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# U.S. Demand for Lamb: The Other Red Meat

by

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## Abstract

This analysis focused on economic forces influencing U.S. lamb consumption at the consumer level. The demand for lamb was shown to be inelastic. Key determinants of lamb consumption were habit persistence, seasonality, own price, and the price of pork. Income, trend and the price of beef were not statistically important factors.

## Epigram

*Exodus 12:4*

You are to determine the amount of lamb needed in accordance with what each person will eat.

## Background

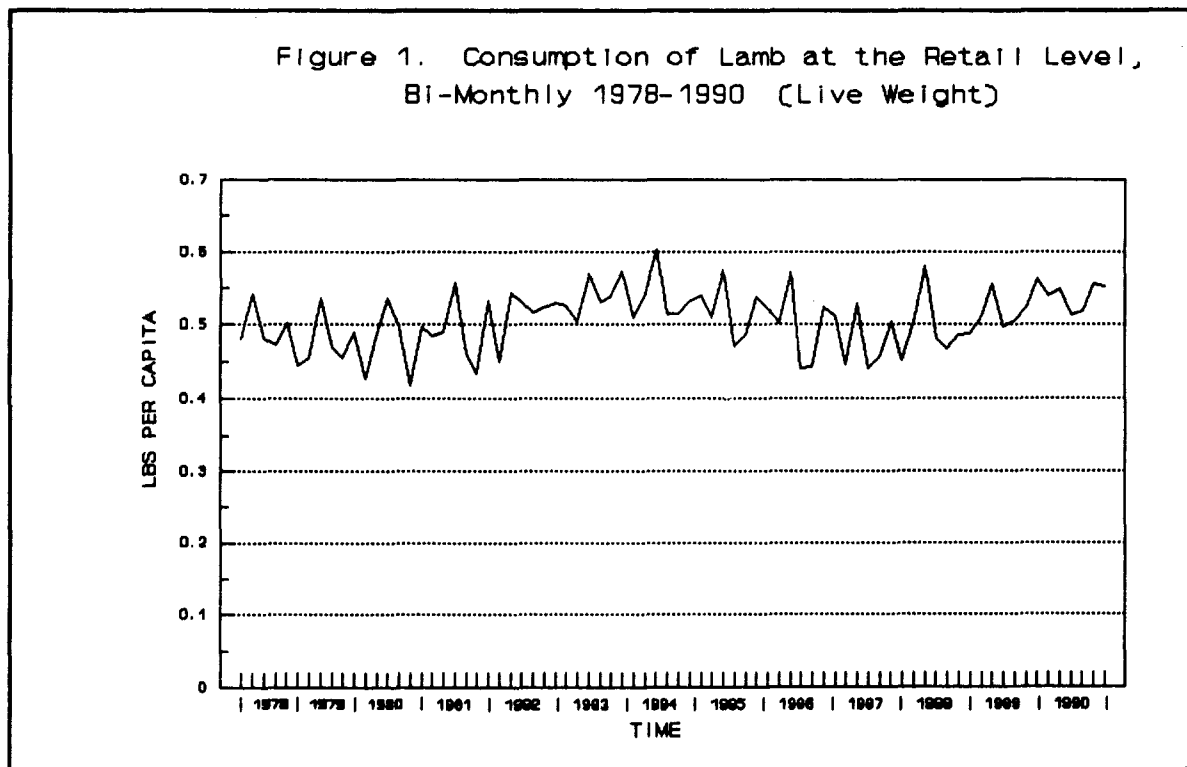
The volume of lamb consumed in the United States is quite low compared to other red meats and poultry (Table 1). Although fluctuating somewhat within a narrow band, U.S. lamb consumption has shown little, if any, real trend over the last two decades (Figure 1). About 30 percent of the consuming public has never even tried lamb, while only 24 percent eat lamb at least once a year (Walker, 1988, 1989).

