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THE DEVELOPMENT OF INDEX FUTURES CONTRACTS FOR FRESH FRUITS AND VEGETABLES

Mark R. Manfredo, James D. Libbin and Lowell B. Catlett[1]

Abstract

The fruit and vegetable industry does not have a risk management instrument or a well-structured price discovery system, such as commodity futures contracts, to aid in the marketing and management of its price risk. Since the 1980s, financial futures contracts based on indexes of stocks, commodities, and currencies have been used to hedge these groups of assets. The purpose of this study was to apply the concept of index futures contracts to the produce industry by developing an index or indexes based on prices of fruits and vegetables and to test their hedging capabilities. Twenty representative fruits and vegetables were chosen to compile indexes for fruits, for vegetables, and for fruits and vegetables together using a trade-weighted arithmetic average of 1989-92 wholesale prices of selected commodities traded on the Dallas Wholesale Fruit and Vegetable Market. The indexes were then tested by simulating a short and long hedge of a portfolio of commodities and by cross-hedging selected individual New Mexico and California produce commodities with the indexes.

Fresh Fruit and Vegetable Marketing

The marketing of fresh fruits and vegetables can be very chaotic as prices can and do rise and drop dramatically within a day or even minute-by-minute. Prices are usually established over the phone by buyers and sellers based on supply and demand in the market place for various grades, qualities, shipping points, delivery points, and amounts. Market participants usually directly call various customers and contacts for market information and general market tone. Some market participants also use market news services like the ones provided by the USDA and such private market news services as Pronet that disseminate market information via fax machine and mail. Additional information is also provided by trade associations.

There is no well developed, accessible, public price discovery system for fresh fruit and vegetables such as a commodity futures market. To manage some of the price risk inherent in fruit and vegetable marketing, many fruit and vegetable marketers pre-sell a large portion of their produce. Many large shippers pre-sell approximately 10% to 30% of their produce about a week or two before shipping. With these contracts, "shippers agree to sell a negotiated quantity at a future date at an f.o.b. price not to exceed a level agreed upon at the time of sale" (Colling et al., 1993, p. 5). Pre-selling provides buyers with upside price protection while it insures the seller of a market outlet. Often produce is pre-sold in conjunction with a retail advertising promotion (Colling et al., 1993).

The overall purpose of this paper is to apply the concept of index futures contracts to the

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development of a fruit and vegetable index. The underlying hypothesis is that a well diversified portfolio of fruit and/or vegetable commodities can be constructed to represent a broadly defined market for fresh produce. The second major objective is to determine the hedging capabilities of the produce indexes. Hypothetically, a futures contract based on this index could be used as a hedging vehicle by fresh produce producers, by purchasers such as supermarkets, and by other elements of the marketing chain including wholesalers, shippers, and co-operatives. Not only could a futures contract on the index be used for hedging purposes, it could also serve as a much-needed open price discovery system (a market benchmark) for the fresh produce industry.

Agricultural Futures Markets

For many years the commodity futures markets have allowed producers and processors of grains, livestock, and other storable commodities to hedge absolute price risk. But for several reasons, commodity futures markets have never been successfully developed for any fruit or vegetable except potatoes and a derivative commodity - frozen concentrated orange juice. For futures contracts on physical commodities to be successful, three conditions usually must exist: uncertainty of prices, large competitive markets, standardization, and storability (Stoll and Whaley, 1993).

Since the primary purpose of futures markets is to provide hedging opportunities, uncertainty about price movements must exist. Uncertainty about prices stem from uncertainties about supply and demand conditions of commodities. Large and competitive markets are necessary to provide liquidity for the futures contract. A liquid futures market can only be maintained if there is also a large liquid cash market for the physical commodity. On the other hand, "futures markets could possibly enhance competition in a market that is not fully competitive" since the futures market "provides an alternative to dealing directly with the producer" (Stoll and Whaley, 1993, p. 78). In addition to a large and competitive market, the cash market for the underlying commodity needs to be one in which standardized units are available. Standardization of grades allows futures contracts to be easily traded. Storability and deliverability of the cash commodity have usually been considered mandatory for successful futures contracts. Because futures contracts call for delivery, the commodity must be storable so delivery may take place at a future date.

The ability to hedge is a very powerful price risk management tool. This risk management vehicle, however, has not been available to producers and marketers of fresh fruits and vegetables. Futures contracts would have to be developed for several commodities, quite possibly as many as 22 major fruits and vegetables, among the 55 or so fruit and vegetable commodities commonly found in U.S. supermarkets, to facilitate the hedging of the entire fruit and vegetable complex. It would be difficult for such a large number of individual fruit and vegetable futures contracts to survive since many fruit and vegetable commodities have relatively small markets. Even the citrus market may not be large and competitive enough to facilitate futures trading despite the fact that citrus is the single largest U.S. fruit group in dollar value of sales. The lack of enough interest in any or all fruit and vegetable futures markets to facilitate adequate trading volume alone would create liquidity problems, thus violating a major requirement for successful futures markets. Further, most fresh produce items have a limited storage life and must be sourced from various regions due to seasonality of production.

Index Futures

Since 1982, equity portfolio managers have used stock index futures contracts to compile diversified portfolios of stocks in an attempt to minimize non-systematic (diversifiable) risk. Systematic risk can be hedged by using a stock index futures contract that mimics the aggregate portfolio of stocks. The financial community also has at its disposal commodity index futures contracts that enable a portfolio manager to hedge a diverse portfolio of physical commodities (which includes not only the agricultural commodities but also metals, petroleum products, and other commodities) and also hedge against inflation. In addition, currency index futures are used to hedge multiple currency risk exposure.

As more and more fund managers invest in diversified portfolios of physical commodities and currencies in addition to their stock and bond portfolios, they are increasingly aware of the need to hedge the systematic risk associated with these portfolios. Due to their flexibility, index futures contracts have been developed for physical and financial commodities, such as the U.S. Dollar Index (USDX) which commenced trading on the FINEX Exchange in 1985, the Commodity Research Bureau's CRB Index (New York Futures Exchange, 1986), and the Goldman Sachs Commodity Index (GSCI) (Chicago Mercantile Exchange, 1992). Commodity indexes, in particular, have received much attention in the past few years as futures exchanges continue to look for new and innovative futures contracts that could contribute to their trading volume (Ring, 1992). The increasing popularity of index futures contracts is due primarily to these basic properties: 1) they are always cash settled, 2) they represent a hedging tool for a portfolio (few merchants deal only in one commodity), and 3) they avoid the trading volume and contract liquidity problems associated with one commodity or instrument contracts.

