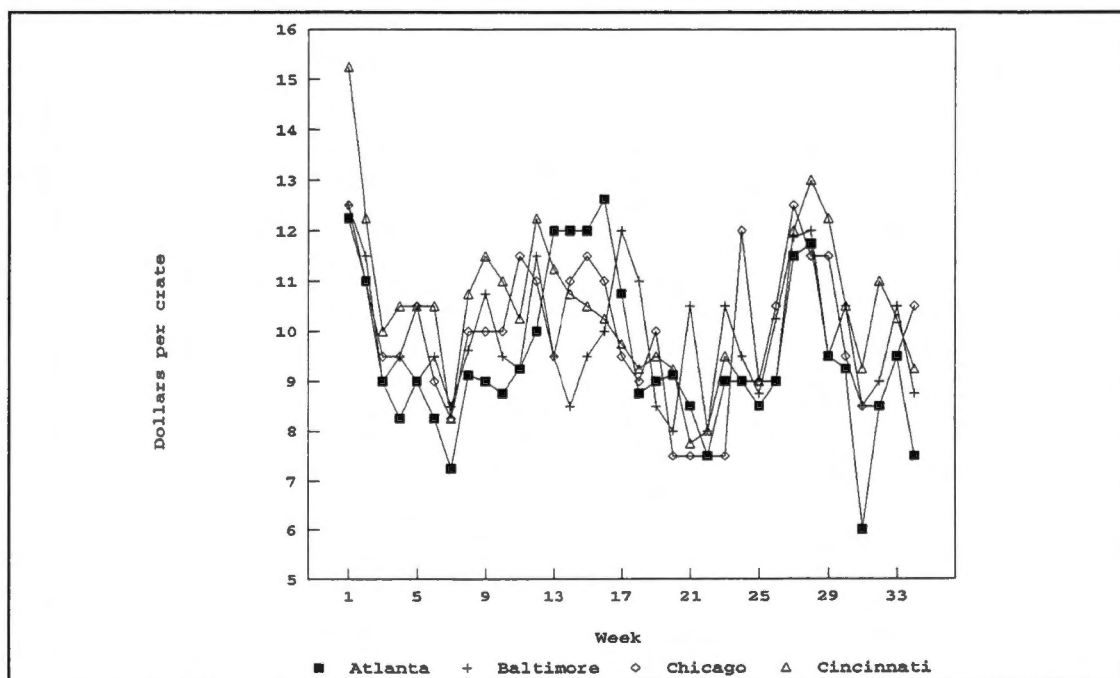
Appendix Figure 71. Okra: Retail and shipping point prices, 1993



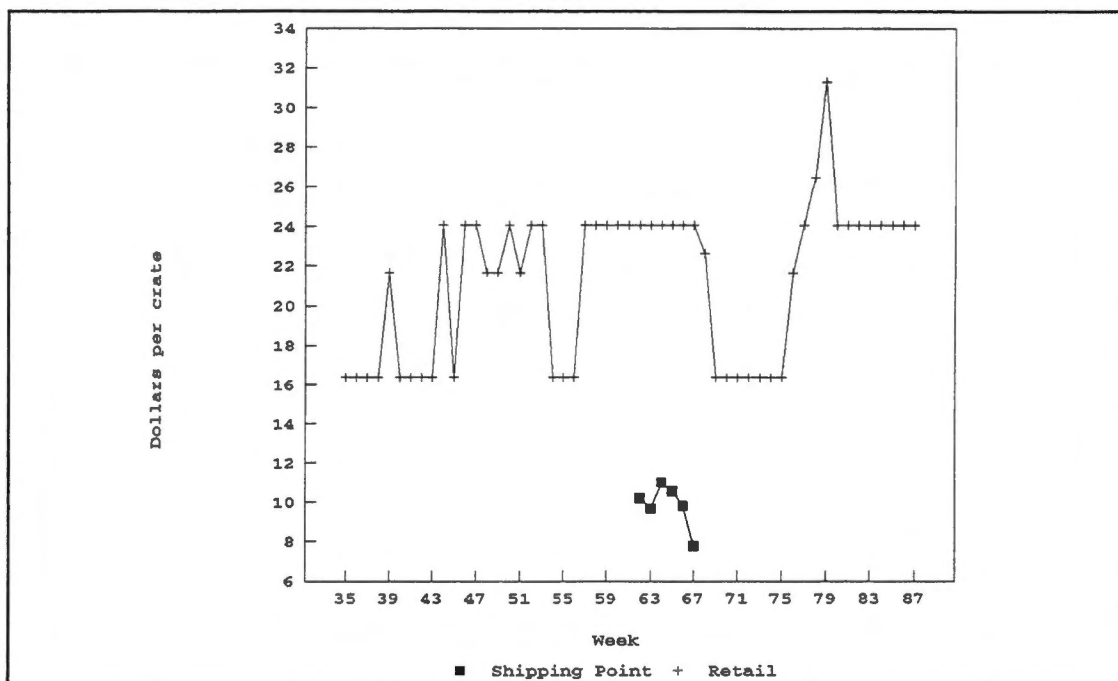
Appendix Figure 72. Okra: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1993



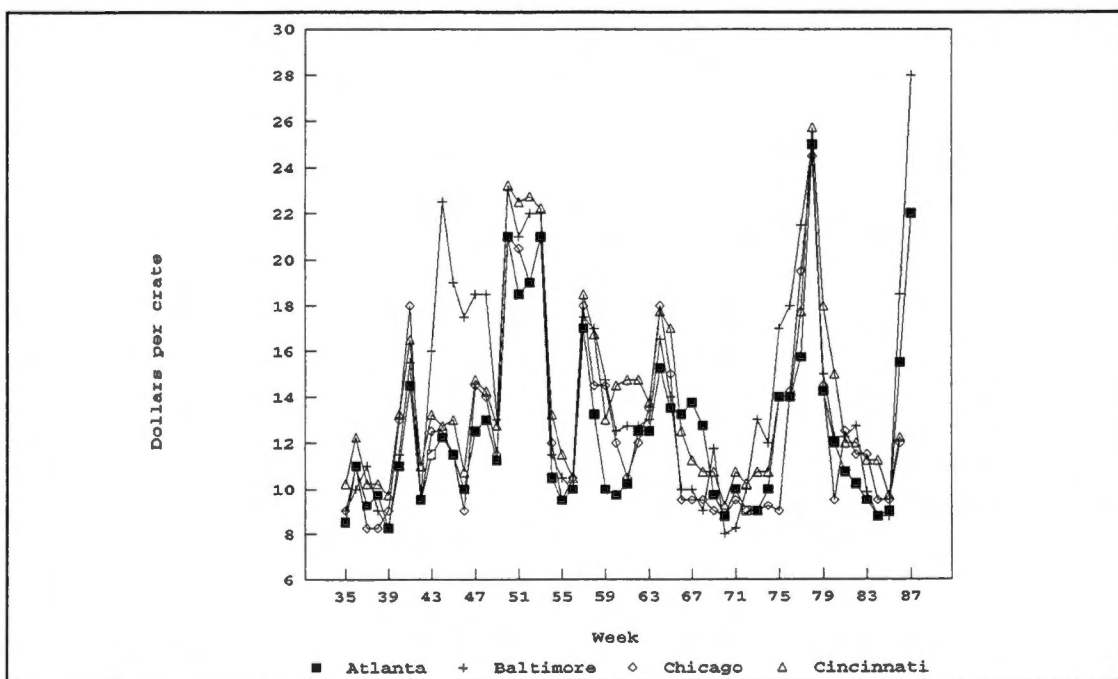
Appendix Figure 73. Green Peppers: Retail and shipping point prices, 1988



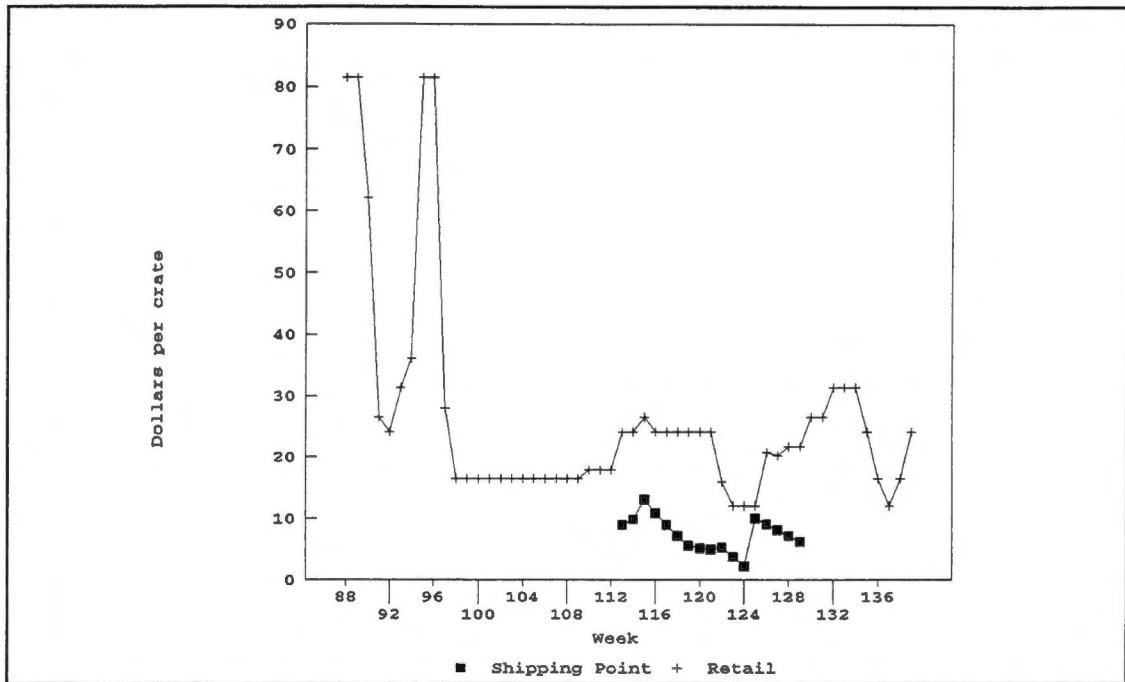
Appendix Figure 74. Green Peppers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market price, 1988



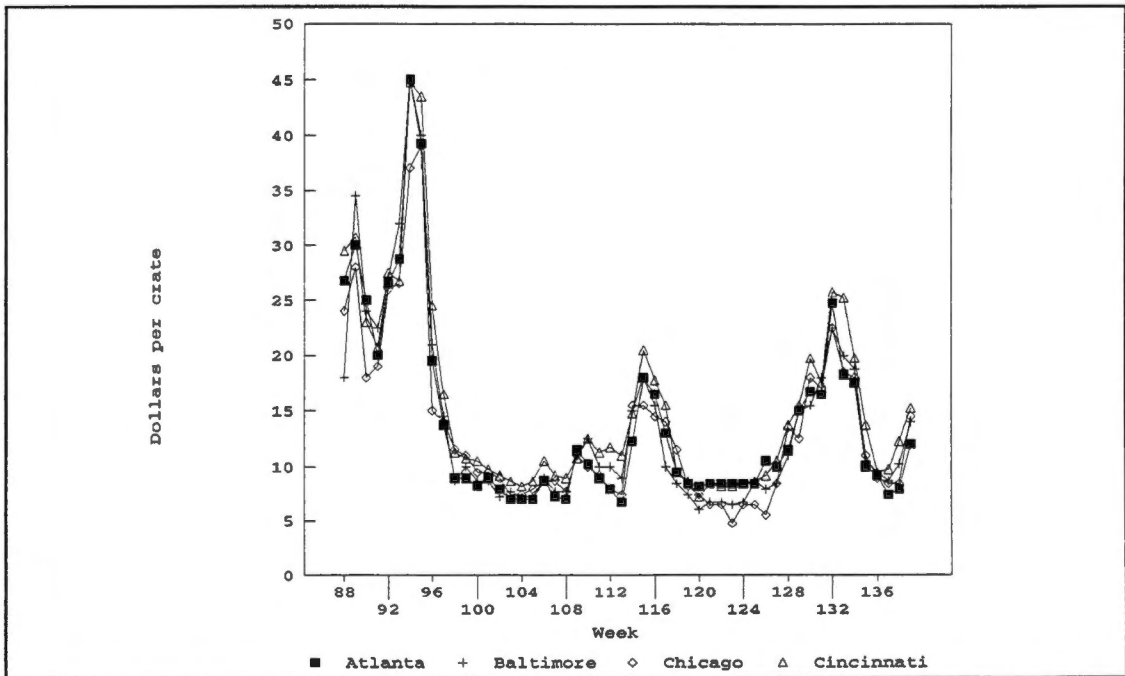
Appendix Figure 75. Green Peppers: Retail and shipping point prices, 1989