The low volume and lack of trend in U.S. lamb consumption is more apparent when compared to consumption patterns in major lamb consuming countries, such as Australia (Figure 2). Total lamb consumption in Australia is more than twice as much as that in the United States, and has grown markedly since 1975. U.S. lamb consumption has stayed fairly constant with little relative variation over the same time period. Per capita lamb consumption is far below that of all

**Table 1: Average Annual U.S. Per Capita Consumption of Meat, Poultry, and Fish Products, 1970-1989 (retail weight equivalent)**

Meat	1970-72	1975-77	1980-82	1985-87	1988-89
	----- lb/capita -----				
Red Meats	133.2	128.9	120.7	117.5	117.7
Beef	79.8	86.0	72.4	72.5	67.0
Veal	1.8	2.7	1.3	1.4	1.1
Pork	49.5	39.0	45.9	42.5	48.6
Lamb	2.1	1.2	1.0	1.0	1.1
Poultry	34.7	36.0	43.8	51.8	59.1
Chicken	28.0	29.0	35.4	41.2	46.0
Turkey	6.7	7.0	8.4	10.7	13.1
Fish & Shellfish	11.9	12.5	12.5	14.8	15.5

Source: Putnam



other meats, including beef, pork, chicken, fish and shellfish, and even turkey (Table 1). Over the past decade, per capita consumption increases were evident for chicken, turkey, and fish and shellfish; a slight decrease in per capita consumption was evident for beef; and consumption patterns were relatively constant for lamb, veal, and pork.

The level of demand for lamb and/or changes in that level over time are important determinants of the long term economic viability of the lamb industry. The focus of this analysis is the particular economic forces influencing U.S. lamb consumption at the retail/consumer level.

This national analysis is concerned with lamb consumer responsiveness to changes in prices of lamb; changes in prices of possible substitutes, specifically beef and pork; and changes in income on a bi-monthly basis. Accordingly, the results should provide insight on: (1) the extent to which lamb prices influence consumption in the aggregate; (2) the sensitivity of lamb consumers to changes in prices of other red meats; and (3) the importance of changes in consumer income for lamb consumption.

#### Data

Bi-monthly data from 1978 to 1990 were used in this analysis. Retail price data for beef and pork and some retail price data for lamb were obtained from *Livestock and Meat Statistics* and *Livestock and Poultry Outlook and Situation*, both published by the USDA. Information pertaining to the Consumer Price Index (CPI) was obtained from the *Economic Report of the President*. Income and population data were obtained from the *Survey of Current Business*. Lamb retail prices were adjusted to a live slaughter-weight basis.

The USDA stopped reporting lamb retail prices in May/June 1981. The American Sheep Industry Association (ASI) contracted the services of a private firm to collect retail price information beginning in 1987. There is no consistent price series available for the data gap, public or private. To circumvent this data availability problem Purcell suggests the integration of retail prices

through 1980 with wholesale prices beyond 1981 together with the use of intercept shifters to account for the abrupt change in price levels after 1981. This method assumes the existence of a direct supply influence on the retail price, which may or may not be the case. Retail prices in this study for the period gap, however, were imputed from an auxiliary regression according to the following:

$$NPLAMB_t = g(\text{TREND}_t^2, \text{SX2-SX6}, \text{NPWHOLE}_t),$$

where

$$\text{TREND} = \begin{matrix} 0 & \text{if year 1,} \\ 1 & \text{if year 2,} \\ & \vdots \\ j-1 & \text{if year } j; \end{matrix}$$

$$\text{SX2-SX6} = \text{set of seasonal dummy variables corresponding to bimonthly periods beginning with March/April}$$

$$\text{TREND}^2 = \text{square of TREND to account for possible nonlinear relationship;}$$

$$\text{NPLAMB} = \text{nominal retail price of lamb; and,}$$

$$\text{NPWHOLE} = \text{nominal wholesale price of lamb.}$$

For this regression imputation, nominal price for the periods January/February of 1978 through March/April of 1981 and the period January/February of 1987 through March/April of 1991 were used as observation for the dependent variable, resulting in 46 observations. The regression results (t-values are given in parentheses) were as follows:

