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THE FUTURES MARKET FOR MAINE POTATOES: AN APPRAISAL

The futures market for Maine potatoes, at the New York Mercantile Exchange, has undergone an extraordinary amount of scrutiny. It has been the object of recurrent attacks which have been ultimately manifest in bills introduced in the United States Congress designed to prohibit potato futures trading. Hearings on these bills have produced extensive testimony (*20*; *29*; *31*; *32*; *33*; *34*). In the light of these efforts, which have heretofore failed (although still another such bill was defeated in the 92nd Congress), the Commodity Exchange Authority (CEA) in the United States Department of Agriculture has published more reports on potato futures trading than on any other commodity futures trading. The CEA has issued numerous full market surveys (*20*; *23*; *25*; *26*; *27*), which for a decade appeared on virtually an annual basis, in addition to two major studies (*22*; *24*). Other official studies of this futures market have also been made by the Department of Agriculture (*14*; *21*; *28*). Two papers in *Food Research Institute Studies* have dealt with this market (*3*; *35*), as have some papers published elsewhere (*1*; *7*; *16*), and another such paper appears elsewhere in this issue (*11*). How does one explain this extraordinary focus upon potato futures trading? And how justify the need for still another study?

It remains true, as H. S. Houthakker observed a few years ago, that "the economic analysis of institutions is not highly regarded or widely practiced among contemporary economists" (*10*, p. 133). This might be argued particularly of futures markets, making even more anomalous the attention paid to potato futures. Yet this attention has not in fact been excessive—it can be explained straightforwardly if not in terms of any single factor—and the improved understanding we now possess of the potato futures market will contribute to better understanding of other futures markets.

The explanation for the extraordinary attention devoted to potato futures begins with the fact that this market has been under persistent attack. As to why the persistent attack, see my earlier analysis (*3*). The Congressional hearings, as aforementioned, elicited much evidence; and official scrutiny obviously underlies the numerous CEA reports. But the explanation runs deeper than this, in both a potato vein and a futures vein. The United States potato-growing industry underwent a dramatic restructuring and relocation during the decade of the 1940s, largely under the aegis of a price-support program which itself attracted wide public attention. The pattern which emerged was one of regional and functional specialization, far more sensitive to the vagaries of potato prices than the anterior potato industry had been. By 1950, when the war-induced price support program had been abandoned, the newly structured and relocated potato industry had demonstrated its capacity to produce quantities greatly in excess of market requirements at 90 percent of parity prices. In a classic example of serendipity, a program which sought nothing beyond assurance of ample supplies from an existing production complex had unveiled an entirely new production complex which was a much more efficient engine of production, but at the same time it was in fundamental disequilibrium at the stable price level which had brought it into being.

In place of the historical pattern of extreme cyclical fluctuation of acreage and prices, the stable prices of the 1940s had induced a steady growth in output on sharply declining acreage. It was clear in 1950 that production already in surplus would continue to expand at prevailing support price levels. Most observers thought that the problem was compounded by the prospect of continual steady decline in per capita consumption, although we argued (correctly as it turned out) that the causes of this decline had run their course (*8*). The downward trend in per capita consumption has indeed been reversed since that time; otherwise the attack on the potato futures market might have been even more intense.

The dimensions of a dramatic restructuring of American potato production during the price support era are detailed in *8* and updated in *15*. Briefly, sideline potato production in a tier of relatively populous "lake states" where dairy and mixed farming predominated (Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania, and New York) declined precipitously. In these states, yields had been low but the very large number of farms each producing a few acres of potatoes had contributed most of the fall production. While their production dropped off rapidly, production in specialized areas, remote from population concentrations, with high yields and large acreages per farm, expanded sharply. (Maine, Idaho, and the Red River Valley area of North Dakota and Minnesota were the prototypes of these specialized producing regions.) Production by states reflected the dramatic shift to remote specialized regions; but even within states the same pattern was reflected in a shift to counties already having high acreage per farm and high yields and a virtual disappearance of potato production from other counties. A new potato industry, with a new set of marketing requirements, had emerged in the price support decade.

While the absence of an efficient forward pricing mechanism had been manifest for decades prior to 1940 in the persistent extreme year-to-year interaction between prices and production, the need and opportunity to develop such a mechanism were greatly enhanced by the industry transformation of the 1940s. Sharp year-to-year price fluctuations, far from being a disaster to the sideline potato grower of the earlier era, more likely added interest to the game. He had his quarter section of dairy and mixed grain farming, on which the decision whether to plant two or three acres of potatoes was hardly a matter of life and death. Nor was the harvest outcome traumatic. If prices were too low to cover the cost of harvesting, the crop could be left in the ground or perhaps fed to livestock; whereas the very high prices were a real bonanza.[1] But monocultural

[1] The contrasting risk attitudes of specialists and sideline producers, as well as the consequences of the contrast for the support program period, are developed at length in *8*.

producers in specialist areas cannot take so light a view of price fluctuations, hence the greater need for an efficient forward pricing mechanism. The opportunity to develop a futures market arose with this need.

Futures markets grow only out of hedging needs, which in turn are perceived most clearly by specialists who have a large stake in prices. Merchants and flour millers, for example, have always used wheat futures almost without exception—bakers almost without exception have not. Cattle futures trading grew much more rapidly than hog futures because cattle feeding had grown more specialized and to a larger scale—hog futures trading began to grow as specialized hog enterprises emerged. Potato futures trading would have been most unlikely to emerge prior to 1940, but would be quite likely to emerge after 1950. And emerge it did, beginning really in 1952,[2] and since growing steadily in a climb that was seriously interrupted only in those years (1955–56, 1958–59, 1963–64, and again in 1970) when the political opposition found enough sponsorship in Congress to pose the threat of prohibition.

The massive transformation of the United States potato industry, which was hastened by the price support program, affords one underlying reason for the special attention devoted to the emergent marketing mechanism. Another deep-seated reason derives from changes in futures trading generally—not only did the potato industry undergo dramatic change, but the institution of futures trading underwent a similarly dramatic, if much less appreciated, alteration. The opponents of potato futures trading have argued that futures trading works for storable commodities, but not for so perishable a commodity as potatoes.[3] This is not the best way to express the difference between futures trading in potatoes and, say, the grains, although the difference does relate to the relative perishability of the potato. All of the earlier futures markets—even those for such commodities as butter and eggs, which are more perishable than potatoes[4]—had emerged and were primarily used as *inventory markets*. For the grains, with continuous inventories, the current "price level" was the same for old crop and new crop futures—the difference between their price quotation was not a market forecast of events yet to occur, but was a price of storage, whether positive or negative (see *37*; *38*). For butter and eggs, which were not held from one "crop" to another, there were no "new-crop" futures; only the current storage season was reflected in futures prices. In both cases, the open interest in futures contracts rose and declined as inventories were accumulated. ***But the potato futures market emerged and was primarily used, not as an inventory market in the above sense, but as a forward-pricing market.*** Clear evidence of this is found in the fact that the open interest in futures did not build up during the storage season, as it does for other annual crops, but during the growing season—reaching a peak before harvest from which it declined throughout the storage season.[5]

The fact that the fall potato crop is stored only until early in the following summer meant not only that futures prices needed to be established during a

[2] The contract failed to attract any but trivial trading prior to 1952, although it had been approved for trading several years earlier.

[3] See *8*, pp. 114–15, for my earlier appraisal of this contention.

[4] Obviously, butter and eggs deteriorate much more rapidly than potatoes under uncontrolled conditions; but it probably also costs more to provide artificial storage for butter and eggs, taking account of both facilities costs and quality deterioration.

[5] More recently the rise in open interest has continued into the storage season, but even so most of the buildup occurs before harvest.

growing season when no inventories were being held, but also that futures prices during the storage season were needed to ration supplies throughout the season with a great deal of precision. The fall crop must be made to last until summer potatoes become available, yet without carrying supplies into summer when old potatoes become a drag on the market. The function which a potato futures market must perform is therefore more difficult in two respects than a futures market for a continuous inventory item such as grain. Futures prices for the forthcoming crop must be established without any old crop *carryin* to serve as a buffer—hence without any current supply response to help guide prices. And futures prices for the harvested crop during the storage season must be established with no possibility that errors in current supply response can be rectified through *carryout* adjustments.

The coordinating task which potato prices (with or without futures trading) must perform is made still more difficult by the extremely low price elasticity of demand.[6] Inelasic demand in combination with discontinuous inventories have imparted exceedingly high year-to-year price variability to potatoes; the same two factors have conspired to impart within season (and especially end-of-season) price variability that is likewise exceedingly high. Historically the supply response pattern has further exacerbated the year-to-year price variability—acreage has increased following high price seasons, inducing low prices and an acreage response that once again brings high prices in a self-perpetuating cyclical pattern.

Such extreme variability as their prices have manifested historically has caused potatoes to be considered an exceptionally uncertain source of income. It must be stressed, however, that the dispersion of this price variability over 66,800 farms producing an average of 2,000 cwt. per farm makes for much less income uncertainty than its concentration in 2,200 farms producing an average of 58,000 cwt. each. (These were the patterns according to which the top 57 percent of farms produced potatoes in 1934 and 1964.) In 1934 potatoes were predominantly a sideline crop the price of which was unrelated to the grower's chief sources of income. But the present potato growing industry, which reflects further consolidation of the restructuring that occurred during the 1940s, is one in which such price variability spells income uncertainty to the operator. Most potatoes are now grown as the sole or major enterprise of the farm, under conditions requiring high costs of equipment, certified seed, fertilizers, and spray materials.

