

A STUDY OF THE ECONOMIC FUNCTIONS OF THE MAINE POTATO FUTURES MARKET

Jeff Sooy and Ben Branch

Abstract. In an update and extension of prior work this study found that the potato futures markets continued to provide very unreliable forecasts of subsequent spot prices. On the other hand and contrary to some past studies an extensive study here failed to turn up any convincing evidence of a cobweb pricing relationship. Moreover the increasing volatility of potato futures prices in the more recent time period raises questions regarding their value as hedging vehicles. Finally it is argued that the market's efficiency might be improved by expanding the current Maine potato contract to permit delivery of round white potatoes grown outside Maine.

The commodity markets are always under attack by some group who think that its interests are threatened. Past attacks eventually led to a prohibition of trading in onion futures even though the subsequent evidence on the matter indicated that such trading had a stabilizing or at worst a neutral impact on price volatility (Gray 1963, Johnson 1973). Like onions, trading in potato futures has also been severely criticized by those who believe that such trading is detrimental to their interests. While various groups have studied the possibility of prohibiting trading in potato futures, no banning legislation has yet been enacted.¹ Still, the effort to disallow futures trading is very much alive (Business Week). Accordingly, a study which examines the trading performance of the potato futures contract should be relevant to decisions about both continued trading in the potato contract itself and the overall desirability of futures trading.

STATEMENT OF PROBLEM AND JUSTIFICATION FOR RESEARCH

Two potential economic functions of the potato futures markets are to facilitate hedging and to give signals that have a stabilizing influence on prices. A function relevant to futures markets with storable commodities such as wheat, corn or silver is that of inventory allocation. With potatoes, however, there is no possibility of long term storage and short term storage is costly. Thus, there is only a modest sized potato inventory to manage.² The limited inventory allocation role, however, makes the potato futures market an excellent vehicle for studying the first two questions.

There is an extensive prior literature on the potato market with a significant flurry of activity in the late 1960's and early 1970's.³ That literature, particularly work by Gray produced evidence supportive of the following conclusions:

1. Planting time futures prices for harvest time potatoes were far more stable than were the prices of those same contracts close to the time of harvest. On the one hand this finding suggested that futures prices had a potentially stabilizing role (because potato farmers could use futures trading to hedge their output and thereby stabilize their income) but on the other hand it indicated that the planting time futures prices were relatively poor predictors of the subsequent harvest prices (because of the low correlation between the two prices).

2. A pronounced cobweb relation in harvest prices with a series of shifts in certain years was alleged to exist. This finding suggested that hedging should be a useful way to avoid or reduce the impact of price volatility.

3. A hedging strategy typically would not only have reduced risk but also increased the average return for potato growers during the period studied.

While these findings suggest that the potato futures market serves a useful economic function, the issues are far from settled. Since only pre-1971 data were analyzed there is no assurance that the favorable aspects of the previous performance have persisted. Moreover, while hedging would be expected to facilitate a reduction in risk, for it to offer the further advantage of a higher average return is like receiving a tip for eating a free lunch. Accordingly it would be useful to investigate the more recent experience of a hedging strategy to determine whether this unusual behavior has persisted. Finally, evidence of a cobweb for harvest prices without recognition of a cobweb pattern in pre-planting futures prices is particularly surprising. Gray argues persuasively that a pattern of recognition in the pre-planting futures market would tend to eliminate the cobweb. This reasoning does, however, leave some troublesome questions. Should not the cobweb pattern have become recognized thereby setting in motion forces which would have eliminated or at least dampened the amplitude of the cobweb? If a pattern persists with significantly predictable regularity, at least some traders should recognize it. While the market as a group could not profit, any single small trader acting in isolation could. If, however, a sufficient number of individuals began trading on the expectation of a cobweb relation, pre-planting prices should indeed begin to produce counter cobweb signals thereby blunting the pattern. In an efficient market this process should quickly eliminate or at least greatly reduce any sort of predictable price pattern (Fama) while up to 1970 at least the cobweb relation appeared to be intact. In light of the foregoing discussion the present research focuses on the basic question: What has been the performance of the potato futures market since 1970? More specifically we are concerned with the predictive ability of the planting time potato futures market, whether a cobweb pattern has persisted into the recent time period and what the impact of hedging would have been on producers' returns and the variability of those returns.

As the current study was taking form, another study of the potato futures, sponsored by the U.S. Senate Committee on Agriculture Nutrition and Forestry, was underway. The study was conducted by a group of researchers at the Department of Agriculture including William Tomek and Allen Paul who had been involved in earlier potato futures work. The recent submission

Ben Branch is Professor and Jeff Sooy graduate student in the Department of General Business and Finance, University of Massachusetts. We would like to thank Bill Tomek, Ann Peck and several unnamed referees for their helpful comments.

¹See various U.S. Congressional Hearings cited in the list of references.

²The inventory allocation role should not be totally ignored. There is a significant amount seasonal inventory allocation and futures trading plays a role here. See "Potato Futures Study," 1979, pp. 79-85.

³See in particular work cited in references by d'Arge and Tomek, Emerson and Tomek, Estes, Gray, hee, Johnson, Merchant, Murphy, Olson, Paul, Paul, Hefner and Helmuth, Schwartz, Simons, Tomek and Gray, Wesson, and Young and Gray. See also various government reports cited in references.

of the final report of that study (herein after referred to as the Potato Futures Study) allows us to draw from their results where applicable to our own work. While it does deal extensively with a number of interesting topics, others with which we wish to deal were not considered in that study.⁴ Moreover, it is often worthwhile to treat a given topic from more than one perspective. Indeed there are some significant differences in both the approaches used and the conclusions reached by the two studies. Thus, although the current study will draw from certain aspects of the "Potato Futures Study," it will still make an independent contribution of its own.

DATA AND METHODOLOGY

Since the most widely cited prior studies in the field are the original Tomek and Gray (TG) study, their update (1971), and a subsequent study by Gray (1972), this study began where they left off. In particular much of the methodology which was employed in their studies is also used here and applied to subsequent data. Data for 1953-1978 are employed to make statistical, graphical, and regression analyses similar to those originally performed either by TG or in the additional analysis by Gray. In many instances tests are run first on data for the 1953-1968 time period then the 1969-78 time period. The data were divided in this way both because prior work largely ended in 1968 leaving the more recent set of data untested (except for the Potato Futures Study) and the resulting subsets contained a sufficiently large number of observations for meaningful testing. As will be seen subsequently the market appears to have been shocked in 1972 such that post 1972 data exhibit very different characteristics from that of the prior period suggesting a split at 1972. The data were not, however, stratified at that point because it would have: severely reduced the degrees of freedom in the latter period; taken advantage of hindsight in the splitting process (making it vulnerable to the criticism that a different date for splitting the data might have led to different results); and made it more difficult to compare this research with the earlier literature.

