FORECASTING FUTURE PRICE TRENDS IN THE U.S. FRESH AND PROCESSED POTATO MARKET

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A "demand" model for fresh and processed potatoes is formulated. The price forecasts for 1983-1992 suggest rising trends for both retail prices in both nominal and real terms. In the next ten years, nominal fresh and processed prices are predicted to increase by 106 percent and 72 percent, respectively.

PROBLEM STATEMENT

The most striking feature of recent U.S. potato demand has been the opposite trends fresh and processed per capita consumption have taken over the past two decades. Fresh per capita consumption declined from 83.2 pounds in 1960 to 55.8 pounds in 1980. In contrast, processed per capita consumption increased rapidly from 25.4 pounds in 1960 to 65.3 pounds in 1979. A possible explanation of these contrasting trends is the increasing demand for convenience foods. Growth in consumption of frozen and other processed potatoes is directly linked to the expansion of fast-food outlets. In addition, nominal and real prices for both products have shown increases, with processed potato prices, in particular, experiencing a sharp rise since 1973. This real price relationship would also be consistent with the rising demand for convenience foods.

OBJECTIVES

The objectives of this paper are three-fold. The first objective is to analyze the significance of the demand for convenience foods in explaining retail potato price patterns relative to other traditional determinants, such as consumption and income. It is hypothesized that the growing number of women in the labor force is an important factor contributing to this increase in processed demand as a result of a labor-leisure tradeoff. Second, an econometric model is developed to forecast fresh and processed potato retail prices from 1983 to 1992.

METHODOLOGY

Conventional demand theory using the price dependent inverse demand approach states that the price of a commodity is determined by per capita consumption of

the commodity, the price(s) or per capita consumption of substitutes and/or complements, consumers' per capita income, and any taste change. Per capita consumption of potatoes and the price of any complement should vary inversely with the price of potatoes, while price(s) of substitutes and income, assuming the good is normal, will have a positive relationship with potato price. Labor-leisure tradeoffs can be either positively or negatively related to potato price and include the labor supply function as an integral component of demand.

The functional form for both fresh and processed potato retail price equations can be written as:[1]

$$\text{FRESHCPI} = f(\text{FRESHC}, \text{FROZCPI}, \text{CAPY}, \text{WLF}) \quad \text{and} \quad \text{FROZCPI} = f(\text{PROCC}, \text{FRESHCPI}, \text{CAPY}, \text{WLF}) \tag{1.1}$$

where

FRESHC = per capita consumption of fresh potatoes in year t

PROCC = per capita consumption of processed potatoes in year t

FRESHCPI = retail price index of fresh potatoes in year t (1967=1.0)

FROZCPI = retail price index of frozen french fried potatoes in year t (1967=1.0)

CAPY = per capita expenditures on non-durables and services in year t

WLF = percentage of women in the labor force in year t.

A composite retail price index for total processed potatoes is not available. Therefore, the retail CPI for frozen french fires serves as a proxy. This proxy is a reasonable substitute since frozen potato consumption accounts for the largest share of total processed potato consumption (about 44 percent over the period 1960-1976). Unfortunately, this index was not compiled after 1976. Therefore, the data were spliced with the retail price index for total processed vegetables to obtain a longer series using percentage changes. A comparison between percent changes for both indices over a similar period suggests this is a reasonable method to extend the series.

Percentage of women in the labor force represents the labor-leisure tradeoff factor (Estes). The hypothesis is that as more women enter the labor force, the less time they have to prepare meals for themselves and/or their families and the greater will be their preference for convenience foods such as a processed potato at the expense of unprepared foods like fresh potatoes. Therefore, this variable should have a positive coefficient in the processed price demand equation and a negative coefficient in the fresh price demand equation.

EMPIRICAL RESULTS

The price forecasting equations (1.1) for fresh and processed potatoes were estimated over the period 1960-1980 by Indirect Least Squares (ILS) since processed price was an explanatory variable in the fresh potato equation and vice versa and the system is exactly identified by the order condition.

The estimated reduced form equations are shown in Table 1. All coefficients for both fresh and processed potato demand have signs consistent with a priori expectations. The R^2 statistic for the fresh and processed reduced form equations are 0.90 and 0.93, respectively.[2] The derived own price flexibilities of demand for fresh and processed potatoes are -2.32 and -0.53, respectively.[3] The income flexibilities for fresh and processed potatoes are 0.76 and 0.69, respectively.