The social influence of the potato had been most strongly felt under the conacre system in Ireland a century before, under which the cottier was forced to subsist upon potatoes by mere virtue of the fact that the landlord was thus enabled to obtain the highest rents (*13*, Chap. XV). The cottier's reliance upon the potato became absolute. A century after the great potato famine, a new potato monoculture emerged in a few specialized areas of the United States. No such fate awaited the United States producer as the Irish cottier had suffered; yet the new industry structure augured a certain revival in the social significance of the potato. For there had emerged a new group of growers for whom the uncertainty of potato prices translated directly into income uncertainty, whose well-being was as directly dependent upon the potato as had been that of the Irish cottier.

Nowhere in the United States are incomes so dependent upon potatoes as in

[6] Usually estimated in the neighborhood of −.2, cf. *8*; *14*; *28*.

Aroostook County, Maine's northernmost county, isolated alike from industry and other agricultural areas, but with soil and climate eminently suited to potato culture. Potato specialization had begun early in Aroostook County, and by 1910 made Maine to be the fourth largest producing state and by 1930 the largest. The response to price certainty under the program of the 1940s was dramatic; acreage rose to well over 200,000 from a trend value of 150,000 and remained at the 200,000-acre level for six years, until support prices were first drastically reduced and then removed. Much other acreage, competitive with Maine's, had come into production in other specialized areas under the price support aegis. Confronted now by this new competition and deprived of price assurance, Maine growers reduced plantings to 100,000 acres in 1951—by far the lowest level of the century. Total fall acreage was also sharply reduced, though nowhere so drastically as in Maine, and prices rose to the highest level since the mid-1920s. Maine plantings went immediately back up to 141,000 acres in 1952, and it looked as though the supply response cycle had been reinstated, with Maine leading the way. Such did not prove to be the case, however, as the historical supply response pattern has diminished dramatically, especially in the eastern and central states, where no statistically significant acreage response to price in the previous year is found for the 1953–70 period. W. M. Simmons, in a study published by the United States Department of Agriculture in 1962, provided early indication of the breakdown in the price-acreage interaction: subsequent confirmation has been much more dramatic than the intimations of his measurements (*14*). Table 1 includes selected results taken from Simmons' study.

The contrast between Maine and Idaho is the most pronounced feature of these results. In the early period Maine plantings were significantly responsive to price the previous year, whereas in the more recent period there was no significant relationship to price in the prior year—planted acreage having become virtually constant. In Idaho the response to price was insignificant in the *early* period, becoming highly significant in the more recent period, with the highest supply elasticity found for any state or region. It is also noteworthy that acreage response to lagged price was not significant in either the eastern or central regions in the 1952–60 period, as it most likely was in the earlier period (since a significant response to price was found for total United States late summer and fall production as well as for two other state groupings that overlap strongly with these regional groupings for 1930–41; the study did not include eastern and central region measurements).

RECENT TRENDS IN SUPPLY RESPONSE

In light of the countertrends indicated in Simmons's earlier analysis (*14*), numerous additional measures of supply response for the period 1953–70 have been undertaken for the present study, the statistical results of which comprise the Appendix. The purpose of this section is to summarize and interpret those findings:[7]

[7] In my earlier analysis (*3*) I took 1952 as a starting point, as did W. G. Tomek and I in *16*. Some objections were made (9) to the inclusion of 1952 in the latter analysis, however, so that to avoid any possible implication of choosing that period which serves my analytical purposes, I have measured all of these supply responses for 1953–70.

TABLE 1.—EQUATIONS RELATING POTATO ACREAGE TO PREVIOUS YEAR'S PRICE AND ACREAGE FOR LATE SUMMER AND FALL PRODUCTION OF POTATOES IN SELECTED PRODUCING REGIONS AND PERIODS*

Equation number	Region[a]	Date	Constant	Coefficients of variable P_{t-1}	Coefficients of variable A_{t-1}	R^2
A	Eastern	1952–60	36.354	19.155 (10.701)	.777 (.254)	.66
B	Central	1952–60	148.073	16.953 (8.830)	.503 (.310)	.46
C	Western	1952–60	117.367	39.901 (11.197)	1.147 (.160)	.90
D	Maine	1931–41	.384	16.680 (3.815)	.830 (.196)	.76
E	Maine	1952–60	123.685	3.020 (2.381)	.100 (.111)	.21
F	Idaho	1931–41	30.574	13.962 (7.775)	.635 (.314)	.36
G	Idaho	1952–60	54.769	23.692 (5.317)	1.140 (.100)	.96

* The equations are from W. M. Simmons, *An Economic Study of the U.S. Potato Industry* (U.S. Dept. Agr., Econ. Res. Serv., *Agricultural Economic Report*, No. 6, 1962), of the form $A_t = A_0 + A_1 P_{t-1} + A_2 A_{t-1}$ where

A_t = Current year's planted acreage for late summer and fall potatoes in the area under study.

P_{t-1} = Previous year's season average price received by farmers for late summer and fall potatoes in the area under study, deflated by index of prices re-received by farmers for all farm products.

A_{t-1} = Previous year's planted acreage of late summer and fall potatoes in the area under study.

Figures in parentheses are the standard errors of the regression coefficients.

[a] Regions are defined as follows:

Eastern includes Maine, Pennsylvania, New York, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and West Virginia.

Central includes Wisconsin, Michigan, North Dakota, Iowa, Ohio, Indiana, and Illinois.

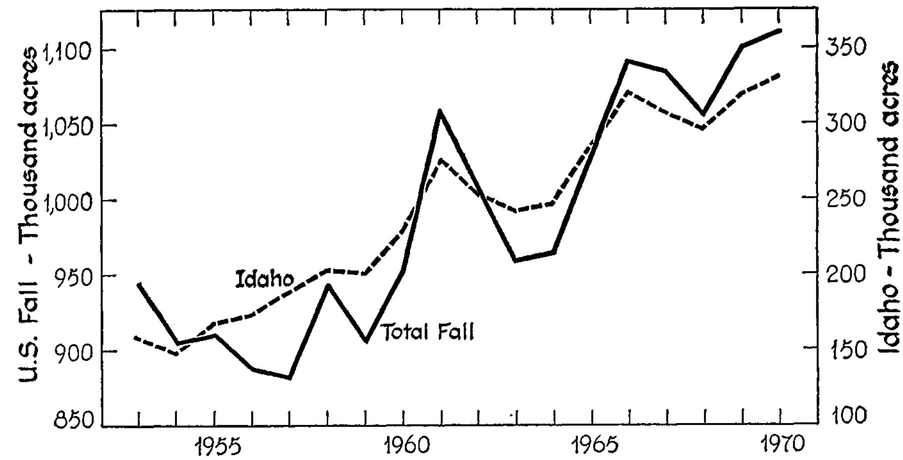
Western includes Idaho, Oregon, Washington, California, Colorado, Nebraska, Montana, Wyoming, New Mexico, Utah, and Nevada.

(1) There has been no significant year-to-year acreage response to price in Maine. There was an upward shift in acreage in 1965 and 1966, however, which appears to have been caused by very high prices in 1964 and high prices in 1965. This is reminiscent of the (much sharper) acreage increase of 1927 and 1928 following two years of exceptionally high prices, although the recent response was much less elastic. It appears, with 1971 plantings back to 145,000 acres, that this upward shift, like that of the mid-twenties, was unsustainable. Apart from this interruption, Maine acreage appears to have adhered very closely to a level trend line throughout the recent period, displaying much less variability than at any time throughout the first half of the century.

(2) There has been a strong upward trend *and* a significant year-to-year response to price in Idaho acreage. Almost all of the upward trend in total fall potato acreage has been accounted for by Idaho alone (see Chart 1).

(3) Eastern region fall potato acreage (including Maine) has declined gradually (although Maine's acreage increased somewhat over the period) and has not displayed year-to-year lagged response to price.

CHART 1.—POTATO ACREAGE PLANTED: UNITED STATES FALL POTATOES, AND IDAHO, 1953–70*



* Data from U.S. Dept. Agr., Bur. Agr. Econ., *Potatoes*, Stat. Bull. 122, Mar. 1953; revised and continued by the Agr. Mktg. Serv. in *Potatoes and Sweet Potatoes*, Stat. Bull. 190, Aug. 1956, and 291, Aug. 1961; and annual summaries.

(4) Central region fall acreage has declined only slightly and has not been significantly related to prior years' prices.

(5) When the late-crop producing states are aggregated, there is still a vestigial acreage response to price. This underscores the difficulty, for any single producing area, of overcoming price and income instability by stabilizing its own plantings. Neither Maine nor any other production area enjoys sufficient market isolation to enable it to stabilize prices through production control, although each region enjoys a certain transportation cost advantage in a major consuming area.

