Production and Price Relationships for West Texas and U.S. Spring and Summer Potatoes

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Abstract

Historically potato producers have seen large year-to-year fluctuations in price and production. The objective of this study was to explain the factors operating in the U.S. warm season potato market and the West Texas portion of the market which underlie price and output determination.

A simultaneous model with eight stochastic equations and four identities was developed to explain price and production for West Texas and each of three U.S. seasonal markets for potatoes. Yearly data for the period 1960-1976 were used to fit the model with 3SLS. The model was very close in predicting prices and quantities from an <u>ex post</u> view. Therefore, estimating equations for the exogenous variables were developed and projections made for the 1977 and 1978 crop years as a test of the model. Results indicate that the model made fairly accurate predictions of quantities and prices.

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Potatoes are the leading vegetable crop in West Texas in both acreage and value of production (16). Vegetable crops, such as potatoes, offer producers potentially higher returns on irrigated acreages than the more traditional crops of cotton, wheat and grain sorghum. However, potatoes and other vegetables are subject to wide variations in price from season to season as well as within the same season. For example, in 1963, West Texas potatoes sold for $2.12 per cwt., while in 1974 the price was $8.20 per cwt. or nearly 4 times as much (15). Such variation makes potato production a risky undertaking, because the farmer is not sure of the return he will achieve at the end of the season. Information about the structure of the potato market would be helpful to farmers if it could be used to help establish the level of prices and demand conditions prevailing in the market for next season at an early date.

The objective of this study is to estimate production and price relationships for West Texas potatoes and for the national spring and summer markets, so that a framework for projecting local prices and quantities could be established. The analysis is based on econometric models which provide a quantitative measure of the structural relationships in the local market and the corresponding segments of the national market.

Geographical Location of Potato Production

Potatoes are produced in each of the 48 Continental States and Alaska. However, the small acreage in Alaska is not reported with U.S. production. Thus, harvest occurs somewhere each month of the year, providing a continuous supply of fresh potatoes. The Statistical Reporting Service of the U.S.D.A. has classified potatoes by harvest season as a means of identification. Prior to 1956, potatoes were classified as early, intermediate and late, but in 1956, six harvest seasons were specified as follows (15):

Seasonal Category	Harvest Period
Winter	January 1 to March 31
Early spring	April 1 to May 15
Late spring	May 16 to June 30
Early summer	July 1 to August 15
Late summer	August 16 to September 30
Fall	October 1 to December 31

These seasonal categories were used until 1973, when the early and late designations were dropped and some shifting was made of production regions among seasonal categories. At present, there are four categories: winter, spring, summer and fall. Potatoes produced in the different seasons satisfy different markets, as explained below.

Fall potatoes account for most of the production. The acreage of fall potatoes has increased over time, and in 1976 the fall category supplied nearly 86 percent of the U.S. market (15, p.7). Production is concentrated in the northern tier of states which have cooler climates. Thus, fall potatoes are well suited for storage. Stored potatoes are sold for processing and compete in the fresh market until stocks are depleted sometime in April. Other uses include feed and seed stocks.

Winter season potatoes are produced in California and Florida. These are the so-called "new potatoes" and command a premium price when sold fresh, even though they account for less than one percent of total quantity supplied.

Spring season potatoes are produced in the southern tier of states and accounted for almost 7 percent of total production in 1976 (15, p. 7). These potatoes are sold for processing, seed and on the fresh market, where they compete with stored potatoes in the early part of the season and with summer potatoes later on.

Summer potatoes are produced in the middle tier of states and are about equal to spring potatoes in terms of volume. However, the majority of the summer crop is sold fresh, since these and late maturing spring potatoes constitute the supply during the summer.

In 1976, 9,600 acres of potatoes yielding 2,352 thousand cwt. were harvested in West Texas during the early summer season. This volume was valued at 12.2 million dollars (15, p. 7) and represented about 20 percent of the national production during the early summer season. Acres planted in the early summer and in West Texas have both declined since 1967, but market share for West Texas has been relatively stable. Thus, the West Texas region represents an important segment of the market for several weeks during the summer season.

International trade in potatoes between the U.S. and other nations is limited. In 1975-76, the U.S. exported about 3 percent of its production and 50 percent of that went to Canada. Europe imported 40 percent. Imports of potatoes came only from Canada in 1975-76 and were equal to about six percent of total exports, most of which were certified seed (13, p. 185). Although international trade data are not classified with respect to seasonal category, potatoes traded are probably harvested during the fall season because of the storage properties of that particular commodity.