$$\begin{aligned} \text{NPLAMB} = & 60.048 + 6.289*\text{TREND} \\ & (10.70) \quad (11.89) \\ & + 0.035*\text{TREND}^2 + 0.471*\text{SX2} \\ & (0.81) \quad (0.40) \\ & + 2.787*\text{SX3} + 3.904*\text{SX4} + 5.294*\text{SX5} \\ & (2.28) \quad (3.10) \quad (4.18) \\ & + 5.687*\text{SX6} + 0.412*\text{NPWHOLE} \\ & (4.58) \quad (5.51) \end{aligned}$$

The goodness of fit measure ( $R^2$ ) was .9946. Trend, seasonality, and the nominal carcass price of lamb were all statistically significant explanatory variables. Using the above relationship and the values for the explanatory variables for the period of the data gap, 34 imputations for the nominal retail price of lamb were estimated. This imputation procedure is highly reliable, given the extremely good fit of the auxiliary regression. The imputed prices were then deflated by the CPI in 1982-1984 dollars, as were all prices and costs. Descriptive statistics of the continuous variables for all models are given in Table 2.

### Demand Analysis

The principle objective was to identify and assess the key factors associated with the variability in U.S. per capita lamb consumption. The analysis considered the sensitivity of lamb consumption to price and income changes which were measured by the respective elasticities. Little research on the nature of the demand for lamb has been done, with little or no consensus estimating the magnitude of the price and income elasticity parameters. Also, analysis of demand for lamb on a national basis is complicated by the fact that lamb is not available in all markets, since regional consumption is predominant in the United States (Williams and Capps). Consequently, prices of competing meats such as beef and pork may not have much impact on lamb consumption.

### Model Development

A statistical relationship between the consumption of lamb at the retail level and the following factors was hypothesized and tested: (1) income; (2) retail price of lamb; (3) retail price of beef; (4) retail price of pork; (5) lamb consumption in the previous period; and (6) a time trend. Mathematically, the relation between lamb consumption and these factors was specified as follows:

$$\text{LAMBCONS}_t = g(\text{LAMBCONS}_{t-1}, \text{TREND}_t, \text{PCI}_t, \text{SX2-SX6}_t, \text{PLAMB}_t, \text{PBEEF}_t, \text{PPORK}_t,)$$