Properties of Index Futures Contracts

Because there is no tangible deliverable underlying commodity, there are some features of index futures that are essential to their success; for example, index futures contracts are cash settled. Contracts are typically settled by using the cash price of the spot index on the last day of trading, therefore convergence of cash and futures is guaranteed (Weiner, 1984). But, for this mechanism to be workable, the components of the underlying index must be liquid. Liquidity of index components is crucial for an index futures contract to succeed, consequently such indexes as the Goldman Sachs Commodity Index (GSCI) and the Commodity Research Bureau's Index (CRB) place liquidity restrictions on their components. Stock indexes meet the component liquidity criteria by requiring that each of the component stocks be traded on a major U.S. stock exchange. The U.S. Dollar Index (USDX), however, is unique in that some of the component currencies do not have liquid futures contracts associated with them.

The maintenance of the underlying index is also very important. The index must be constantly recalculated by an impartial body in an open manner as price changes in the underlying components occur. This information must also be quickly disseminated to various vendors and exchanges. Also, the index divisor must be maintained to accommodate changes in the composition of the index such as stock splits and addition and subtraction of companies or commodities. Index maintenance is usually performed by the company or association that developed the index. For example, the Standard and Poors Corporation performs all maintenance functions for the S&P 500 and the Commodity Research Bureau performs all maintenance functions for the CRB Index. However, some futures exchanges maintain certain indexes that are traded on their floors, (e.g. FINEX, a division of the New York Cotton Exchange, maintains the USDX).

Hedging with Index Futures Contracts

The characteristics of index futures contracts allow flexibility with hedging. The most common hedging practice with index futures is portfolio hedging which involves hedging the systematic risk that remains after diversification of a portfolio of assets. Individual assets within the index may also be cross-hedged. For cross-hedging to be effective, there must be a significant correlation between the physical asset and the futures contract. Both of these hedging techniques are difficult to implement due to basis variability. In portfolio hedging, the matching of the cash portfolio to the futures portfolio is very important since a mismatch of the cash portfolio with the index can lead to basis risk greater than absolute price risk. If only a single asset is hedged using an index, the hedger may benefit from hedging the market risk aspect of the component, however, there is still considerable non-systematic risk remaining since the single asset being hedged is not a diversified portfolio (Weiner, 1984). Index futures contracts are also used to participate in market moves before taking a position in the physical asset. This same anticipatory hedge strategy can be used for commodities or currencies as well. Commodity and currency index futures are often used instead of taking actual cash positions due to the leverage properties of futures contracts.

Construction of Indexes

The manner in which an index is constructed is very important to its success. It is basically a choice of the individual or organization that develops the index as to how the index is calculated. Three major considerations must be evaluated when developing an index since each can affect the index as a market performance indicator: weighting, composition, and calculation procedure (Weiner, 1984).

Most indexes use some form of weighting scheme to determine how much each component will make up of the index. The most common weighting methods are value weighting (also known as capitalization weighting), equal weighting, price weighting, and trade weighting. Value or capitalization weighting multiplies the price of the index component by the number of units outstanding of the component in the market (Stoll and Whaley, 1993). For instance the S&P 500 uses the number of common shares outstanding as the capitalization portion of the equation (price x common shares outstanding) while the Goldman Sachs Commodity Index uses world production statistics (price x world production).

Capitalization weighting means that the components of the index are weighted according to their market value. Because of this, any one stock will influence the S & P 500 index in relation to the stocks' relative market value therefore, the real market value of the index at a point in time (I_t) is:

$$I_t = \sum_{i=1}^{N} n_{it} P_{it} \tag{1}$$

where:

P_{it} = current price per share of stock I at time t
n_{it} = number of shares of stock I outstanding at time t
N = the number of stocks in the index

Since this is an index, a divisor must be used to represent the value of the index at a chosen base period. The base period value for the S&P is the average market value of those 500 stocks during the period 1941-43 and that value was set (scaled) equal to 10 (Weiner, 1984, p. 42). Therefore the index value in period t would be:

$$I_t = \frac{\sum_{i=1}^{N} n_{it} p_{it}}{Divisor_0} \tag{2}$$

where:

$$Divisor_0 = \sum_{i=1}^{N} n_{i0} p_{i0} \tag{3}$$

Price weighting is basically the same as value weighting except that the capitalization of the component is not taken into consideration, only the price of the underlying component is used. A price weighted index is calculated as follows:

$$I_t = \frac{\sum_{i=1}^{N} p_{it}}{Divisor_0} \tag{4}$$

This is similar to equal weighting, in which each of the underlying components of the index carry the same weight; however, only percentage changes in the component prices are used, rather than absolute price changes (Stoll and Whaley, 1993). The Value Line Index, an equal-weighted arithmetic index, is computed as follows:

$$I_c = I_p \, x \, \frac{1}{N}\sum_{i=1}^{N}\frac{P_i}{C_i} \qquad (5)$$

where:

I_c = current value of index,
I_p = closing value of index on previous day,
P_i = current price of stock I,
C_i = closing price of stock I on the previous day, and
N = the number of component stocks in the index
(Kansas City Board of Trade, 1993)

Trade weighting multiplies the price of the component by the percentage that the component represents in the market. This is similar to capitalization weighting; however, for many indexes such as currency indexes, it is difficult to compute the exact capitalization, therefore, the relative importance of the component in the market place is used.

Finally, the calculation procedure used in developing the index is extremely important. While most indexes are arithmetically averaged, as indicated in equations 1 to 5, some are geometrically averaged. Under geometric averaging, the values or returns are multiplied and the nth root is taken, where n represents the number of elements included in the index (Stoll and Whaley, 1993).

Evaluation of Index Construction

Equal weighting and price weighting are virtually identical except that price-weighted indexes are implicitly weighted by their prices. One advantage of a price-weighted index is that the index is only affected by the price of the asset or underlying component. The capitalization level does not play a role. A disadvantage of price-weighting is that absolute prices are used, consequently all assets with equal prices have equal weights (Weiner, 1984). In addition, "the effect of a percentage change in the price of an asset in the index will be sensitive to the initial price of the asset", Krull and Rai (1992, p. 551). Further, "changes in prices of thinly traded assets have the same weight as those that are heavily traded" (Krull and Rai, 1992, p. 551). Another weakness of price weighting is that a change in unit definition can change the weight. For instance, if wheat is quoted on a hundredweight (cwt) basis instead of a bushel basis (bu), then the relative importance of wheat would increase by 67%.