The interpretation of these patterns would appear to be quite direct in light of the earlier discussions of the new structure of the potato industry and the new forward pricing mechanism. With the virtual disappearance of any sideline potato production in the eastern and central states, the acreage variability and response pattern would be sharply diminished in consequence of the production commitment alone. A large modern potato enterprise entails a heavy investment in specialized equipment, and especially in the eastern and central regions this enterprise occurs in areas where the cash crop alternatives to potatoes are not close (see *8*). Land and capital resources specialized to potato production reduce the elasticity of acreage response to price and impart relative stability to plantings. A further impetus to acreage stability has been provided by the futures market, which throughout the period has been increasingly well used by the potato industry and thus increasingly representative. The quoted price for the November future at planting time has been remarkably stable from year-to-year, and has displayed no relation to the price of the current crop. *Futures prices have reflected a market expectation of acreage stability, and hence to the extent they have been taken as guides have helped to impart acreage stability.*

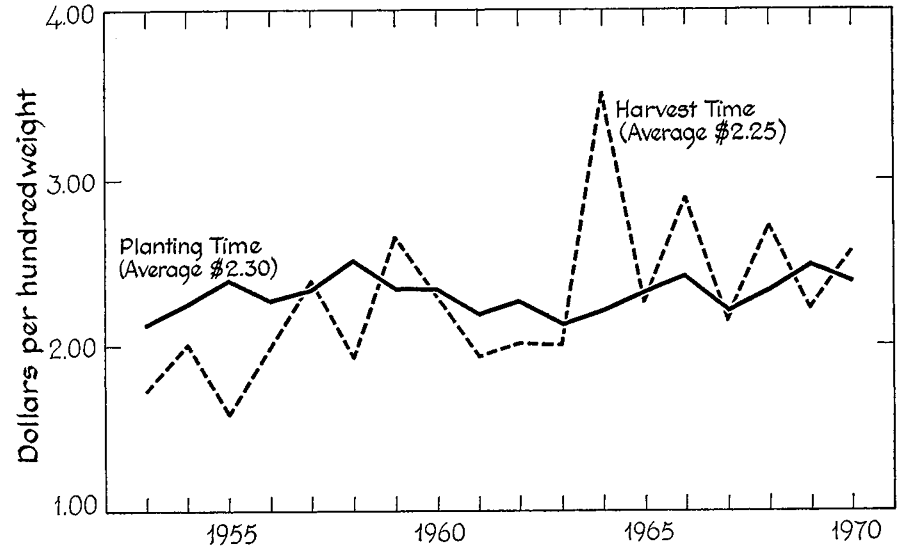
The same factors which enabled a diminution in the acreage response levels of the eastern and central states help to explain why the Idaho supply response has been aggravated. The area of expanding production in Idaho is one in which other intensive crops provide close alternatives; hence there is greater scope for shifting acres into and out of potatoes. Idaho farmers are also remote from the New York futures market, and evidently make little use of it either for hedging or as a forward price indicator. (The Idaho potato contract at the Chicago Mercantile Exchange has attracted significant use only in the past two years.) The strong upward trend in Idaho acreage may be ascribed first of all to the pronounced westward shift in the population over this period. In addition, the russet potato produced in Idaho enjoys consumer preference and has therefore benefited from rising incomes. Prices received by Idaho growers have corresponded closely with those received in other regions and have displayed no trend relative to competing areas. Idaho growers have been able to increase yields steadily with rapidly expanding acreages and to do this without a sacrifice in relative prices. Maine, in contrast, was already achieving optimum yields at the beginning of this period and can only expand acreage at some yield sacrifice by bringing marginal land under cultivation; it also faces a higher barrier to expansion in the form of own price elasticity than do other regions (*14*, pp. 81–83).

THE ROLE OF THE FUTURES MARKET IN THE CONTEXT OF PRICE AND INCOME VARIABILITY INDUCED BY SUPPLY RESPONSE

The important contrast between a pure forward pricing market and markets for continuous inventory crops has been shown by Tomek and Gray (*16*). The argument and evidence are worth summarizing here as a prelude to further consideration of the price behavior of potato futures. We showed that for a continuous inventory crop such as corn, the planting time quotations for harvest-time futures are good forecasts of harvest-time prices. This is owing chiefly to the fact that large enough inventories are carried over each year to permit substantial new crop developments to be absorbed by inventory adjustment. Thus the mid-April quotation for December corn futures is to a certain extent a self-fulfilling prophecy. For this reason the corn grower has little incentive, *from the standpoint of price variability*, to hedge his growing crop in futures. His price and income variability will be about the same whether or not he hedges at planting time. (He may of course have other incentives to hedge, but a routine hedge at planting time will not reduce price variability.)

The situation in potatoes, with no inventories carried through the growing season, stands in sharp contrast. The mid-April estimate of the November futures price provides a very poor forecast (in fact, the springtime estimates of November potato futures prices do not correlate at levels significantly different from zero with the final November estimates). The springtime estimates vary only slightly from year to year, and do not depart significantly from the mean of the final November futures price for the period 1953–70. The final November price, meanwhile, has remained highly variable, and the consequence is that the spring prices have provided a near-perfect hedge against year-to-year price and income variability. The potato grower has been enabled to obtain approximately the same average annual price by routinely hedging each year, and with greatly reduced variability. In fact, while a calculation (such as was shown in *3*) reveals that the average price of the November future on April 15 (pre-planting) has not differed significantly from the average price on October 15 (harvest) (see Chart 2),

CHART 2.—PRICES OF NOVEMBER POTATO FUTURES ON APRIL 15 AND OCTOBER 15, 1953–70*



* Data from U.S. Dept. Agr., Commodity Exchange Authority, *Commodity Futures Statistics*, annual issues.

this does not convey the full advantage even of routine hedging. The greater variability in harvest-time prices also entails higher prices for smaller quantities and lower prices for larger quantities; hence the *weighted* average price and income have been correspondingly higher for the less variable price series. Selective hedging, at other dates and prices, has been even more advantageous than routine hedging, as we show below.

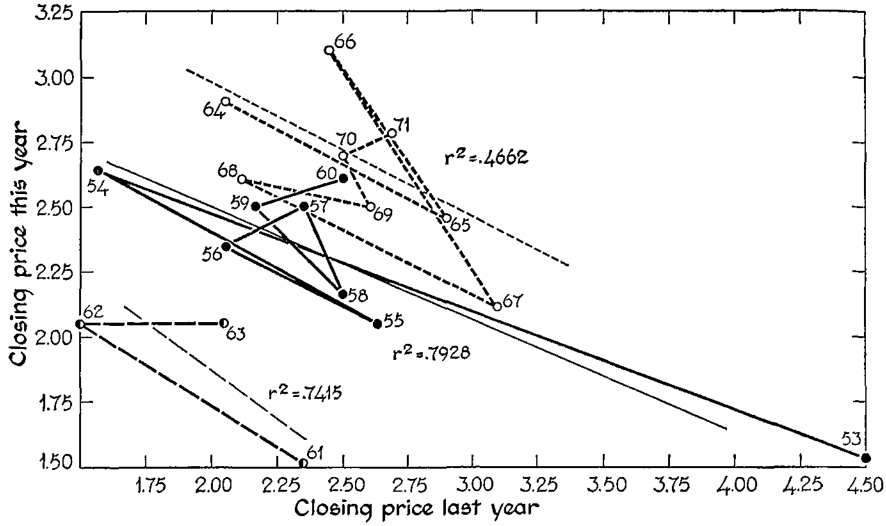
We need now to consider the role of futures prices in the setting provided by a cyclical price pattern induced by supply response to recent and current prices. The basic phenomenon is well recognized in earlier studies of potato prices as well as some other agricultural sectors[8] (e.g., the "corn-hog" cycle), but little if any attention has been given to the role of futures in this context. The level of potato prices in the current year clearly continues to induce a significant supply response (in total fall potato acreage) despite the evident diminution of that response in some production areas and its virtual disappearance (as a year-to-year phenomenon) in Maine. This response mechanism clearly provides a basis for price forecasting of the new crop future, even before planting intentions have been surveyed.

As an example, the closing price of the November futures contract each year provides a good basis for forecasting its closing price in the following year. Chart 3 shows the unadjusted data in three groups of years: 1953–60, with a very pronounced cobweb; 1961–63, when a significant interruption resulted from a struc-

[8] A. B. Larson provides a convenient summary of such studies in *12*, where he poses the important question whether a "cobweb" or "harmonic motion" model provides the appropriate interpretation of such cycles. For present purposes that question need not be resolved, since what we say with regard to future prices would apply in either case, although the estimating equations in Simmons (*14*) and in the present study are implicitly premised upon a cobweb model.

CHART 3.—AUTOCORRELATION BETWEEN SUCCESSIVE FINAL PRICES OF NOVEMBER FUTURES, 1953–71*

(Dollars per cwt.)



* Based on U.S. Dept. Agr., Commodity Exchange Authority, *Commodity Futures Statistics*, annual issues.

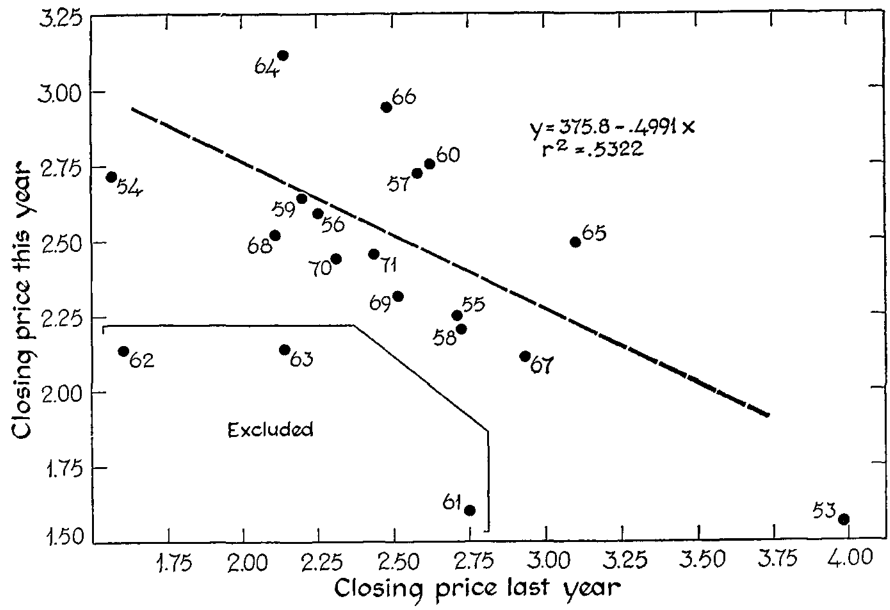
tural shift in the relationship; and 1964–71, with another pronounced cobweb at a somewhat higher price level, suggestive of an upward trend in unadjusted potato prices over the nineteen-year period. The only serious departures from a regular cobweb occurred between 1960 and 1961, when the relationship shifted downward drastically, and again between 1963 and 1964, when it shifted back upward drastically. The explanation for this interruption is found in the very large increase in acreage in 1961, which was *not* indicated in terms of the cobweb, although it was far larger than any annual increase during the period. After this random acreage shock had been worked out, and with the help of a sharp yield decline in 1964, the cobweb was reinstated at higher price levels. It is noteworthy that the March 1 planting intentions in 1961 gave clear warning of this sharp increase, hence the "forecasting" ability of the cobweb model was not that badly impaired if only one observed the warning that this random shock was occurring.