Note that our splitting of the data at 1968-69 rather than 1972-73 illustrates one basic difference between our approach and that employed in the Potato Futures Study. In that study "... a dummy variable, that takes the value of one in crop year 1973 and thereafter and zero in 1972 and before, was included in some equations. This is based strictly on the observation of scatter diagrams that seem to suggest a "one time" shift in the price quantity function between 1972-73" (p. 16). Thereafter much of their statistical analysis is performed on data stratified at 1973. They indicate that the data were stratified in 1973 because that appeared to give the best fit. In the process the volatility inherent in the price-quantity relationships over the 1972-73 period is submerged in the stratification. Thus, a possibly unrealistic picture may emerge by choosing to divide the data at the point that minimizes instability. Whether or not the post 1973 experience is the best predictor of future conditions depends upon the causes and permanence of the underlying shift in price-quantity relations that appeared to occur at that time. We do not know of any specific cause for an underlying shift that took place at that time and none is presented in the Potato Futures Study. Thus, the apparent shift in 1973 could reflect either an alteration in the underlying structure or a random shift that may well be followed by further shifts. We initially decided to divide our

⁴For example while both studies deal with the topic of hedging (although somewhat differently), the Potato Futures Study does not take up either the question of future prices as predictors of subsequent cash prices on the cobweb question—both issues given considerable interest on the prior literature. On the other hand the Potato Futures Study includes a very detailed discussion of the history and mechanics of the potato futures markets, topics only briefly mentioned herein.

data at 1968-69 and have chosen to retain that division and to resist suggestions that we change even after observing the alternative approach. We leave it to the reader to decide whether or not it is best to divide the data where you get the best fit. Note, however, that the same logic that suggests that the data be stratified in 1973 would also suggest a similar stratification in 1961-63 where another structural shift seemed to occur.

Following the practice of the earlier literature the closing prices on the last trading day of April of each year for the post-harvest November Maine potato futures⁵ contract were taken to represent the forward prices provided by the futures market at planting time and closing prices of the contracts on their expiration dates⁶ are used as the immediate post-harvest prices. Data on the acreages planted are used to test for a supply oriented cobweb price structure. Finally the price performance of the November potato contract is used to compute an annual rate of return for the 1953-1978 time period employing simple trading rules based on a cobweb supply response. To test the value of a hedging strategy the level and stability of income for both Maine and Idaho potato farmers are computed for both a hedged and an unhedged strategy. The first test employed a regression model to examine the forecasting ability of the futures market.

POTATO FUTURES PRICES AS FORECASTERS

In the simple linear regression model, $P^c = a + bP^f$, the cash price at harvest (P^c) is viewed as a function of the springtime futures price (P^f). P^f is defined as a perfect and unbiased forecast of P^c if for each year $P^c = P^f$. If the futures market accurately anticipates the forward prices for the futures contract, then the R^2 (R^2 corrected for degrees of freedom) value of the regression equation should be reasonably close to one, the intercept "a" should be close to zero and the slope "b" should be close to one. Such values would suggest that the independent variables P^f (the April 30 closing price for the November contract) is both an accurate (high R^2) and an unbiased ("a" close to zero and "b" close to one) predictor of the dependent variable (the closing price at expiration of the November contract). The results of fitting this regression to the two subperiods (1953-1968 and 1969-1978) as well as for the entire 1953-1978 period are summarized in Table 1.

Table 1
Regression Results for Futures Prices As Predictors of
Subsequent Cash Prices*

	Intercept	Slope	\bar{R}^2	F
1953-1968	-1.99	1.91	.12	1.77
November Potato Contracts	(2.43)	(1.08)		
1969-1978	2.28	.50	.20	1.75
November Potato Contracts	(1.24)	(.28)		
1953-1978	.72	.80	.57	29.16
November Potato Contracts	(.46)	(.14)		

*Numbers in parentheses are standard errors.

⁵There are in fact two different potato futures contracts. The Chicago Mercantile Exchange has been trading Russet (Idaho) potato futures since 1931. Beginning in 1941 the New York Mercantile trading in round white potatoes grown in Maine. The latter contract's volume has since 1945 substantially surpassed trading in Russet futures. Accordingly almost all of the empirical work in the area has dealt with the Maine potato futures contract.

⁶There is some danger in this approach as the expiration day prices are potentially subject to thin market trading forces and occasionally a short squeeze (Jackewicz, Gomex and "The Potato Futures Study"). The alternative, however, is to use actual cash prices which are also subject to short squeezes plus grading and classification problems.

For all the periods analyzed, the regressions produced intercept estimates which were different from zero, slopes estimates different from unity and \bar{R}^2 values which were substantially less than one. The failure of futures prices to produce reliable forecasts is particularly dramatically illustrated for the 1969-1978 period which had an intercept equal to 2.28, a slope of .50, and an \bar{R}^2 value of only .20. Thus, over this period the independent variable (the closing futures price on the last trading day of April) did not provide an especially accurate forecast of the price of the dependent variable, (the cash price at expiration of the November contract). For the 1953-1968 period TG had found an intercept of negative 1.99 which is appreciably different from zero, a slope of 1.91 which is not very close to one and an \bar{R}^2 of .12 which is substantially less than one.

For the combined time period (1953-1978) the intercept was .72, the slope .80 and the \bar{R}^2 value equalled .57. While these latter figures are closer to the values expected of an accurate and unbiased predictor than those found for either of the two separate subperiods, both the slope and the intercept are more than one standard error from the values that an unbiased predictor of P^c would have taken. Moreover it is clear that the slope of .80 is a result of an averaging process applied to the early period value of 1.91 (much above one) and .50 (substantially below one). That the longer term slope coefficient is relatively close to unity tends to hide the fact that its value over shorter subperiods has fluctuated substantially. Similarly the intercept is brought closer to zero by the averaging process.

Quite clearly the pre-planting potato futures prices are not providing particularly reliable forecasts of harvest time prices. Corn and soybean futures, in contrast, were found to produce much more reliable (both in terms of R^2 and closeness of the slope coefficient to one) "forecasts" (Tomek and Gray). No doubt a reason for the superior predictive performance of corn and soybean futures is the link between the cash and the futures markets provided by long term storable inventories.

THE COBWEB PRICE STRUCTURES

According to the cobweb hypothesis if the price of potatoes was high one year, farmers would attempt to increase their plantings the following year causing that year's potato price to fall and with that reduced price, farmers would put fewer resources into growing potatoes the next year and so on. A number of interesting questions are raised by this hypothesized behavior: (1) Does the cobweb price structure in fact continue to exist once it is recognized and publicized? (2) If it does continue, is it truly a supply oriented price structure? (3) Could futures traders use this hypothesized cobweb pattern to formulate trading rules that would produce a superior rate of return on invested margin?

The Pattern of Successive Final Prices of November Futures

To explore the history of the cobweb price pattern, Figure 1 is used to illustrate the relation between successive final prices of November futures for the time period 1953-1978. The figure plots one year's final prices for November potato futures relative to the prior year's final price. Along the 45° line prices are equal from year to year. In a cobweb relationship prices would rise one year and fall the next. This would be seen in our diagram as a zig-zag pattern across the 45° line. A rise in prices would be seen as an outward movement as time goes on.