As with price weighting, equal weighting of index components has the advantage in that "no single month or commodity has undue impact on the index" and also from a hedging point of view since "price risk is typically distributed evenly across the time horizon" (New York Futures Exchange, 1990, p. 10). Equal weighting can be appropriate for indicating movements in the prices of typical assets. Equal weighting is often criticized, however, since as with price weighting, thinly traded assets have the same weight as those of more actively traded assets.

Equally weighted indexes are also more difficult to mimic because a portfolio must be continuously rebalanced when there is a price change for any asset in the index (Krull and Rai, 1992).

Value or capitalization weighting is by far the most popular weighting scheme for index futures contracts. Value weighting gives more weight to assets with larger market capitalization, therefore it is easy to mimic because there is no need to rebalance a properly weighted portfolio (Krull and Rai, 1992). Trade weighting is very similar to capitalization weighing since weights are based on the relative share of business of the components (i.e., USDX uses the importance individual currencies have in world trade as weights). Like value weighting, components affect the index price to the same degree that they affect the market. Surprisingly, a 1987 study done by Hervey and Strauss which examined 12 trade-weighted indexes revealed that for the most part, "neither the difference in weights nor the inclusion nor omission of certain countries materially affected their values" (cited in Krull and Rai, 1992, pg. 552). Despite the results of Hervey and Strauss, Stoll and Whaley (1993) discovered that composition did make a difference with stock indices, but only slightly. They believe the reduction in standard deviation from the MMI (1.7453) to the DJIA (1.6640) to the S&P 500 (1.5825), and, finally, to the NYSE (1.4916) "reflects increasingly higher degrees of diversification" (Stoll and Whaley, 1993, p. 106). The DJIA has 30 stocks, the S&P 500 has 500, and the NYSE has more than 1500 (Stoll and Whaley, 1993).

By far, arithmetic averaging is more commonly used than geometric averaging. Geometric averaging is too complicated, which makes arbitrage and hedging difficult because "it is impossible to assemble a geometrically-weighted cash portfolio" of components (New York Futures Exchange, 1990, p. 9). Also, the price movements of a geometric index in general do not correspond to price movements in a stock portfolio so futures contracts have less hedging value (Stoll and Whaley, 1993).

Data

Secondary data were used in every step of this research. Several sources were examined during the theoretical development of this study to develop a computational form for a fruit and/or vegetable index that would best represent the market for fresh fruits and vegetables. The fruits and vegetables used in the construction of the indexes were the most popular varieties sold of these commodities as reported by the Produce Marketing Association's (PMA) Top Ten Fruits and Vegetables (1991) report which is based on produce department sales (table 1). Daily historical prices for the major fruits and vegetables for the years 1989-92 were provided by the USDA Market News Service at the Dallas (Texas) Wholesale Fruit and Vegetable Market, one of 19 major terminal fruit and vegetable markets monitored by USDA. A more robust test and a more representative futures contract should be based on a broader market definition than just Dallas, maybe an average of all 19 major markets or a specific subset of these markets.

The daily prices supplied by USDA represent a wholesale price paid by primary receivers for the principal packs, varieties, grades, sizes, and origins of various fresh produce items. Each commodity price report listed a high and low price for the day for various sizes, origins, varieties, and grade (good quality unless otherwise stated). A single price was chosen that was most representative of the particular commodity based on size, origin, and variety. The most actively traded sizes for the most common variety (using PMA) of each commodity were drawn from the professional experience of the head market reporter at the USDA Market News Service at the Dallas Wholesale Fruit and Vegetable Market. Many times the Market News Service data would not distinguish between varieties of commodities since varietal differences were usually only seasonal (i.e., navel oranges in the fall and winter or valencia oranges in the spring and summer). If more than one origin was listed, the origin selected was the one which had the most volume of shipment (volume was based on average truckloads shipped as indicated on yearly summary price reports for the Dallas Wholesale Fruit and Vegetable Market). Therefore, the most actively traded size and origin with the largest volume of shipment was assumed to be the most representative price for the commodity. Two of the fruits in the PMA's top ten list, peaches and mangoes, were eventually eliminated from further analysis. Prices for peaches were listed for only approximately four months of the year, providing an insufficient window. Mango prices were also quoted on a limited basis. Some of the major commodities were divided into sub-categories including apples (red and golden), citrus (grapefruit, lemons, limes and oranges), grapes (red and green), potatoes (russet and red), and onions (yellow, red, and white). Information on the breakdown of these markets was provided by the respective trade associations: Washington Apple Commission, California Citrus Mutual, California Table Grape Commission, and National Onion Association, and by NASS.

There were some limitations on the data used in this research. First, the data provided by the PMA, the leading organization in the analysis and promotion of fresh produce, on the top ten fruits and vegetables was primarily qualitative in nature. The sales figures provided by the PMA came from multiple sources that were somewhat conflicting. Also, the trade associations contacted lacked hard data on the market breakdown of their respective commodities, therefore their estimates were used. In addition, the ERS did not have average U.S. retail price information for all commodities utilized in the index; therefore, the average 1989 Dallas Wholesale Market price was used. On occasion, prices were not quoted for a certain commodity. When this happened, the last quoted price was used. Also, the f.o.b. prices used for selected New Mexico and California-grown commodities (used later in the cross-hedging examples) were only reported for days in which the market was active enough to report a price, therefore, price data for the beginning and ending of a harvest season was sparse.

Construction of Fruit and Vegetable Indexes

In this study, three produce indexes were calculated: one for fruits, one for vegetables, and one for both fruits and vegetables combined. A trade-weighted arithmetic index formula was chosen to compute these three indexes for several reasons. First, the fruits and vegetables used in the composition of this index represent approximately 65% of all fruit and vegetable sales according to the PMA. Secondly, the formula used to calculate these indexes is similar to the most active and successful index futures contract, the S&P 500. Even though the S&P 500 and its cousins are constructed as capitalization weighted indexes, trade weighting is similar since the weights affect the index price to the same degree that they affect the market. In addition, the use of arithmetic averaging in the construction of these indexes makes it easy to compute, therefore increasing the potential use of these indexes for hedging and arbitrage purposes. For these reasons, a trade-weighted arithmetic index should provide the best chance for these indices to be accurate performance indicators for the fresh produce industry. The formula for each of the three indexes is:

$$I_t = \frac{\sum_{i=1}^{N} P_{it} W_{it}}{Divisor_0} X\ 100 \qquad (6)$$

where:

N = the number of commodities in the index
P_{it} = average price of commodity I at time t
W_{it} = weight assigned to particular commodity at time t
$Divisor_0$ = Base period value (base period = 1989)

where: (7)

$$Divisor_0 = \sum_{i=1}^{N} P_{i0} W_{i0}$$

The prices used were the average of the daily high and low price for the respective individual commodities in the indexes. The base year for all three indexes was the 1989 average of all daily values (the sum of the individual commodity prices multiplied by their respective weights). Therefore, for the years 1990-92, the index value represents how produce prices performed relative to the base year 1989 in percentage terms, thus the indexes represent a performance benchmark for the produce industry based on 1989 prices.