In view of the evident upward price trend manifest in the unadjusted prices employed in Chart 3, we also show, in Chart 4, the same relationship with the November futures prices deflated by the annual index number of prices received for all farm products. The regression line in Chart 4 has been fitted to sixteen observations, deleting the 1961–63 observations.

Without arguing that the cobweb model is the best one in which to cast these data (harmonic motion, as Larson [*12*] points out, might be virtually impossible to distinguish from the cobweb in this "discrete" case), and without insisting that this is the ideal formulation of the cobweb model, it is quite clear that the relationship shown here has provided a useful basis for forecasting in the absence of *any* other information. Indeed, just how useful the year-to-year cycle has been as a basis for forecasting may be more fully appreciated by contrasting it with the

CHART 4.—CLOSING PRICES OF NOVEMBER FUTURES DEFLATED BY ANNUAL INDEX NUMBERS OF PRICES RECEIVED FOR ALL FARM PRODUCTS, 1953–71*

(Dollars per cwt.)



* Data based on U.S. Dept. Agr., Commodity Exchange Authority, *Commodity Futures Statistics*, annual issues, and U.S. Dept. Agr., Bur. Agr. Econ., *Potatoes*, Stat. Bull. 122, Mar. 1953; revised and continued by the Agr. Mktg. Serv. in *Potatoes and Sweet Potatoes*, Stat. Bull. 190, Aug. 1956, and 291, Aug. 1961; and annual summaries.

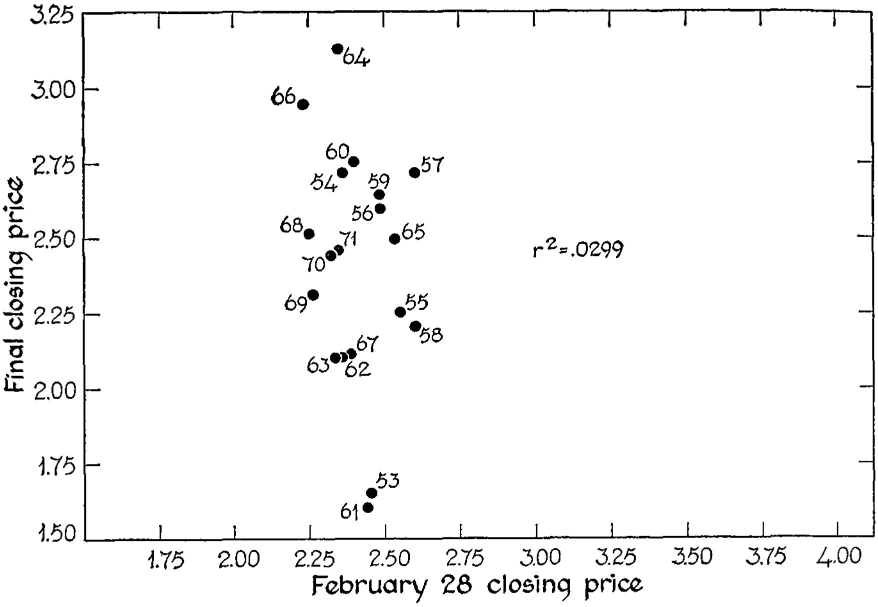
estimates provided *later* in futures price quotations. In Chart 5 are shown, for example, the February 28 quotations of the November future employed in Chart 4. Clearly the February 28 price of the November future provides a useless forecast of its *own* final price, yet more than three months earlier the price of a *different* November future has provided a very useful forecast. Shall we conclude that futures traders simply do not understand one of the most basic price determining relationships in the potato economy, and in consequence produce worthless price forecasts unrelated to the realities of that economic segment? There are those who have drawn similar conclusions, and who would welcome this one. (See the various hearings or bills to prohibit potato futures trading: *29*; *30*; *31*; *32*; *33*; *34*.) But we shall now see that a much different conclusion is compelled—one with important implications for better understanding of futures markets generally as well as for an appraisal of the performance of the potato futures market.

"Good" Price Forecasts as Self-Defeating Prophecies

To understand why a futures market cannot reflect the "good" price forecasts exhibited in Chart 4, it is only necessary to see why these would be self-defeating prophecies. High futures prices following a year of low prices would quickly evoke a production response that does not otherwise occur, and thereby lead to lower prices which do not otherwise occur. The cycle persists because production

CHART 5.—FEBRUARY 28 AND FINAL CLOSING PRICES OF NOVEMBER POTATO FUTURES, DEFLATED BY ANNUAL INDEX NUMBERS OF PRICES RECEIVED FOR ALL FARM PRODUCTS, 1953–71*

(*Dollars per cwt.*)



* Data based on U.S. Dept. Agr., Commodity Exchange Authority, *Commodity Futures Statistics*, annual issues, and U.S. Dept. Agr., *Agricultural Statistics*, annual issues.

responds to current and recent prices, but if futures prices were to reflect the anticipation of this response they would necessarily abort it in that reflection; simply because the assurance of higher prices would easily overcome the expectation of lower prices. By the same token, low futures prices following a year of high prices would not only discourage plantings to the extent that producers respond directly to the quotations but would undermine the capacity and disposition of intermediaries (banks, fertilizer dealers, potato dealers) to finance plantings, thereby discouraging production via a more indirect route. Looked at in another way, the opportunity that buyers would have to assure their forward supplies at low prices would be dissolved as, in seizing the opportunity, they would bid prices up. Not only does a futures market afford the opportunity to gear production plans prospectively instead of retrospectively; but a futures market cannot reflect the backward oriented cobweb mechanism without evoking the responses and hence the prices which will prove that reflection wrong.

The foregoing is an obvious enough explanation of the relationship between futures prices and a cyclical supply response mechanism; but it has not, to the best of my knowledge, been fully stated heretofore. Of course all of the writings on the cobweb, modified cobweb, or harmonic motion mechanisms (including our own of two decades ago [*8*] and those referred to in *12*) recognized that the response to current or recent prices *caused* it and that a forward oriented response would *cure* it. But no one, and least of all myself, adduced the stronger proposition that, *even prior to the time that the generalized production response becomes oriented to them, futures prices must reflect only appropriate responses to prospective prices.*[9]

Suppose the potato market to be completely dichotomized between those whose expectations do and those whose do not take the cobweb into account—that prices in alternate years are $2.00 and $3.00 per cwt., in a "perfect" cobweb. Those who observe the cobweb will always be out of phase with those who do not, and their expectations will always be one dollar apart, which would mean that they should be on opposite sides of the market at the intermediate and essentially invariant futures prices. The earliest test that can be made of this proposition from published data is on May 31 of each year, by which time all futures contracts held must be in new crop delivery months, the last old crop (May) future having expired. There is some evidence that the large (reporting) hedgers and speculators are responsive to the cobweb relation, which means that small traders, whose net positions are opposite the aggregate net positions of reporting traders, are more victims than students of the cobweb.

Futures Markets Are Not Forecasting Agencies

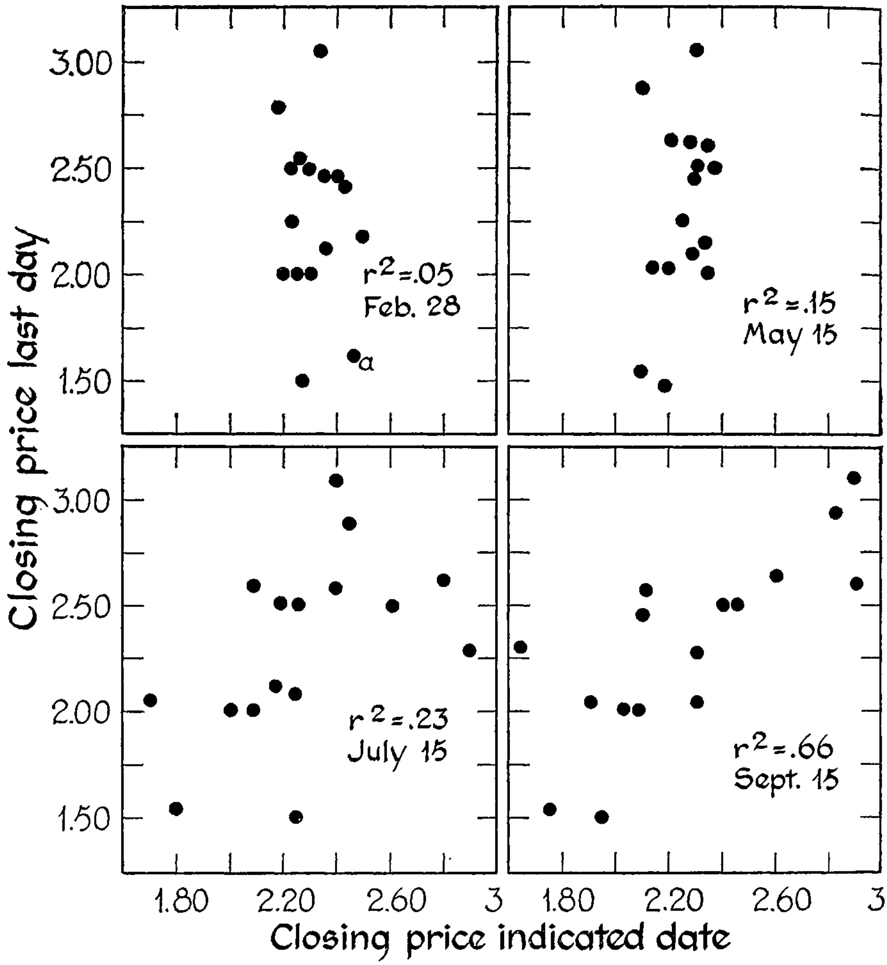
The behavior of potato futures prices shown in Chart 5 provides another illustration of a distinction drawn by Holbrook Working in 1948—that a futures market cannot act both as a forecasting agency and as a medium for rational price formation (*37*). Working showed that when continuous inventories are held, spot and successive futures prices are linked together by these inventories—so closely that developments anticipated between different future dates cannot be reflected in future prices. This linkage imparts an aspect of "self-fulfillment" to the "prophecies" embodied, for example, in new crop grain futures prices at planting time. Tomek and I showed that this does not obtain in potato futures because no inventories are held over the growing season (*16*).