Potatoes produced during the early summer season are shipped to major markets throughout the U.S. However, those produced in West Texas go primarily to markets in the Mid-west and East, such as Chicago, St. Louis, Memphis, Atlanta, Washington, D.C., Philadelphia and New York City. Early summer potatoes produced in California are shipped primarily to western markets and to the East Coast as well. Potatoes produced on the Delmarva Peninsula are shipped to points on the East Coast.

Thus, the national market is actually a group of markets separated by seasonal and regional differences. The regional markets are affected by production in other regions during the same season and by the overlapping of production from other seasonal categories at the beginning and end of each season. Market prices are affected by transportation costs between production and consumption regions as well as by differences in variety, size and quality of potatoes produced. Therefore, prices vary among producers within production areas as well as among seasonal categories.

In keeping with the objective of the study, the scope of the analysis was limited to consideration of the U.S. spring and summer potato markets with particular emphasis on West Texas. These markets deal almost completely in fresh potatoes. As Hee (8, p. 7) notes potatoes produced during the spring and summer have very short shelf lives (2-3 weeks) and do not store well, making them a perishable commodity. Thus, the marketing alternatives of producers are limited. Price fluctuates in relation to general availability and quality of the products on the market at any given time and will change when fresh market conditions change. Since producers have very little, if any, control over such conditions, they can be classified as price takers in the market. This position makes reliable price information essential.

<u>Analytical Model</u>

The model formulated to estimate price and production relationships for warm season potatoes has four major components: the West Texas market, the U.S. spring market, the U.S. early summer market and the U.S. late summer market. West Texas potatoes are classified as early summer and compete directly in that seasonal slot with production from other areas of the country. Components for spring and late summer were included to account for the overlap between these seasonal categories and early summer. Because of the overlap, potatoes classified by USDA as spring may be harvested relatively late and sold at a time when early summer potatoes are being marketed, or vice versa. To the extent that this cross-seasonality occurs in marketing, production from adjacent seasons affects price for a particular seasonal category. Since the USDA does not publish data that can be used to adjust for this behavior, three seasonal categories are used in the model.

The seasonal categories are based on the pre-1973 classifications rather than the new classifications because of the difficulty of adjusting the data to conform to the new standards. After consulting with USDA personnel in Washington, the following states were considered early summer: Alabama, California, Delaware, Maryland, North Carolina, Tennessee, Texas and Virginia. The following states were considered to be late summer: California, Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Nebraska, New Jersey, New Mexico, North Carolina, Ohio and West Virginia. Because California and North Carolina appear in both the early and late seasons, the following procedure was used to separate their acreage and quantity sold with the average price used for both seasons. For early summer, 56.55 percent of California's and 34.77 percent of North Carolina's totals were used. For late summer, 43.45 percent of California's and 65.23 percent of North Carolina's totals were used. These percentages were based on the averages for 1960-1971.

The model was specified with separate utilization and production relations for each of the four components. Thus, a simultaneous system of eight equations and four identities was used in the estimation process. Simultaneous determination of prices and quantities was assumed to reflect the interdependency of the West Texas and U.S. early summer markets and the cross-seasonal marketing among the three national categories.

Annual time series data for the period 1960 to 1976 were used in the estimation. Because the error terms across equations were more than likely contemporaneously correlated through the use of time series data and the model specification, three-stage least squares was chosen as the estimation process. The equations were specified as linear additive relations containing the following variables:

Production relations

$$\hat{Q}tx = f\ (APtx,\ \hat{P}es,\ IVP) \qquad (1)$$

$$\hat{Q}es = f\ (APes,\ \hat{Q}s,\ \hat{P}s,\ IVP) \qquad (2)$$

$$\hat{Q}ls = f\ (APls,\ \hat{Q}es,\ IVP,\ \hat{P}ls) \qquad (3)$$

$$\hat{Q}s = f\ (APs,\ \hat{Q}es,\ \hat{P}s,\ IVP,\ \%FM) \qquad (4)$$

Utilization equations

$$\hat{P}tx = f\ (Q\hat{P}Ctx,\ \hat{P}es) \qquad (5)$$

$$\hat{P}es = f\ (Q\hat{P}Ces,\ \hat{P}s) \qquad (6)$$

$$\hat{P}ls = f\ (Q\hat{P}Cls,\ Pf,\ \hat{P}es) \qquad (7)$$

$$\hat{P}s = f\ (Q\hat{P}Cs,\ \hat{P}es,\ Pf\text{-}1) \qquad (8)$$

Identities

$$\hat{Q}PCtx = \hat{Q}tx/POP \qquad (9)$$

$$Q\hat{P}Ces = \hat{Q}es/POP \qquad (10)$$

$$Q\hat{P}Cls = \hat{Q}ls/POP \qquad (11)$$

$$Q\hat{P}Cs = \hat{Q}s/POP \qquad (12)$$

where the small letters tx, es, ls, s and f refer to the West Texas, early summer, late summer, spring and fall seasonal categories, respectively, and the capital letters are as follows:

QPC is the quantity per capita of potatoes sold from the various seasonal categories in pounds per person.