Before one can determine whether or not these retail price patterns mentioned earlier will continue in the future, the model must be tested for forecasting reliability. Table 2 presents some within sample (1960-1980) evaluation statistics. There are numerous goodness-of-fit measures for evaluating forecasts (see Tomek and Robinson). Two commonly used measures are the mean absolute percentage error and Theil's inequality coefficient (U_2). The

TABLE 1. COEFFICIENTS FROM REDUCED FORM[1]

	INTERCEPT	PROCC	FRESHC	CAPY	WLF	R2
FRESHCPI	13.054	-0.014[2] (-0.61)[3] [-2.42]	-0.056 (-3.25) [-0.50]	0.673 (1.98) [1.44]	-0.259 (-1.04) [6.61]	0.90
FROZCPI	0.640	-0.015 (-1.07) [-0.11]	-0.002 (-0.24) [-0.56]	0.337 (1.64) [0.76]	0.016 (0.12) [0.44]	0.93

[1]Method of estimation was Indirect Least Squares.

[2]Numbers in parentheses are t-statistics.

[3]Numbers in brackets are reduced form flexibilities.

TABLE 2. INTRASAMPLE EVALUATION STATISTICS (1960-1980)

Dependent Variable	Mean	Mean Absolute Percentage Error	Theil's Inequality Coefficient
FRESHCPI	1.4355	9.96	0.63
FROZCPI	1.3623	5.48	0.88

mean absolute percentage errors for within sample prediction are less than 10 percent for both fresh and processed potato prices. The Theil U_2 coefficient (see Theil and Leuthold) has a lower bound of zero implying perfect forecasts. A U_2 value of 1 indicates that forecasts are no better than the naive no-change extrapolation. Values larger than unity for Theil's U_2 coefficient implies that the forecasting model is less accurate than no-change extrapolations. Both fresh and processed price forecasts have values between zero and one. These statistics indicate that the model tracks both prices well within the sample period.

A robustness test is one way to assess the forecasting ability of the two demand equations. This test essentially compares forecasts from these equations beyond the sample period with actual values. Table 3 shows the comparison between actual and forecasted retail prices for 1981 and 1982. Other than the 1982 retail fresh potato price forecast, the forecast errors are less than six percent.

Several factors may account for the relatively large forecast error in

TABLE 3. OUT OF SAMPLE ROBUSTNESS TEST FOR 1981-1982

	Actual	Predicted	Absolute % Error
Index			
FRESHCPI			
1981	3.500	3.300	5.71
1982	2.963	3.430	15.76
FROZCPI			
1981	2.603	2.621	0.69
1982	2.857	2.770	3.05

predicting the 1982 retail price for fresh potatoes. First, fresh consumption in 1982 was probably lower than what would be "normal" given the sizes of the previous years' crops. Higher fresh consumption, in turn, would have reduced the predicted value of the retail price and decreased the percentage error from the actual price. Second, the influence of marketing costs are largely uncaptured in the model. In 1982, the estimated farm to retail spread declined 11 percent for round white potatoes and fell 26 percent for Russets. These declines could account for some of the disparity between the actual and predicted value of the 1982 retail price index for fresh potatoes.

Some assumptions are necessary for a price forecasting model to predict successfully. First, the model must reflect the economic behavior of consumers. The earlier disucssion of performance statistics partially confirms this assumption. Additionally, as Lucas notes, the behavior captured by the model must continue in the future. This assumption is weakened as the forecasting time horizon lengthens. Finally, a number of exogenous factors need to be given future values for forecasting. This is usually done either by assuming recent past trends continuing in the future or by using projections by other analysts. In our model, per capita consumption expenditures were taken from an econometric forecasting firm's baseline forecasts. The women in the labor force variable was taken from Department of Labor forecasts and potato consumption forecasts were taken from one of the author's ERS 10-year baseline assessments. Thus, a cautionary note is warranted in interpreting model projections. These projections are ideally viewed as another piece of evidence in an analyst's information set based on explicit assumptions. Assumptions for the exogenous values used to forecast fresh and processed consumption for 1983-1992 are shown in Table 4.