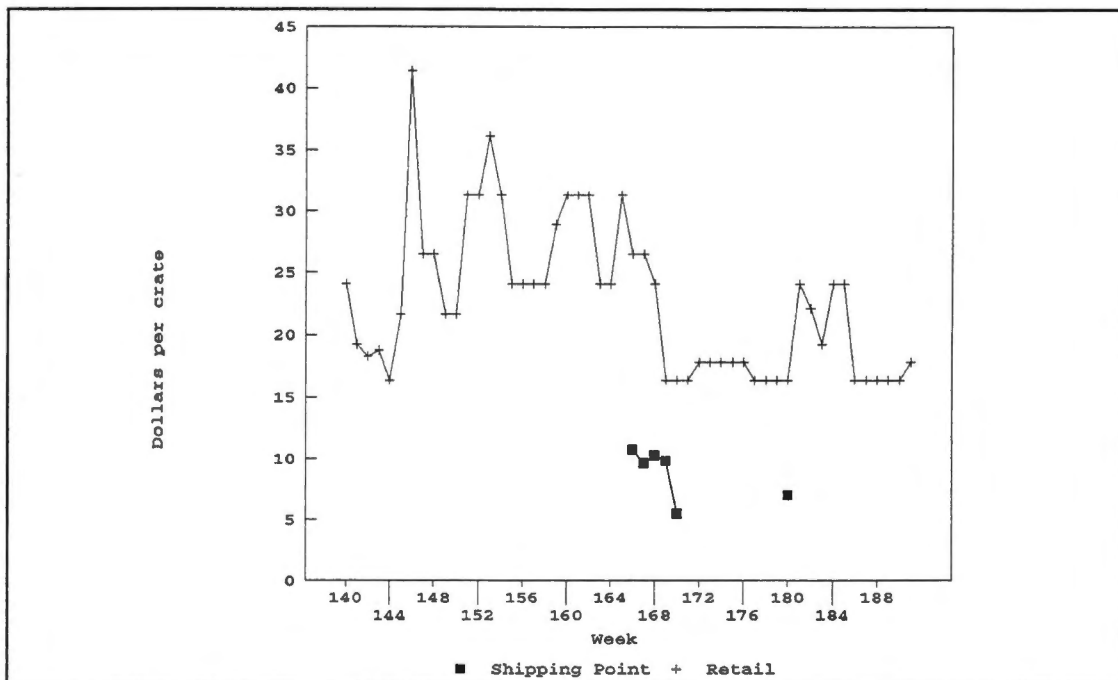
Appendix Figure 76. Green Peppers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1989



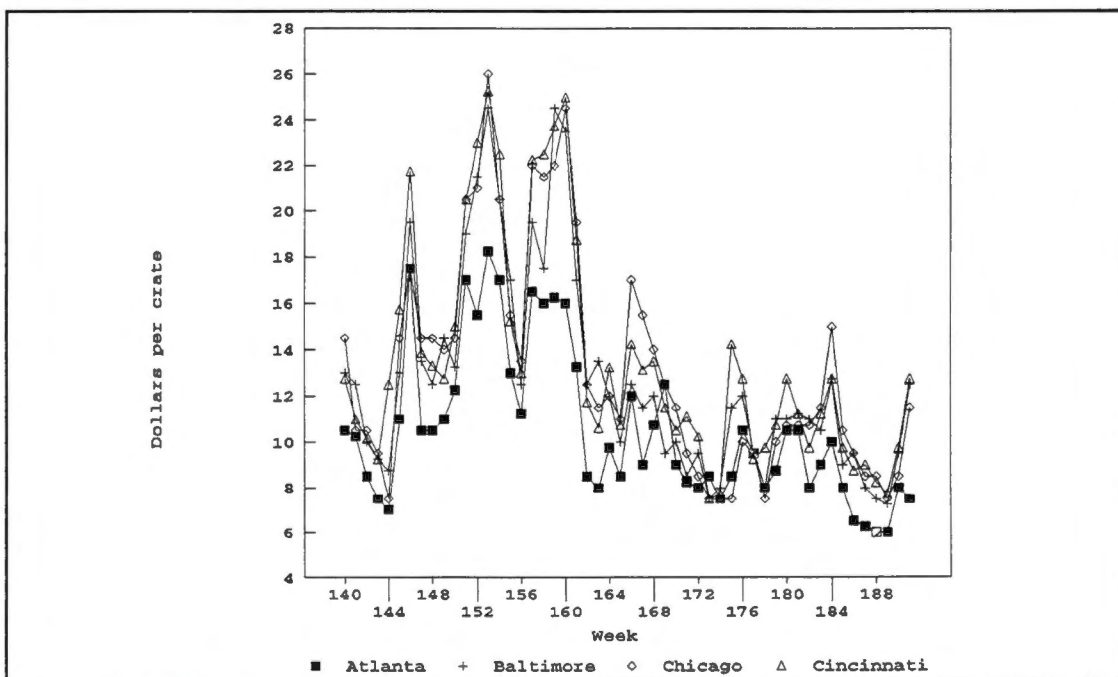
Appendix Figure 77. Green Peppers: Retail and shipping point prices 1990



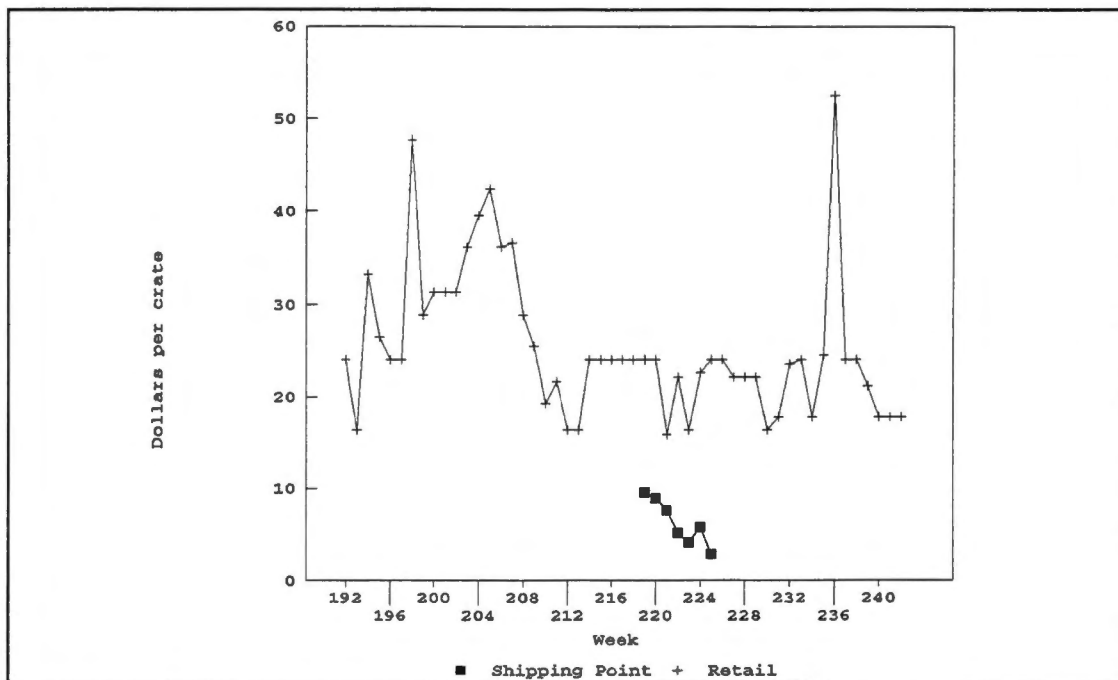
Appendix Figure 78. Green Peppers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1990



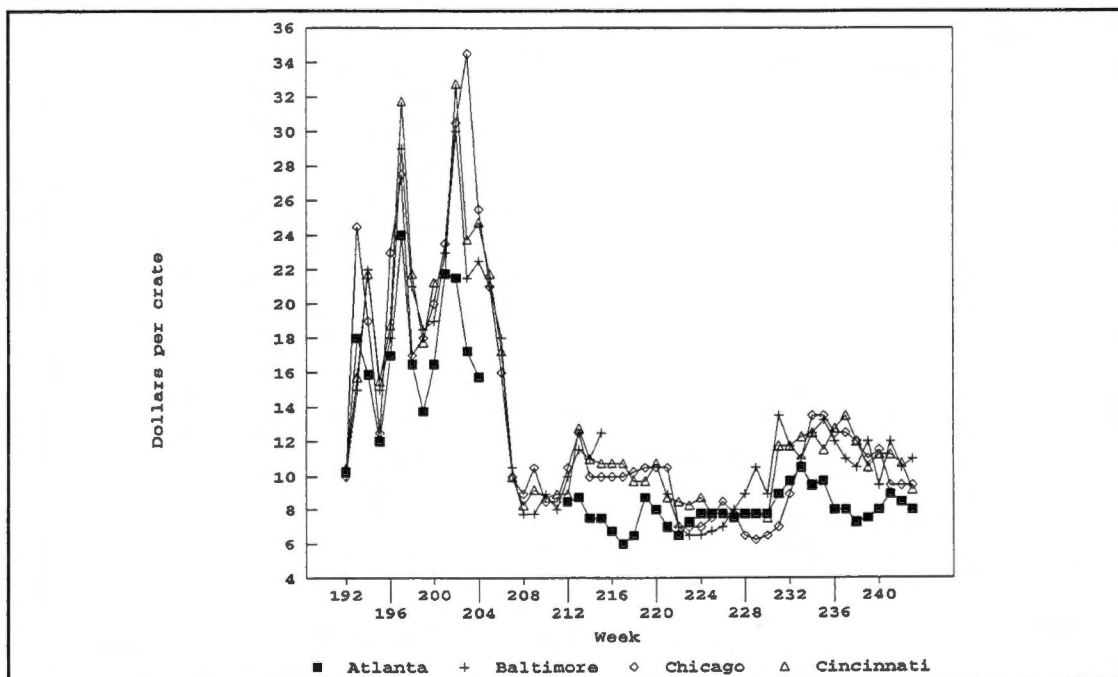
Appendix Figure 79. Green Peppers: Retail and shipping point prices, 1991



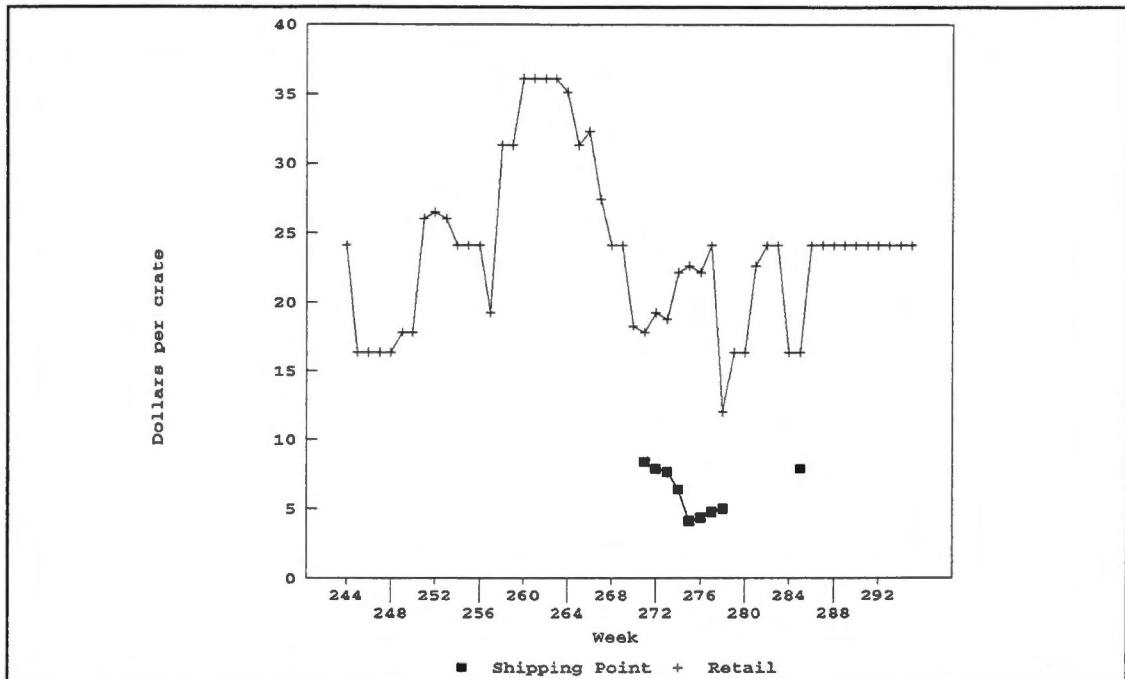
Appendix Figure 80. Green Peppers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1991