Q is the quantity of potatoes from the various seasonal categories in 1000 cwt.

POP is the U.S. population for the 48 states, July 1, in 100,000 persons.

P is the average farm price received for potatoes sold in the various seasonal categories in dollars per cwt.

AP is the acreage planted to potatoes in the various seasonal categories in 1000 acres.

IVP is the Index of Vegetable Production compiled by USDA for the previous year (1967 = 100).

%FM is the percent fresh market and indicates the percent of all potatoes sold in the U.S. the previous year that were used for table stocks.

Variables denoted by a circumflex (^) are endogenous, all others are exogenous.

The production relationships express quantity sold as the dependent variable. The factors assumed to affect quantity sold are given in Figure 1. Production minus on-farm use (feed, seed and food), skrinkage and spoilage or loss determines the physical quantity sold. As the diagram depicts, on-farm use and these other factors are affected by current potato prices, quantity of potatoes offered for sale from other seasonal categories or areas in competition with these potatoes, and weather. The factors which determine production are acres harvested and yield per acre. Yield varies directly with the quantity, type and price of inputs employed, production practices used and weather. The quantity and type of inputs used, as well as the production practices, are related to the current prices of the inputs and the price of potatoes as related to the prices of competing crops. Acres harvested are equal to acres planted less acres abandoned. Abandonment is not a constant, but fluctuates yearly with market price of potatoes and weather. In years when price is relatively low, abandonment increases substantially. Acres planted depend on expected income from potatoes, especially as it relates to expected income from other crops, and to some extent on the amount of land suitable for potato production and capacity of available specialized harvest equipment. These last two factors are tied to previous acreages.

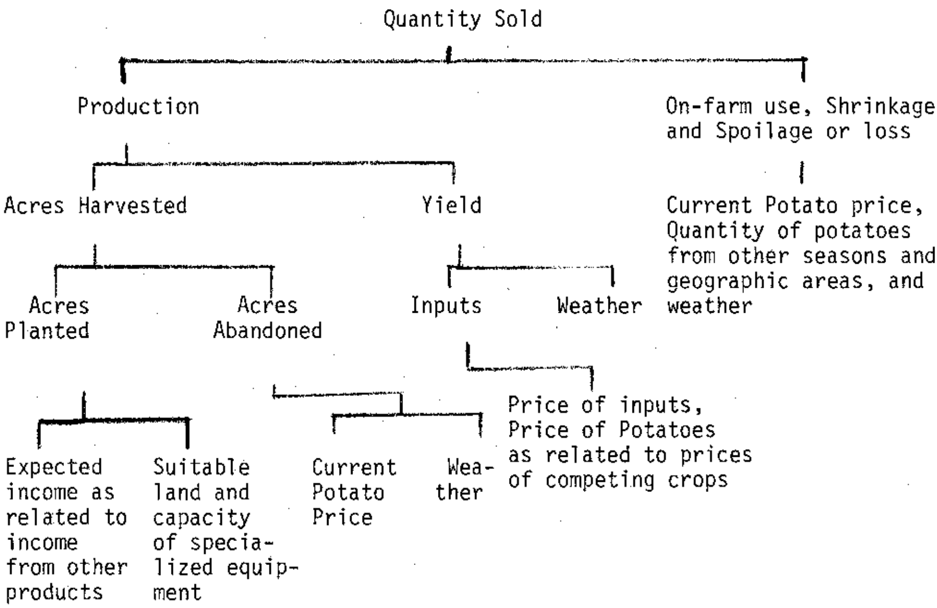

Figure 1. Schematic of factors that affect quantity of potatoes sold in the production relations.