Another illustration taken from grain futures makes the point that futures markets are not forecasting agencies in essentially the same way as it is made in potato futures—involving the self-defeating prophecy. This was provided in my 1962 paper, where I showed the influence of the government loan program on wheat futures prices (*5*). The mechanism may be illustrated briefly. For a succession of years wheat prices at harvest time were low, owing to production in excess of market requirements at the price support level. Between harvest (July) and December, market prices moved upward as the excess production moved into government hands. Thus it came to be recognized that the December futures price would rise to the loan level, even if its price in July might be thirty cents below the loan level. Why then was the December futures price not forecast at the loan level to begin with? Because this would have been a self-defeating prophecy—wheat would not have moved under the loan program if the market price already reflected the same level as the loan alternative; and if wheat did not move under the loan program the December futures price would not rise.

[9] My own failure to perceive this necessity until quite recently is reflected in a statement published only two years ago: "[The cobweb theorem] suggests a rationale for a linkage between prices for potatoes in successive years, which should be reflected in the springtime expectations [in futures] about the forthcoming crop but apparently is not" (*16*, p. 377). Clearly the cobweb should *not* be reflected in November futures prices prior to planting—and clearly it *is* not.

CHART 6.—SEASONAL EMERGENCE OF POTATO FUTURES PRICE "FORECASTS," 1953–68*

(*Dollars per cwt.*)



* Reprinted from R. W. Gray and W. G. Tomek, "Temporal Relationships Among Futures Prices: Reply," *Amer. J. Agr. Econ.*, May 1971 (7).

[a] In 1953 the February 28 quotation is for the "old" November contract; for the other dates quotations are for the "new" November contract.

The conflict between "forecasting" and "rational price formation" is resolved again in favor of the latter in the February 28 prices of November potato futures. A "forecast" emanating from the cobweb theorem would elicit supply (or demand) response which would defeat the forecast; hence the market arrives rationally at the long-run equilibrium price level, and does not begin to reflect supply response until good information bearing upon the current year's supply becomes available.

Chart 6 taken from 7 shows the seasonal emergence of improved estimates of November potato future prices, and Table 2 shows the statistics for five such estimates. Not until September 15, in this series of data, do the "rationally formed prices" become good "forecasts"—in fact the year-to-year "forecasts" made from

TABLE 2.—ESTIMATED LINEAR REGRESSIONS OF THE CLOSING PRICES AT THE CONTRACT EXPIRATION ON THE PRICES FOR SELECTED EARLIER DAYS FOR THE NOVEMBER MAINE POTATO FUTURE, 1953–68*

Date	Intercept	Slope	R^2
February 28 (29)	4.64 (2.79)	−.99 (1.19)	.05
April 30[a]	−2.50 (2.54)	2.12 (1.12)	.15
May 15	−3.00 (2.50)	2.32 (1.09)	.24
July 15	.91 (.70)	.62 (.30)	.23
September 15	.31 (.39)	.88 (.17)	.66

* All data are in dollars per cwt. Numbers in parentheses are standard errors. The table is from R. W. Gray and W. G. Tomek, "Temporal Relationships Among Futures Prices: Reply," *Amer. J. Agr. Econ.*, May 1971, p. 364. The data are calculated from U.S. Dept. Agr., Commodity Exchange Authority, *Commodity Futures Statistics*, various issues.

[a] This estimate differs slightly from R. G. Heifner's (see his Table I); presumably the data differ somewhat. For 1953–70 the regression coefficients are essentially unchanged and $r^2 = .21$.

the cobweb (Chart 4) are as good as these two-month "forecasts." Yet the one-year "forecasts" would be no good whatsoever if the futures market evoked them as price estimates, whereas the two-month "forecases" are futures quotations.

This distinction between a forecasting agency and a medium for rational price formation may become clearer if we imagine for a moment that a futures market *is* a forecasting agency, in the sense that the weather bureau, for example, is a forecasting agency. The essential distinction is that no forecast issued by the weather bureau is going to change the weather. For this to be true of a futures market would require that it be in fact what some of its critics mistakenly imagine it to be, namely, a gambling casino in which no valid delivery obligations are contracted for, but in which participants simply wager on price outcomes. Imagine a group of gamblers in an isolated chamber *into* which all information relevant to potato supply and demand is channeled, but *from* which no information emanates as to the terms of their wagers. Their consensus forecast *would* reflect the cobweb-type relation that exists, as well as current information when it emerges. Prior to the time that planting and other production decisions are taken, their consensus forecast would be a "better" forecast of ultimate price levels than is the futures price; but "better" only in the trivial sense that it would come closer, on the average, to the ultimate price level. It would not provide any guide to action—whether production or marketing action—for potato producers; nor would it provide any escape route, for individuals or the industry, from the price and production variability to which they have been exposed.

Futures markets are hedging markets rather than gambling casinos. As such they provide continuous guides to production and marketing decisions, and enable the establishment of firm forward prices in hedging positions. The potato futures market, as a medium for rational price formation, has provided that setting in which prices established prior to planting time each year have approximated the long-run equilibrium price. These futures prices cannot be accurate forecasts in an unstable equilibrium because these would be self-defeating; but they can induce a stable equilibrium only as rapidly as producers respond to the prices which the market generates. That there has been incentive to so respond, and that those who have done so have benefited therefrom, we see in the ensuing sections.

THE POTATO FUTURES MARKET AS A MEDIUM FOR HEDGING

The most important function of a futures market is to provide a hedging medium for those engaged in commodity commerce—growers, merchants, processors, wholesalers, and retailers of potatoes in this instance. Since the market we are examining calls for delivery of Maine potatoes, most of its hedging use has emanated from the Maine industry, and the opposition to this market also originates in Maine, we shall focus primarily upon hedging opportunities and hedging results from a Maine standpoint. Maine being a seller of potatoes, the chief interest is in a selling hedge (by growers, grower-shippers, or by those, like fertilizer dealers, who finance growers),[10] although the Maine processor, for example, would be concerned with a buying hedge. The selling hedge from Maine's standpoint consists of two quite different alternatives at different times of the year: (1) a forward-pricing hedge during or prior to the growing season, on which the forthcoming crop is priced; and (2) an inventory (or carrying charge) hedge after the crop is harvested, during a storage season when a spot or futures sale is a continuous alternative, in contrast to the pre-harvest period when only futures sales are feasible.

The Forward-Pricing Hedge

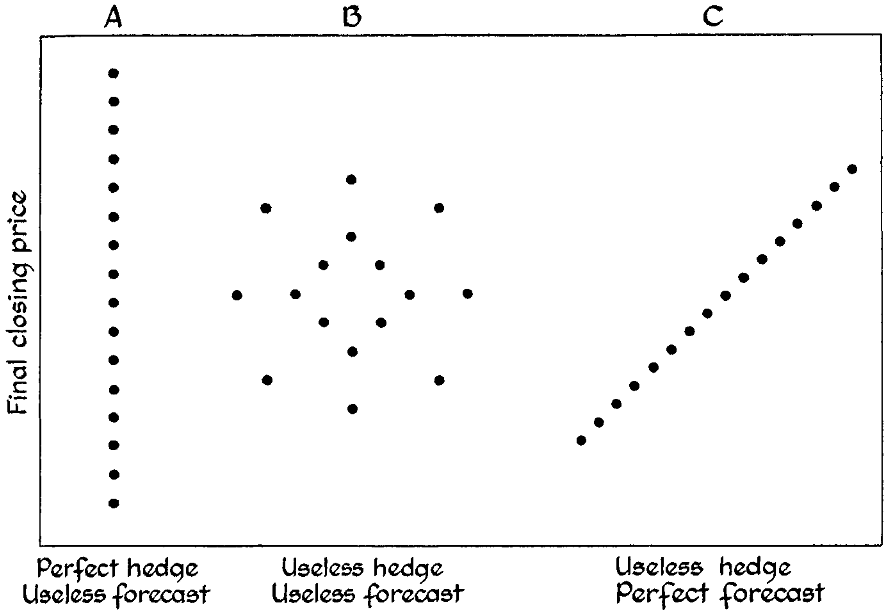
Considering first the hedging that occurs prior to harvest, there are several means of assessing the opportunities that the market has provided as well as the results which have been obtained. Two time spans are focused upon initially: (1) the span extending from "zero information" to "full information," i.e., from February 28, prior to the first survey of planting intentions, to the last day of trading in the November future, after which no additional information can influence the price of this first new-crop future; (2) the span extending from April 15, just ahead of planting but after March 1 planting intentions have been released (about March 20), to October 15, by which time the harvest is completed. A routine selling hedge over these two time intervals has provided essentially identical results (as indeed are obtained for any time spans with beginning dates prior to April 15 and terminal dates after October 15, although not all possible combinations are shown here—previous studies have shown results, through 1968, for February 28 and April 30 initiations vs. final November termination [5; *16*]).

The results are:

(1) The initial prices are uncorrelated with the final prices. The observations cluster closely about the mean value of the initial price and are widely dispersed

[10] See the paper by A. C. Johnson elsewhere in this issue for analysis of the hedging use of this market (*11*).