The price patterns in the figure may be divided into four groups: (1) 1953-1960, with a pronounced cobweb pattern, (2) 1961-1963 where a significant interruption resulted in a structural shift in the relationship, (3) 1963-1971 with another pronounced cobweb at a

somewhat higher price level, suggestive of an upward trend in unadjusted potato prices, and (4) 1972-1978, with another drastic shift upward again in the final prices and a pronounced cobweb at the higher price level. Serious departures from the cobweb occurred between 1960 and 1961 when the relationship shifted downward dramatically; 1963 and 1964 when it shifted upward and 1971, 1972 and 1973 with another dramatic upward shift.

The poor predictive performance of the April potato futures contract may be due to either of two different causes. First, relevant weather conditions, planting intentions demand for the product, prices of competing products and the like may be so uncertain in April that no predictive technique is likely to be very accurate. Second, the market may be relatively inefficient in interpreting the relevant evidence. In the latter case profitable trading opportunities would be available to those who were more efficient in their information analysis, but this would violate the efficient market hypothesis (Fama). While the results cited thus far do not allow us to discriminate between these two possible explanations, subsequent parts of the paper do shed some light on this matter. One suggested method of producing more accurate forecasts than those implicit in futures prices is to utilize the hypothesized cobweb relation to make price forecasts. That possibility is now considered.

There are at least three possible ways to explain the evidence of an apparent cobweb in a fashion that is consistent with market efficiency. First, the cobweb's dramatic and unpredictable shifts may introduce sufficient variability into the system to cause traders to lose enough money during one of the shift periods to discourage them from trying to make profitable use of the pattern when the cobweb is behaving consistently. It becomes a semantic question whether one calls such unpredictable fluctuations a cobweb pattern with random shifts or just a random pattern. Second, farmers may not necessarily be reacting to the last year's prices. Some other random process (such as the weather or exogenous shifts in demand) may have been responsible for the observed pattern. Thus any projection of a continued year to year back and forth alternation in prices would be highly suspect if it resulted from random (and therefore unpredictable) forces. Third, even if the farmers fail to notice the cobweb, enough futures traders may take advantage of it to eliminate the profit potential. To help resolve these matters one can test a significant cobweb response pattern using statistical rather than graphical analysis; planting patterns can be examined to see if there is some type of cobweb response pattern in supply; and a cobweb inspired trading rule can be tested. Each of these approaches is explored in the following sections.

A Statistical Test for a Cobweb

Statistical procedures provide a method of testing relationships that leaves much less room for disagreement over interpretation than is the case with graphical analysis. Since the cobweb hypothesis anticipates a year to year alternation in prices, a regression of the current year's price change on the past year's change should, according to the hypothesis, produce a significant negative coefficient on the independent variable. Estimating such a regression for the 1953-1978 period produced the following:

$$\Delta \text{NOV}_t = .272 - .412 \Delta \text{NOV}_{t-1}$$

(.206) (.205)

$$R^2 = .11$$

$$DF = 23$$

$$F = 2.84$$

where:

ΔNOV_{t-1} = closing price for November futures in year t less its value for year t-1.

Figure 1
Successive Year Final Prices For November Potato
Futures 1952 - 1978

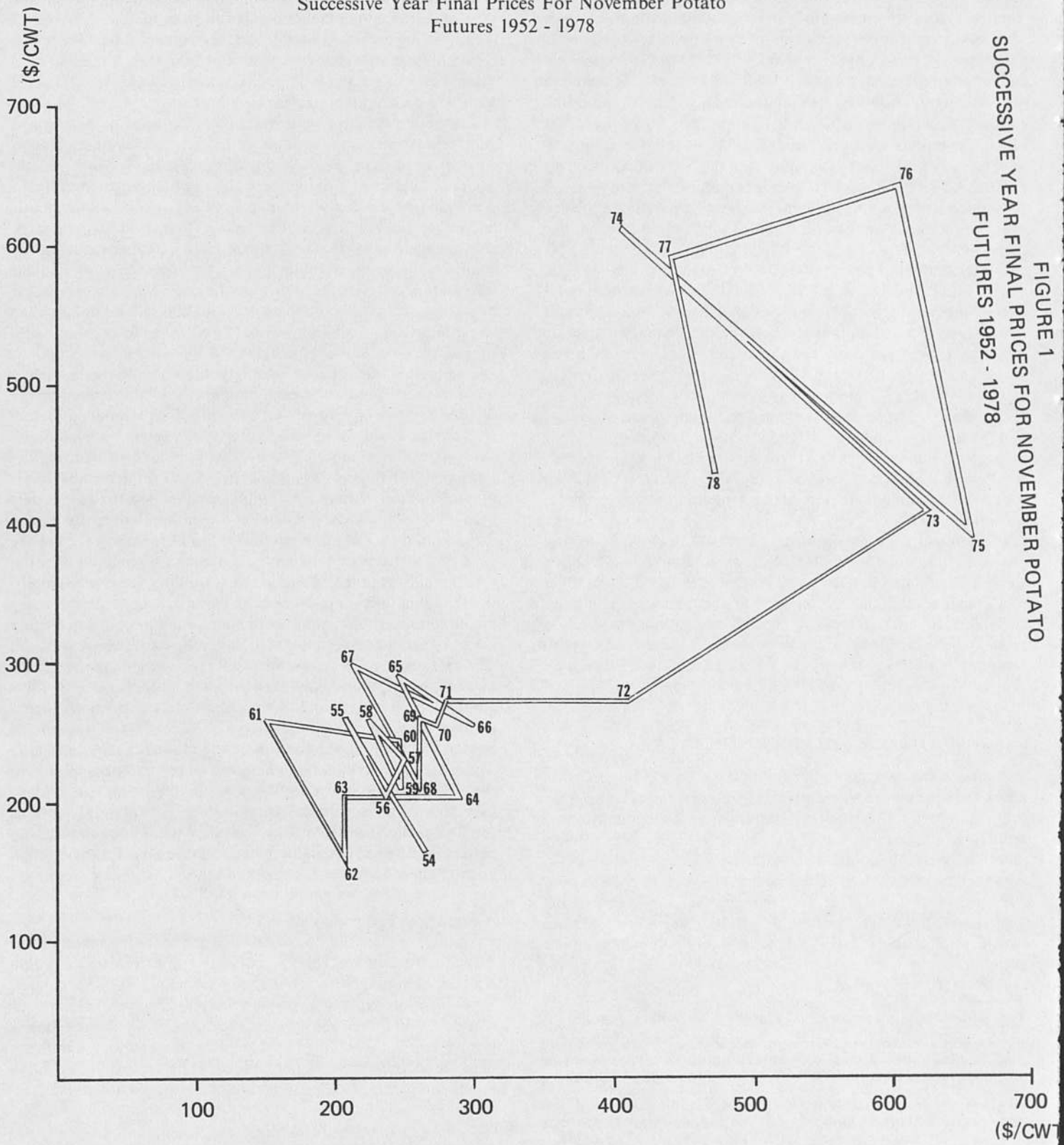


FIGURE 1
SUCCESSIVE YEAR FINAL PRICES FOR NOVEMBER POTATO
FUTURES 1952 - 1978

These results do show some suggestive evidence of a cobweb type relationship since the coefficient on the lagged value of the price change is significantly negative. On the other hand the 89 percent of the variation left unexplained is an indication that many other factors affect potato prices. To test whether the cobweb persisted over the entire period, the data were divided into two separate time periods and the equation reestimated:

$$\begin{array}{l} \Delta \text{NOV}_t = .194 - .240 \Delta \text{NOV}_{t-1} \\ (.184) \quad (.261) \end{array} \quad \begin{array}{l} \bar{R}^2 = .057 \\ \text{DF} = 14 \\ F = .85 \end{array}$$

$$\begin{array}{l} \Delta \text{NOV}_t = .813 - .499 \Delta \text{NOV}_{t-1} \\ (.605) \quad (.373) \end{array} \quad \begin{array}{l} \bar{R}^2 = .090 \\ \text{DF} = 7 \\ F = .69 \end{array}$$