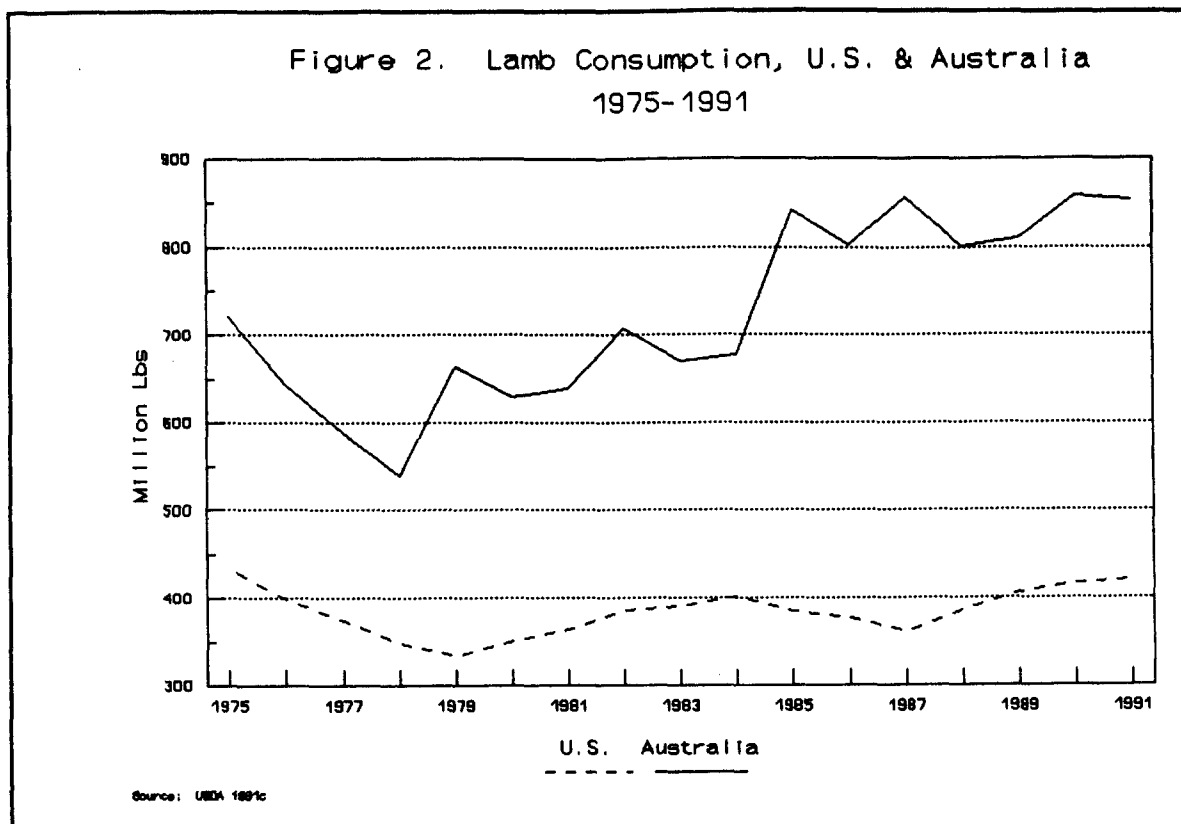
where

TREND =	0 if year 1, 1 if year 2, : j-1 if year j;
SX2-SX6 =	set of seasonal dummy variables corresponding to bimonthly periods beginning with March/April;
PCI =	real per capita disposable income in 1982-84 dollars;
PLAMB =	real retail price of lamb;
PBEEF =	real retail price of beef;
PPORK =	real retail price of pork; and
LAMBCONS <sub>t-1</sub> =	per capita consumption of lamb in previous time period.

Consumption was measured as total disappearance of lamb on a per capita basis, in live slaughter weight terms. Seasonality was expected to have a significant effect on lamb consumption. In particular, the bimonthly periods of March/April (Easter) and September/October (Rosh Hashana) were expected to be higher in lamb consumption. The base period in the analysis was January/February.

Lamb was also expected to be a normal good and so income was hypothesized to have a positive effect on consumption. Consistent with economic theory, own price effects were expected to be negative. Beef and pork were hypothesized to be substitutes for lamb, and as such, their respective prices were expected to be positively related to lamb consumption. George and King offer empirical evidence to substantiate the claim that beef and pork are substitutes for lamb.

Given that lamb consumption occurs primarily among certain ethnic segments of the population (Williams and Capps), habit persistence was explored in the analysis. Assuming a Nerlovian partial adjustment hypothesis, previous period consumption was hypothesized to be positively related to current period consumption. Furthermore, in light of the partial adjustment hypothesis,



**Table 2: Descriptive Statistics of Continuous Variables in the Demand Analysis**

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
NPLAMB	138.23	158.61	32.80	86.60	176.79
NPWHOLE	77.00	76.81	7.05	62.59	94.00
LAMBCONS	0.5072	0.5101	0.0407	0.4186	0.6040
PCI	10731	10450	963.79	9577	12371
PLAMB	131.48	131.80	8.61	115.70	150.00
PBEEF	112.47	104.45	14.50	94.89	151.58
PPORK	103.92	100.44	13.06	88.14	138.66

the coefficient associated with lagged consumption was also expected to be less than one.

A trend variable was used as a proxy for two separate influences affecting the food industry in the last several years: (1) the emphasis on diet, health, and nutrition; and (2) the emphasis on away-from-home food markets. The trend variable would thus be hypothesized to be positively related to lamb consumption (Capps, Savell, and Griffin).