CHART 7.—THREE HYPOTHETICAL PRICE RELATIONSHIPS BETWEEN A FORECAST AND REALIZED (FINAL CLOSING) PRICE FOR A FUTURES CONTRACT*



* Chart reprinted from R. W. Gray and W. G. Tomek, "Temporal Relationships Among Futures Prices: Reply," *Amer. J. Agr. Econ.*, May 1971.

around the mean value of the final price. The F ratio (of the variance between initial and final prices) is extremely high. (See Charts 2 and 5, and compare with Chart 7 above.) From the hedger's standpoint, this means that variability in year-to-year prices has been dramatically reduced through a routine hedging program—selling November futures on February 28, and buying them at the close of the contract; selling them on April 15, and buying them back on October 15; or any routine program over a similar span. To the extent that his output has correlated with total output, the reduction in income variability has been somewhat less than the reduction in price variability.

(2) The mean value of the initial prices in these routines has been essentially identical to the mean value of the final prices. Over the interval from February 28 to final November the mean values (1953–71) were identical in the deflated prices and less than a penny apart in the undeflated prices. Over the interval from April 15 to October 15 (1953–71) the mean value declines by less than four cents (undeflated); there is no measurable statistical trend in futures prices over any similar intervals (1953–71). From a hedging standpoint, this has meant that the reduction in price and income variability just adduced has been achieved at no sacrifice in price level. Indeed, assuming some positive correlation between individual and total production, the routine hedger has had a somewhat higher income from the sale of potatoes than the nonhedger.

Considered from the standpoint of year-to-year price and income variability, which has been probably the most serious problem confronting the Maine potato grower, the futures market has afforded a near perfect hedge in a routine hedge placed any time before planting and lifted any time between harvest and the expiration of trading in the November contract.

This characteristic performance of potato futures prices was stressed in testimony I gave in 1963 (*3*; *33*). The hedging opportunity implicit in this characteristic was also spelled out. One of the counterarguments which had been made was that the hedging capacity of the market was severely limited, such that any large-scale attempt by growers to avail themselves of this opportunity would be price-depressing and self-defeating. It was possible to respond at the time, employing data through 1962, that the largest year-to-year increases in hedging had not strained market capacity or given any sign that this would occur. Since 1962, there has been significant further growth in hedging use, without impairment to the hedging results.

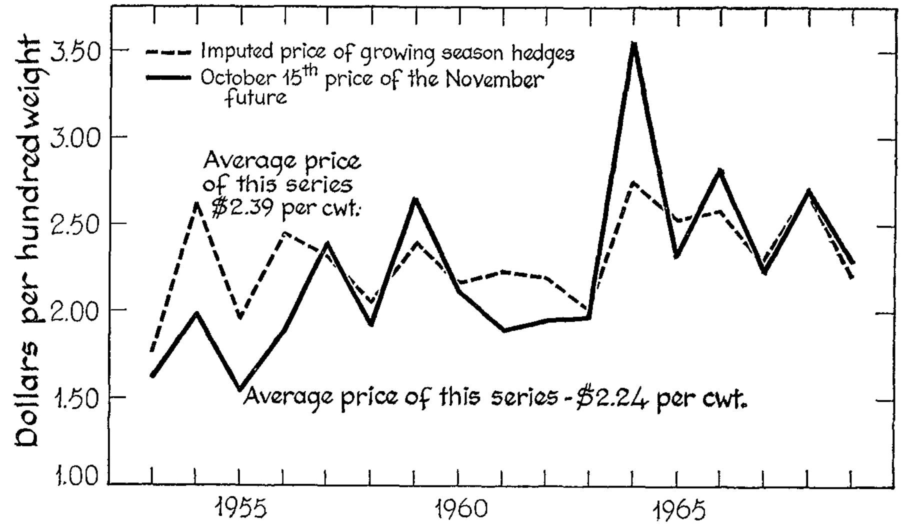
It is perhaps never quite convincing to speak of what could have been, especially when it appears so simple. Nor is it possible to say with any great precision—from published records—what have been the results of forward price hedging of potatoes. We can nevertheless impute results from CEA data which make it clear that actual hedging has been at least as successfully conducted as the "dumb" routines described here.

One little test pertains to the early season hedging, done before planting time. As of April 15, when most of the open interest is in the expiring (old-crop) May future, it is a fair assumption that the short open interest in the new-crop futures (November and beyond) is hedging. On this assumption, we can then ascertain whether or not the selective hedging undertaken this early in the season has been well selected. The range of open interest in new-crop futures at this date has extended from 217 contracts to 2,123 contracts. Has it varied in accordance with subsequent price movement?

Since the November contract declined in price by an average of four cents per cwt. between April 15 and October 15 (1953–70), and since an average of 868 contracts was held on April 15, we can compute that the gain to the short position would have been $17,360 in total if the same open interet had been held each April 15. But when the actual open interest in each year is multiplied by that year's price change, the gain to the short position was $627,845. (Both computations ignore commissions or other costs.)

A more complete test of forward price hedging is one that extends throughout the growing season. For purposes of this test we have priced all incremental reported short hedging in the November contract throughout the period May 15 to October 15 each year. The procedure, using the semimonthly data in the annual CEA statistical publication (*19*), was to multiply all increments to reported short hedging by the average of November futures prices obtaining at the beginning and end of the preceding semimonthly interval, then aggregate these results to obtain the imputed weighted average price at which growing season hedges were placed. Each season's weighted average price is then compared with the October 15 price of the November future. The question is simply whether these growing season hedging increments occurred at prices more or less advantageous than an unhedged "spot" sale immediately after the harvest. The resultant comparison, portrayed in Chart 8, shows that growing season hedgers made better sales than nonhedgers who sold at harvest time. Hedgers obtained

CHART 8.—COMPARISON OF GROWING SEASON HEDGES WITH SPOT SALE AT HARVEST, 1953–69*



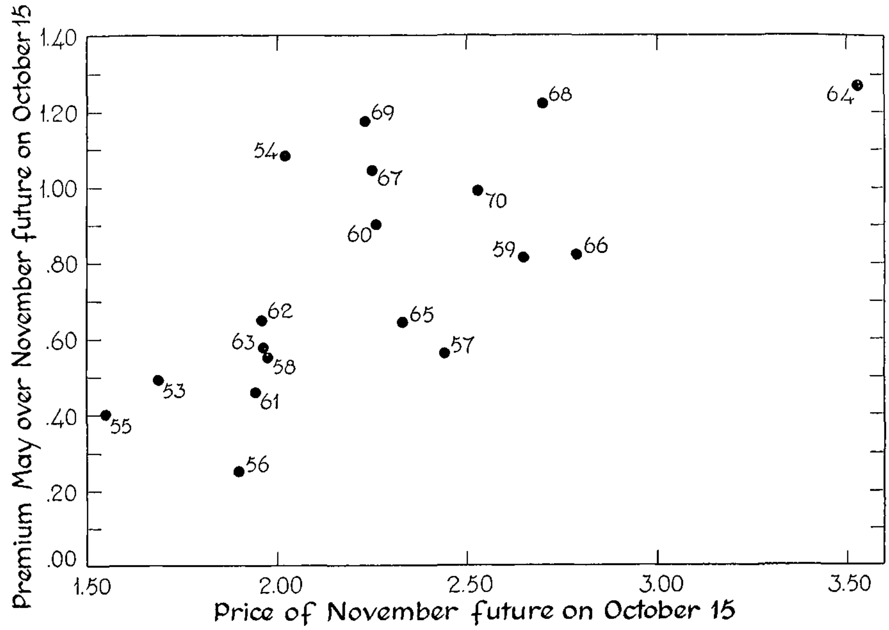
* Based on U.S. Dept. Agr., Commodity Exchange Authority, *Commodity Futures Statistics*, annual issues. See text for method of calculating imputed price.

much greater year-to-year price stability, at annual prices averaging seven cents per cwt. higher than nonhedgers. The chart does not show the still further advantage resultant from the fact that more hedging was done at higher prices than at lower prices, such that the *weighted* average price of hedging increments for the seventeen-year period was $2.39 per cwt., whereas the unhedgd sales prices weighted by Maine production still averaged $2.24 per cwt. This also means, however, that more hedging has occurred in years when it was *least* advantageous in view of subsequent price developments, but *most* advantageous in view of current price levels. Reporting hedgers have thus manifested the risk-averse philosophy that says, "A bird in the hand is worth two in the bush."

Storage Season Hedging

Once the fall potato crop is harvested, it becomes an inventory commodity for which the hedging considerations are similar to those applying to other storable crops. The difference between cash and successive futures prices reflects a return for storage which can enable growers or grower-shippers to make rational storage decisions at assured returns, providing of course that they have facilities for storing potatoes. An important difference between potatoes and the crops that require annual carryovers rests, however, in the fact that the fall potato crop cannot be economically stored until the next fall harvest, hence there exists no possibility that supplies can be in effect borrowed from the forthcoming crop in the event of current shortage. Thus potato futures prices do not reflect inverse carrying charges at times of current shortage, as do the prices of continuous inventory crops; and indeed the market-determined carrying charges for potatoes tend to be higher during periods of shortage than at other times. The incentive to store

CHART 9.—RELATION BETWEEN PRICE LEVEL AND CARRYING CHARGE, 1953–70*
(*Dollars per cwt.*)



* Based on U.S. Dept. Agr., Commodity Exchange Authority, *Commodity Futures Statistics*, annual issues.

potatoes is thereby greater when they are in short supply, which is the opposite of the continuous inventory case.[11]

Maine potatoes are stored in larger proportion to the crop and later into the season than potatoes from any other producing region, hence the inventory guidance provided by futures prices is of critical importance to the Maine industry. A properly functioning futures market can enable the grower (or grower-shipper) to rationalize the decision whether to store or sell at harvest time (and if to store, for what period). A major criticism of a non-futures marketing system has been that it allows harvest-time price depression followed by an excessive seasonal rise in prices, owing to the marketing risk of owning the stored crop and the urgency which growers feel to sell at harvest (see *1*; *2*). If the owner of potatoes can choose between firm prices at harvest and firm futures prices which reflect costs of storage, his decision is greatly simplified. He is also better off using a futures market decision rule providing that the harvest-time estimates of subsequent prices turn out to have been reasonably good (in a forecasting sense) and to have been unbiased estimates. We need then to evaluate the futures price behavior in these lights.