The production relations chosen for this model express quantity sold as a function of acres planted, own potato price, and an index of vegetable production for the previous year. The index of vegetable production was used in an effort to capture the relative profitability of potatoes as related to the prices of competing crops. An increase in the index indicates more production of vegetables, hopefully in response to relatively higher vegetable prices. While the price of vegetables would have been a preferable variable as far as economic theory is concerned, to our knowledge no price index for vegetables is currently published. There are too many different vegetable crops to choose one or two and suggest their prices as the relevant ones for the model. The prices of inputs were left out of the model because of statistical difficulties. The data used are annual time series and unfortunately, input prices have increased rather steadily during the time span under consideration. This upward trend in input prices causes difficult estimation problems. Therefore, input prices were not included as a variable. The aggregative nature of the national early summer, late summer and spring potato production relations also dictated that a weather variable not be included. Geographic production is so dispersed as to make it extremely difficult to include weather in a meaningful way.

The West Texas price for potatoes should be closely related to the national early summer price. Discrepancies should be due to transportation charges for potatoes of the same size and quality. The national price was used in the equation because it was considered to be the one which ultimately affects quantity sold. As the national price increases, so will the West Texas price and thus the quantity offered for sale.

While information on competing crops in production could have been included in the production expressions it was omitted because of the lack of one or two good candidates. The vegetable crops tried (onions, carrots, lettuce) and the field crops added nothing to the power of the estimating equations; hence they were left out. The problem is worse for the national equations because of the potentially great number of crops.

The production equation for U.S. early summer potatoes expresses quantity sold as a function of acres planted, price, the index of vegetable production and the quantity sold in the U.S. spring season. The first three variables should be directly related to quantity sold in the early summer as discussed above. Quantity sold during the spring is included in this equation to account for the cross-seasonal effects of potatoes classified by USDA as spring being marketed in the early summer season. Potatoes produced for the three warm season markets, spring, early summer and late summer are essentially the same quality even though they are produced in different geographic locations. Also, they have the same general characteristics with respect to color, shape and eating quality, which makes them close, if not perfect substitutes. Therefore, many of the factors which affect spring production also might affect early summer production. If so, the coefficient of spring quantity should be positive.

The production relation for U.S. late summer potatoes was specified so quantity sold was related to acres planted, price, the index of vegetable production, and the quantity sold in the U.S. early summer season. As such it is analagous to the equation just presented.

The U.S. spring production equation expressed quantity sold as a function of acres planted, price, the index of vegetable production, the quantity sold in the U.S. early summer category and the percent of last year's production that was sold as table stocks or as fresh market potatoes. This last variable was included with spring production since these potatoes compete directly in the market with potatoes from the winter season and with stored potatoes from the fall season for fresh sales. Since stored potatoes are a direct substitute for fresh spring potatoes, the greater the percent sold fresh, as opposed to processed, the fewer spring potatoes will be sold fresh. Thus, its sign should be negative.

Equations 5 through 8 are consumption relations and express farm price received for potatoes as a function of quantity sold per capita and prices of potatoes from other seasonal groups. Income was not included as a variable in these expressions because previous work (8, p. 24) found consumption to be independent of income. George and King (4, p. 70) estimated the income elasticity of demand for potatoes to be .008 while Brandow (1, p. 17) reported the income elasticity for potatoes and sweet potatoes to be .08. To our knowledge these elasticity estimates were not tested for statistical significance. The elasticity estimates are low enough that income might not be significant in its effect on price, or statistically significant either, thus it was omitted. Hee (8) also found no good substitute commodities in consumption for potatoes, therefore none were used in this study. The prices of substitute potatoes used in the equations were for those seasons that compete at the same time in the market as the potatoes of interest. Seasonal markets are defined by USDA on the basis of when most potatoes from that season are usually harvested. Actual harvest dates will both precede and follow the period of most active harvest. Thus, potatoes harvested from adjacent seasons such as spring and early summer will be on the market at the same time and will be substitutes. Consumption equations were specified at the farm level because the identity of seasonal groups is maintained only at this level; retail data are not reported in this manner.

The identities, equations 9 through 12, define quantity per capita as the ratio of quantity sold and population and were needed to tie the consumption and production expressions together.

Findings

The estimates of the parameters of the system are presented in Table 1. The coefficients of the production relations had the expected signs and nine were twice the size of their standard errors which will be used here as a rough measure of significance since t statistics are not exactly valid for three-stage least squares, but Monte Carlo evidence suggests the distortion is usually small (3, p. 109). The index of vegetable production (IVP) and percent fresh market (%FM) did not perform well, as indicated by the relative size of their standard errors in equations 1, 3 and 4. For the consumption equations the coefficients had the expected signs, but the quantity per capita variables had relatively large standard errors.

The reduced form of the system was obtained after the identities were linearized (9, pp. 120-121). The reduced form is needed to estimate the values of individual endogenous variables and is presented in Table 2.