With fewer degrees of freedom the coefficients are no longer significant by traditional standards and the R^2 are even lower than for the combined sample. Still the coefficients have retained their negative signs and both have magnitudes within one standard deviation of the coefficient obtained for the regression for the entire time period. While these results do not lead one to reject a cobweb relation, neither are they particularly supportive of the hypothesis.

TESTING FOR A COBWEB SUPPLY RESPONSE PATTERN

In his 1972 article Gray employed both graphical and statistical analysis to conclude that there was no discernable supply response in Maine potato planting acreage but that there did appear to be a price response pattern in Idaho acreage. A statistical analysis of 1953-1978 data should shed additional light on this issue. A test for a cobweb oriented supply response for both Maine and Idaho was made with a regression of the change in the number of acres planted on the previous year's price change:⁷

$$\begin{array}{l} \Delta \text{MP}_t = 4.880 + .337 \Delta \text{NOV}_{t-1} \\ (.6427) \quad (.6404) \end{array} \quad \begin{array}{l} \bar{R}^2 = .00 \\ \text{DF} = .23 \\ F = .23 \end{array}$$

$$\begin{array}{l} \Delta \text{IP}_t = 12.642 + 8.226 \Delta \text{NOV}_{t-1} \\ (.8443) \quad (.8414) \end{array} \quad \begin{array}{l} \bar{R}^2 = .00 \\ \text{DF} = 23 \\ F = .53 \end{array}$$

⁷This model differs somewhat from that employed by Gray who used the actual number of acres planted as an independent variable and used the previous year's average as the dependent variable. Also rather than using the lagged change in prices, he introduced the two components (Nov t-1 and Nov t-2) separately. The two models are equivalent if the coefficient on previous year's average is close to unity (which in general it was for Gray's results) and the coefficients on the two components of Nov t-1 are similar in magnitude but opposite in signs (which in general was not the case). We choose to use a model which constrained the variables (by forming differences) both because it closely approximated the form of the relation that the hypothesis predicts and the introduction of the two lagged price variables together may create a multicollinearity problem. Ideally one would have preferred to build a complete supply response model and then determine whether a cobweb variable added any explanatory power. If, however the hypothesized cobweb supply response is an important factor in determining supply, the current admittedly crude methodology should be capable of revealing it.

where:

ΔMP_t = the number of acres of potatoes planted in Maine in year t less the number planted in year t-1.

ΔIP_t = the number of acres of potatoes planted in Idaho in year t less the number planted in year t-1.

The Maine results show no evidence of any type of cobweb supply response as the coefficient is not statistically different from zero.⁸ While the sign on the coefficient of the Idaho equation is consistent with a cobweb response, it is not statistically significant at even the 70 percent level to say nothing of the traditional 90 or 95 percent levels. If there is a cobweb supply response for Idaho growers, it is much too subtle to be revealed by the current methodology. Still proponents of the cobweb hypothesis might argue that even a supply response too weak to be detected by this methodology may be sufficient to set prices oscillating, if demand is relatively inelastic. Accordingly, we proceeded to test some cobweb inspired trading rules.

A Test of Cobweb Based Trading Rules

The final test for a cobweb pattern to be reported in this paper is an examination of the profits which would have been made by one who based trading decisions on a cobweb model. While there are a large number of forms that a cobweb trading rule might take,⁹ the three rules reported below are representative. Traders are assumed to base their April 30 trading decisions on price performance up to that time. If prices rose, they would expect a decline and vice versa with short or long positions assumed depending on the signals given. The three rules tested here base their trading decisions on the following price comparisons:

- #1— $\Delta \text{NOV}_{t-1} = \text{NOV}_{t-1} - \text{NOV}_{t-2}$
- #2— $\Delta \text{NOV}_{t-1} - \text{April}_{t-1}$
- #3— $\Delta \text{April}_t - \text{NOV}_{t-1}$

The first rule implies that if the final price of the November futures contract rose from year t-2 to year t-1, one should expect a subsequent price decline and thus attempt to profit from the expected decline by assuming a short position in April of year t. Rule 2, in contrast, bases its signal on the comparison of the November futures contract price in November versus April of year t-1. When the November futures contract falls from April to November, the hypothesized price move is in the opposite direction in the following year. The final rule bases its signal on the comparison of the current year's April price to the November futures contract with the final price of the previous year's November contract. A positive difference would signal a sell, while a buy would be indicated by a negative difference. The testing of each of these three rules assumed that a trade acts on the signal in April of year t by going long or short on the November contract and then closes out his or her position at the expiration of the November contract.

Of the nine separate tests only rule #3 for the 1969-1978 period offered a return that exceeded that available from a government

⁸Regressing both the Maine and Idaho data over the separate 1953-1968 and 1969-1978 periods produced no evidence of significant cobweb supply response.

⁹For example, one might set up a trading rule based on some combination of futures prices, or cash prices, thresholds levels and stop loss orders. Clearly if enough different forms of the rule are tested, some will prove profitable over the test period but are unlikely to continue to produce profitable performance once applied to a subsequent time period. To guard against such data mining it is best to test a relatively small number of simple rules and if any of them prove profitable retest them on a second time period.

guaranteed passbook savings account.¹⁰ On balance these trading rule results suggest that regardless of the November to November price pattern, the corresponding subsequent April to November price "pattern" does not offer any clearly profitable trading opportunities that a true cobweb relation would have led us to expect.

Taken together these three sets of cobweb results offer no more than very weak support for the cobweb hypothesis. The graphical analysis is ambiguous. The statistical test for the cobweb is marginally significant over the total time period but not for the two separate time periods. No significant supply response is found for either Maine or Idaho and none of the cobweb inspired trading rules produces consistent excess returns. If there is a cobweb type relationship here, it is rather weak and well hidden by random forces. Moreover these results suggest that if there is a way of improving on the futures price "predictions," the cobweb is not a major part of the answer.