Three different weighting schemes were tested. The first set of weights was calculated based on commodity sales information provided by the Produce Marketing Association (PMA) in their top ten fruits and vegetables for 1991 list. Total dollar sales for each commodity were then summed and the percentage of dollar sales of each commodity was computed. When more than one category of produce was used (i.e., red and golden apples) the total dollar value was split equally between the two varieties (table 2). The second weighting scheme, shown in table 3, is basically the same as the first except for commodities that had more than one category listed. In this case, the total sales value for the respective commodity was split based on the percentage that the variety represents in the market. The third weighting scheme attempted to account for both quantity and price of the underlying component commodities. U.S. per capita consumption (1989) of each commodity was used as the quantity figure. This value was then multiplied by the U.S. average retail price per pound. The dollar values for each commodity (volume x price) were summed and the value proportion weights were calculated for each commodity. These weights are presented in table 4. Since the average index value for 1989 is the base year value for each of the indices, the index value oscillates around the 100 level. The 1990 to 1992 index values show the performance of the produce prices in relation to the 1989 base year value. All of the indexes have similar patterns of movement regardless of the weighting scheme used. This supports Hervey and Strauss' 1987 conclusion that differences in the weighting of an index do not materially affect their values.

Throughout the remainder of this paper, the trade-weighted indexes calculated with the weighting scheme based on annual per-capita consumption data and average U.S. retail prices will be used. This weighting scheme was chosen for use in the hedging simulations since it accounts for both quantity and price, while the other two weighting schemes are based solely on estimated total dollar sales. Within the hedging examples, the calculated index price is assumed to be the futures price. If actual futures contracts were based on these indexes, the futures price would represent the index value plus the cost of carry.

Hedging a Portfolio of Fruits and Vegetables: A Short-Hedge Example

The short hedge assumes that the hedger is a marketer of fresh produce, most likely a wholesaler or a wholesale buying unit for a supermarket chain, who desires to take possession of produce commodities and then attempt to sell the produce to retailers at a later date (Table 5). The wholesaler is concerned that produce prices may fall between the time the produce is purchased and the time when the produce is sold to a retailer. This scenario assumes that the wholesaler acquires a variety of fruits and vegetables on April 1, 1992 worth approximately $50,000. The wholesaler has purchased this produce in an attempt to mimic the composition of the fruit/vegetable index and has thus purchased commodities in the same proportion as the index weights (table 4). The fruit/vegetable index value on April 1, 1992, is 126.23. Anticipating that the value of this portfolio could decrease before it is sold to the retailer, the wholesaler hedges the portfolio. On April 1, 1992, the wholesaler sells enough fruit/vegetable index futures contracts at 126.23 to cover the $50,000 portfolio. Since the wholesaler has perfectly mimicked the index, the value of his cash portfolio is also 126.23 on April 1, 1992. The value of 126.23 is acquired by taking the sum of the contributions of each of the components and dividing it by the base year value 1989=12.02.

The wholesaler subsequently sells the portfolio on April 10, 1992. As seen in this example, the value of some of the cash portfolio components have changed Overall, the value of the portfolio has decreased from $50,000 to $46,626--a loss of $3,374 from the original value of the portfolio. On the date of the sale, the wholesaler simultaneously buys back the futures contracts at 111.61. The value of the cash portfolio decreased by 6.75% and the index moved in the same direction by 11.56%. Since the cash portfolio was exactly compiled to mimic the fruit/vegetable index, a perfect hedge has taken place. Both the cash portfolio and the index fell by 11.56% (sum of the cash portfolio index contribution/base year 1989=12.02).

Hedging a Portfolio: A Long-Hedge Example

If a wholesaler has promised delivery of a specific quantity of produce for delivery at a future date, the wholesaler is concerned that prices will rise between the time the order was placed and the time of purchase and delivery. In this case, the wholesaler would take a long position in the futures market on April 1, 1992, the date that order was made. In the meantime, the wholesaler would source the produce. Delivery would take place on April 10, 1992, and subsequently the futures position would be offset by selling the appropriate number of futures contracts. In this scenario, the wholesaler would have actually had a gain in the cash market of 6.75% (11.57% if the cash portfolio is converted into the index value) and a loss in the futures market of 11.57% since the value of the portfolio decreased. If the wholesaler has exactly mimicked the index, any gains in the cash market would have been equally offset in the futures market (a perfect hedge). Therefore, by long hedging, the wholesaler would have been protected if the price of the produce commodities in the portfolio would have risen before delivery took place.

Implications of Hedging a Portfolio of Produce Commodities

The success of hedging a portfolio of produce commodities depends heavily on how the portfolio is constructed. Since the cash market portfolios in these examples exactly matched the fruit/vegetable index, perfect hedges took place. By holding a diversified portfolio of produce commodities, the non-systematic risk of the components is virtually diversified away. In real life situations, it is very difficult to exactly mimic an index. Therefore, there will be increased basis variability if the cash portfolio does not exactly match the index. Marketers of produce who would use an index instrument such as the fruit/vegetable index would need to make sure that the cash portfolio closely follows the index in order to prevent basis risk (value of cash portfolio - index value) being greater than the absolute price risk. If basis risk is greater than the absolute price risk, then it is actually detrimental to hedge since losses in the cash market would also be realized in the futures market.

Cross Hedging

In addition to being used as a way of protecting the value of a portfolio of produce commodities, produce indexes might also be used as a vehicle for cross hedging. Cross hedging is merely the process of hedging a particular commodity with a futures contract that is different. More important than the physical similarities or differences between the cash commodity and the futures contract is the degree in which the cash and futures prices move together. According to Anderson and Danthine (1981, p. 1189), "cross hedges are in order whenever the cash/futures correlation is a constant different from zero". Therefore if the price relationship between the individual commodities in the produce indexes move together with the indexes in such a manner to yield correlation coefficients significantly different from zero, cross hedging may be possible. This would aid growers of produce commodities, especially growers of single commodities, in the marketing of their products by providing an opportunity to protect the value of their crops against falling prices thus decreasing the variance of revenues.