Table 1. Stage Three Estimates of the Structural Equations

- - - - - - - - - - - - - - Production Relations - - - - - - - - - - - -

(1) $$\hat{Q}tx = -988.6 + \underset{(13.37)^{a/}}{172.8\ APtx} + \underset{(37.71)}{136.4\ \hat{P}es} + \underset{(11.28)}{5.99\ IVP}$$

(2) $$\hat{Q}es = -28640 + \underset{(30.69)}{183.9\ APes} + \underset{(0.06365)}{0.1748\ \hat{Q}s} + \underset{(129.6)}{293.1\ \hat{P}es} + \underset{(33.03)}{197.5\ IVP}$$

(3) $$\hat{Q}es = -10080 + \underset{(18.49)}{143.6\ APls} + \underset{(0.1424)}{0.277\ \hat{Q}es} + \underset{(57.68)}{97.93\ IVP} + \underset{(245.6)}{14.81\ \hat{P}ls}$$

(4) $$\hat{Q}s = -6670 + \underset{(19.75)}{138.6\ APs} + \underset{(0.2415)}{0.5001\ \hat{Q}es} + \underset{(223.2)}{21.55\ \hat{P}s} + \underset{(93.6)}{107.3\ IVP} - \underset{(40.57)}{51.94\ \%FM}$$

- - - - - - - - - - - - - - Utilization Equations - - - - - - - - - - - -

(5) $$\hat{P}tx = 0.8171 - \underset{(0.3919)}{0.2938\ \hat{Q}PCtx} + \underset{(0.09296)}{1.034\ \hat{P}es}$$

(6) $$\hat{P}es = -0.1804 - \underset{(0.1507)}{0.04944\ Q\hat{P}Ces} + \underset{(0.102)}{1.146\ \hat{P}s}$$

(7) $$\hat{P}ls = 1.057 - \underset{(0.034)}{0.04288\ Q\hat{P}Cls} + \underset{(0.1128)}{0.4971\ Pf} + \underset{(0.07065)}{0.2377\ \hat{P}es}$$

(8) $$\hat{P}s = 0.8517 - \underset{(0.04255)}{0.03575\ Q\hat{P}Cs} + \underset{(0.07305)}{0.681\ \hat{P}es} + \underset{(0.08823)}{0.2845\ Pf\text{-}1}$$

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a/ Numbers is parentheses below the regression coefficients are standard errors. For a definition of the variables see page 7.

When historical data for 1960-1976 were used to test the model, the estimates of the endogenous variables were close to their actual values. The average percent error ranged from 3 to 8 percent for the quantity variables and from 8 to 15 percent for the price variables (Table 3). In this model, prices were not estimated with the same degree of precision as the quantities, but there was very little difference in the number of turning point errors (Table 4). A turning point error occurs when the actual change in a variable from one time period to the next is in the opposite direction from the change predicted with the model. The equation for quantity of late summer potatoes, Qls seemed to do the worst with six turning point errors while one equation had no errors for the 17 year period. The estimates did not seem to contain a systematic bias since the number of overestimation errors was about equal to the number of times the variables were underestimated (Table 4).

As a further test of the predictive accuracy of the reduced form equations, Theil's Inequality or U_2 Coefficients (11, p. 28) were computed. In this test, the relative magnitudes of the actual values of the variables and their estimates were used. The model yields an errorless forecast of the actual and estimated values of the variables are equal. In this case, Theil's Inequality Coefficient yields a value of zero. Perhaps the most naive forecast the model could make would be that if no change in the value of the variables from one time period to the next. In this case, the U_2 Coefficient yields a value of one. For the reduced form obtained in this study, the U_2 Coefficients range

Table 2. Reduced Form Equations for the Endogenous Variables.

Endogenous Variables	Constant Term	APtx IVP	APes %FM	APls Pf-1	APs POP	Pf
Qtx [a/]	243,403	172.8 -0.12037	-4.10983 0.821264	0 188.394	-2.19151 0.231099	0
Qes	30720.6	0 221.168	190.924 -7.80513	0 493.796	20.8277 0.600688	0
Qls	-18553.3	0 158.985	52.7632 -2.14014	143.554 141.599	5.71089 0.174588	7.3597
Qs	-21063.4	0 210.516	90.708 -54.7476	0 508.982	146.092 0.595519	0
Ptx	1.14262	0.0869009 -0.000060534	-0.00206683 0.000413013	0 0.0947431	-0.00110211 -0.000519962	0
Pes	-9.82567	0 0.111225	0.0960157 -0.00392519	0 0.248329	0.0104742 -0.00252606	0
Pls	-2.16344	0 0.0799534	0.0265345 -0.00107627	0.0721932 0.0712097	0.002872 -0.00351649	0.00370119
Ps	1.99727	0 0.105868	0.045617 -0.0275325	0 0.255966	0.0734695 -0.00603204	0

