The Influence of Microwave Ovens

On the Demand for Fresh and Frozen Potatoes*

by

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Abstract

Growth in the number of homes with microwave ovens has changed food preferences and preparation methods. The objective of this study was to determine the impact that microwave oven ownership has had on the demand for fresh and frozen potatoes. Using data from the 1970-88 period, demand equations were estimated for fresh potatoes, frozen potatoes in the retail market and frozen potatoes in the food service market.

Results indicate that increases in the percentage of homes that own microwave ovens have shifted demand outward for fresh potatoes but inward for frozen potatoes. If potato processors can develop a microwave frozen french fry that satisfies consumers, microwave ovens could boost the demand for frozen potatoes along with the increase in demand for fresh potatoes.

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*The views expressed are the views of the authors and do not necessarily represent the views or the policies of the USDA.

Introduction

A relatively new technology--the microwave oven--is dramatically changing the U.S. food industry. The microwave oven revolution is young. Figure 1 shows that as recently as 1979 less than ten percent of U.S. households owned microwave ovens. By the late 1980s about eight out of ten homes had microwave ovens. They are now almost as common as refrigerators.

Consumer food preferences and preparation habits are continually adapting to new technology. The speedy, easy-to-use microwave oven has helped fuel the expansion of demand for convenience in U.S. food products. Food manufacturers have responded by developing products specifically designed for the microwave.

Microwave popcorn, pizza and soup are some examples of this product development. Some firms have also tried to adapt products that are popular in fast food restaurants, such as hamburgers and french fries, to the microwave market. Although microwave french fry products are on the market, success has been very limited. The problem is that consumers prefer crispy, crunchy, firm french fries but the microwave french fry product is soggy. French fry processors are trying to develop a more crisp product, but no company has come up with the necessary breakthrough technology (Valentino, 1988).

Microwave ovens are also used as a faster alternative for preparing traditional foods that need no additional product development. A recent Good Housekeeping Institute poll found that 79 percent of microwave owners used them for preparing baked potatoes, 66 percent for frozen vegetables and 55 percent for bacon. Baking fresh potatoes was the top-rated use (Valentino, 1988).

Objectives

The purpose of the research was to gain insights into the impact that microwave ovens have on the demand for major potato products. The specific objectives were:

(1) To determine the impact of microwave oven ownership on the demand for fresh potatoes.

(2) To determine the impact of microwave oven ownership on the demand for frozen potatoes in the retail market.

(3) To determine the impact of microwave oven ownership on the demand for frozen potatoes in the food service market.

The third objective deals with an away-from-home market but was included in order to determine the impact of microwave ovens on the entire frozen potato market. It was hypothesized that consumers would substitute consumption of microwave-prepared fresh potatoes for frozen potato products in both the retail and food service markets.

Methods

Although research has been conducted on the suitability of potato varieties for baking in microwave ovens (True, et al., 1989), the influence of microwave oven ownership on overall potato demand has not been investigated. Other researchers (Cardwell and Davis, 1980; Guenthner, 1987; and Jones and Ward, 1989) have estimated demand functions for potato products but none included microwave oven ownership as an explanatory variable. The methods used to estimate the demand functions in this study are discussed below.

Data Considerations

Annual data for the 1970-88 period were used to estimate the demand equations. The U.S. Department of Agriculture (USDA) provides data on consumption of potatoes by product type but not on amounts sold in the retail and food service markets. A private firm, Nielsen Marketing Research, was the source of retail frozen potato volume and prices. Food service quantity data was estimated by subtracting the Nielsen retail quantities from USDA estimates of total consumption of frozen potatoes. Fresh potatoes were not segmented into retail and food service sectors due to data limitations.