To determine the cross hedging abilities of the produce indexes, simple Pearson correlation coefficients were calculated between the cash price at Dallas of the underlying index components and the index values for the years 1989 to 1992. These correlation coefficients are shown in table 6. Most of the calculated correlation coefficients are statistically significant at the alpha = .0001 level. This shows that the underlying cash prices and the index prices tend to move together (either positively or negatively) over the four year period from 1989 to 1992. The statistically significant correlations give rise to the possibility of cross hedging individual components of the indexes with the indexes themselves. There is not a substantial difference between the correlations for the various weighting schemes. Further, certain fruit commodities had strong correlations with the vegetable indexes and certain vegetable commodities had strong correlations with the fruit indexes (i.e., cantaloupes and carrots). The correlations between the component cash prices and the fruit/vegetable combination indexes appear to reflect a combination of the rho values for the cash fruit/fruit index and cash vegetable/vegetable index.

Cross Hedging: A New Mexico Example

To illustrate the potential use of the produce indexes for cross hedging, hypothetical cross hedges were constructed using f.o.b. prices for selected New Mexico produce crops. Simple Pearson correlation coefficients were calculated between the New Mexico f.o.b. cash prices and the value of the indexes for the years 1989 to 1992. Correlations were calculated between each commodity and the fruit, vegetable, and fruit/vegetable indexes. Several of the correlations were significant at the alpha = .0001 level illustrating potential for cross hedging. The correlations were calculated only for the time window in which New Mexico f.o.b. prices were reported (during the harvest season). Correlation coefficients were also calculated for each year individually to help illustrate the movement of the f.o.b. cash price and the index values during these very short time periods. Cross hedges were simulated for the New Mexico yellow onion crop for the years 1990 to 1992. In all cases, the hedge was assumed to be placed on the first day that f.o.b. prices for New Mexico yellow onions were listed by the USDA Market News Service. The hedge was lifted on the last day that f.o.b. prices were listed. This assumes that the producer would be selling the crop on the last day that prices were reported. The grower is concerned that prices may decline between the beginning and the end of the harvest season and therefore hedges the position using the produce indexes. Table 7 shows the results of these hedges.

Hedging in 1990 would have resulted in losses in the cash market and in the index futures market because the cash and index prices did not follow each other. In 1991, however, an onion grower would have benefitted from hedging since the average New Mexico yellow onion price declined by 34.38% from 6/10/91 to 8/26/91 and the vegetable index price decreased by 42.02% while the fruit/vegetable index decreased by 23.98%. In 1992, the cash and the index prices did move together, however in this situation, an onion grower would ideally not want to be hedged since the gains in the cash market would be offset by losses in the index futures market. However, if the position was hedged with the proper quantity of index futures contracts, the cash equivalence of the initial $5.00/sack price of the crop would have been protected.

Cross Hedging: A California Example

Hypothetical cross hedges were also conducted for two selected California grown commodities to test the cross hedging effectiveness of California commodities with the produce indexes since the produce indexes in this study are calculated from wholesale prices at the Dallas Wholesale Fruit and Vegetable Market. California tomatoes were selected for the test due to the strong correlations that this component has with the vegetable and fruit/vegetable indexes (approximately 80% with the vegetable index and 67% with the fruit/vegetable index (significant at the alpha = .0001 level).

California tomatoes were hedged using both the vegetable and fruit/vegetable indexes (table 8). In 1990, the California f.o.b. price and the index values moved in opposite directions, thus if a California tomato grower hedged in 1990, the producer would have recognized losses in both the cash market and the futures market. In 1991, however, the cash and index values did move together and a tomato grower would have benefitted from hedging. In 1992, the average f.o.b. cash price and the vegetable index did move together with the cash price increasing by 9.09% and the futures by 3.35% from 6/8/92 to 11/19/92. Again, in this case the grower would prefer not to be hedged since there was a cash market gain. The fruit/vegetable index for 1992 did not move with the cash market as evidenced by the correlation coefficient of -.1239 at alpha = .1890 therefore if the grower used the fruit/vegetable index to hedge, losses in both the cash market and futures market would be realized. Cross hedges were also simulated for New Mexico fall lettuce, eastern New Mexico russet potatoes and California peaches with similar results.

Implications for Cross Hedging

There are several things to consider when using an index vehicle to cross hedge a single commodity. First, the grower or marketer must examine his or her own risk preference/avoidance factor. One of the problems inherent in cross hedging is basis variability. The stronger the movements of the cash market are correlated with the index, the less basis variability there will be. Therefore, commodities that have stronger correlations with the indexes would tend to be better candidates for successful cross hedges. With any cross hedge, the hedger must determine whether the increased basis risk is greater than the absolute price risk associated with the commodity. As illustrated, significant correlation coefficients do not guarantee that the cash and index prices will move together. The correlations are merely a tool to help determine if there will be adequate correlation of price movements between the cash and indexes to warrant a cross hedge. Therefore, as seen in the above examples, if basis risk is greater than the absolute price risk, losses may be realized in both the cash market and futures market.

The hedging of only one component in the index leaves the hedger exposed to a considerable amount of non-systematic risk since one commodity does not constitute a diversified portfolio. In essence, only the market risk exposure is being hedged. However, a hedger may still benefit from hedging the market risk aspect of the component. Again, this is a risk preference decision for the producer. Also, in an up market, gains in the cash market will be negated by losses in the futures market with a short hedge. However, if properly hedged, the initial cash value of the crop would be locked in guaranteeing that revenue. A producer must decide whether to hedge the entire value of the crop or only a portion (the decision to over or under hedge). A producer with good price forecasting skills can aid in this decision with selective hedging techniques. For instance, if a grower anticipates that his or her crop price will increase, he or she may decide not to hedge or hedge only a portion of the value of the crop. An understanding of hedging ratios is also important since it is necessary to have an adequate number of futures contracts to properly hedge the cash position. An exact matching of the value of the futures position to the cash position would appear to be difficult, based on the above examples since it is hard to predict how much the cash market would change in relation to the index value.

Summary and Conclusions

The main purpose of this paper was to examine the concept of creating indexes and eventual index futures contracts based on a wide range of fresh fruits and vegetables. Fruit, vegetable, and fruit/vegetable indexes were calculated for the years 1989-92 using USDA data from the Dallas Wholesale Fruit and Vegetable Market. A trade-weighted arithmetic index formula would provide the best chance for these indexes to be accurate market performance indicators and successful hedging vehicles. This study also set out to evaluate the hedging capabilities of such instruments in the context of hedging a portfolio of fruits and vegetables and the hedging of individual produce commodities. The results indicate that a portfolio of fruits and vegetables may be successfully hedged if the hedger is able to compile portfolios of fruits and vegetables that closely match the index. The results also indicate that successful cross hedging of individual produce commodities is possible, depending on the hedger's price forecasting abilities. For each of the commodities examined, the cash price and the index value moved in the same direction two out of the three years tested. Significant correlation coefficients between the produce commodity and the index may be helpful in identifying potential cross hedges but in no way guarantees their success.