Table 2. (continued)

QPCtx	6.13047	-0.0255315	-0.0305479	0	-0.0162893	0
		-0.0463028	0.00610437	1.40031	0.00190464	
QPCes	5.46332	0	-0.0301307	0	-0.0160668	0
		-0.0447974	0.006021	1.38119	0.00169427	
QPCls	2.4484	0	-0.00829987	-0.00309565	-0.00394223	0.496941
		-0.0140768	0.00147734	0.325255	0.000553515	
QPCs	4.50082	0	-0.0221498	0	-0.013568	0
		-0.0342918	0.00508459	1.21594	0.00136944	

[a/] For a definition of the variables see page 7.

Table 3. Average Percent Error for Estimates of Endogenous Variables Using Historical Data for 1960-1976 in the Reduced Form Equations

Variable	Average Percent Error	Ranges of the Percent Errors
Qtx [a/]	7.80	0.15 - 25.01
Qes	3.57	0.09 - 8.19
Qls	4.03	0.16 - 9.38
Qs	2.87	0.08 - 7.04
Ptx	15.25	1.31 - 47.88
Pes	15.18	1.74 - 34.58
Pls	7.82	0.41 - 20.20
Ps	14.02	0.61 - 27.49

[a/] For a definition of the variables see page 7.

Table 4. Overestimation, Underestimation, and Turning Point Errors for Endogenous Variables

Endogenous Variables	Overestimation Errors	Underestimation Errors	Turning Point Errors
		number	
Qtx[a/]	6	11	5
Qes	7	10	4
Qls	7	10	6
Qs	9	8	0
Ptx	7	10	3
Pes	9	8	5
Pls	9	8	1
Ps	10	7	5

[a/] For a definition of the variables see page 7.

in value from .26 to .64 indicating that the model performs considerably better than a naive "no change" model (Table 5).

Model Predictions for 1977 and 1978

In order to use the reduced form equations for predictions for future time periods, the future values of the nine exogenous variables must be estimated. The estimating equations for these variables contained an additional four variables whose future values also were needed. Projections were available for one of these, thus 12 variables were estimated by ordinary least squares regression methods. The regression equations are presented in Table 6. The first six equations estimate acres of potatoes planted during the various seasonal categories and in West Texas as a function of last year's acreage planted and lagged price received for potatoes with the exception of fall which did not include lagged acres planted. In three of the equations, an extra variable was included. In the West Texas equation the extra variable was last year's grain sorghum price since grain sorghum seems to be the one major field crop common to all the potato producing counties in the area. In the spring category, acres planted to potatoes the preceding fall was used as an extra variable since fall storage potatoes seem to affect the spring crop.

The winter farm price received for potatoes was related to acres planted to winter potatoes and to the price received for last fall's crop since fall storage potatoes compete side by side with winter potatoes in the stores.

Table 5. Theil's Inequality Coefficients Computed for the Endogenous Variables.

Endogenous Variables	U_2 Coefficient[a]
Qtx[b]	.480
Qes	.321
Qls	.400
Qs	.255
Ptx	.636
Pes	.606
Pls	.394
Ps	.489

[a] The formula for the coefficient is $U_2 = \sqrt{\frac{\Sigma\ (\Delta E_t - \Delta A_t)^2}{\Sigma\ (\Delta A_t)^2}}$

where A_t and E_t are the actual and estimated values of the coefficients in time t.

[b] For a definition of the variables see page 7.

Table 6. Ordinary Least Squares Equations for Predicting Endogenous Variables.

Exogenous Variable	Constant Term	Independent Variables	R^2	Durbin-Watson
APtx	5.646	0.720APtx-1, 1.814Ptx-1, -3.984GS (4.20)[a/] (3.69) (-4.16)	.73	*
APes	-8.324	1.043APes-1, 0.814Pes-1 (5.55) (0.78)	.83	2.28
APls	-10.338	0.991APls-1, 2.681Pls-1 (10.23) (1.32)	.93	2.18
APs	230.356	.7376APs-1, 1.624Ps-1, -0.188APf-1 (4.72) (0.63) (-3.75)	.81	2.77
APf	-109.859	38.848Pf-1, 13.459APw, 8.767IVP (3.76) (4.43) (4.67)	.74	2.02
Pw	1.850	-0.088APw, 1.695Pf-1 (-1.89) (9.68)	.94	2.80
Pf	1.689	-0.010APf, 0.015IEO, 0.052POP (-3.18) (1.31) (1.41)	.73	2.01
IEO	-6.653	1.088IEO-1, 0.367T (16.48) (0.98)	.99	1.50
IVP	60.855	0.330IVP-1, 0.554T (1.40) (2.17)	.81	2.02
APw	-1.785	0.934APw-1, 0.618Pw-1 (4.33) (1.22)	.65	1.67