The carrying charges which the market reflects to the owner of potatoes at time of harvest are shown in Chart 9. The incentive to store potatoes is clearly related to their price level over this period of time, being much stronger when potatoes are higher priced. While it costs somewhat more in terms of interest

[11] See *37* for the classic statement of the relationship for the continuous inventory case.

charges to store expensive as opposed to cheaper potatoes, the chief difference lies in losses from shrinkage during the storage period. Since expensive potatoes lose just as much weight in storage as do cheap potatoes, the storage costs are proportionately higher. It is also true that the market-determined carrying charges are higher per month later in the season, reflecting the acceleration of weight loss over time. It must be recalled, however, that potato and grain futures operate under different constraints. The grain futures markets encourage release of stocks when these are currently in short supply, always on the assumption, due to continuous inventories, that more supplies will become available. The potato futures market encourages *holding* of stocks when these are currently in short supply, always on the assumption that supplies are to be rationed over a finite interval. Rational hedger response can be the same in either case; but the market signal to which the hedger responds reflects these different constraints.

In terms of the accuracy of its price forecasts, the potato futures market over the storage interval has behaved more like grain futures markets. In the context of our earlier analysis of the non-inventory contrast (*16*), potato futures price estimates after harvest behave as we would expect. The postharvest estimates of prices later in the storage season are illustrated in Chart 9. The equations for these March futures data and another set of observations on the May futures are shown in Table 3.

These are "good" forecasts in the sense that the slopes and intercepts are appropriate, but the lack of closeness of fit allows ample scope for speculation and hedging.

A final point pertaining to the storage season price estimates is that they have been unbiased. The mean value of the March futures prices (1953–70) was 2.64 per cwt. on October 15 and 2.57 per cwt. on February 28. For the May future, the mean values were 3.09 per cwt. on November 15 and 3.11 per cwt. on April 30.

To summarize these results in terms of hedging, the owner of potatoes who has hedged every year after harvest has achieved substantial reductions in price and income variability at no sacrifice in their levels. He has received a known level of carrying charges, which at their lowest levels presumably cover storage costs. Because the higher carrying charges that emerge in years of higher prices have usually not been reflected early in the growing season (before the higher prices have emerged) there has been a significant tendency for spreads to be higher after harvest than earlier in the season. Thus, for example, the October 31 spread between November and May futures has averaged some eighteen cents higher than the July 15 spread between the same futures. Clearly the owner has been well-advised to hedge his storage potatoes after harvest rather than earlier in the season. Finally, the selective hedger who has linked his storage decision

TABLE 3.—STORAGE SEASON PRICE RELATIONSHIPS FOR POTATOES

Where x_1 = February 28 price of March future (1953–70)	Where x_1 = April 30 price of May future (1953–70)
x_2 = October 15 price of March future	x_2 = November 15 price of May future
$x_1 = -.2478 + 1.0675\, x_2$	$x_1 = .0985 + .9742\, x_2$
(.7663) (.2849)	(1.077) (.3401)
$R^2 = .4674$	$R^2 = .3389$

to the carrying charge has, on the one hand, obtained high carrying charges in some years, and on the other hand has sold his potatoes in those years when prices subsequently declined.

The Costs of Hedging

The foregoing analyses of both hypothetical and imputed hedging results have ignored the question of hedging costs. Such costs consist of explicit charges—brokerage commissions and interest on margin deposits—plus whatever implicit costs may occur in the form of price estimates biased against the hedgers' positions or execution costs which take the form of dips and bulges in prices as hedging orders are placed or lifted in the trading pit.

The explicit charges, while they vary over long periods of time as commission rates or margin levels are changed or as interest rates fluctuate, are nevertheless known at any point of time. A simple calculation enables these to be expressed in terms of cents per cwt. For example, given a round turn (non-member) commission rate of $30 per contract, initial margin deposit of $300 per contract, and an interest rate of 8 percent, the following results apply:

Commission	$30.00
Interest on margin at 8 percent for six months	12.00
	$42.00

which for a 50,000 lb.-contract is equivalent to 8.4 cents per cwt. If the hedging position is held for shorter or longer periods the costs vary accordingly; whereas if the price changes so as to require maintenance margin, the interest cost rises (but so does the value of the hedged potatoes).

A carlot of potatoes is a relatively low-valued futures contract, enabling relatively low margin deposits. Yet at the same time potato price fluctuations are relatively large, so that safe margin levels cannot be commensurately low when compared with other futures contract values. Moreover, the actual costs of brokerage are not related to contract values, but rather to trading volume. In consequence of these considerations, it costs more per unit of value to hedge potatoes than it does to hedge grains, for example.

A comparison may be made with soybeans for illustrative purposes, assuming (non-member) commission rates of $30 and initial margin levels of $1,000 per contract (5,000 bushels):

Commission	$30.00
Interest on margin at 8 percent for six months	40.00
	$70.00

per contract which is equivalent to 1.4 cents per bushel.

It is important to bear in mind that the contrast between explicit costs of hedging potatoes and soybeans is inherent in the two commodities—even without futures markets for either one, brokerage and other marketing costs are much higher per unit of value in the case of potatoes.

Apart from explicit hedging costs, we have already observed that there has been no detectable bias in potato futures prices, hence the remaining question pertains to the implicit execution cost of establishing and removing hedging commitments. Working has explained this cost as follows: "To the extent that hedging orders affect the price, hedgers tend to sell on price dips and to buy on price bulges, and therefore tend to lose money on their transactions in futures. The consequent losses, being incurred for the sake of obtaining prompt execution of orders, may be called the execution cost of hedging" (*36*, p. 5). He then proceeds to summarize existing evidence in support of this theory, and to provide important new evidence from a trading record in cotton futures. Of the existing evidence he states, *inter alia*, that, "Scalping of at least the larger dips and bulges can be done with some success by merely following a simple set of trading rules. The best published evidence of this fact that I know appears in a study of Smidt" (*36*, p. 16). Seymour Smidt's study provides the basis for analysis conducted here of the execution costs of hedging potatoes (*15*).

Smidt analyzed the daily closing prices of May soybeans futures for a ten-year period, testing whether departures of various magnitudes (one to four cents per bushel) from moving averages of various lengths (one to ten days) displayed tendencies to reversal or continuity. His most significant finding was that price changes of one cent or more (close to close) tended to be partially reversed on the following day; such that on an average for the ten years all such price changes were reversed by almost one cent on the day following the change. (Working, *36*, p. 16, points out that adjusting for the length of holding interval strengthens Smidt's findings.) If Smidt's findings are interpreted as a rough approximation of the generalized execution cost of hedging soybeans, they would say that it cost about one cent per bushel to place and another cent to lift soybean hedges.

To apply such a test to potatoes requires, in Working's terminology, employing a net with a larger mesh. Potato futures prices fluctuate over considerably wider ranges on a day-to-day or other short interval basis than do soybean futures prices. In Table 4 are shown the results of applying three different trading rules to potatoes, together with the most significant of Smidt's results for soybeans.

TABLE 4.—RESULTS OF RULES TESTING POSITIVE PRICE DEPENDENCE*

Potatoes 1959–60				Soybeans 1952–61			
Action signals				Action signals			
Length of moving average (*days*, N)	Change required (*cents per cwt.*, K)	Results May future (*cents per cwt.*)[a]	Number of moves	Length of moving average (*days*, N)	Change required (*cents per bu.*, K)	Results May future (*cents per bu.*)[a]	Number of moves
1	3	−3,057	771	1	1.0	−338	384
1	5	−1,967	516	1	2.0	−112	177
1	10	+ 51	212	1	3.0	− 29	83
2	3	+ 192	345	2	1.0	+ 52	178
2	5	+ 830	208	2	2.0	+ 28	69
2	10	− 225	74	2	3.0	+ 84	37

* Data for soybeans from Seymour Smidt, "A Test of the Serial Independence of Price Changes in Soybeans Futures," *Food Res. Inst. Studies*, V, 2, 1965. Data for potatoes similarly calculated by the author.

[a] Profits (+) or losses (−) before commissions.

The results clearly exhibit the greater price volatility of potato futures in comparison with soybean futures—in the periods shown there were more close-to-close price changes per year in potato futures exceeding three cents than there were exceeding one cent in soybean futures (and similarly more five cent-changes in potato futures than two cent-changes in soybean futures, and more ten cent-changes in potato futures than three cent-changes in soybean futures). Beyond this contrast, the results are highly conformable between soybeans and potatoes. Both reflect strong one-day reversals but not two-day reversals. Also, the smallest of the three price changes is the most effective screen for these one-day reversals in each case. This suggests that the execution costs of hedging potatoes, due to the thinner market and much greater inherent instability of price, may be approximately four times as great (per cwt.) as in soybeans (per bu.).

If we now aggregate the explicit and estimated implicit costs of hedging in the two markets it would appear that total costs of hedging soybeans assuming unbiased price estimates[12] may be of the order of 3.5 cents per bushel (approximately 1.4 cents of explicit cost, as calculated earlier, plus approximately one cent for each execution, in and out). The same calculation for potatoes yields an estimate of sixteen cents per cwt.—eight cents explicit cost plus approximately four cents for each execution, in and out.