Since the concept of an index and subsequently index futures contracts based on fresh produce is new, further research needs to be conducted before the success or failure of such a concept can be determined. First, an in-depth survey of the characteristics and idiosyncrasies of the fresh produce industry could provide a greater insight into how these indexes could be utilized and to the acceptance of such a product by the produce industry. Further research into the development of produce indexes themselves could be conducted by examining alternative weighting schemes which incorporate changing weights for different periods of the year based on seasonality of the components. Indexes could also be calculated for other terminal fruit and vegetable markets and examined in the context of which terminal market or combination of terminal markets best represent the produce market on a nation wide basis. In a further extension of the concept, processing fruits and vegetables might be included as a cross-hedge.

Overall, it appears that the fresh produce industry could benefit from index futures contracts for fresh fruits and vegetables. The ability to hedge in the futures market would provide producers and marketers with greater marketing and risk management alternatives.

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Table 1. Top ten fruits and vegetables for 1991[1], per capita consumption and average retail price.

Commodity	Common Varieties	Total Estimated Sales	Per Capita Consumption (lbs.)[2]	Average Retail Price Per Pound ($/lb.)[2]
Fruit				
Bananas	Cavendish	$ 2,286,474,000	24.70	0.45
Apples	Red & Golden Delicious, Jonathon, and Rome Beauty	$ 3,753,589,000	20.50	0.69
All Citrus[3]		$ 2,483,971,000		
Grapefruit			6.40	0.525
Lemons			2.30	0.995
Limes			0.70	0.370
Grapes	Green: Perlette & Thompson Red: Flame, Ruby, RED Globe and Christmas Rose	$1,431,303,000	7.20	1.205
Oranges	Navel, Valencia & Temple	$1,363,146,000	11.80	0.558
Cantaloupes	Top Mark, PMR 45, PMR 450, and Magnum	$749,730,000	9.50	0.330
Strawberries	Pajaro, Chandler, Selva, Oso Grande, and Seascape	$681,573,000	3.00	1.296
Peaches	Springcrest, Flavorcrest, June Lady, Fay Elberta, and O'Henry	$613,415,000		
Watermelons	Jubilee, Crimson Sweet Gray, and Royal Sweet	$613,415,000	12.30	0.140
Mangoes	Francisque, Haden, Keitt, Kent, Tommy Atkins, and Van Dyke	$102,236,000		
Vegetables				
Potatoes	Russet, Round Reds, Long White, and Round White	$2,266,750,000	48.00	0.342
Lettuce	Iceberg, Looseleaf, and Butterhead	$1,799,333,000	26.80	0.605
Tomatoes	Round, Globe, & Cherry	$2,543,001,000	14.30	0.912
Onions	Bermuda, Globe, and Creole	$997,452,000	13.90	0.361
Carrots	(size only) Jumbo, Med-Large, and Baby Whole	$523,081,000	7.60	0.136
Broccoli	Calabrese	$1,049,334,000	3.50	0.390
Peppers	Green & Red Sweet	$944,400,000	4.30	0.962
Cucumbers	Ashley, Marketer, Palomar, Long Market, and Pointsett	$734,533,000	4.40	0.656
Spinach	Savoy, Semi-Savoy and Flat Leaf	$419,733,000	0.60	0.500
Celery	Pascal	$568,064,000	7.00	0.531

[1]PMA, 1991.
[2]Source: Economic Research Service (ERS).
[3]All citrus includes oranges, grapefruits, lemons, limes, and tangerines/tangelos.

Table 2. Calculation of weighting scheme 1.

Commodity	Total Dollar Sales (000)	Value Proportion Weights (separate)	Value Proportion Weights (combined fruits & vegetables)
Fruit			
Bananas	$2,286,474	19.05%	9.60%
Apples (total)	$3,753,589		
red	$1,876,795	15.64%	7.88%
golden	$1,876,795	15.64%	7.88%
Other Citrus (total)	$1,120,825		
grapefruit	$373,608	3.11%	1.57%
lemons	$373,608	3.11%	1.57%
limes	$373,608	3.11%	1.57%
Grapes (total)	$1,431,304		
green	$715,652	5.96%	3.00%
red	$715,652	5.96%	3.00%
Oranges	$1,363,146	11.36%	5.72%
Cantaloupes	$749,731	6.25%	3.15%
Strawberries	$681,573	5.68%	2.86%
Watermelons	$613,416	5.11%	2.57%
Total Fruit	$12,000,057	100.00%	
Vegetables			
Potatoes (total)	$2,266,750		
russet	$1,133,375	9.58%	4.76%
round reds	$1,133,375	9.58%	4.76%
Lettuce	$1,799,333	15.22%	7.55%
Tomatoes	$2,543,001	21.50%	10.67%
Onions (total)	$977,452		
yellow	$325,817	2.76%	1.37%
white	$325,817	2.76%	1.37%
red	$325,817	2.76%	1.37%
Carrots	$523,081	4.42%	2.20%
Brocolli	$1,049,334	8.87%	4.40%
Peppers	$944,401	7.99%	3.96%
Cucumbers	$734,534	6.21%	3.08%
Spinach	$419,734	3.55%	1.76%
Celery	$568,064	4.80%	2.38%
Total Vegetables	$11,825,683	100.00%	
Total Fruit and Vegetables	$23,825,740.30		100.00%

Table 3. Calculation of weighting scheme 2.