Table 6. (continued)

Exogenous Variable	Constant Term	Independent Variables	R^2	Durbin-Watson
%FM	42.200	0.336%FM-1, -1.122T (1.32) (-2.29)	.95	2.17
POP	10.421	.958 POP-1 (296.54)	1.00	1.35

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a/ The figures in parentheses below the coefficients are Student's t values. All those which exceed 1.746 are significant at the .05 level of probability.

b/ For a definition of the variables see page 7. Those not defined there are:
- w -- Refers to the winter seasonal category for potatoes. Thus APw is acres planted in the winter season, Pw is the farm price received for winter season potatoes, etc.
- GS-- Last year's average price per cwt. for grain sorghum received by U.S. farmers (2).
- IEO- An index of eating out constructed from data on food consumption away from home (1967=100).
- T -- A time variable with 1960 = 1, 1962 = 2, ...

* The first time this equation was estimated, the Durbin-Watson Statistic indicated the presence of positive autocorrelation. The autocorrelation coefficient was estimated by first difference methods to be 0.50 and the equation was reestimated. The adjusted coefficients are presented here.

The fall potato price was expressed as a function of acres planted during the fall season, the index of eating out since many fall potatoes are processed into products used by eating establishments such as chips and frozen french fries, and population.

The index of eating out was projected because it was needed in the preceding equation. It was simply related to last year's index and time, as were the index of vegetable production and percent fresh market. Population was projected as a function of last year's population.

Once the estimating equations were obtained for the exogenous variables, future values for the variables were generated from them for the 1977 and 1978 crop years. The projections were used in the reduced form equations to obtain estimates of the values of the quantities and prices of potatoes for the various seasonal categories for 1977 and 1978 as a test of the model. The quantity projections fit better than the prices, although the quantity projections for the early summer season were too high (Table 7). The 1977 and 1978 prices were more in line with the projections than the 1976 prices. In 1976, an early eastern crop caused abnormally low prices (17, p. 11) which the model did not project. (The actual and estimated prices for 1960 through 1976 are contained in the appendix.) The price projections from the model for 1978 were fairly close to the actual values, with the exception of West Texas. In 1977 and 1978 the actual price differential between West Texas and the early summer market seemed wider than usual. Thus, the model underestimated the West Texas price for these years, although it closely estimated the early summer price. Acres planted were underestimated for

Table 7. Actual and Estimated Values of Acres Planted, Quantity Sold and Prices of Potatoes, Selected Seasons, 1977 and 1978.

Season	Acres Planted		Quantity Sold		Price	
	Actual	Estimated	Actual	Estimated	Actual	Estimated
	----1000 acres----		-----1000 cwt.----		--dollars per cwt.--	
			1977			
Spring	92.8	94.0	22343	21677	6.23	5.41
Early Summer	53.8	64.1	7384	9377	5.40	5.81
Late Summer	54.4	56.9	10858	11035	3.93	4.32
West Texas	10.5	7.4	2282	1717	6.98	6.60
			1978			
Spring	93.4	88.1	17507	21538	7.07	6.52
Early Summer	53.2	63.5	7224	9811	7.01	7.07
Late Summer	50.5	57.6	10440	11357	4.68	4.52
West Texas	11.2	9.4	2225	2241	8.56	7.83

West Texas for both 1977 and 1978, but 1978 quantity was very close, which suggests an abnormally low yield in 1978 for the region. This may also explain the relatively high 1978 West Texas price, since the production from the region is generally the main fresh market quantity available in the U.S. for a short time during the summer.

The early summer acres planted estimating equation did not perform as well as it could have. Early summer acreages planted were overestimated by 10 thousand acres for both 1977 and 1978, which affected the quantity sold projections. The remaining equations in the model were more accurate.

Summary and Conclusions

Potatoes are an important vegetable crop to producers in West Texas, as more acres are grown than any other vegetable. However, prices are unstable and cause expected returns from potatoes to be difficult to estimate.

In this paper, production and utilization relations were obtained for West Texas potatoes and for the national spring, early summer, and late summer markets so a framework for projecting local prices and quantities could be established. Prices and production in all three of the national markets were found to influence the local market for potatoes.