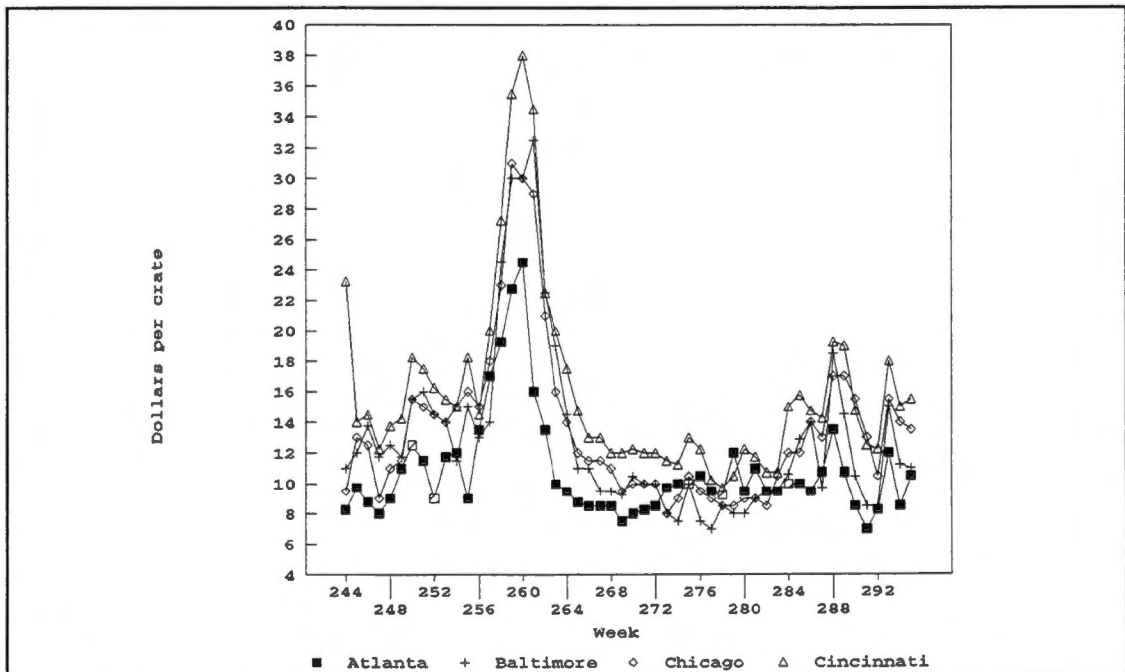
Appendix Figure 81. Green Peppers: Retail and shipping point prices, 1992



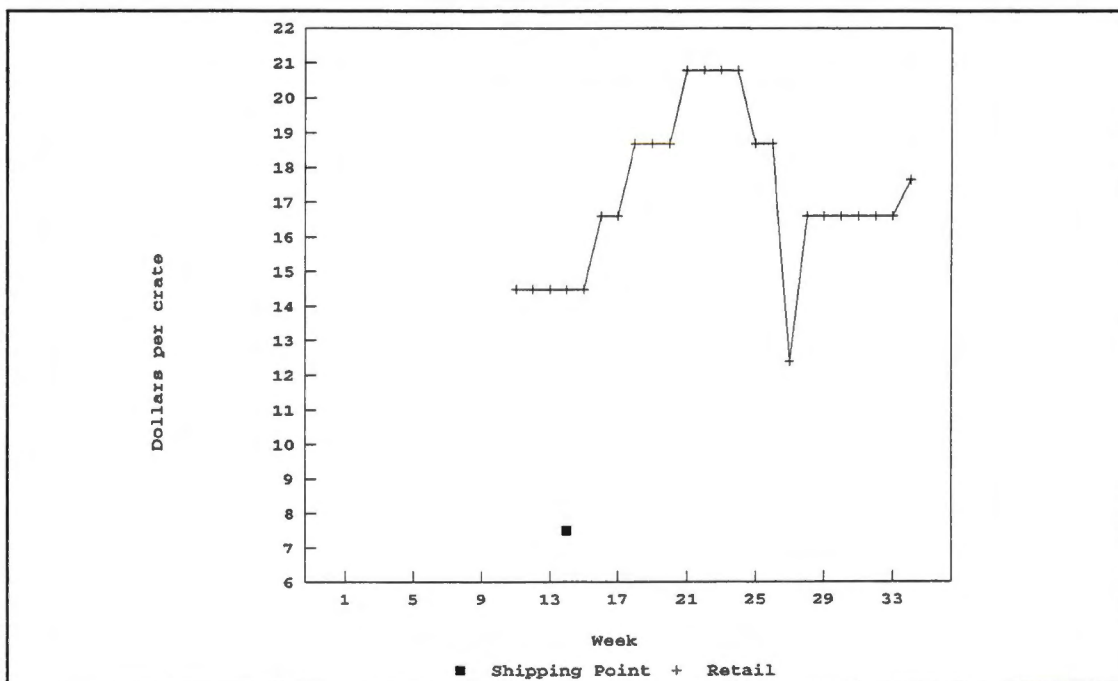
Appendix Figure 82. Green Peppers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1992



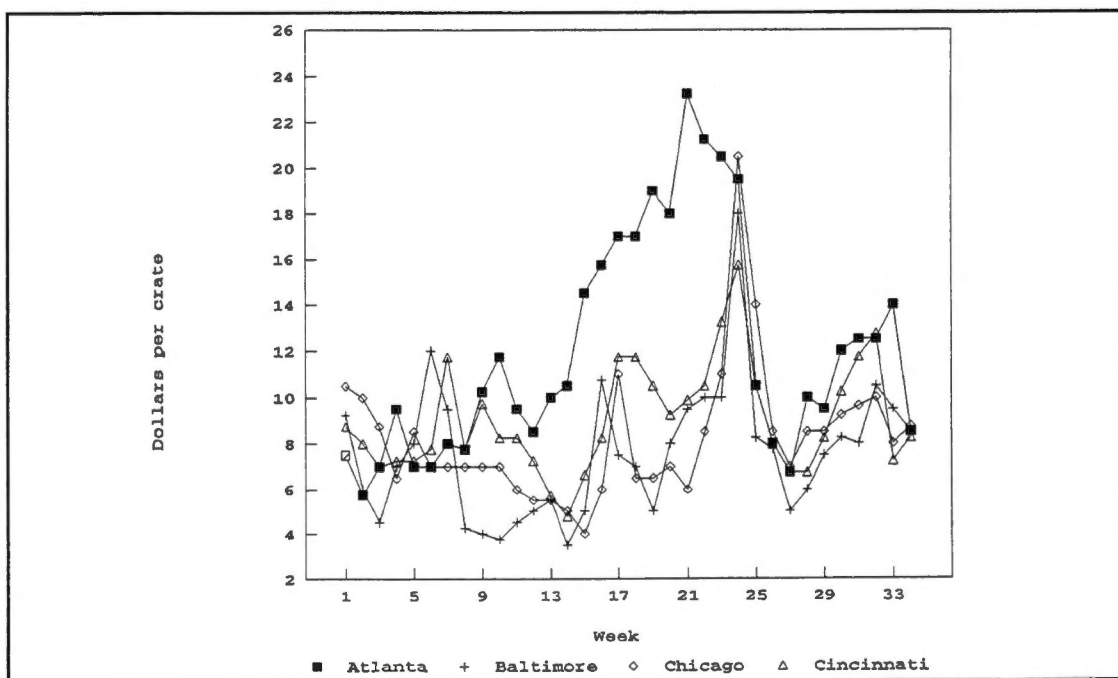
Appendix Figure 83. Green Peppers: Retail and shipping point prices, 1993



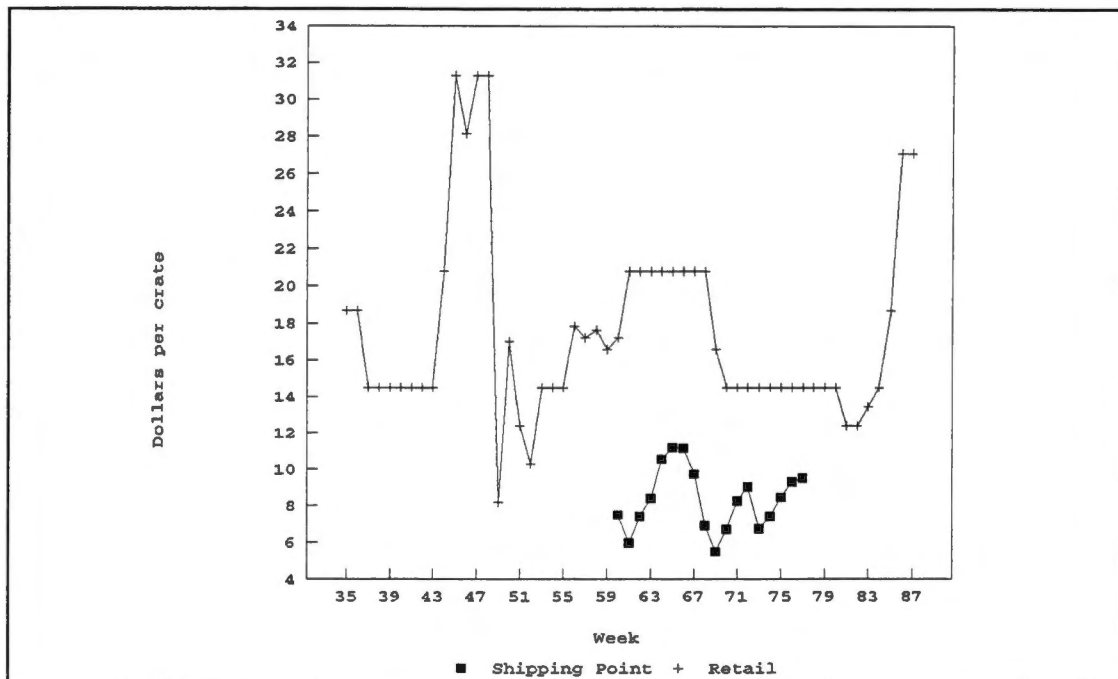
Appendix Figure 84. Green Peppers: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1993