Commodity	Total Dollar Sales (000)	Value Proportion Weights (seperate)	Value Proportion Weights (combined fruits & vegetables)
Fruit			
Bananas	$2,286,474	19.05%	9.60%
Apples (total)	$3,753,589		
red (73%)	$2,740,120	22.83%	11.50%
golden (27%)	$1,013,469	8.45%	4.25%
Other Citrus (total)	$1,120,825		
grapefruit (34%)	$381,080	3.18%	1.60%
lemons (48.3%)	$541,358	4.51%	2.27%
limes (17.7%)	$198,386	1.65%	0.83%
Grapes (total)	$1,431,304		
green (60%)	$858,782	7.16%	3.60%
red (40%)	$572,521	4.77%	2.40%
Oranges	$1,363,146	11.36%	5.72%
Cantaloupes	$749,731	6.25%	3.15%
Strawberries	$681,573	5.68%	2.86%
Watermelons	$613,416	5.11%	2.57%
Total Fruit	$12,000,057	100.00%	
Vegetables			
Potatoes (total)	$2,266,750		
russet (80%)	$1,813,400	15.33%	7.61%
round reds (20%)	$453,350	3.83%	1.90%
Lettuce	$1,799,333	15.22%	7.55%
Tomatoes	$2,543,001	21.50%	10.67%
Onions (total)	$977,452		
yellow (89%)	$869,932	7.36%	3.65%
white (7%)	$68,422	0.58%	0.29%
red (4%)	$39,098	0.33%	0.16%
Carrots	$523,081	4.42%	2.20%
Brocolli	$1,049,334	8.87%	4.40%
Peppers	$944,401	7.99%	3.96%
Cucumbers	$734,534	6.21%	3.08%
Spinach	$419,734	3.55%	1.76%
Celery	$568,064	4.80%	2.38%
Total Vegetables	$11,825,683	100.00%	
Total Fruit and Vegetables	$23,825,740.30		100.00%

Table 4. Calculation of weighting scheme 3.

Commodity	Per Capita Volume (lbs.)	Average Annual Price per lb. ($/lb.)	Value (volume x price)	Value Proportion Weights (seperate)	Value Proportion Weights (combined fruits & vegetables)
Fruit					
Bananas	24.70	0.449	11.09	20.12%	9.30%
Apples (total)	20.50	0.688			
red (73%)	14.97	0.688	10.30	18.68%	8.63%
golden (27%)	5.54	0.688	3.81	6.91%	3.19%
Other Citrus					
grapefruit	6.40	0.525	3.36	6.10%	2.82%
lemons	2.30	0.995	2.29	4.15%	1.92%
limes	0.70	0.370	0.26	0.47%	0.22%
Grapes (total)	7.20	1.205			
green (60%)	4.32	1.205	5.21	9.45%	4.37%
red (40%)	2.88	1.205	3.47	6.30%	2.91%
Oranges	11.80	0.558	6.58	11.95%	5.52%
Cantaloupes	9.50	0.330	3.14	5.69%	2.63%
Strawberries	3.00	1.296	3.89	7.06%	3.26%
Watermelons	12.30	0.140	1.72	3.12%	1.44%
Total Fruit	98.40		55.11	100.00%	
Vegetables					
Potatoes (total)	48.00	0.342			
russet (80%)	38.40	0.342	13.13	20.48%	11.01%
round reds (20%)	9.60	0.342	3.28	5.12%	2.75%
Lettuce	26.80	0.605	16.21	25.28%	13.60%
Tomatoes	14.30	0.912	13.04	20.34%	10.94%
Onions (total)	13.90	0.361			
yellow (89%)	12.37	0.361	4.47	6.96%	3.75%
white (7%)	0.97	0.361	0.35	0.55%	0.29%
red (4%)	0.56	0.361	0.20	0.31%	0.17%
Carrots	7.60	0.136	1.03	1.61%	0.87%
Brocolli	3.50	0.39	1.37	2.13%	1.14%
Peppers	4.30	0.962	4.14	6.45%	3.47%
Cucumbers	4.40	0.656	2.89	4.50%	2.42%
Spinach	0.60	0.5	0.30	0.47%	0.25%
Celery	7.00	0.531	3.72	5.80%	3.12%
Total Vegetables	130.40		64.13	100.00%	
Total Fruit and Vegetables	228.80		119.24		100.00%

Table 5. Hedge for a portfolio of produce commodities.

Date 4/1/92

Commodity	Cash Market: weight	dollar value	price/unit	units	value	index contribution
Bananas	9.30%	$4,650.00	12.88	361	$4,650.00	1.20
Red Apples	8.63%	$4,315.00	17.38	248	$4,315.00	1.50
Golden Apples	3.19%	$1,595.00	22.75	70	$1,595.00	0.73
Grapefruit	2.82%	$1,410.00	11.75	120	$1,410.00	0.33
Lemons	1.92%	$960.00	16.50	58	$960.00	0.32
Limes	0.22%	$110.00	15.13	7	$110.00	0.03
Green Grapes	4.37%	$2,185.00	13.38	163	$2,185.00	0.58
Red Grapes	2.91%	$1,455.00	14.88	98	$1,455.00	0.43
Oranges	5.52%	$2,760.00	11.00	251	$2,760.00	0.61
Cantaloupes	2.63%	$1,315.00	22.75	58	$1,315.00	0.60
Strawberries	3.26%	$1,630.00	15.50	105	$1,630.00	0.51
Watermelons	1.44%	$720.00	0.28	2571	$720.00	0.00
Russet Potatoes	11.01%	$5,505.00	6.50	847	$5,505.00	0.72
Round Reds	2.75%	$1,375.00	15.75	87	$1,375.00	0.43
Iceburg Lettuce	13.61%	$6,805.00	7.50	907	$6,805.00	1.02
Tomatoes	10.94%	$5,470.00	31.00	176	$5,470.00	3.39
Yellow Onions	3.75%	$1,875.00	20.75	90	$1,875.00	0.78
White Onions	0.29%	$145.00	28.50	5	$145.00	0.08
Red Onions	0.17%	$85.00	17.00	5	$85.00	0.03
Carrots	0.87%	$435.00	11.00	40	$435.00	0.10
Broccoli	1.14%	$570.00	13.50	42	$570.00	0.15
Peppers	3.47%	$1,735.00	24.88	70	$1,735.00	0.86
Cucumbers	2.42%	$1,210.00	18.13	67	$1,210.00	0.44
Spinach	0.25%	$125.00	11.50	11	$125.00	0.03
Celery	3.12%	$1,560.00	9.75	160	$1,560.00	0.30
Portfolio value:	100.00%	$50,000.00			$50,000.00	