FIGURE 1
Microwave Oven Ownership
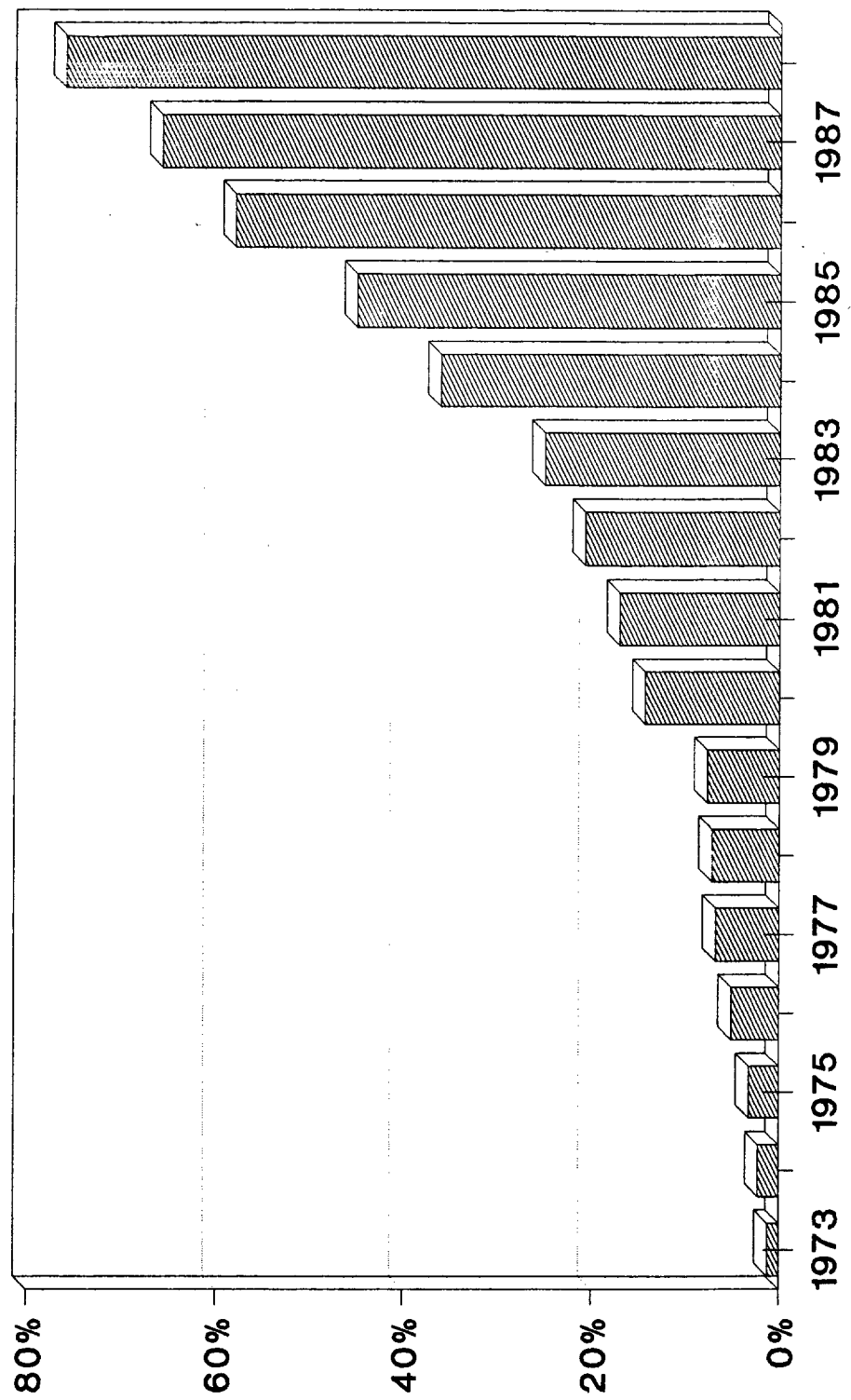
Source: U.S. Department of Commerce

Price data for frozen potatoes in the food service market were not available. Interviews with industry executives indicated that nonprice variables may be more important than prices in the food service market for three reasons. First, many restaurants fix their potato product prices for long periods. Second, many restaurants do not list a separate menu price for potato products but include them in meal packages. Third, the food service market includes schools, hospitals, nursing homes, prisons, and military bases where clientele are not directly charged a price for potato products.

Public sources were used to obtain most of the data for the explanatory variables. The U.S. Department of Commerce was the source for data on population, consumer price index, consumer income, the hamburger price index, the percentage of females in the labor force, the percentage of homes with microwave ovens, and restaurant sales.

Advertising data were purchased from Leading National Advertisers for two types of potato advertising expenditures: generic and frozen. The generic advertising included expenditures by the Potato Board, the Idaho Potato Commission, the Washington Potato Commission, and other state potato associations. Although retail food stores frequently feature fresh potatoes in newspaper ads, a fresh potato advertising data series was not found.