It remains now to consider the effects of the type of hedging conducted in potato futures on these estimates, and the growth of the potato futures market upon the level of hedging costs. Whereas virtually the entire commercial movement of the soybean crop has come to be hedged in futures, still only a minor fraction of the potato movement is so hedged. At any given point in time the open interest in soybean futures tends to somewhat exceed the visible supplies (merchantable stocks) plus the factory stocks (held by crushers); and open interest is highly correlated with the sum of these two stocks figures over time. Stocks held on farms tend not to be hedged, however. For potatoes, not even the merchantable stocks held in Maine are fully reflected in the open interest, much less the total stocks. Moreover, potato hedging is conducted when no stocks are in existence, at a time when the hedging is perforce purely "anticipatory."[13] The implications of these facts are twofold. First, potato hedging necessarily partakes of the nature of flat price "forecasting" during the growing season, when no "basis" relationship exists; and it is clearly more selective than soybean hedging during the storage season when a "basis" relationship does exist. This makes it important to correct the implicit costs of routine hedging for the effectiveness of the anticipatory and selective hedging actually practiced. The theory of execution cost of hedging assumes that hedgers tend to place market orders to assure prompt execution of trades, and that as "urgent" sellers or buyers they must sacrifice an execution cost. This is probably a valid assumption for such well-used futures markets as those for the grains and cotton, in which execution costs are low. But the very recognition of higher execution costs in potato trading tends to militate against routine market orders, suggesting that hedgers may not pay the full implied execution costs.

[12] It appears that soybean futures prices may have been downward biased during the early part of the period considered here, as they probably no longer are (see *4*, Table 1).

[13] See *38* for a distinction between various classes of hedging.

Even if hedgers are presumed to pay the implied execution costs, this must at a minimum be offset against the estimated returns resultant from skillful selection of the price levels at which to place anticipatory or selected hedges, some estimates of which have been provided in the preceding section. The opportunity cost of not hedging needs to be balanced against the explicit and any implicit costs of placing and lifting the hedges. This comparison is most direct during the growing season, when the hedging is necessarily anticipatory. Results shown above suggest that hedging has been conducted at a price level advantage of from seven to fifteen cents per cwt., quite apart from the advantage of reduced price and income variability. Hedging costs over the pre-harvest interval have probably been substantially offset by the opportunity costs of not hedging; thus the net cost of hedging may have been near zero.

A similar comparison is not so easy to draw for the storage season, nor is it so important. The owner of stored potatoes always has a cash market alternative at hand, and it is difficult to believe that he would make the wrong choice between a cash and futures sale when the alternatives lie clearly before him. Opportunity exists to make wrong judgments of whether to hedge *stored* potatoes or not; but it seems most unlikely that a hedge would be placed which would net less than immediate cash sale, brokerage and execution costs included. Additionally, where the storage period is concerned, it is worth recalling that the price estimates are unbiased.

It is in short difficult to imagine a futures market no larger than this one, dealing in a commodity subject to great price variability and high marketing costs in any case, providing such rich hedging opportunities at any lower cost. It should be stressed that the comparison with soybeans which has been drawn here is a comparison with the best used futures market in history, dealing in a commodity with a much less serious marketing problem than potatoes. In this comparison the potato futures market appears to be a useful and viable hedging medium.

CONCLUSIONS

This has been an analysis of the performance of a new marketing institution in the context of an old and stubborn marketing problem. The futures market for Maine potatoes has been active for less than two decades whereas potato price uncertainty and cyclicality have persisted since the price record began. The historical variability of potato prices had been arrested during the price-support program of the 1940s—a program which induced the emergence of a highly specialized potato growing industry, born out of price certainty and far more dependent upon price certainty than its antecedent conglomeration of sideline potato enterprises and barely nascent specialists. Could the mutant survive the ancestral diet, or did it depend wholly upon the mother's milk which had imparted such vigor up to the weaning stage? Was there an even better alternative, whereby a diet of reasonable price stability could be developed which would assure the survival of the new industry on its own feet?

An organized futures market is the logical mechanism through which to enable producers to plan production according to prospective prices and to convert these to certain prices through hedging. The potato futures market was the first ever to attract significant hedging business in the context of discontinuous inventories and a cyclical price-production pattern. The forward pricing and inventory rationing functions are both more difficult and more important in this case, as compared to such continuous inventory cases as the grains. The success of this market, in economic terms, has already been demonstrated—it has provided reasonable signals to those who would look and price certainty at reasonable levels to those who would avail themselves of it by hedging. The level of hedging use has continued to grow, hence the measure of success has gradually increased. Anything like full success from a total industry standpoint cannot be achieved until a much larger segment makes use of this or other potato futures markets, but already there are signs of improvement in industry production response. Most importantly to date, however, has been the contribution of this market to the vanguard of potato growers and shippers who use it. The analysis in this paper can leave no doubt as to why its users support it.

None of this helps to account for the persistent political opposition to potato futures trading; indeed, there may be no logical way to account for this. My own impressions were set forth in *3*, and there is little that I would add beyond two observations on historical perspective. Futures markets, in the United States and abroad, have always encountered political opposition and have frequently been vigorously opposed by the commodity segments into which they were introduced. Yet established futures markets find their strongest adherents throughout those commodity segments; and populist agrarian opposition to futures in the United States has nearly vanished. The second note on historical perspective has a much more recent frame. Since the introduction of potato futures trading, and even since the last political attack upon it, several other futures markets have been successfully launched in somewhat similar environments. The markets for pork bellies, live hogs, live cattle, fresh broiler chickens, and fresh eggs all deal with non-inventory or discontinuous inventory commodities, some of which have been plagued by production response cycles. It is tempting to think that history may be on the side of the potato futures market after all, recording its political as well as economic success—both against great odds.

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APPENDIX

EQUATIONS RELATING POTATO ACREAGE TO PREVIOUS YEAR'S (OR PREVIOUS TWO YEARS') PRICE AND PREVIOUS YEAR'S ACREAGE SELECTED PRODUCING REGIONS AND PERIODS*

Equation number	Date	Constant	Coefficient of variable P_{t-1}	P_{t-2}	A_{t-1}	R^2
			MAINE			
1	1953–70	22.68	.0610	.0186	.7534	.7068
		(24.13)	(.0169)	(.0149)	(.1592)	
2	1953–70	17.88	.0644	...	.8053	.6743
		(24.26)	(.0169)		(.1564)	
3	1953–60	300.9	−.0198	...	−1.074	.6566
		(70.61)	(.0288)		(.4650)	
4	1953–64	142.3	.0313	.0274	−.0601	.3230
		(76.23)	(.0371)	(.0179)	(.4972)	
5	1965–70	561.0	−.2217	.0107	−2.328	.7643
		(188.6)	(.0957)	(.0156)	(1.091)	
6[a]	1953–70	142.9	−.0001	.0146	−.0130	.0736
		(52.43)	(.0284)	(.0141)	(.3343)	
			LATE SUMMER AND FALL PRODUCING STATES EX-MAINE			
7	1953–70	13.63	.4616	.1464	.8580	.8086
		(108.0)	(.1491)	(.1368)	(.1196)	
8	1953–60	427.1	.4162	...	.3516	.5878
		(339.5)	(.1825)		(.4116)	
9	1953–64	−6.143	.6584	−.0017	.8734	.5870
		(245.5)	(.2787)	(.1876)	(.2630)	
10[a]	1953–70	66.69	.4185	.1337	.8027	.4493
		(227.6)	(.2209)	(.1448)	(.2411)	
			IDAHO			
11	1953–70	−.2416	.2282	−.0458	.9080	.9592
		(14.84)	(.0506)	(.0514)	(.0561)	
12	1953–70	−3.837	.2188	...	.8952	.9569
		(14.18)	(.0492)		(.0538)	
			CENTRAL STATES (FALL)			
13	1953–70	200.5	.0641	.0596	.3067	.2060
		(84.79)	(.0579)	(.0503)	(.2490)	
14	1953–70	206.0	.0649	...	.3248	.1263
		(85.80)	(.0586)		(.2519)	
			EASTERN STATES (FALL INCLUDING MAINE)			
15	1953–70	75.99	.0739	.0295	.6509	.4208
		(73.85)	(.0468)	(.0402)	(.2502)	
16	1953–70	61.27	.0831	...	.7175	.3985
		(69.98)	(.0444)		(.2296)	

* See note on facing page.

While equations (1) and (2) suggest a continued acreage response to price in Maine, counter to the indications of Simmons's equation (E) in text Table 1, equation (3) confirms Simmons's finding and suggests further that equations (1) and (2) reflect a major shift instead of year-to-year response. Maine acreage shifted upward abruptly in 1965 and 1966. When the data are segmented as in equations (4) and (5) it becomes clearer that there was only one significant acreage response to price in Maine during the entire period—that occurring in 1965 and 1966 after the high prices of 1964. Equation (6) shows the entire period with means adjusted to eliminate the 1965 shift, and reveals no residual acreage response.

The response in the late states is significant, is much more elastic for the earlier segment; equation (9), and not similarly effected by the adjustment of means, equation (10).

The Idaho and central states equations (11), (12), (13), and (14) need no elaboration. The eastern states results (15) and (16) are undoubtedly much influenced by Maine, as the late producing states results are undoubtedly much influenced by the western states.

* Equations are of the form $A_t = A_0 + A_1 P_{t-1} + A_2 P_{t-2} + A_3 A_{t-1}$ where

A_t = Current year's planted acreage for late summer and fall potatoes in the state or region. (In thousands.)

P_{t-1} = Season average price received by farmers for late summer and fall potatoes in the state or region in the previous year.

P_{t-2} = Season average price received by farmers for late summer and fall potatoes in the state or region two years previously.

A_{t-1} = Acreage planted to late summer and fall potatoes in the state or region in the previous year.

Figures in parentheses are the standard errors of the regression coefficients.

[a] With means adjusted for the upward shift that occurred in 1965.