ANALYZING PRICE VARIATIONS FOR CANNING AND FREEZING APPLES

by

William G. Tomek and B. A. Dominick, Jr.

January 1970 No. 2

ANALYZING PRICE VARIATIONS FOR CANNING AND FREEZING APPLES*/

William G. Tomek and B. A. Dominick, Jr.

The large apple crop in 1969 and the consequent decline in price from the level of the previous year has provided renewed interest in the factors influencing apple prices. This paper presents a statistical analysis of farm-level prices of canning and freezing apples, emphasizing those received by New York growers.1/ A concluding section outlines the applicability of such an analysis to the negotiation of prices between growers and processors.

Prices received by New York growers are closely related to those in other states (figure 1). The market for processed apple products is a national one, and apple prices in various states have many "causal" factors in common. These factors are sufficiently strong so that prices in individual states tend to move together from year to year. Thus, regardless of the particular state price being analyzed, the type of explanatory variable considered tends to be the same. Of course, prices in the different states do not coincide, and we try to capture this difference by considering individual state variables.

The annual prices reported for canning and freezing sales are averages. Naturally, the specific prices received by growers may be higher or lower than the reported average price. By definition, changes in the annual average price through time represent the central tendency of price changes. Thus, an analysis of this average price is concerned with the "general" factors influencing prices and not with factors, such as size or variety, that influence prices of specific lots of the commodity.

Alternative Equations

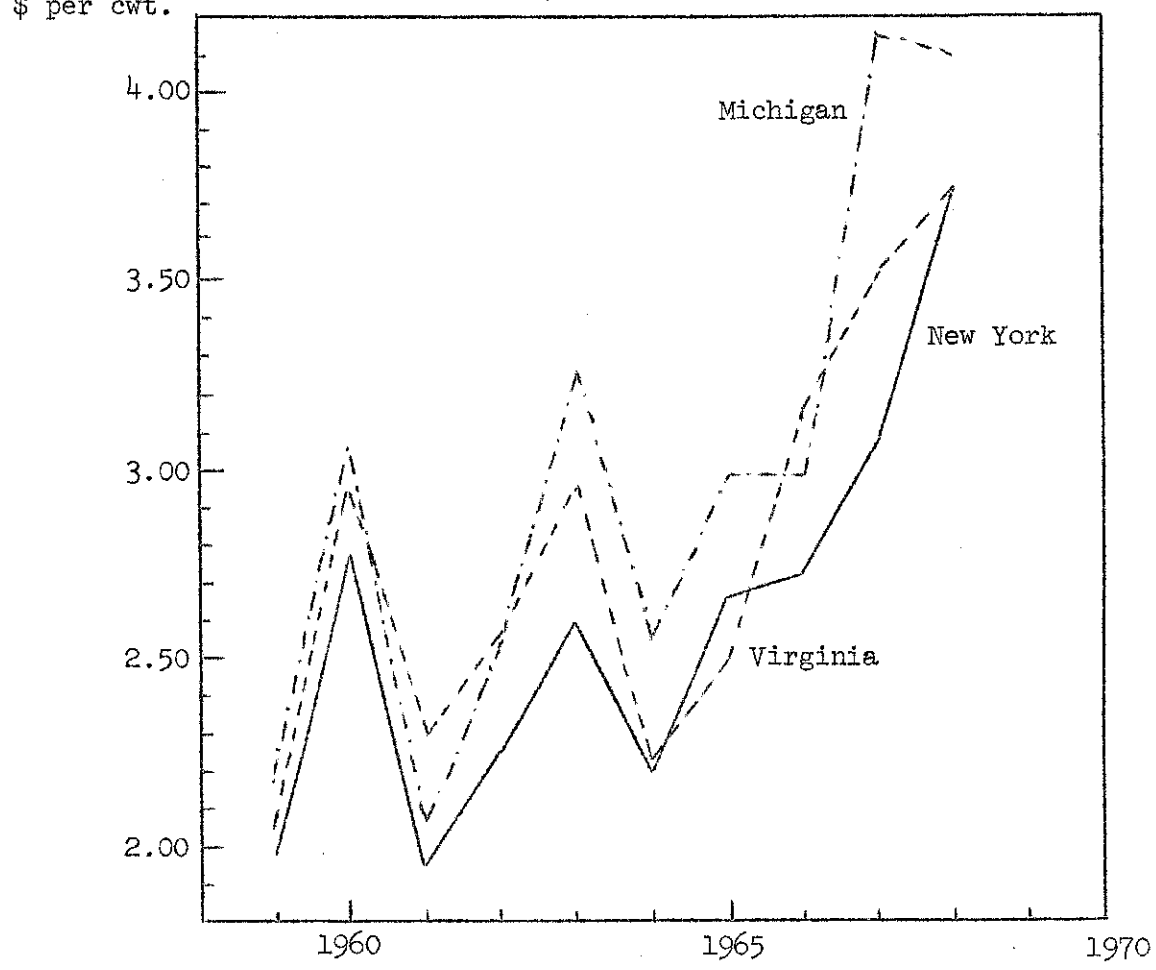
We consider two equations in analyzing prices received by New York growers for canning and freezing apples. One makes New York price a function of an Appalachian Belt State opening price and of New York State production. The Appalachian price may be viewed as a benchmark from which we adjust for New York production. The main advantage of this approach is simplicity; price is