Explanatory Variables

Economic theory suggests that the demand for a product is influenced by own-price, prices of other products, consumer income, consumer tastes and preferences, and population. Explanatory variables were selected to capture the influence of these factors on the demand for fresh and frozen potatoes.

Own-prices were used as explanatory variables for two of the three potato market components. Prices were not included in the food service markets for frozen products for reasons given earlier. Prices of both substitutes and complements were included in the models. The two potato products were considered substitutes for

each other. Hamburger was treated as a complement to frozen potatoes since a traditional American meal is hamburger and french fries. According to economic theory, an increase in the price of hamburger should cause a decrease in the demand for hamburger and frozen french fries simultaneously.

The prices of many other goods and services can influence the demand for potatoes. In order to capture this influence the consumer price index was included by deflating all monetary variables. Similarly, population was incorporated into the model by dividing all quantities of potato products, consumer income and restaurant sales by population.

The consumer income variable used in this model was real, disposable, after-tax income per capita. Consumer income can have either a positive or negative impact on the demand for a product. For example, as income increases, consumers might increase their purchases of easy-to-prepare processed foods but decrease purchases of staple food products that require more preparation time.

Changes in consumer tastes and preferences can also affect the demand for potatoes. Four types of explanatory variables were considered in the model to account for changing tastes and preferences: (1) percentage of females in the labor force, (2) percentage of homes with microwave ovens, (3) restaurant sales, and (4) advertising. Females in the labor force and microwave ovens were used to capture the changing preference for convenience. Restaurant sales was used to capture changing preferences for meals away from home.

Estimation Methods

The approach of this study was to estimate demand equations based on time series data. The model was fit using the ordinary or generalized least squares technique. A separate linear equation was estimated to depict the demand for each of the three potato market components. Autocorrelation problems detected by the Durbin-Watson statistic were resolved by the Cochrane-Orcutt method.

Since prices of potato products were treated as independent variables, there could be simultaneous equation bias in parameter estimates. The bias could be dealt with by using econometric techniques such as two-stage least squares or three-stage least squares. Johnston (1960), however, says that for small sample sizes, ordinary least squares may actually perform better than those methods (pages 468-470).

Although there is some multicollinearity in the data, it was not sufficient to take remedial action. Gujarati (1988) says, "In one situation, however, multicollinearity may not pose a serious problem. This is the case when R^2 is high and the regression coefficients are individually significant as revealed by high t values" (page 308). Although Gujarati does not give specific guidelines, the R^2 and t values were judged to be sufficiently high in this model.

Results

Table 1 shows the results of the estimated equations for the three potato products. Each column contains an equation for the potato product listed at the top of the column. For example, the fresh potato equation is the first column of numbers corresponding to the explanatory variables on the left. Blank spaces indicate that the explanatory variable was not relevant to that potato product.

The R^2 (coefficient of determination) listed at the bottom of the column for each potato product is a measure of how well the equation fits the data. In general, the R^2 values for all three equations were quite high, suggesting models developed in this study fit the data very well.

The second row of numbers in Table 1 shows that the retail price of the potato products had the expected negative impacts on quantity demanded. Demand elasticity provides a convenient means to compare market characteristics for fresh versus frozen potatoes. The own-price elasticities of demand, calculated at the means, for fresh and frozen-retail are -0.14 and -0.55, respectively. These elasticities suggest that consumption of fresh potatoes is less responsive to changes in price.

Disposable per capita income had a positive impact on frozen potato markets but the impact was negative for fresh potatoes. Apparently higher incomes cause people to increase their purchases of frozen potatoes at the expense of fresh potatoes. This confirms previous work by other researchers (Cardwell and Davis, 1980; Guenthner, 1987; and Jones and Ward, 1989).

Fresh potato price was found to have a positive influence on the demand for frozen potatoes in both the food service and retail markets. As a substitute product, when the price of fresh potatoes goes up, the demand for frozen potato products increases. Hamburger was found to be a complement for frozen potatoes in both the retail and food service markets. The negative coefficient indicates that when the price of hamburger increases, the demand for frozen potato products decreases.