The functions were estimated from time series data for the years 1960-1976 using 8 stochastic and 4 identity equations in a simultaneous system using three-stage least squares. A set of linear equations was specified for the West Texas market and each of the three national markets mentioned earlier. The reduced form was obtained from the structural equations and was used to make ex post estimates of potato prices and quantities with the data. These fit closely with very few turning point errors and a balance between overestimation or underestimation errors. Thus, the simultaneous model was deemed good enough to use as a basis for projections.

The exogenous variables in the system were projected for the 1977 and 1978 crop years with single equation ordinary least squares models. These projection values were fed into the simultaneous equation model to generate future values for prices and quantities of potatoes for each market for those years as a test of the predictive accuracy of the model. The price and quantity projections seemed consistent with past trends in the data and indicated that the model performed fairly well except for the early summer acres planted equation, which might perform better if respecified. If recent trends continue and the proportion of potatoes consumed fresh continues to decrease, projections for West Texas for more distant time periods could be expected to show a leveling off, if not a decline in quantity produced, if the same forces remain at work in the market.

With the expected continued increase in consumption of processed potatoes relative to fresh, fall production should increase relative to the remaining seasonal categories. Another factor which tends to favor the fall season is the increased level of stored potatoes and the longer storage time which allows these potatoes to compete for longer periods of time in the spring market. One way the spring and summer periods could remain at present levels or possibly even increase, would be through the development and adaptation of a potato variety that can be easily processed and stored under present conditions in those regions.

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APPENDIX

Appendix Table. Actual and Estimated Values of the Endogenous Variables, 1960-1976.

	Qtx[a/]		Qes		Qls		Qs	
	----- 1000 cwt. -----							
Year	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated
1960	1874	1849	12467	12700	19658	19474	28503	28829
1961	2161	2036	13316	13106	20389	19764	30884	29511
1962	1843	1668	10713	11368	15894	16484	23764	24971
1963	1967	1857	10801	11156	14734	15456	27006	26198
1964	2151	1898	9934	9764	13586	14657	23451	23087
1965	2023	2271	10347	10748	15245	14648	29063	28680
1966	3313	3248	12566	12324	14102	14918	29157	29179
1967	3250	3396	12804	12324	14761	14626	25768	27582
1968	3467	3319	12916	12099	15318	14631	24832	24484
1969	3404	3399	12478	13236	14282	14836	26362	26723
1970	3428	3265	12079	11696	14284	13743	25237	23869
1971	2299	2874	10525	10875	13033	13012	23033	23621
1972	2262	2597	9819	9317	12088	11272	20431	20709
1973	2833	2437	9957	9562	10027	10968	20689	21824
1974	2151	2435	11299	11289	12256	11960	23730	23686
1975	2071	1999	8108	8772	11367	10688	19501	19873
1976	2266	2274	9965	9938	11250	11305	24183	22857

[a/] For a definition of the variables see page 7.

Appendix Table. (continued)

	Ptx		Pes		Pls		Ps	
	---dollars per cwt.---							
Year	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated
1960	3.08	2.92	2.26	2.33	2.27	2.06	2.65	2.49
1961	2.15	2.30	1.72	1.75	1.53	1.63	1.78	1.99
1962	3.06	2.18	2.16	1.58	1.98	1.58	2.48	1.80
1963	2.12	2.50	2.02	1.91	2.17	2.00	1.91	2.08
1964	2.93	3.33	3.37	2.72	2.90	3.13	3.68	2.75
1965	4.65	5.51	4.04	4.87	2.66	2.93	4.74	4.65
1966	2.39	2.94	2.06	2.52	2.33	2.31	2.18	2.63
1967	3.40	2.95	2.85	2.55	2.08	2.19	2.35	2.65
1968	3.00	2.90	2.66	2.48	2.18	2.37	3.10	2.59
1969	3.34	3.19	2.67	2.77	2.45	2.46	2.64	2.86
1970	3.82	3.77	3.44	3.31	2.68	2.53	3.28	3.30
1971	3.00	3.75	2.61	3.23	2.26	2.43	2.51	3.20
1972	4.70	3.97	2.89	3.40	3.18	3.11	2.93	3.32
1973	7.40	5.74	7.78	5.09	4.83	4.38	6.05	4.80
1974	8.20	8.05	6.06	7.32	4.21	4.35	6.08	6.77
1975	7.90	7.12	6.80	6.36	4.92	4.47	6.15	5.88
1976	5.20	7.69	5.31	6.94	3.50	4.15	5.30	6.41