---

*/ Paper prepared for Economic School for Cooperative Extension Agents, Cornell University, December 16, 1969, and for the 1970 Proceedings of the New York State Horticultural Society.

1/ For an earlier analysis see Austin C. Lowry and William G. Tomek, Forecasting the Farm Price of Apples for Canning and Freezing in New York State, Cornell University A. E. Res. 219, May 1967.

Figure 1. Prices for Canning and Freezing Apples in Michigan, Virginia, and New York



a function of only two variables.2/ This simplifies making short-run price forecasts. The equation implicitly assumes that similar "general" factors influence both Appalachian and New York prices, and since Appalachian prices are established first, they provide a benchmark from which to judge New York prices. However, this approach has the disadvantage of not expressing New York price as a function of specific economic factors influencing price.

The second equation makes price a function of local (state) production, competing states' production, carryover stocks of processed apple products, and real disposable income. Each of these variables is divided by the U. S. population, thereby adjusting for population growth. The population and income variables are intended, of course, to measure changing consumer demand for apple products; we expect demand to grow with growth in income and population. The size of inventories of processed products at the beginning of the crop year will influence processors' demand for the current crop. A larger than average carryover, other factors constant, implies a lower than average farm price. Naturally, crop size is an important explainer of price. We separate out state production from the national total, hypothesizing that local production is particularly important in determining local price. Since the market for processed products is nationwide, local processors must take account of national conditions, but on the other hand, processors are primarily dependent on local supplies. Thus, it seems reasonable that both local and national production are important variables but that their impacts on local price may be somewhat different.

The type of variable to be included in our analysis is ascertained on the basis of logic, but such logic does not help with all the problems of analysis. For instance, how should production in competing states be measured? As production in major Eastern producers? Should Michigan be included? Or, should all other states be included? There are many other questions such as the historical time period to be considered in the analysis and the specific mathematical relationship (type of curve or line) between the variables. The answers to such equations are obtained from a trial-and-error process and the judgment of the analysts. Price analysis is to some extent an art rather than a science.

Our analysis is based on data for the 10-year period 1959-1968. We use straight line relationships. Two equations, based on the two alternatives outlined, are presented. An explanation of the results follows.

(1) $Y = 1.992 - 0.333\ X_1 + 0.778\ X_2$

$R^2 = .93$

where Y = farm-level price of apples for canning and freezing in New York, $ per cwt.;

X_1 = production in New York, pounds per person (in United States);

2/ Total New York production is divided by U. S. population to give a measure in pounds per capita. Thus, price is in a sense a function of three variables.

X_2 = opening price of apples in Appalachian Belt States, $ per cwt.

(2) $Y = 4.820 - 0.520\ X_1 - 0.112\ X_3 - 0.133\ X_4 + 0.0015\ X_5$

$R^2 = .95$

where Y and X_1 are defined above;

X_3 = production in U. S. minus production in New York, pounds per person (in U. S.);

X_4 = stocks of applesauce, canned slices, and frozen slices, pounds per person (in fresh equivalent);

X_5 = real (deflated by CPI) disposable income, dollars per person.

Interpreting Results

In equation (1), about 93 per cent of the variation in price is associated with the variation in the two explanatory variables. The coefficient for X_1 suggests that a one pound change in New York production (per person in the U. S.) will change New York price about 33 cents per hundred in the opposite direction, adjusting for the level of Appalachian price.3/ A one dollar change in Appalachian price is, on the average, associated with a 78 cent change in the New York price, adjusting for New York production. Naturally, the two prices have a positive relationship, but the Appalachian price has a higher average level and fluctuates more than the New York price.

In equation (2), approximately 95 per cent of the variation in price is associated with variation in the four explanatory variables. In this case, a one pound change in New York production is estimated to change New York price about 52 cents a hundred, holding other factors constant. A one pound change in all other U. S. production is associated with an 11 cent change in price, other variables constant.