Table 2
Trading Rule Results

Time Period	Rule 1	Rule 2	Rule 3
	ΔNOV_{t-1}	$\text{NOV}_{t-1}-\text{April}_{t-1}$	$\text{April}_{t-1}-\text{NOV}_{t-1}$
1953-1968	2.60%	-3.42%	-1.69%
1953-1978	.47%	-1.94%	-2.76%
1969-1978	.03%	-1.56%	9.44%

HEDGING

Prior work by both Gray and TG indicates that pre-planting futures prices for delivery at harvest time are much more stable than harvest time near expiration futures. Thus a potato farmer who hedged his or her expected output prior to planting time through a futures market short position could thereby shift to the "longs" much of the income variability that they would otherwise incur. These results, however, only pertain to the 1953-1970 period and they fail to deal with the important matter of the linkage between futures prices and the cash prices received by growers. A much more recent study concerning the 1968-77 period by Young and Tomek also found that a hedging strategy did reduce risk (income variability) for the period and region studies (Young and Tomek). Somewhat curiously, they found in addition that a storage strategy (wait until March 1 of the following year to sell) offered the highest return along with the greatest degree of risk. These results, however, are based entirely on a study of the upstate New York growing area—a region much less important to the potato industry than either the Maine or Idaho potato growing areas. Finally the Potato Futures Study included an extensive analysis of the hedging potential of the Maine potato futures contract to potato growing in various parts of the country. A conclusion was that the contract could be used to reduce price risk during the storage period for Maine producers. The risk reduction tended to be less effective as the distance from Maine increased and varied considerably from interval to interval and from location to location. They also found that hedging tended to be less effective in recent than in earlier years. As with most of their analysis the data were stratified at 1973 and only go back to 1959. Moreover, their conclusions were based

largely on the behavior of the basis. "[C]ash and future prices must be correlated and the basis must narrow over the storage period for the futures market to be useful in conducting storage hedging" (p. 73). There are, however, other types of (non-storage) hedges which can also be relevant to the issue of the hedging usefulness of the contract. Accordingly the present study which covers a somewhat different set of time periods and uses a different approach to hedging testing, offers a different viewpoint on the subject.

Before turning to the tests some discussion is needed of the ways that risk may be defined and effectiveness tests that each risk concept implies. There are three distinct ways that risk may be defined *vis a vis* commodity analysis.

The simplest and most straightforward approach is to relate risk to the standard deviation of the cash price about its mean value (or trend value or inflation corrected mean). While producer income volatility stems from variability in costs, quantity and cash price, in this approach cost and output variability are ignored or taken as exogenous and hedging is viewed as a method of reducing the impact of price variability on income variability. Thus, if prior to or about the time of planting, futures prices for harvest time delivery are more stable than the prices of these same contracts at delivery, hedging one's expected output in the futures market should reduce this type of price variability risk. This is the concept of risk which underlies the type of hedging analysis employed by Gray and in part by Young and Tomek. Peck in contrast argued that the appropriate measure of variability is variability relative to the expected (rather than the past average) price. Thus the grower (or producer) would normally compare the expected market price with the expected controllable costs of production. Presumably the degree of resource commitment would depend upon both the attractiveness of the expected price-cost margin and the degree of confidence in that expectation compared with the available alternatives.

A third approach originating in the finance literature's capital asset pricing model views variability as stemming from two sources: that which is common to all investment assets (due largely to fluctuations in the economy) and the residual variation which is caused by everything else. Those (investors, farmers, processors, etc.) having sufficient flexibility in their resource commitment decisions, can largely eliminate the residual variation through diversification. Thus only the systematic or nondiversifiable risk remains to be dealt with through hedging. Clearly very few people and virtually no farmers who are primarily committed to growing potatoes are likely to be in a position to diversify as effectively as the capital asset pricing model assumes is possible. Accordingly risk in the capital asset pricing sense will not be considered further in the current analysis.

Peck's measure of risk in terms of variability about the forecasted price is suited to a situation where resources are easily shifted from one use to another. With potato farming, particularly Maine potato farming, the most important resource is land which is particularly well suited to potato farming and not to any other uses. The resource commitment decision does not depend so much on whether to put the land into potato production or to plant something else but rather: how much of the marginal land should be devoted to potatoes? Thus, income stability will be largely determined by stabilizing the revenues received from the output. Only for the much smaller component of marginal land, which may be planted or held out of production depending upon price expectations, does the ability to rely upon forecast prices have a major role in stabilizing income. Accordingly, in the current analysis price stability is used as the risk criterion.

Because futures contracts can lead to actual delivery of the commodity, we know that there should be a fairly strong relationship between local delivery cash prices and near delivery

¹⁰For simplicity in computing these results we assumed a \$60 round trip commission and a margin requirement of \$500 per contract with no margin adjustment required as prices change. In view of the magnitude and general direction of these results, it is unlikely that taking more precise account of margins and commissions would have altered the basic conclusion.

futures prices for the contract to have hedging usefulness but various factors (variations in cost and availability of transport, contract specifications, storage cost variations and the like) can cause the basis to fluctuate substantially. Thus to test the hedging potential of the futures market we first need to determine how closely the futures prices correspond to the cash prices received by growers. Accordingly the following regressions, means and standard deviations were estimated for the 1953-1978 time period:

$$\text{MPR}_t = 1.14 + 1.192\text{NOV}_t$$

(.213) (.086)

$$\bar{R}^2 = .83$$

$$\text{DF} = 24$$

$$F = 153.2$$

$$\text{IPR}_t = .214 + 1.282\text{NOV}_t$$

(.421) (.23)

$$\bar{R}^2 = .54$$

$$\text{DF} = 24$$

$$F = 28.2$$

	Mean	Sd
MPR	2.11	1.35
IPR	1.86	.81
NOV	3.11	1.38

where:

MPR_t = Average November price received by Maine growers in year t.

IPR_t = Average November price received by Idaho growers in year t.

The b value for the variable is highly significant in both equations and the corrected R squares are .83 and .54 which suggest a close correspondence between spot and futures price movements. Furthermore, the \bar{R}^2 values might have been still higher had not the comparison been between a November "close" for futures prices with a November "average" (reflecting intramonth variability) for the cash market.¹¹ The November close does tend to be about \$1.00 higher than the cash price paid to Maine farmers and \$1.25 more than that paid to Idaho growers. This differential reflects both the cost associated with moving the product from its growing area to the primary consuming markets and the fact that the reported cash prices average the price of table stock potatoes with those sold for processing (at a lower price).

Both the Gray article and the earlier TG paper suggested that one could use the relatively stable April 30 price of the futures contract to hedge against subsequent price variability. Fluctuations in the cash market would be largely offset by movements in the value of the futures position only if the futures prices in April are in fact less volatile than the prices on those same contracts in November. To test that proposition the mean, standard deviation, coefficient of variation, and an F-ratio have been calculated for selected potato futures price data (Table 3). The F-ratio (ratio of variance of cash to futures prices) employed here is a test of the difference between the variance of the price of a futures contract on the new crop for the last trading day in April and the variance of the same future

Table 3
Maine Potato Futures Prices

Price Variable	Mean \bar{X}	Std. Dev. S.	Coefficient of Variation S/ \bar{X}	F-Ratio
1953-1968				
November Potatoes				
April 30 Close	\$2.26	\$.09	4.08%	19.85*
Last Day Close	\$2.32	\$.41	17.72%	
1969-1978				
November Potatoes				
April 30 Close	\$4.16	\$1.55	37.25%	.89
Last Day Close	\$4.37	\$1.46	33.42%	
1953-1978				
November Potatoes				
April 30 Close	\$2.98	\$1.33	44.34%	1.09
Last Day Close	\$3.11	\$1.38	44.47%	

*Significant at 99% level of probability.