The impact of females in the labor force was positive for both the retail and food service frozen potato equations but negative for the fresh equation. As more women are employed outside the home they are likely to substitute frozen potatoes for fresh potatoes for the sake of convenience. Jones and Ward (1989) reached the same conclusion.

On the other hand, microwave ovens ease the preparation of potatoes at home. People who own microwaves are likely to substitute fresh potatoes for frozen potatoes. The positive coefficient for the microwave oven variable in the fresh equation and the negative coefficients in the frozen equations support this hypothesis. This relationship may have existed during the study period because consumers were not aware of, or satisfied with, the frozen potato microwave products. Product development and advertising could change this in the future.

The restaurant sales variable was positive for fresh potatoes and frozen potatoes in the food service sector. The increasing number of restaurants that feature baked potato bars appears to have had a positive influence on the demand for fresh potatoes away from home. The negative impact on the retail market for frozen potatoes suggests that when consumers increase their pur-

Table 1. Estimated Equations for U.S. Fresh and Frozen Potato Demand, 1970-1988

Explanatory Variables	Dependent Variables - Per Capita Quantity Demanded (lb/person)		
	Fresh	Frozen Retail	Frozen Food Service
Constant	150.0	1.40	-32.8
Retail Price	-5.82 (1.55)	-5.29 (6.22)	
Consumer Income	-4.03 (2.41)	0.66 (7.22)	3.65 (4.02)
Price-Substitute Fresh Potatoes		0.64 (2.62)	3.37 (1.39)
Price-Complement Hamburger		-0.003 (1.34)	-0.14 (6.60)
Females in Labor Force	-1.37 (6.22)	0.15 (13.50)	0.18 (1.53)
Microwave Ovens	0.25 (9.12)	-0.035 (12.10)	-0.14 (7.17)
Restaurant Sales	0.54 (1.05)	-0.017 (4.19)	0.12 (4.06)
Advertising Generic	-0.007 (1.38)		1.11 (3.40)
Advertising Frozen		0.023 (2.48)	
Auto-Correlation Coefficient	-0.43 (1.35)	-0.49 (1.62)	-0.68 (2.82)
R^2	0.87	0.97	0.97

Numbers in parentheses are T-values. Potato product prices are $/lb. Consumer income and restaurant sales are $1000/person. Females in labor force and microwave ovens are percentages. Price of hamburger is the retail price index. Advertising variables are million $. All money variables are deflated by CPI.

chases of frozen potato products in restaurants, they reduce their purchases for consumption at home. This supports a common concern among potato processors regarding the tradeoff between retail and food service markets.

Generic potato advertising was found to have a positive impact in the frozen potato food service market, but a negative impact on the demand for fresh potatoes. This is consistent with results reported by Jones and Ward (1989).

Implications

The estimated demand equations reveal the wide variety of factors that affect the demand for fresh and frozen potato products in the United States. Consumer income, females in the labor force, percentage of households with microwave ovens, and restaurant sales had opposite impacts on the demand for different potato products. This suggests that as these market forces change, consumers substitute one type of potato product for another.

The microwave oven variable documents the positive impact that microwave ovens have had on the demand for fresh potatoes. The recent turnaround in the decline of fresh potato per capita consumption may be due partly to increased microwave oven ownership. The positive health aspects of eating fresh fruits and vegetables has probably also helped. The microwave oven has simply made it easier to prepare a healthy food--fresh potatoes. Recent Potato Board efforts to focus on potato convenience in its advertising and promotion efforts should have a positive response with microwave oven owners.

Microwave oven ownership was found to be a negative factor in the demand for frozen potatoes in both the retail and food service markets. Apparently consumers who own microwave ovens substitute fresh potatoes prepared at home for frozen potatoes consumed at home and away from home. The net effect, however, is an increase in total potato consumption. The equation coefficients indicate that a one unit increase in the percentage of homes owning microwave ovens could increase fresh potato consumption per capita by 0.25 pounds and decrease frozen potato con-

sumption by 0.175 pounds (Table 1). The increase in the fresh market more than offsets the decrease in the frozen market.

Microwave ovens have had an impact on the food industry in general and the potato industry in particular. The rapid growth in microwave oven ownership, however, may be slowing. With 80 percent of homes already owning microwaves, additional growth opportunities may be limited. The future influence of microwave ovens on potato demand will depend on product development and promotion of potatoes as a convenience food.

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