Futures Market

Index value 126.23

Index value: 126.23
(sum of index contribution/base year = 12.02) x 100

Date 4/10/92

Commodity	weight	price/unit	units	value	index contribution
Bananas	9.30%	11.88	361	$4,288.98	1.10
Red Apples	8.63%	17.75	248	$4,406.86	1.53
Golden Apples	3.19%	22.75	70	$1,595.00	0.73
Grapefruit	2.82%	11.75	120	$1,410.00	0.33
Lemons	1.92%	16.50	58	$960.00	0.32
Limes	0.22%	15.13	7	$110.00	0.03
Green Grapes	4.37%	13.38	163	$2,185.00	0.58
Red Grapes	2.91%	14.88	98	$1,455.00	0.43
Oranges	5.52%	11.00	251	$2,760.00	0.61
Cantaloupes	2.63%	14.75	58	$852.58	0.39
Strawberries	3.26%	10.75	105	$1,130.48	0.35
Watermelons	1.44%	0.30	2571	$771.43	0.00
Russet Potatoes	11.01%	6.50	847	$5,505.00	0.72
Round Reds	2.75%	15.75	87	$1,375.00	0.43
Iceburg Lettuce	13.61%	7.50	907	$6,805.00	1.02
Tomatoes	10.94%	18.50	176	$3,264.35	2.02
Yellow Onions	3.75%	24.00	90	$2,168.67	0.90
White Onions	0.29%	29.75	5	$151.36	0.09
Red Onions	0.17%	24.00	5	$120.00	0.04
Carrots	0.87%	11.00	40	$435.00	0.10
Broccoli	1.14%	9.00	42	$380.00	0.10
Peppers	3.47%	24.88	70	$1,735.00	0.86
Cucumbers	2.42%	16.13	67	$1,076.52	0.39
Spinach	0.25%	11.50	11	$125.00	0.03
Celery	3.12%	9.75	160	$1,560.00	0.30
Portfolio value:	100.00%			$46,626.24	

Index value 111.62

Index value: 111.62
(sum of index contribution/base year = 12.02) x 100

Absolute Dollar Change

4/1/92	$50,000.00
4/10/92	$46,626.24
Value change	($3,373.76)
Percentage change	-6.75%

Change In Cash Index

4/1/92	126.23
4/10/92	111.62
	-14.61
	-11.57%

Change in Futures Index

4/1/92	$126.23
4/10/92	$111.62
	($14.61)
% change:	-11.57%

Table 6. Pearson correlation coefficients between individual components and indexes for 1989-92 (Prob > Rho under Ho: Rho=0)[1].

COMMODITY	Indexes[2] Fruit 3	Vegetable 3	F & V 3
Fruit			
Bananas	0.47286 0.0001	0.42737 0.0001	0.60252 0.0001
Apples:			
red	0.57387 0.0001	-0.13429 0.0001	0.23015 0.0001
golden	0.43885 0.0001	-0.02950 0.3524	0.23227 0.0001
Other Citrus:			
grapefruit	0.06211 0.0501	-0.00290 0.9273	0.03337 0.2927
lemons	0.35269 0.0001	0.03405 0.283	0.23122 0.0001
limes	0.13727 0.0001	0.14156 0.0001	0.18845 0.0001
Grapes:			
green	0.37768 0.0001	0.05166 0.0001	0.25959 0.0001
red	0.40856 0.0001	0.03650 0.2498	0.26586 0.0001
Oranges	0.74507 0.0001	-0.12973 0.0001	0.33446 0.0001
Cantaloupes	0.33302 0.0001	0.22575 0.0001	0.36643 0.0001
Strawberries	0.18285 0.0001	0.03950 0.2129	0.13642 0.0001
Watermelons	0.32426 0.0001	0.33219 0.0001	0.44256 0.0001

	Indexes[2] Fruit 3	Vegetable 3	F & V 3
Vegetables			
Potatoes:			
russet	-0.34815 0.0001	0.22861 0.0001	-0.02735 0.3886
round reds	0.01961 0.5364	0.33167 0.0001	0.26571 0.0001
Lettuce	0.07568 0.0169	0.30174 0.0001	0.27504 0.0001
Tomatoes	0.11680 0.0002	0.79112 0.0001	0.6732 0.0001
Onions:			
yellow	0.15361 0.0001	0.42850 0.0001	0.41719 0.0001
white	0.29630 0.0001	0.28135 0.0001	0.38708 0.0001
red	-0.00306 0.9232	0.12213 0.0001	0.09177 0.0001
Carrots	0.39147 0.0001	0.22614 0.0001	0.40066 0.0001
Broccoli	0.19423 0.0001	0.01547 0.6259	0.12463 0.0001
Peppers	0.18299 0.0001	0.69750 0.0001	0.64031 0.0001
Cucumbers	0.09797 0.002	0.42758 0.0001	0.38485 0.0001
Spinach	0.27647 0.0001	0.03228 0.3088	0.18537 0.0001
Celery	-0.01421 0.6543	0.34086 0.0001	0.25296 0.0001

[1]Top number represents correlation coefficient and bottom number represents significance level.
[2]Fruit, vegetable, and F & V (1-3) represent the three weighting schemes used in calculating the fruit, vegetable and fruit/vegetable indexes.

Table 7. Cross hedges for New Mexico yellow onions (1990-92).

		Cash	*Futures*			
1990 New Mexico yellow onion hedges						
Date:		**Cash Price ($/sack):**	**Vegetable Index:**		**Fruit/Vegetable Index:**	
6/5/90		$7.00	Sell @	85.85	Sell @	95.93
8/24/90		$4.50	Buy @	97.80	Buy @	103.40
	Absolute change:	($2.50)		11.95		7.47
	% change:	-35.71%		13.92%		7.79%
1991 New Mexico yellow onion hedges						
6/10/91		$8.00	Sell @	131.61	Sell @	131.97
8/26/91		$5.25	Buy @	76.31	Buy @	100.32
	Absolute change:	($2.75)		-55.30		-31.65
	% change:	-34.38%		-42.02%		-23.98%
1992 New Mexico yellow onion hedges						
6/4/92		$5.00	Sell @	83.51	Sell @	93.80
8/7/92		$7.50	Buy @	107.66	Buy @	108.61
	Absolute change:	$2.50		24.15		14.81
	% change:	50.00%		28.92%		15.79%

Table 8. Cross hedges for California tomatoes (1990-92).

		Cash	*Futures*			
1990 California tomato hedges						
Date:		**Cash Price ($/carton):**	**Vegetable Index:**		**Fruit/Vegetable Index:**	
6/4/90		$5.00	Sell @	86.50	Sell @	98.79
11/9/90		$4.50	Buy @	106.53	Buy @	105.35
	Absolute change:	($0.50)		+20.03		+6.56
	% change:	-10.00%		+23.16%		+6.64
1991 California tomato hedges						
6/25/91		$11.00	Sell @	132.66	Sell @	134.52
11/7/91		$5.50	Buy @	116.15	Buy @	124.19
	Absolute change:	($5.50)		-16.51		-10.33
	% change:	-50.00%		-12.45%		-7.68%
1992 California tomato hedges						
6/8/92		$5.50	Sell @	84.65	Sell @	96.07
11/19/92		$6.00	Buy @	87.49	Buy @	95.3
	Absolute change:	+$0.50		+2.84		-0.77
	% change:	+9.09%		+3.35%		-0.80%