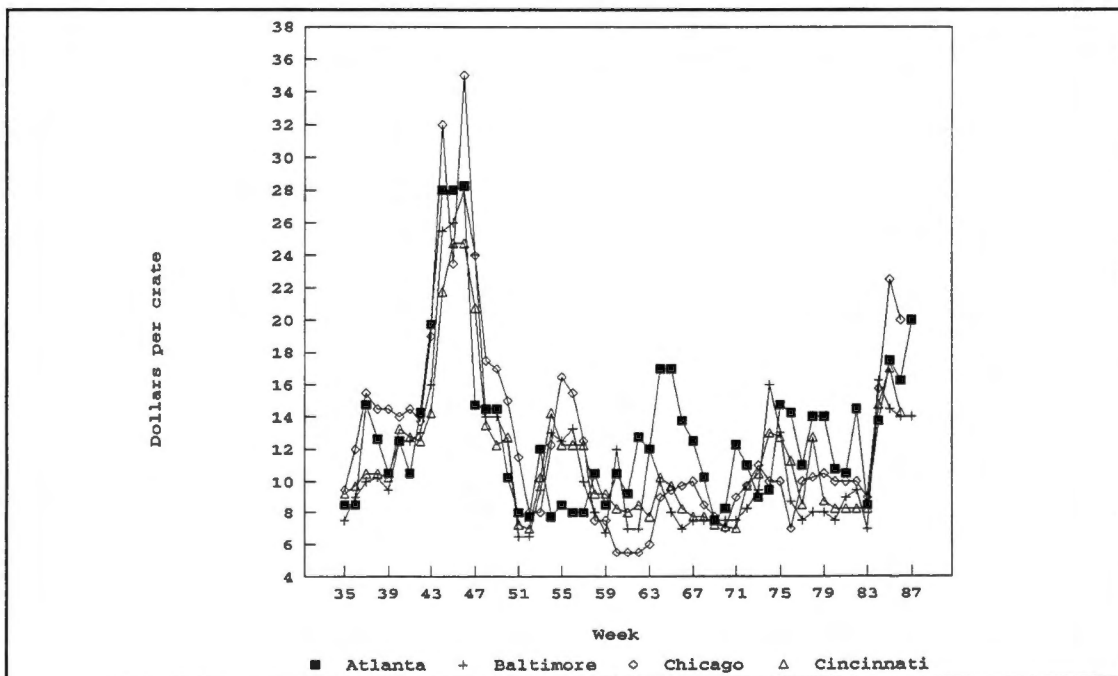
Appendix Figure 85. Yellow Squash: Retail and shipping point prices, 1988



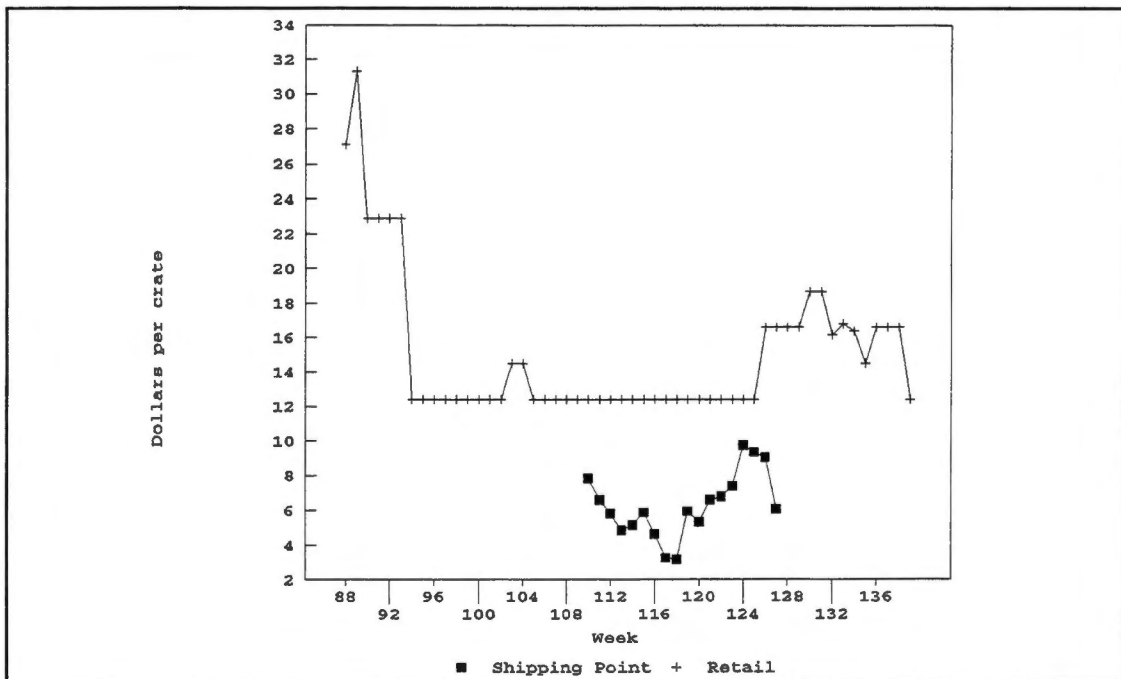
Appendix Figure 86. Yellow Squash: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1988



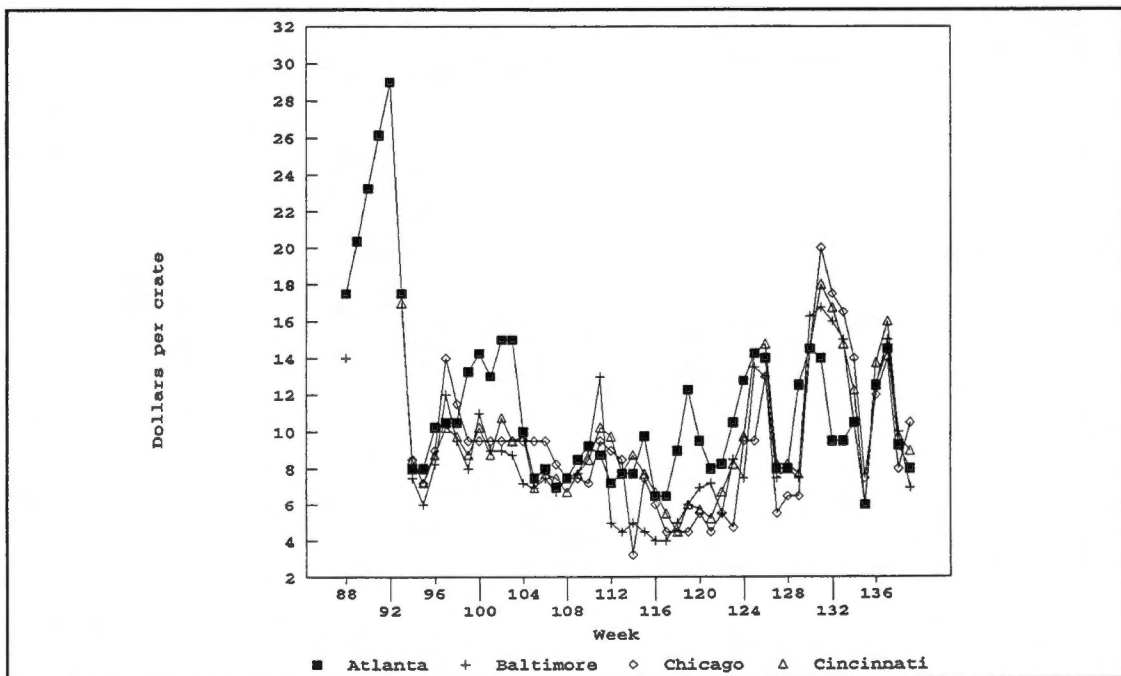
Appendix Figure 87. Yellow Squash: Retail and shipping point prices, 1989



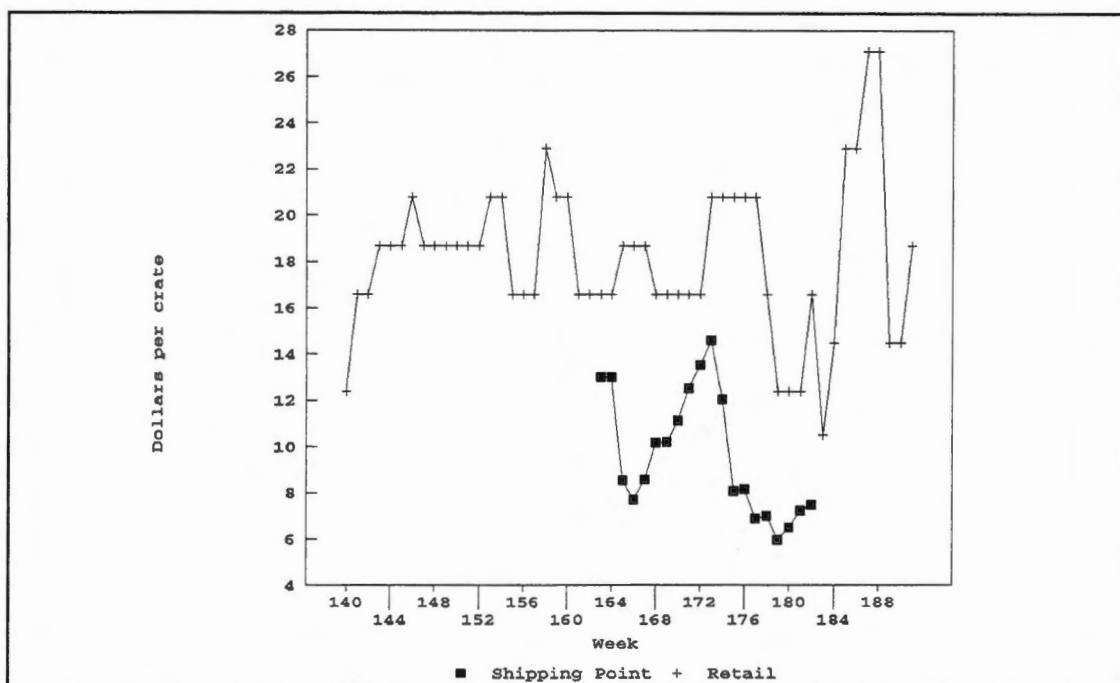
Appendix Figure 88. Yellow Squash: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1989



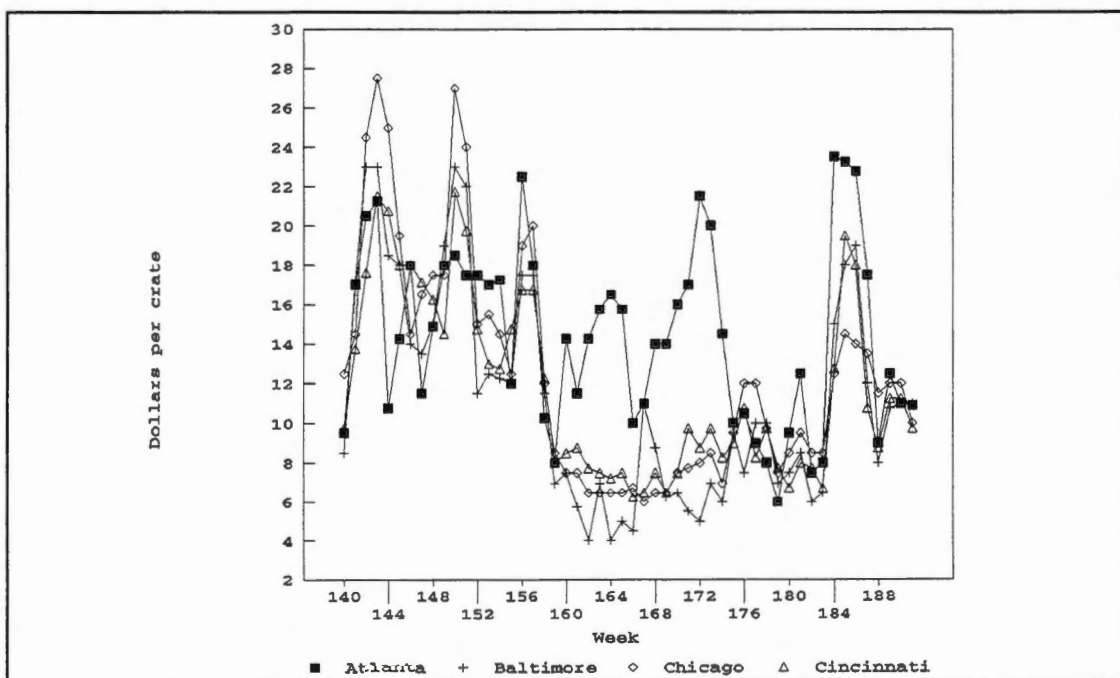
Appendix Figure 89. Yellow Squash: Retail and shipping point prices, 1990