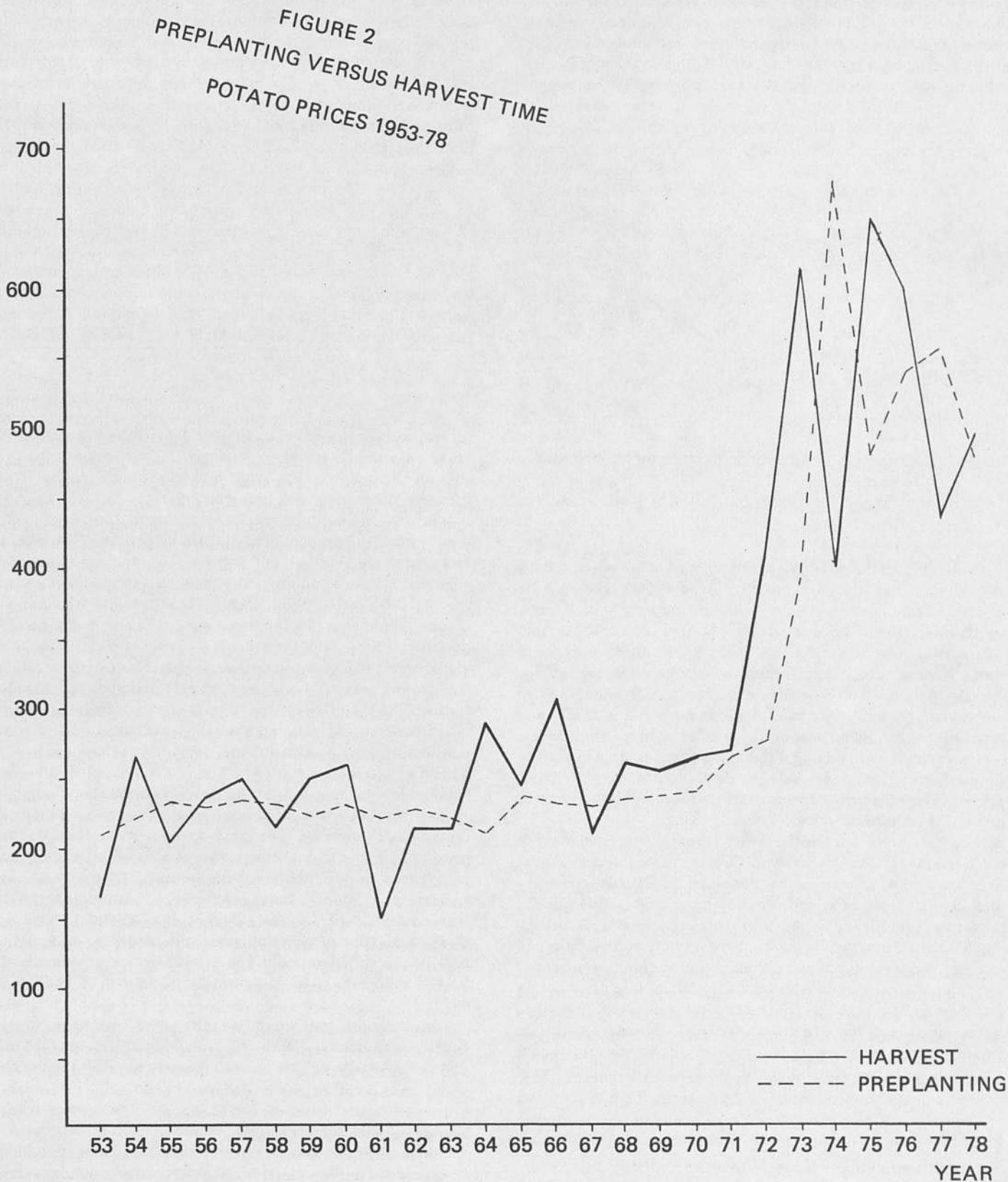
contract on the November expiration date (cash price equivalent). These data should reveal any changes in the pattern of the price structure between the 1953-1968 time period as analyzed by TG and the 1969-1978 time period analyzed here.

It is obvious that there have been substantial variations in all of these measures throughout the different periods. However, the mean, standard deviation and coefficient of variation for the 1969-1978 period were all much greater than the respective measures for the 1953-1968 period. While inflation in the general price level may account for the rise in the mean price, the rise in the standard deviation is far greater than could be explained by inflation alone. There is also an increase in the standard deviation of the expiration date closing price: \$1.46 for the 1969-1978 period compared to \$.41 for the 1953-1968. The change in these standard deviations reflects an increase in the variability of the respective prices, but also reveals a significant alteration in the total structure of prices for the Maine potato futures market, dramatically illustrated in Figure 2 which shows comparisons for the 1953-1978 period of the April 30 closing prices of November Maine potato contracts with the price on the expiration date. For the 1953-1968 period the springtime price of the November contract is very stable while the subsequent post-harvest price is highly variable around this April 30 price line. In the period roughly beginning in 1971, however, there was a marked departure from this 1953-1970 price pattern. Both the April 30 and expiration date closing prices shifted upward markedly and became much more variable. The April 30 price went from a level of \$2.42/cwt in 1969 to \$6.75/cwt in 1974 and then to \$4.85/cwt in 1975.

That the April and November prices have been approximately equally variable in the 1972-1978 period greatly weakens the belief that futures market can be used to reduce return variability. There is, however, another test of the value of hedging. Presumably a grower wishing to hedge will assume a short position early in the season and then repurchase the contracts about the time his or her potatoes are harvested. To test the value of such an approach we have computed the average price per bushel and its standard deviation for Maine and Idaho farmers who sell their crops in the cash market compared with those who hedge by taking a short position on April 30 and closing out their position at expiration (late November).

¹¹Note that these results only indicate that year to year fluctuations in futures prices are correlated with year to year fluctuations in cash prices. One is also concerned with intrayear fluctuations. While not tested here, that question was extensively examined in the Potato Futures Study where it was found that "in most years, the basis decreased from November to February, providing a positive return to hedged storage. However, there were large differences between years and the basis rarely followed a steadily declining path." (p. 79) Thus there was a considerable amount of intrayear instability in futures—cash price movements.