Although the coefficient associated with U. S. production is smaller than the one for New York production, this doesn't mean that U. S. production is a less important influence on New York price -- at least in the following sense. Year-to-year changes in U. S. production are obviously bigger than those in New York. For instance, U. S. production (other than New York) is estimated to have increased over 5 pounds per capita from 1968 to 1969. If no other factors changed, this increase would imply a 55 cent per hundred decline in New York price. In contrast, local production is estimated to have increased 0.4 pound, implying a 21 cent decrease in price.

3/ New York production typically would not change by as much as one pound per person -- over 200 million pounds -- from one year to the next.

The carryover variable's coefficient indicates that a one pound change in inventory is associated with a 13 cent per hundred change in price, net of other variables. The income coefficient estimates that a one dollar increase in real disposable income per person would increase the farm price of canning apples 0.15 cent; i.e., a 100 dollar increase would increase price 15 cents per hundred, other factors constant.

While the variables in each equation "explain" a large proportion of the annual variation in New York price, they do not "explain" all of it. We must accept the fact that some variation in price results from random and/or unmeasurable factors. About 5 to 10 per cent of the variation in the price of canning and freezing apples in New York is not explainable, at least in terms of the measurable variables used in our analysis.

The impact of changing economic conditions on price is illustrated in Table 1. From 1960 to 1968, total apple production increased, but this was offset by population growth. Carryover increased even on a per capita basis, but overall demand increased, which is partly if not solely attributable to larger disposable incomes by consumers. Thus, apple prices were higher in 1968 than in 1960. The price decrease from 1968 to 1969 is associated with an increase in production, both local and national, and in carryover, and these increases were larger than the growth in demand.

Table 1. Variables Influencing New York Apple Prices for Selected Years

Variable	Crop Year 1960	1968	1969 (prel.)
N. Y. production (lb./cap.)	4.0	4.1	4.5
Other U. S. prod. (lb./cap.)	23.0	22.9	28.0
Carryover (lb./cap.)	1.4	1.8	2.1
Disp. income ($/cap.)	1883	2443	2470
N. Y. canning price ($/cwt.)	2.79	3.74	2.75-2.82 (forecast)

To keep 1969 in proper perspective, however, we must observe that 1969 prices approximately equal those in 1960 even though production in New York is 27.6 per cent larger in 1969 than in 1960. Thus, the dollar value of apple sales for canning and freezing in New York is about 25 to 30 per cent larger in 1969 than in 1960. Since the Index of Prices Paid by Farmers (in the U. S. for all items, including living as well as production expenses) increased 26.6 per cent from October, 1960, to October, 1969,4/ the "real" or "deflated" value

4/ The Index was 297 in October 1960 and 376 in October 1969 (1910-14 = 100).

of apple sales is approximately equal for the two time periods. In this context, it is interesting to note that 1960 was considered a "good" year for New York growers perhaps because it represented a year of a price increase from the previous year, while 1969 is considered a "poor" year because it represents a year with a substantial price decrease. The evaluation of a particular year obviously depends on the standard of comparison.

Short-Term Forecasts

The estimated equations may be used to make pre-harvest forecasts, i.e. to compute an average price from preliminary values of the explanatory variables under the assumption that historical relationships will prevail in the forthcoming crop year. In equation (1), preliminary estimates of crop size in New York, U. S. population, and an opening Appalachian price are required to forecast New York price. In equation (2), estimates of U. S. production, carryover, and real disposable income are also required. Pre-harvest estimates of crop size and inventory are available. While "official" projections of population and income for the forthcoming crop year are not available, past trends in growth of these variables can be used to make reasonable projections for purposes of forecasting price. Once the preliminary values of the explanatory variables are available, the estimated equation is used to compute a value of the dependent variable (price). For example, in equation (1), if X_1 = 4.528 (lb./capita) and X_2 = 3.00 ($/cwt.), then

$$Y = 1.992 - 0.333\ (4.528) + 0.778\ (3.00)$$

$$= 2.82\ (\$/\text{cwt.}).$$

Using a similar procedure with equation (2) gives an estimate of 2.75 per hundredweight.