The potato price forecasts for 1983-1992 are shown in Table 5, The nominal fresh potato price index is predicted to rise from 3,331 in 1983 to 6.871 in 1992 (an increase of 106 percent). This doubling of prices may appear somewhat steep, However, one should keep in mind that prices also doubled from 1971 to 1980 (from 1,173 to 2.558). The nominal processed potato price index is forecasted

Table 4. Assumptions Used for Forecasting Retail Prices of Potatoes

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
FRESCHC[1]	50.1	50.3	50.0	49.7	49.4	49.0	48.7	48.4	48.1	47.7
PROCC[1]	65.6	66.0	66.3	66.6	66.9	67.3	67.6	67.9	68.2	68.6
CAPY[2]	7.629	8.547	9.352	10.149	10.702	11.567	12.148	12.453	13.037	13.721
WLF[3]	43.160	43.660	44.160	44.480	44.481	43.130	43.450	45.770	45.960	46.030
DEF[4]	2.202	2.343	2.515	2.741	2.862	3.070	3.035	3.296	3.433	3.575

[1]Estimates for 1893-1992 taken from Michael Stelmacher's 10-year baseline analysis - ERS, USDA (pounds per capita).

[2]Estimates for CAPY were taken from a private consulting firm's forecasts (per capita terms).

[3]For the 1983-1992, forecasts were taken from Bureau of Labor Statistics estimates.

[4]Implicit price deflator for nondurable goods and services (1972=1.0) taken from a private forecasting firm's 10-year forecasts.

TABLE 5. DEMAND MODEL FORECASTS, 1983-1992

	NOMINAL PRICES		REAL PRICES[1]	
	FRESHCPI	FROZCPI	FRESHCPI	FROZCPI
	----------Index----------		----------Index----------	
1983	3.331	2.836	1.513	1.288
1984	3.857	3.147	1.646	1.343
1985	4.302	3.422	1.711	1.361
1986	4.774	3.691	1.742	1.347
1987	5.081	3.879	1.775	1.355
1988	5.605	4.170	1.826	1.358
1989	5.933	4.367	1.955	1.439
1990	6.074	4.471	1.843	1.356
1991	6.438	4.667	1.875	1.359
1992	6.871	4.895	1.922	1.369

[1]Nominal prices deflated by DEF.

to increase from 2.836 in 1983 to 4.895 in 1992. This 72 percent increase in processed potato price is also similar to the increase in processed price from 1971 to 1980 (the price index rose from 1.101 to 2.251 - an increase of 104 percent).

SUMMARY AND IMPLICATIONS

The economic model suggests the demand for convenience foods induced by labor-leisure decisions plays an important role in explaining current U.S. potato price patterns, especially for fresh potatoes. This labor-leisure factor will continue to play a role in determining potato demand, but its long run influence is uncertain. It is reasonable to assume the percentage of women in the labor force will stabilize over time. This stability will tend to moderate increases in the demand for convenience foods and cause processed price to rise less rapidly and fresh price to increase somewhat more, ceteris paribus. This direction was reflected in the forecasts from our model. There are other demographic features that should ideally be accounted for in the long run - namely household size and the age-sex composition of the population.

The prospect of a stable pattern of total U.S. per capita potato consumption does not necessarily mean the U.S. potato industry cannot expand by finding new demand channels. The relationship found in the U.S. between processed potato demand relations and the demand for convenience foods could also be translated into overseas markets. Indications are that this is already

occurring in developed countries. The demand for dehydrated and frozen potatoes "is being generated by the rapid acceptance of U.S.-style snack foods and the institutional outlets for marketing them"[4], particularly in Japan and Europe. Developing countries also may prove to be excellent export markets for the U.S. potato industry to develop. Many of these countries have rising real incomes, an increasing desire for leisure time, and are adopting current western culture which encourages women to compete with men in the labor market.

NOTES

[1]Fresh and processed potato consumption and retail price data are found in Vegetable Situation, U.S. Department of Agriculture, Economic Research Service (various issues). Data for CAPY and WLF were taken from Monthly Labor Review, U.S. Department of Labor, Bureau of Labor Statistics, (various issues).

For this price forecasting model, we assume that production and, hence, consumption are fixed. Inventories and net exports currently play a small enough role in the potato market to make this assumption reasonable.

[2]The R^2 statistic is the coefficient of determination adjusted for degrees of freedom. An R^2 statistic equal to 0.90 implies that the independent variables in a regression equation explains 90 percent of the variation in the dependent variable (adjusting for degrees of freedom).

[3]The price flexibility coefficient represents the percentage change in price associated with a one percent change in quantity, other factors constant. The estimated flexibility of demand for fresh potatoes is -2.32 which implies that a one percent increase (decrease) in quantity demanded yields a 2.32 percent decrease (increase) in fresh potato price. Another commonly used flexibility measure is income flexibility, which measures the percentage change in price associated with a one percent change in income, other factors constant.

[4]See Powell, Jules V. "Marketing Outlook for Potatoes", speech presented at the United Fresh Fruit and Vegetable Association Meeting, Las Vegas, Nevada, February, 1980.

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