Figure 2
Preplanting Versus Harvest Time
Potato Prices 1953 - 78



The results (Table 4) for Maine indicate that for every time period the unhedged position would have produced a higher price per cwt. than the hedged position. There also would have been a reduction in price variability during 1953-1968 although not for the 1969-1978 or the full 1953-1978 period. Moreover the risk reduction for the 1953-1968 period amounts to no more than a 10 to 20 percent decrease in the standard deviation of the price and an actual increase for the most recent period. The mean price available to Idaho growers is lower for a hedged than an unhedged position. On the other hand only for 1953-1968 was there a reduction in the standard deviation to be derived from a hedging strategy. Surprisingly the use of hedging over the 1969-1978 period would have doubled the standard deviation of the return. In other words an Idaho grower who hedged his position would have generally received both a lower and a more variable price than one who had not hedged. This finding is no doubt due at least in part to the fact that most of the futures trading is in the Maine contract which does not permit substitution of the Idaho potato for delivery.

Table 4
Hedged Versus Unhedged Positions

Price Per CWT		
	Mean ¹²	Standard Deviation
Maine with Hedge		
1953-1978	1.98	1.52
1953-1968	1.27	.12
1969-1978	3.12	2.01
Maine Without Hedge		
1953-1978	2.11	1.35
1953-1968	1.34	.46
1969-1978	3.34	1.41
Idaho With Hedge		
1953-1978	1.74	1.30
1953-1968	1.39	.28
1969-1978	2.31	2.00
Idaho Without Hedge		
1953-1978	1.86	.80
1953-1968	1.45	.42
1969-1978	2.53	.85

SUMMARY AND CONCLUSIONS

A number of both new and updated findings have emerged from the present study. First, the previous finding that pre-planting potato futures prices are not reliable forecasters of harvest time prices has been extended to the more recent period. Both graphical and statistical analyses leave open the possibility that the November to November cobweb price pattern may have continued through 1978 but the evidence is that at most a very weak cobweb effect is superimposed on a number of other effects. Moreover, no evidence was found of any significant cobweb supply response pattern and trading rules based on the cobweb hypothesis were generally unable to produce profitable returns. Thus, if there is a cobweb relation, it is very weak and does not allow one to improve significantly on the futures market price "forecast." Third, the use of a simple hedging strategy by Maine potato farmers would, over

the 1953-1969 period, have led to both a small sacrifice in realized price and a reduction in price variability. In the more recent time period, however, hedging would have both reduced return and increased risk. Moreover, Idaho potato growers would not generally have been able to stabilize their incomes by hedging in the principal potato futures market in either time period. Fourth, it is clear from both the cobweb and the hedging analyses that the potato market experienced a major shock in 1972 and that the type of relatively low and stable pre-planting futures prices that characterized most of the 1953-1972 period ended abruptly in 1972. While the higher price level can be ascribed to inflation, the cause of greater volatility is less clear. Perhaps the traders of pre-planting futures observed the subsequent cash price volatility and in attempting to anticipate such variability, traded in ways that transferred it to the pre-planting period. It is even possible that the various academic articles on the subject, most of which were published by the end of 1971, had some effect on trading. While Gray argued that the recognition of a cobweb relation would set in motion forces that would destroy the relation, it may be only happenstance that the market seemed to take note of the relation shortly after the Gray article appeared in print.

One of the purposes of this study was to address the question of the role of the potato futures market in fostering economic efficiency, i.e., in stabilizing prices. The results suggest that it does not. Regarding the hedging value of futures trading the answer appears to be a qualified "no." While potato growers may have been able to use a hedging strategy to reduce the impact of price variability during the 1953-1969 period, farmers who routinely hedged would have experienced increased price variability and received a reduced price as a result of their hedging activity during the latter period. Note that the Potato Futures Study which examined basis movements and storage hedging, however, reached a different conclusion. Quite possible potato futures have value in some types of hedging and not in others. It is safe to conclude, on the basis of the current effort, that we failed to find a very strong case for using the potato futures contract as a hedging vehicle. There is, of course, the point that growers who hedged would have known with greater certainty early in the year what the revenue from their crop would be. Such knowledge might have helped them decide how much land to put into cultivation and how intensely to cultivate what was put in.

Clearly the Maine potato contract has not been an especially useful vehicle for hedging Idaho potatoes (or particularly useful for Maine potatoes for that matter). Perhaps the Chicago Merchantile Exchange's Idaho potato contract could be promoted to the point where it generates a volume sufficient to facilitate extensive hedging. The Chicago exchange has already made some efforts in this regard, but it is not clear what more can be done. The great potato default of 1976 (Jackwicz) and the more recent halting of near delivery potato futures trading in 1979 (Gomex) both were due in large part to the restrictive nature of the New York Merchantile Exchange's potato contract pointing up the need for a more effective contract. One possibility suggested in the Potato Futures Study would be to permit delivery of round white potatoes grown outside of Maine as well as the currently permitted delivery of round white potatoes grown in Maine. By increasing the sources of deliverable grade potatoes, the likelihood of a delivery squeeze would be substantially reduced.

The implications of these results for the stabilizing-destabilizing argument is even less clear. Since potato futures trading extends backward for a relatively long time it is not possible, as was done with onions, to compare the seasonal pattern of potato prices with and without futures trading. Had the futures prices in April been shown to be reliable forecasts of harvest prices, this result could

¹²The mean price reported here neglects the transactions cost associated with a hedging strategy. Gray (*op. cit.*) estimates such costs to be in the order of 8.4¢ per cwt.

have been used to argue that to the extent that these prices influence grower intentions, they are stabilizing. That is not what was found. The failure to find a cobweb supply response also suggests that the influence of the futures market on growers' planting intentions is relatively slight. In any case the various results reported here do not provide support for the view that the futures market has a destabilizing influence on prices. Rather than banning trading in potato futures what appears to be needed is an improved vehicle for futures trading in the Idaho potato.