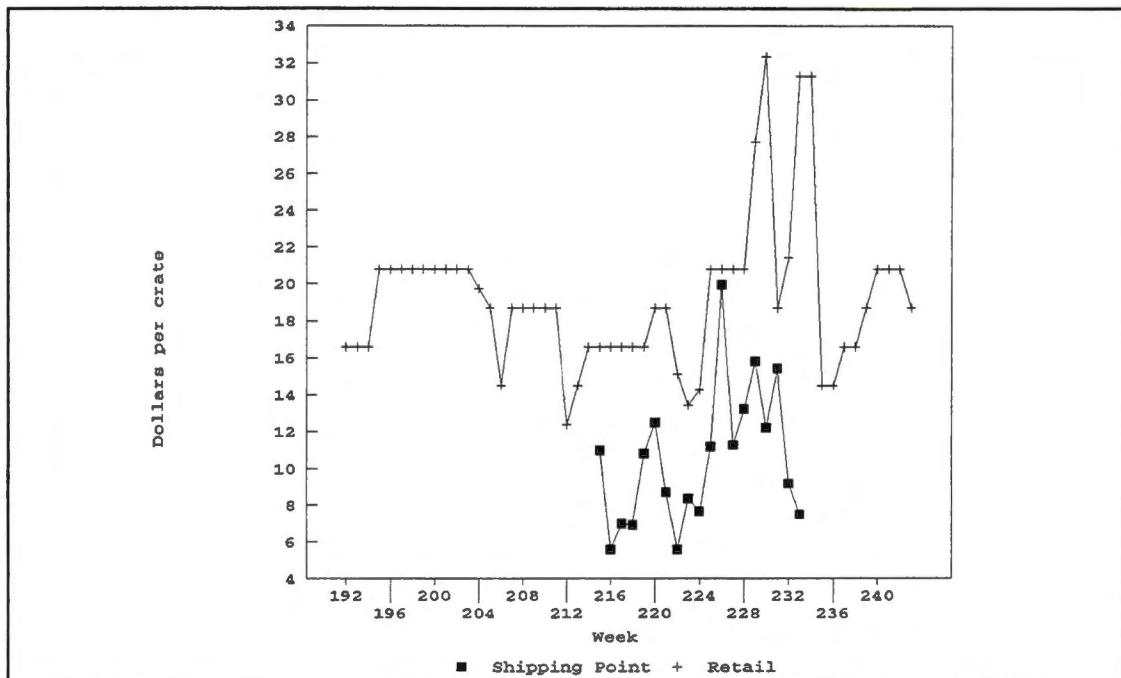
Appendix Figure 90. Yellow Squash: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1990



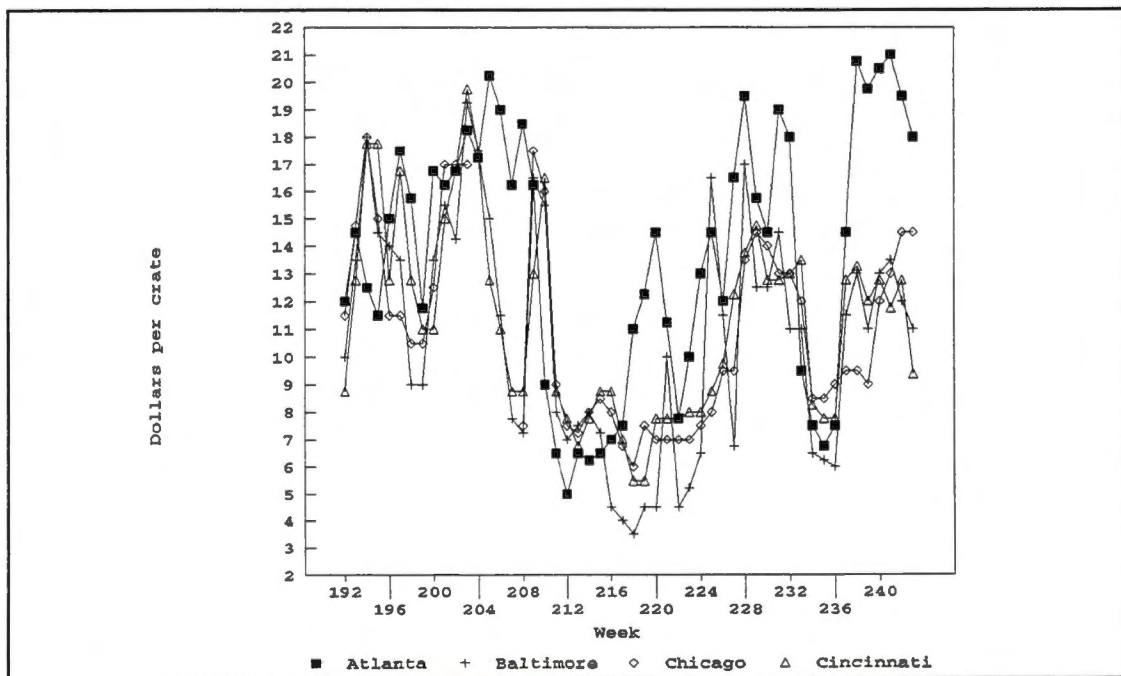
Appendix Figure 91. Yellow Squash: Retail and shipping point prices, 1991



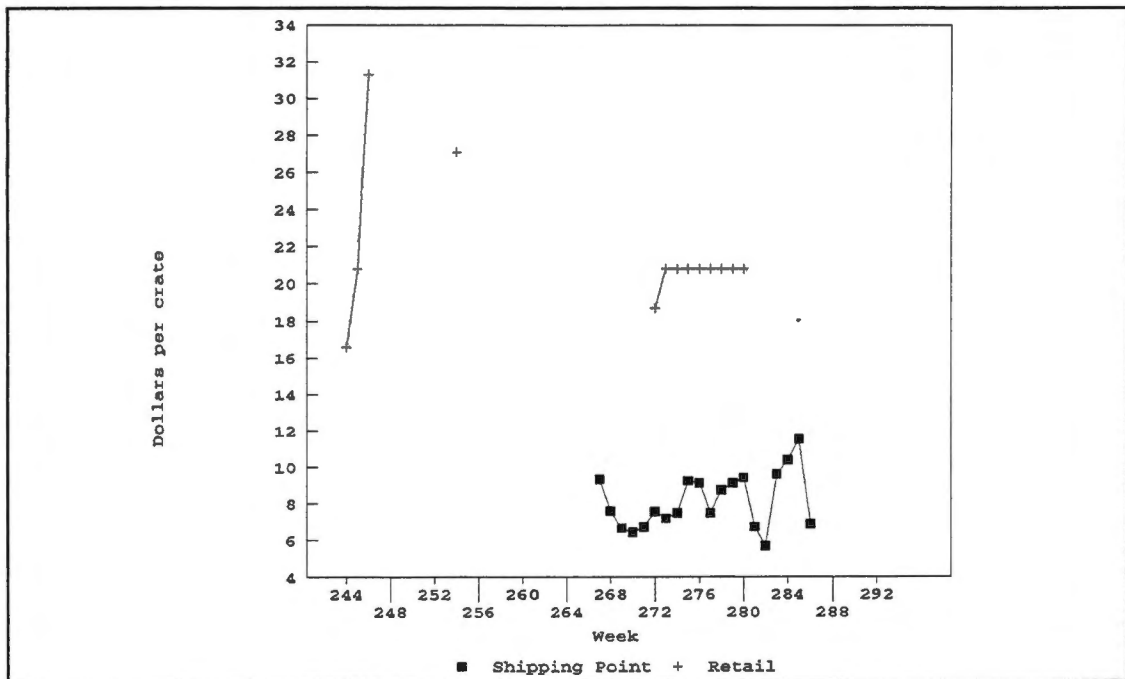
Appendix Figure 92. Yellow Squash: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1991



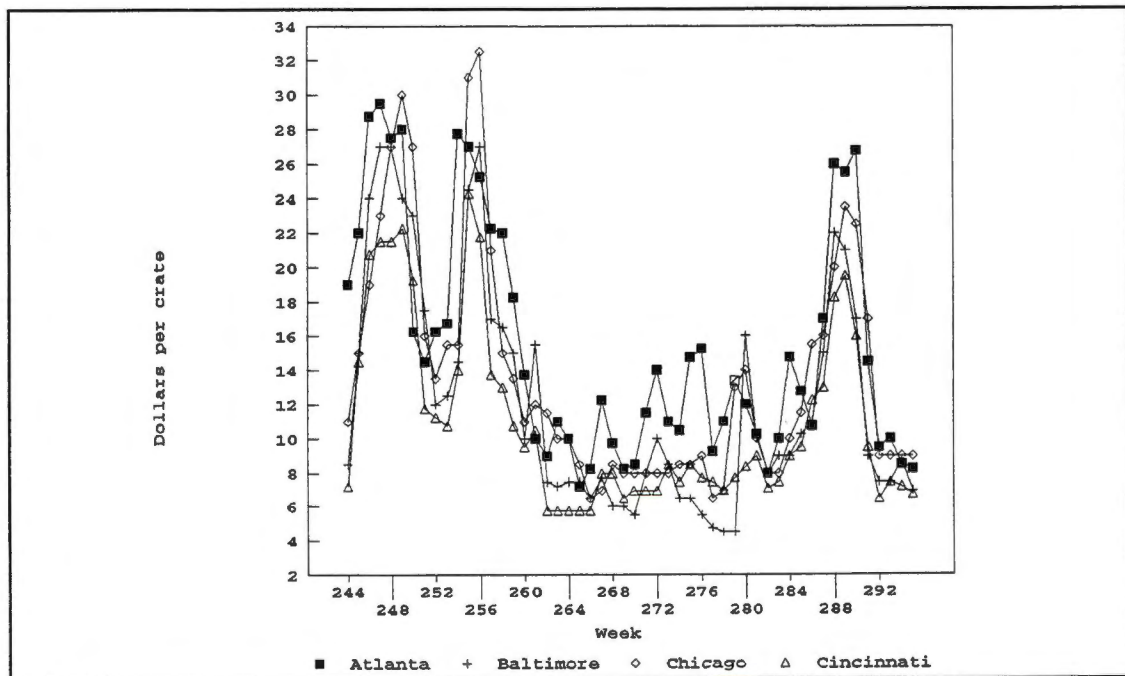
Appendix Figure 93. Yellow Squash: Retail and shipping point prices, 1992



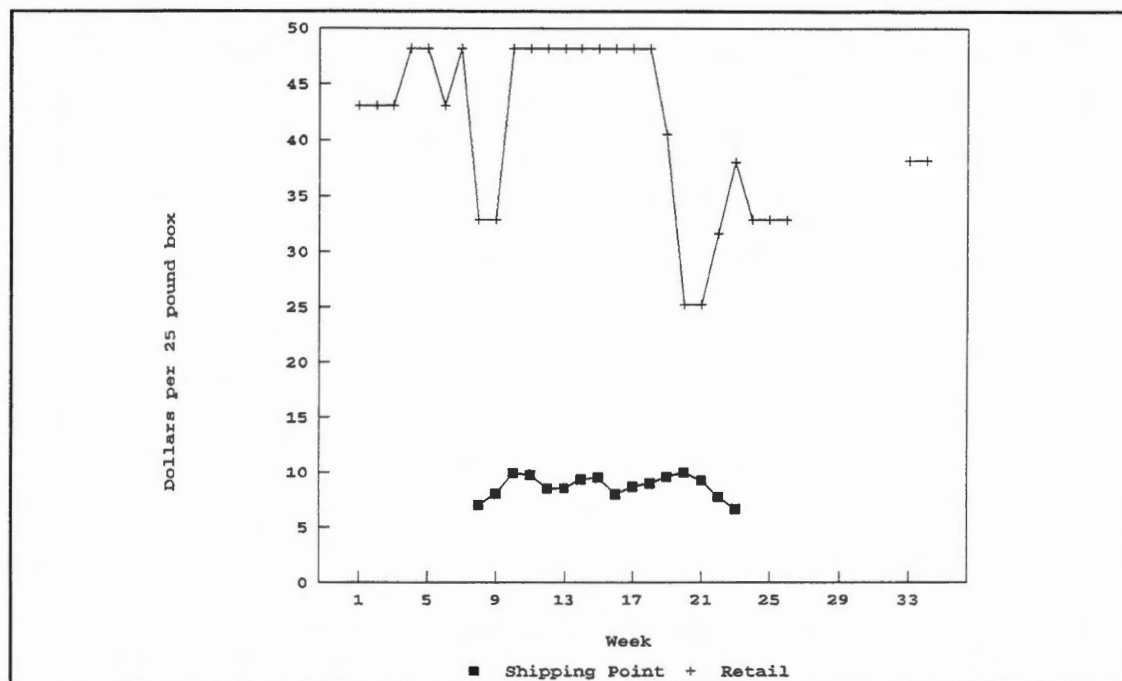
Appendix Figure 94. Yellow Squash: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1992