Forecasts of price derived from these equations can be faulty for several reasons. First, they are conditional on the values assigned the explanatory variables. If the USDA incorrectly estimates crop size, say, in August, then the resulting price forecast is likely to be wrong. Second, as we observed, price fluctuations are partly associated with random, unobservable factors. For instance, if a crop is characterized by below average quality and consequently if an unusually large proportion of apples must go into processing, then prices for processing apples are likely to be lower than those expected from past, average relationships. Third, estimates of the forecasting equation are based on historical experience. While we use recent and hopefully relevant experience, relationships may change with the passage of time. Consumer preferences can change; new substitutes are developed.5/

Nonetheless, equations such as those presented in this paper can provide reasonable guides to future changes in the average level of prices (figures 2 and 3). In the historical period, the prices computed from the equations are

---

5/ Clearly the historical relationship between the price and quantity of butter was changed by the development of margarine.

Figure 2. Equation Using Appalachian Price as Benchmark

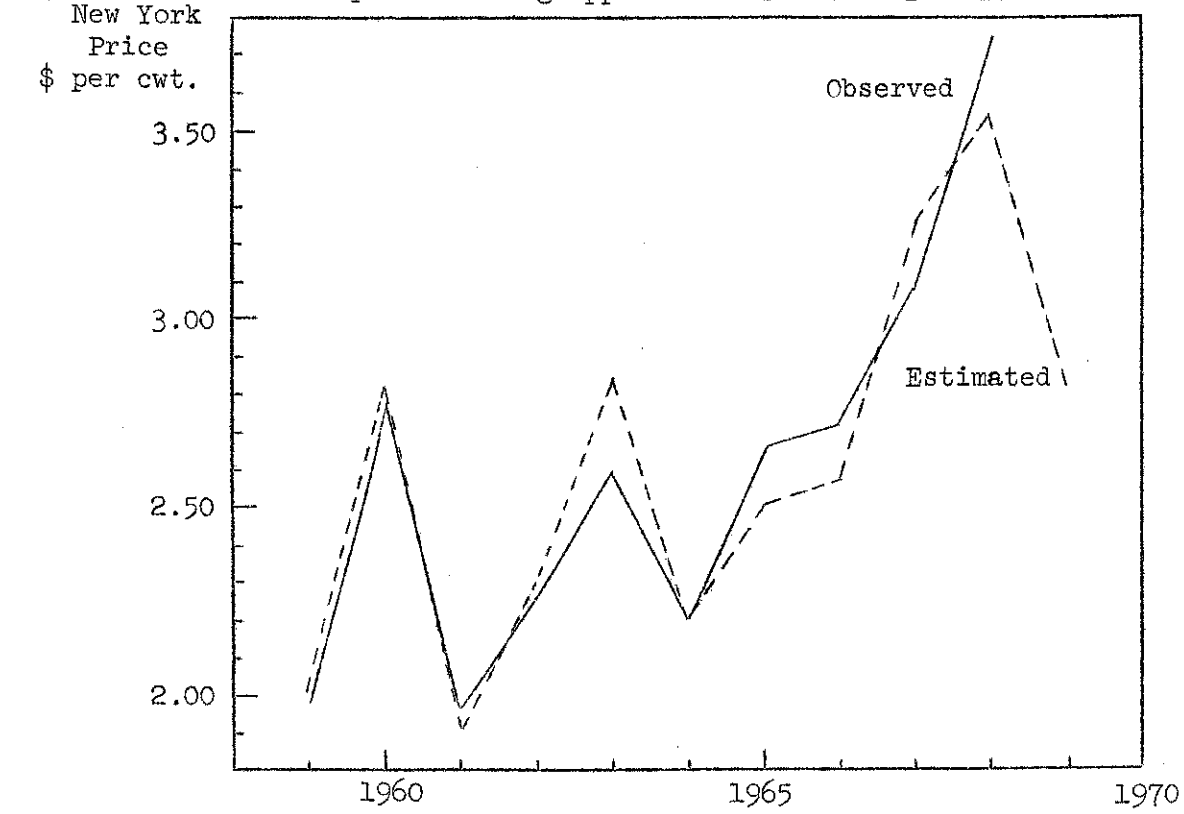
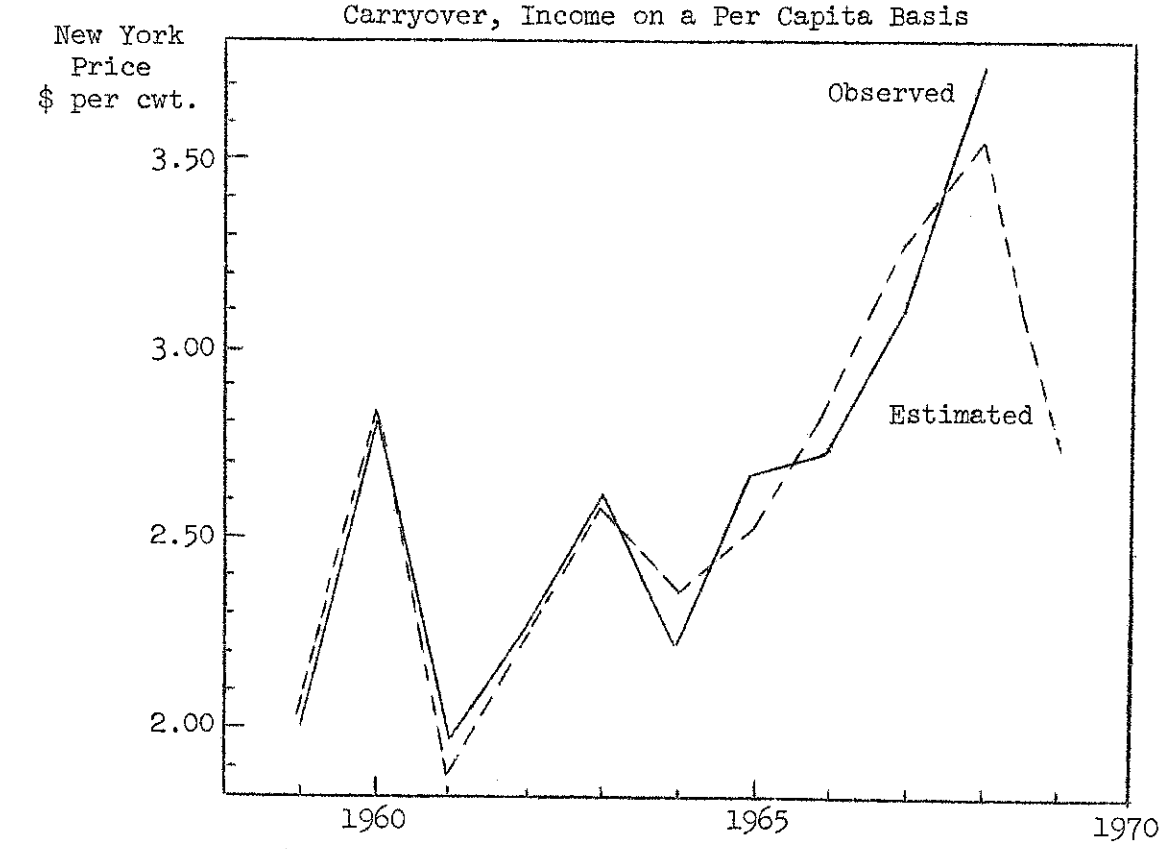