REFERENCES

- "A Fresh Eye on Potato Futures." *Business Week*. July 2, 1979, 84.
- Commodity Exchange Authority. *Futures Trading in Potatoes, 1954-55*. USDA, Washington, D.C., November 1955.
- Commodity Exc Authority. *Commodity Futures Statistics*. Annual issues. 1940-41 to 1971-72.
- Commodity Exc Authority. *Commitments of Traders in Commodity Futures*. Monthly issues. 1972-1974.
- Commodity Exc Authority. Surveys of potato futures issued under various titles, 1955-1965 and 1970.
- Commodity Futures Law Reports. *Commodity Exchange Act Extension and Amendments*. November 1975, Pt. II, Commerce Clearing House, Inc., June 26, 1978.
- Commodity Futures Trading Commission. New York Mercantile Exchange. *Proposed Maine Potato Contract*. Transcript of Proceedings at Presque Isle, Maine, July 26, 1976.
- Commodity Futures Trading Commission. *Trading in Maine Potato Futures Contract*. Transcript of Public Hearing at Presque Isle, Maine, May 9, 1979.
- d'Arge, Ralph C., and William G. Tomek. *Concepts and Consequences of Hedging Long Island Potatoes*. Cornell University A. E. Res. 166, March 1975.
- Emerson, Peter M., and William G. Tomek. "Did Futures Trading Influence Potato Prices?" *Amer. J. Agr. Econ.* 51(1969):666-72.
- Estes, Edmund, Leroy Blakeslee, and Ronald Mittelhamer. "U.S. Potato Demand: Static and Dynamic Characteristics." Paper presented at annual meeting of the American Agricultural Economics Association, Pullman, Washington, July 29-August 1, 1979.
- Fama, Eugene. *Foundations of Finance*. New York: Basic Books, 1976.
- Gomex, D. "Shipments of Maine Potatoes Fail to Make the Grade, So Futures Trading is Halted." *Wall Street Journal*. March 12, 1979, p. 28.
- Gray, Roger W. "The Attack Upon Potato Futures Trading in the United States." *Food Res. Inst. Studies*. 4(1964):97-122.
- Gray, Roger W. "The Futures Market for Maine Potatoes: An Appraisal." *Food Res. Inst. Studies*. 11(1972):313-41.
- Gray, Roger W. "Onions Revisited." *Journal of Farm Economics*. 45 (1963); Reprinted in A. Peck, editor *Selected Writing in Futures Markets*. Chicago Board of Trade. Chicago, 1977, 325-328.
- Gray, Robert W. "The Characteristic Bias in Some Thin Futures Markets." *Food Res. Inst. Studies* 1, 3, 1960.
- Gray, Roger W. and William G. Tomek. "Temporal Relationships Among Futures Prices: Reply." *Amer. J. Agr. Econ.* 53(1971):362-66.
- Gray, Roger W. and D. J. S. Rutledge. "The Economics of Commodity Futures Markets: A Survey." *Rev. Mktg. and Agr. Econ.* Sydney: Australia, December 1971.
- Gray, Roger W., V. L. Sorenson and W. W. Cochrane. *An Economic Analysis of the Impact of Government Programs on the Potato Industry of the U.S.* Univ. of Minnesota Agr. Exp. Sta. Tech. Bull. 211, 1954.
- Hee, Olman. *Demand and Price Analysis for Potatoes*. USDA Tech. Bull. 1380, July 1967.
- Jackewicz, S. "Big Flap About Potato Futures Defaults Isn't Over Despite Settlement Price Move." *Wall Street Journal*, June 29, 1976, p. 16.
- Johnson, Aaron C. Jr. "Whose Markets? The Case for Maine Potato Futures." *Food Res. Inst. Studies*. 11(1972):293-312.
- Johnson, Aaron C. Jr. *Effects of Futures Trading on Price Performance in Cash Onion Markets, 1930-1968*. USDA, ERS. Tech. Bull. No. 1470, February 1973.
- Merchant, C. H. *Uses Maine Potato Growers Make of the New York Mercantile Exchange*. Maine Agr. Exp. Stat. Bull. 567, Nov. 1957.
- Murphy, H. J., et al. *Potato Variety Trials for 1978*. Univ. of Maine Agr. Exp. Sta. Bull. 757, May 1979.
- Olson, Wayne L. *The Extent and Price Effects of Floor Trading in the New York Mercantile Exchange Potato Futures Market*. USDA, CEA, June 1970.
- Paul, Allen B. *Treatment of Hedging in Commodity Market Regulation*. USDA, Tech. Bull. No. 1538, April 1976.
- Paul, Allen B. "Comments on the Kansas City Board of Trade Proposal to Permit Futures Trading in a 30-Industrial Stock Average." In Commodity Futures Trading Commission, *Hearings* Washington, D.C., October 25-26, 1978.
- Paul, Allen B., Richard G. Heifner and John Helmuth. *Farmers' Use of Forward Contracts and Futures Markets*. USDA, Agr. Econ. Report No. 320, March 1976.
- Potato Facts: Product Costs*. Commodity Economics Division, ESCS, USDA, Winter 1979, mimeo.
- Peck, Anne. "Hedging and Income Stability: Concepts, Implications, and an Example." *Readings in Futures Markets Book II*. Chicago Board of Trade, 1977, pp. 237-252.
- Schwartz, Anita M. *Futures Trading in Maine Potatoes*. Market Survey Report No. 2, Commodity Exchange Authority, U.S. Dept. of Agr., Washington, May 1971.
- Simons, Will M. *An Economic Study of the U.S. Potato Industry*. USDA Agr. Econ. Rep. No. 6, March 1962.
- Tomek, William G., and Robert W. Gray. "Temporal Relationships Among Prices on Commodity Futures Markets: Their Allocative and Stabilizing Roles." *Amer. J. Agr. Econ.* 52(1970):372-80.
- U.S. Congress. 84th, 1st Session, House. *Hearings Before a Subcommittee of the Committee on Agriculture and Forestry*. December 6-7, 1955.
- U.S. Congress. 85th Congress, 1st Session, House. *Hearings Before the Committee on Agriculture and Forestry*. May 1-3, 1957.
- U.S. Congress. 1st Session, Senate. *Hearings Before a Subcommittee on Agriculture and Forestry*. August 12, 1957.
- U.S. Congress. 2nd Session, Senate. *Hearings Before the Committee on Agriculture and Forestry*. March 22-26, 1958.
- U.S. Congress. 2nd Session, House. *Prohibit Trading in Potato Futures, Hearings Before the Subcommittee on Domestic Marketing of the Committee Agriculture*. April 29-30, May 28, June 18 and 19, 1958.
- U.S. Congress. 88th Congress, 1st Session, Senate. *Irish Potato Futures Trading, Hearing Before a Subcommittee of the Committee on Agriculture and Forestry*. September 30, 1963.
- U.S. Congress. 1st Session, House. *Prohibit Trading in Irish Potato Futures on Commodity Exchanges, Hearings Before the Subcommittee on Domestic Marketing of the Committee on Agriculture*. April 8-10, 1963.
- U.S. Congress. 92nd Congress, 2nd Session, House. *Prohibit Trading in Irish Potato Futures on Commodity Exchanges, Hearings Before the Subcommittee on Domestic Marketing and Consumer Relations of the Committee on Agriculture*. January 20 and 21, March 16 and 17, 1972.
- U.S. Congress. 95th Congress, 2nd Session, Senate. *Reauthorization of The Commodity Futures Trading Commission*. Report of the Committee on Agriculture, Nutrition, and Forestry. 1978.
- U.S. Department of Agriculture, Agricultural Marketing Service. *Fresh Fruit and Vegetable Wholesale Market Prices*. Annual and Daily issues for major eastern cities.

U.S. Department of Agriculture. *Fresh Fruit and Vegetable f.o.b. Prices*. For major producing areas, annual and daily issues.

U.S. Congress. 96th, 1st session, Senate. *Potato Futures Study*. Report to the Committee on Agriculture, Nutrition and Forestry. 1979.

Wesson, William T. *The Economic Importance of Futures Trading in Potatoes*. USDA Mktg. Res. Rep. No. 241, June 1958.

Working, Holbrook. "Speculating on Hedging Markets." *Food Res. Inst. Studies*. 1(1960):13-24.

Working, Holbrook. "Futures Markets Under Renewed Attack." *Food Res. Inst. Studies*. 4(1963):13-24.

Young, R. and W. Tomek. "A Comparison of Marketing Strategies for Potatoes in Upstate New York." *Cornell Agricultural Economic Staff Papers*. No. 78-15. June 1978.