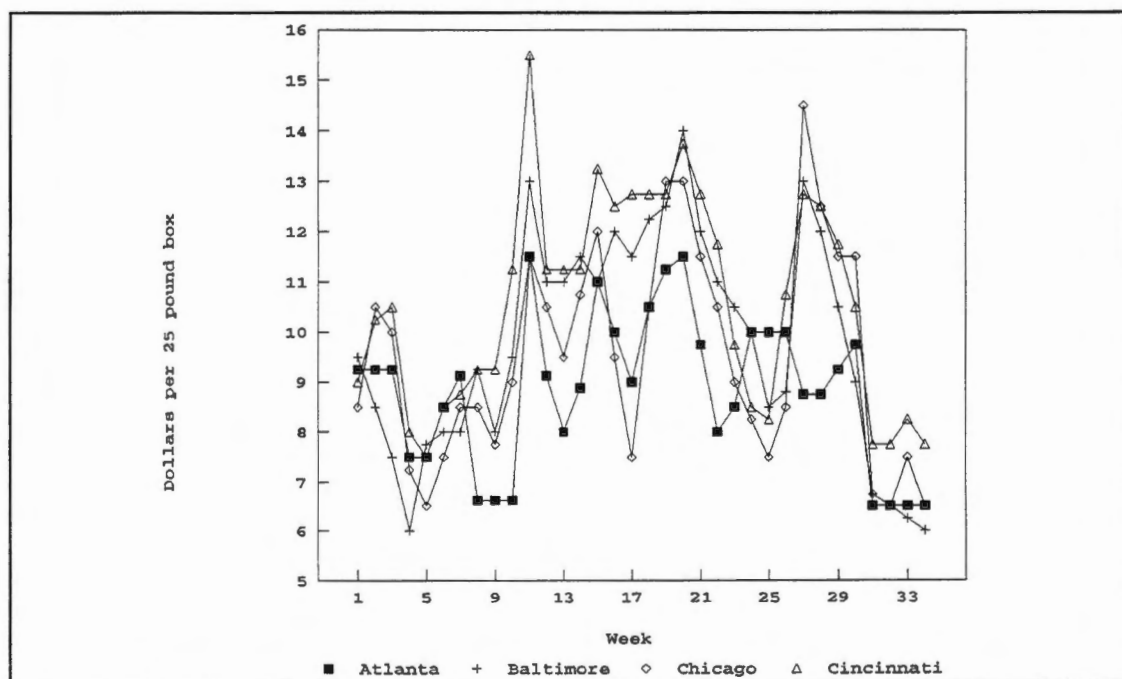
Appendix Figure 95. Yellow Squash: Retail and shipping point prices, 1993



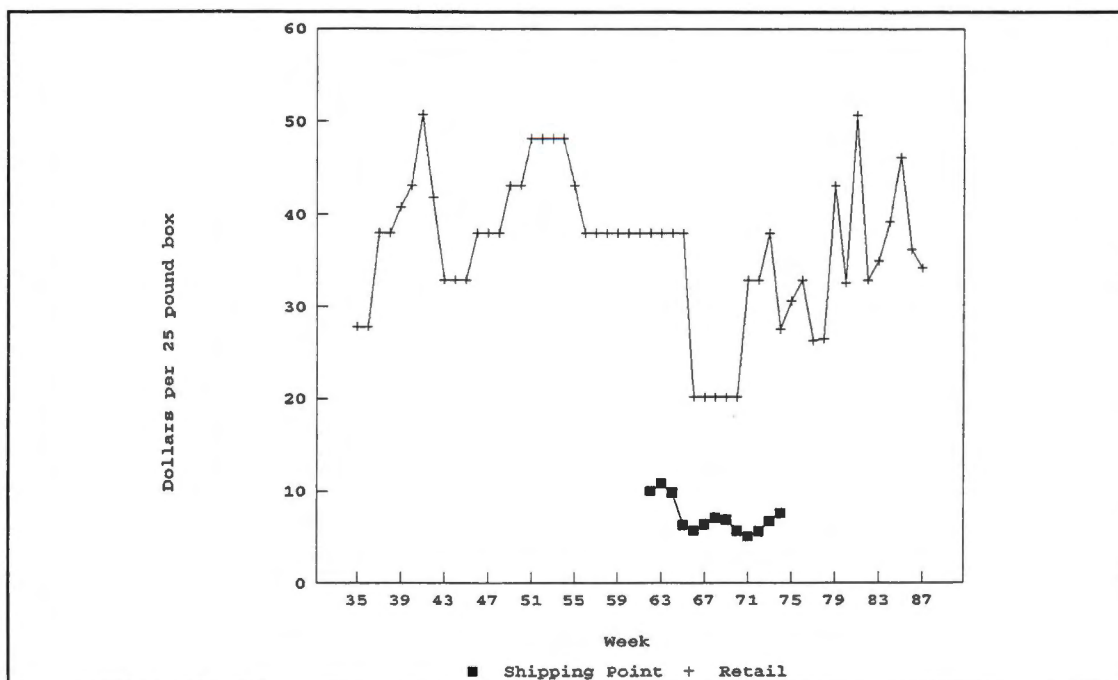
Appendix Figure 96. Yellow Squash: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1993



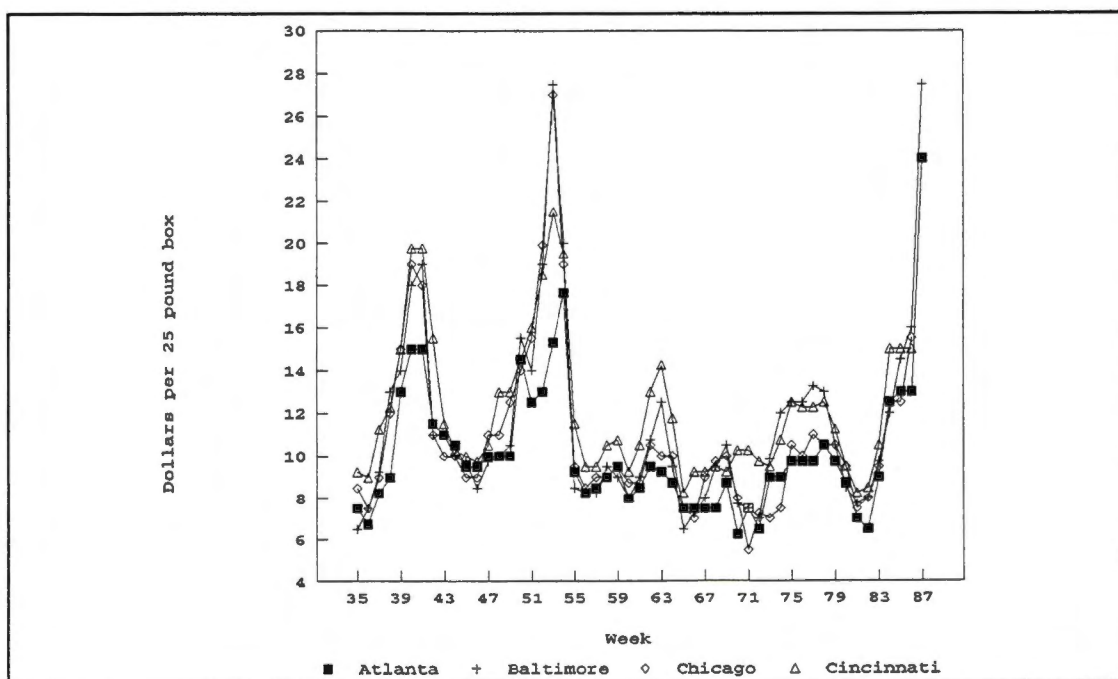
Appendix Figure 97. Tomatoes: Retail and shipping point prices, 1988



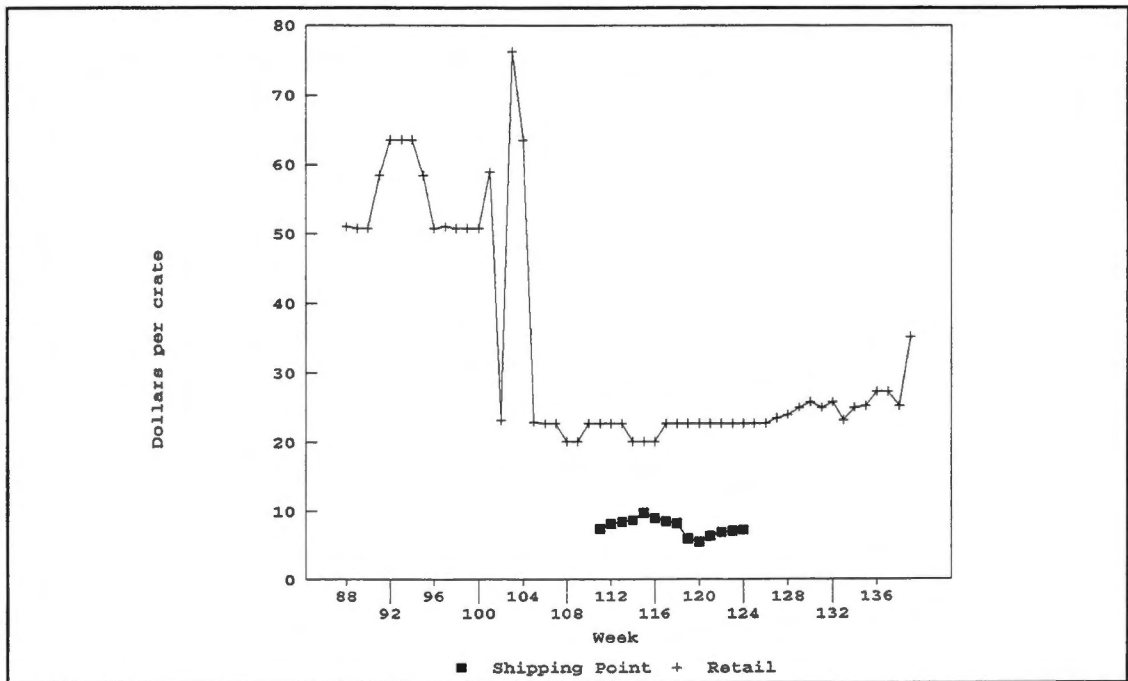
Appendix Figure 98. Tomatoes: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1988



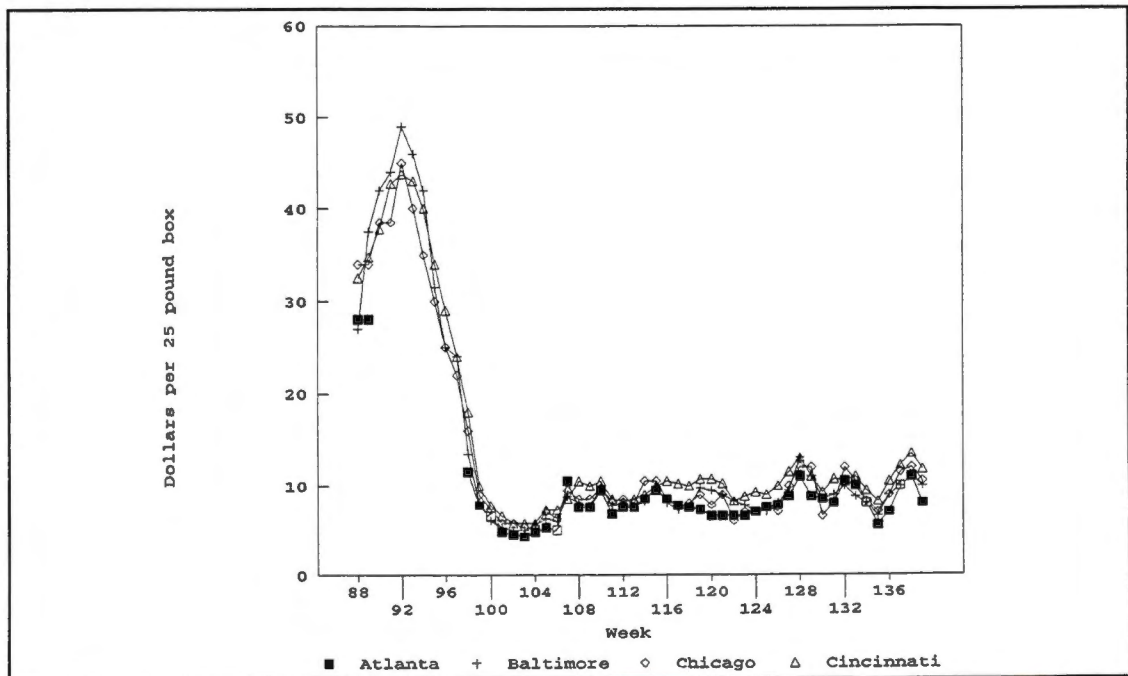
Appendix Figure 99. Tomatoes: Retail and shipping point prices, 1989