Figure 3. Equation Using New York Production, Other U. S. Production, Carryover, Income on a Per Capita Basis



similar to the observed prices, and the computed price moves from year to year in the same direction as observed price. This suggests that a forecast would capture the direction of change in price from one year to the next and would be reasonably close to the subsequently observed value.

Of course, the computed prices with the exception of 1969 are ex post forecasts; that is, they are based on the final (best) estimates of the explanatory variables. In a true forecasting situation, preliminary estimates of the explanatory variables must be used to compute the dependent variable. As explained previously, an error in pre-harvest estimate of crop size (or other variable) can lead to a forecasting error. Such errors may not be large, and the forecast can be quite accurate. But, normally, we would not expect a true ex ante forecast to be quite as precise as the computed values of the dependent variable for the historical sample period.

Applicability to Price Negotiations

Price analyses and forecasts, such as those discussed in this paper, may be a useful component of a negotiation process between growers and processors. A price forecast may be used as a benchmark for the subsequent, detailed negotiations. A necessary first step, however, would be for the participants to agree on the relationship (equation) which is to serve as the basis for negotiations. As discussed above, the judgment of the analyst is an important ingredient of a price analysis. Thus, while a consensus may be reached rather easily on an appropriate equation, it is to some extent a matter for negotiation.

Given an agreement on a historical relationship among variables, then the participants must agree on the relevant levels (magnitudes) of the explanatory variables for the current year (under negotiation). These are the expected levels of the variables in the equation, which influence price, and hence these are the values used in computing the forecast of the average price, which forms the benchmark for negotiations. Clearly there will be uncertainty prior to and during harvest about the magnitudes of the explanatory variables, and naturally it would be to the advantage of growers to err in the direction of higher prices and conversely for processors. In other words, a second important step is to reach agreement on the "true" magnitudes of the factors influencing price.

The final step is to negotiate price differentials about the computed average price, conditions of delivery, and other factors influencing returns to individual growers. Variables, such as variety and size, influence the prices of specific lots of apples delivered to processors. A price forecasting equation based on the average price has little to say about such specific details; rather, a forecast of an average price simply provides a starting point for the more detailed negotiations.