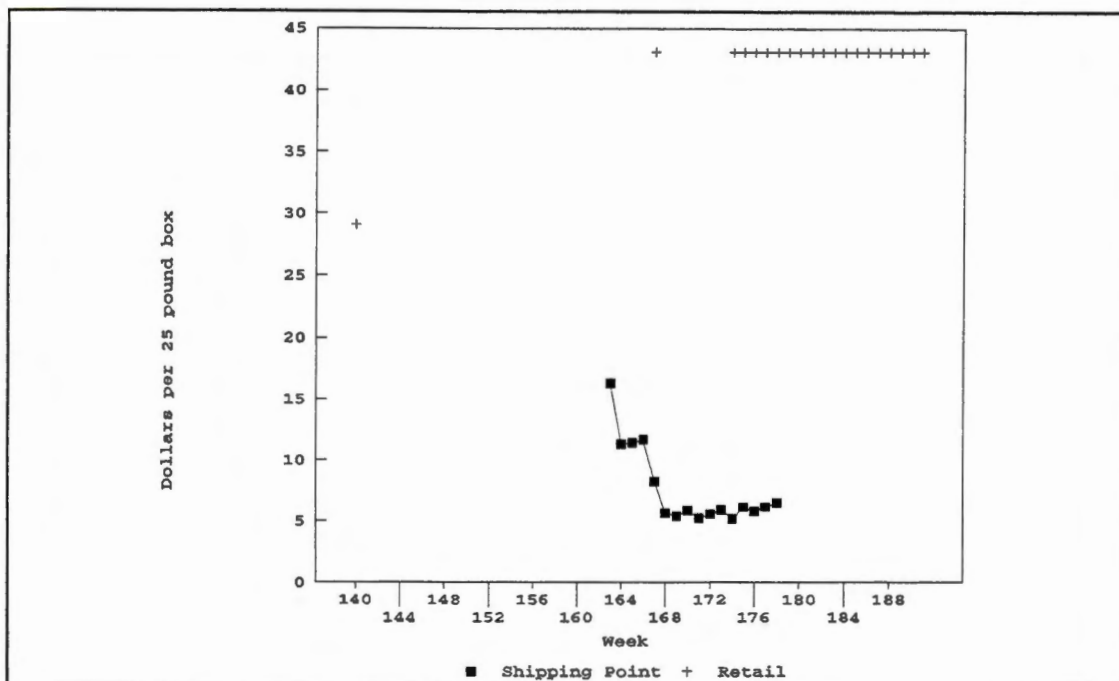
Appendix Figure 100. Tomatoes: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1989



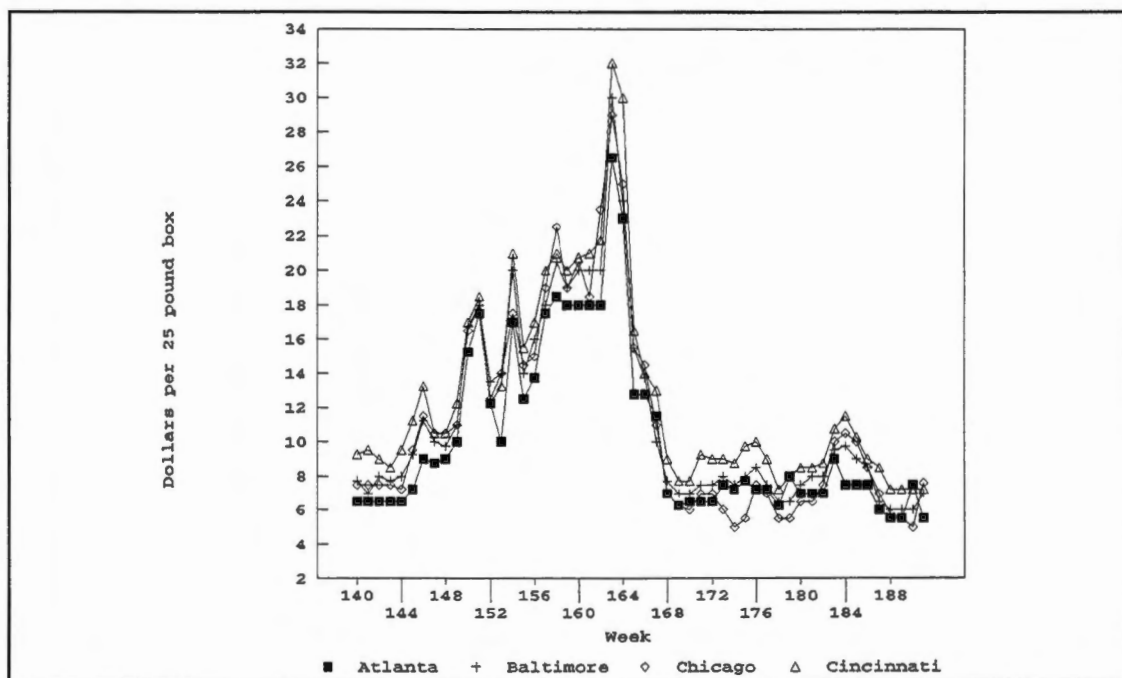
Appendix Figure 101. Tomatoes: Retail and shipping point prices, 1990



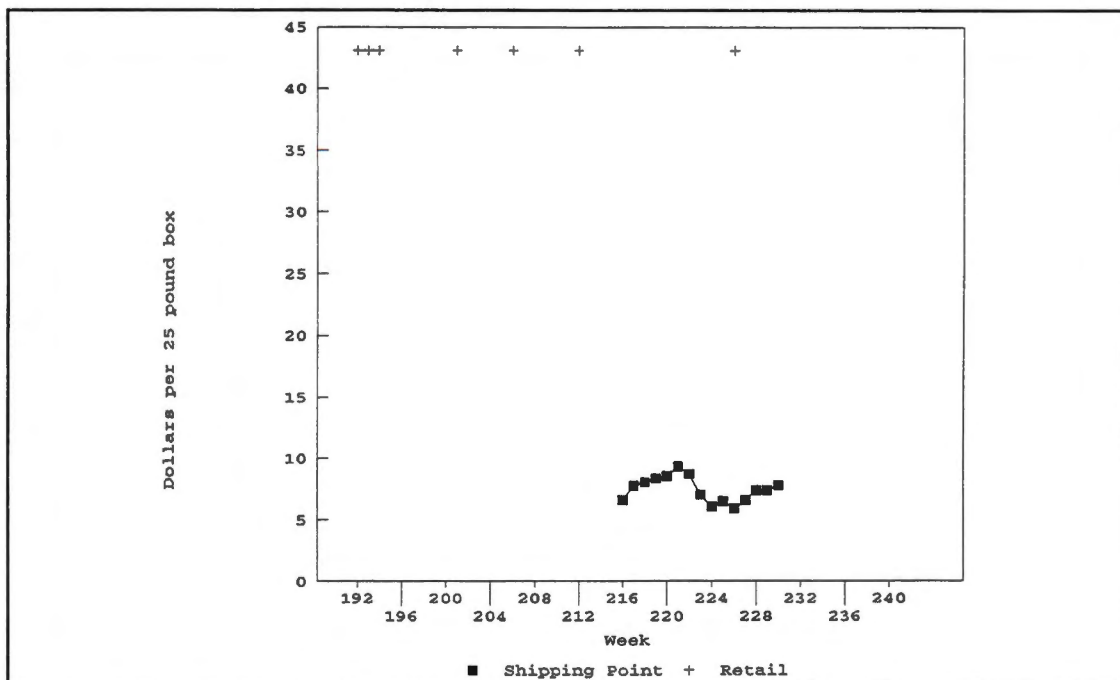
Appendix Figure 102. Tomatoes: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1990



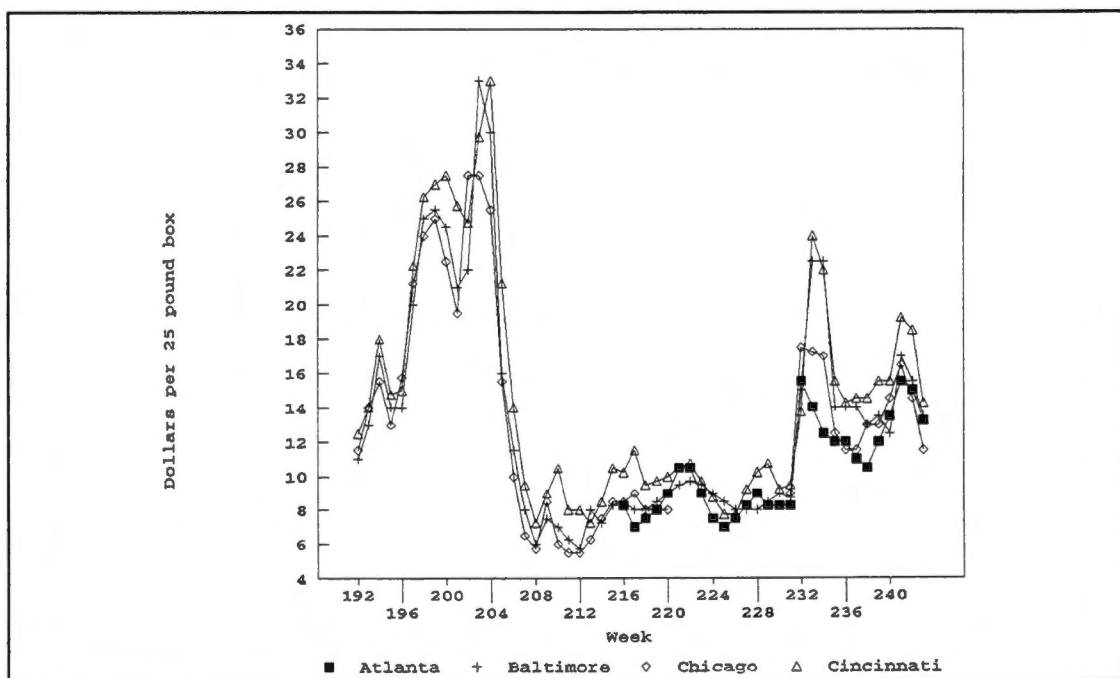
Appendix Figure 103. Tomatoes: Retail and shipping point prices, 1991



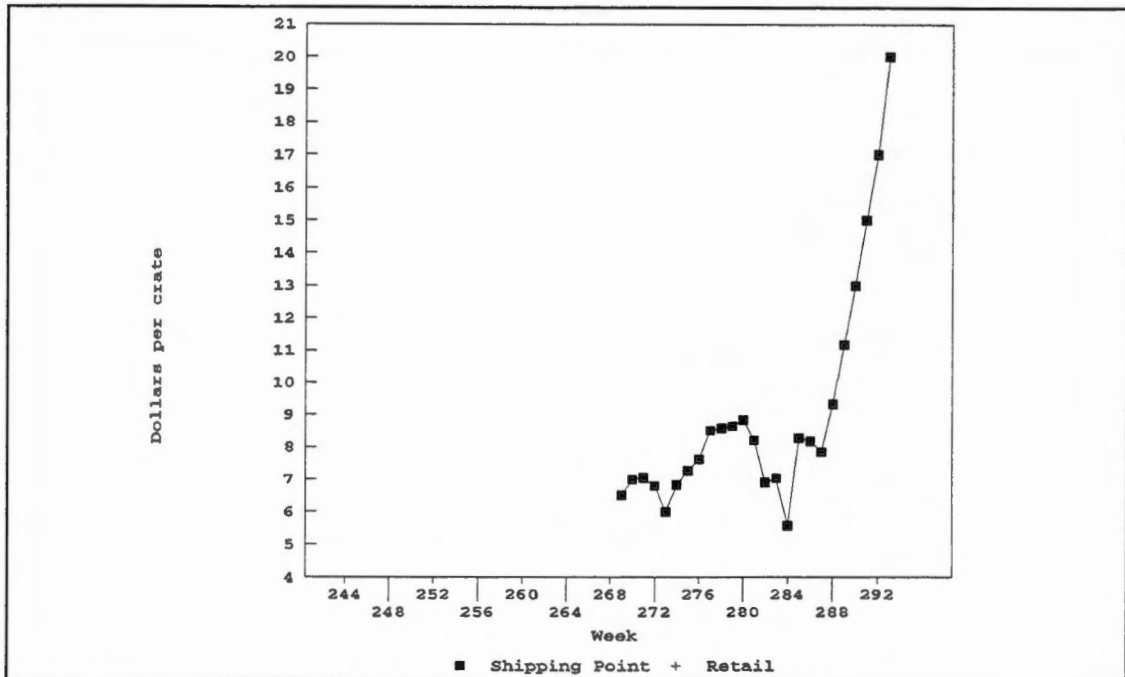
Appendix Figure 104. Tomatoes: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1991



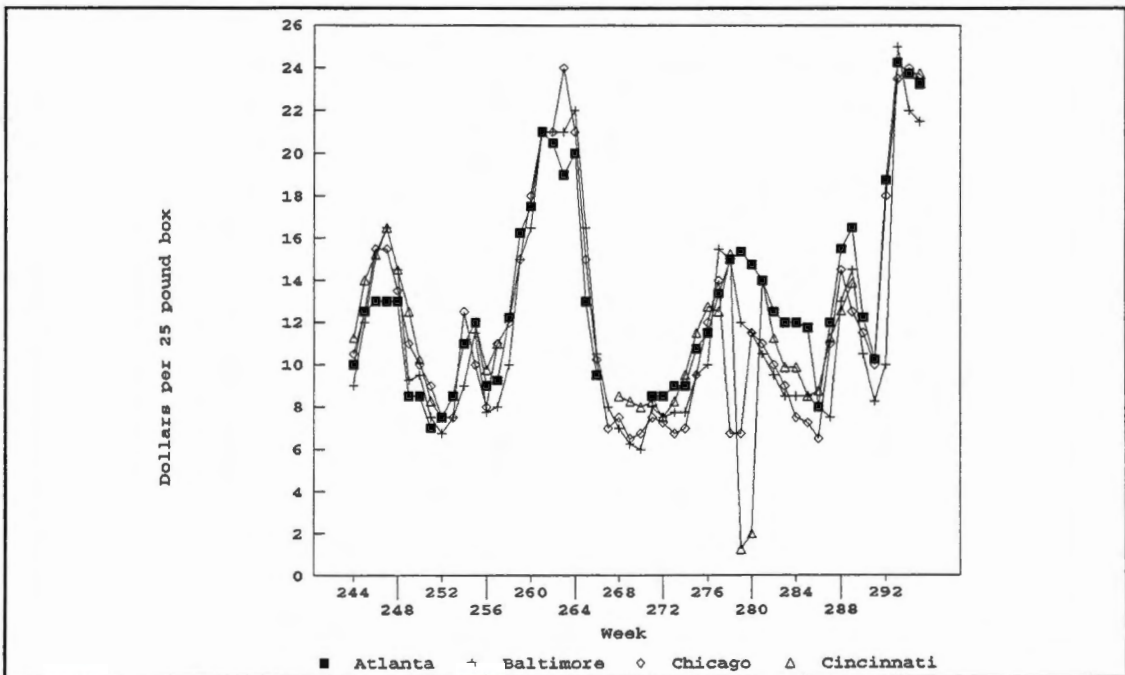
Appendix Figure 105. Tomatoes: Retail and shipping point prices, 1992



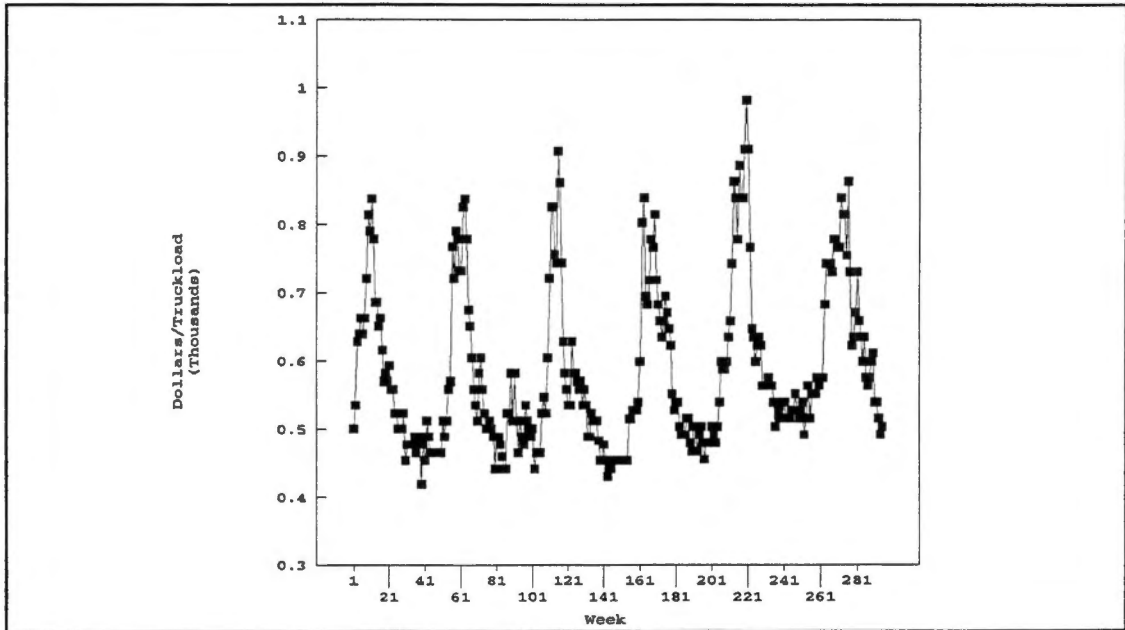
Appendix Figure 106. Tomatoes: Atlanta, Baltimore, Chicago, and Cincinnati. average wholesale market prices, 1992



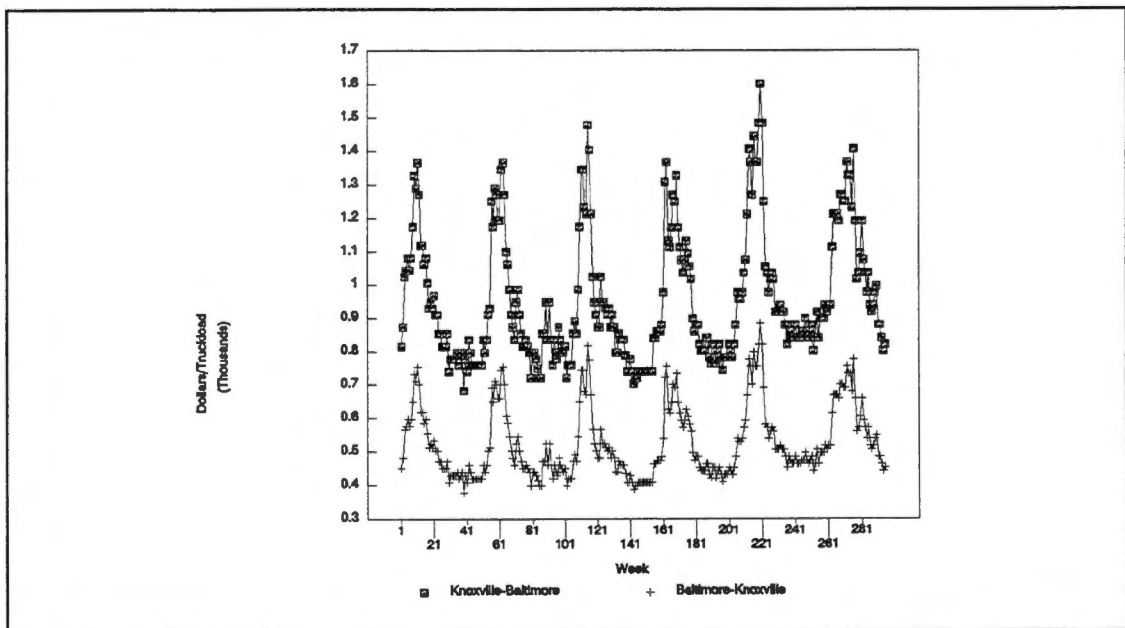
Appendix Figure 107. Tomatoes: Retail and shipping point prices, 1993



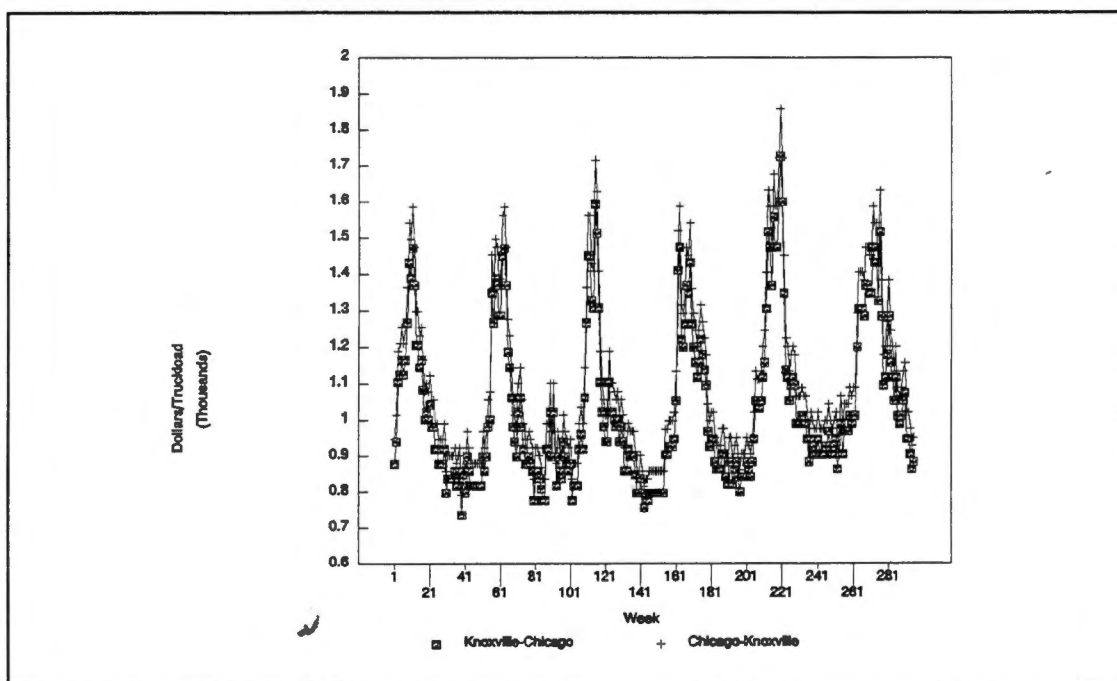
Appendix Figure 108. Tomatoes: Atlanta, Baltimore, Chicago, and Cincinnati, average wholesale market prices, 1993



Appendix Figure 109. Estimated transportation costs between Knoxville and Atlanta or Cincinnati for a truckload of vegetables



Appendix Figure 110. Estimated transportation cost between Knoxville and Baltimore for a truckload of vegetables



Appendix Figure 111. Transportation costs between Knoxville and Chicago for a truckload of vegetables

VITA

Brian Todd Carver was born in Lebanon, Tennessee, on May 31, 1971 to Roger and Sherry Carver. His family has always resided in rural Macon County.

He attended elementary school at Westside Elementary in rural Macon County and was graduated from Macon County High School in 1989. In August of 1989, he entered the University of Tennessee at Knoxville where he received the degree of Bachelor of Science in Agriculture with a major in Agricultural Economics and a minor in Business in May of 1993.

He accepted a research assistantship from the Department of Agricultural Economics and Rural Sociology and began graduate studies at the University of Tennessee in August of 1993. His requirements for the Master of Science degree were completed in August of 1995.

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