### Empirical Results

Structural parameter estimates and associated t-statistics for the demand model at the national level are shown in Table 3. The goodness-of-fit ( $R^2$ ) associated with this analysis was 0.586. Based on the runs test, there was no evidence of serial correlation. The Durbin h-statistic, arguably the most preferred test of serial correlation in the presence of a lagged dependent variable, could not be computed because the product of the sample's size times the estimated variance associated with the coefficient of the lagged dependent variable exceeded one.

All estimated coefficients were of the expected sign. Key factors associated with lamb consumption were: (1) previous period consumption, (2) seasonality, (3) own price, and (4) retail price of pork. Significance of the coefficient associated with  $LAMBCONS_{t-1}$  substantiates the claim of habit persistence in the purchase of lamb, primarily by traditional consumers. Relative to January/February, lamb consumption is greater by 0.0557 lb. per capita in March/April and by .0174 lb. per capita in September/October, reflecting the effects of the Easter and Rosh Hashana holidays, respectively. Consumption was lower by .0248 lb. per capita in May/June and .0243 lb. per capita in July/August.

Retail price of lamb was a statistically important factor affecting lamb consumption. At the sample means, the own price elasticity of demand was estimated at -0.6248, signifying an inelastic demand for lamb across the 1978 to 1990 time period. The elasticity estimates across all observations in the sample (Figure 3) clearly illustrate two points: (1) the own price elasticity

of lamb consumption is in the inelastic range for all 78 observations ranging from -0.4898 to -0.7830, and (2) elasticity estimates exhibit relatively little variability as indicated by a coefficient of variation equal to only 12 percent.

With the presence of the lagged dependent variable in the model, the own price elasticity reflects only the short-run sensitivity of consumption to price, i.e., the price-demand relationship over one year. The long-run elasticities were obtained by dividing the short-run parameter estimates by one minus the coefficient associated with the lagged dependent variable, resulting in an estimation still in the inelastic range at -0.7906.

Pork and beef appear to be gross substitutes for lamb, but only pork was statistically significant. The cross-price elasticity of the demand for lamb with respect to the retail price of pork was 0.1312, at the sample means.

The results also indicated that income and trend are not statistically important factors in influencing lamb consumption. The upward albeit insignificant trend in lamb consumption may be due to health and nutrition influences or the growing trend in food service. The positive albeit insignificant relationship between consumption and income implies that lamb is a normal good.

These results differ to some degree from those reported by Purcell, who found that the traditional shifters of demand were not statistically significant. In the Purcell study, variations in per capita consumption were mostly explained by variations in lamb prices and trend. In our study, per capita consumption was shown to be significantly influenced by habit persistence of traditional lamb consumers, seasonality, own price, and *pork* price. Income, trend, and the retail price of beef were not statistically important.

### Implications

For the past two decades, lamb has remained a minor player in the grocer's meat case. The results of this study suggest some important implications for lamb consumption and the analysis of lamb consumption for strategic decision-making by the lamb industry:

**Table 3: Structural Parameter Estimates an Associated t-Statistics for the Demand Model, Bimonthly Observations, 1978-1990.**

Variable	Parameter Estimate	t-Statistic	Elasticity		
			At Beginning of Period	At Sample Means	At End of Period
Intercept	0.4703*	3.87			
LAMBCONS <sub>t</sub>	0.2098*	1.76			
TREND	0.1328E-02	0.26			
SX2	0.5573E-01*	5.22			
SX3	-0.2485E-01*	-1.84			
SX4	-0.2435E-01*	-2.24			
SX5	0.1742E-01	1.54			
SX6	-0.1467E-01	-1.28			
PCI	0.1433E-04	0.71			
PLAMB	-0.2413E-02*	-2.55	-0.6904	-0.6248	-0.5671
PBEEF	0.1578E-03	0.35			
PPORK	0.6431E-03*	1.58	0.1769	0.1312	0.1187

$R^2 = 0.5861$

DW = 2.0751

Runs Test = -0.5048

$F_{SX2-SX6} = 16.74^*$  (with 5 an 65 degrees of freedom respectively)

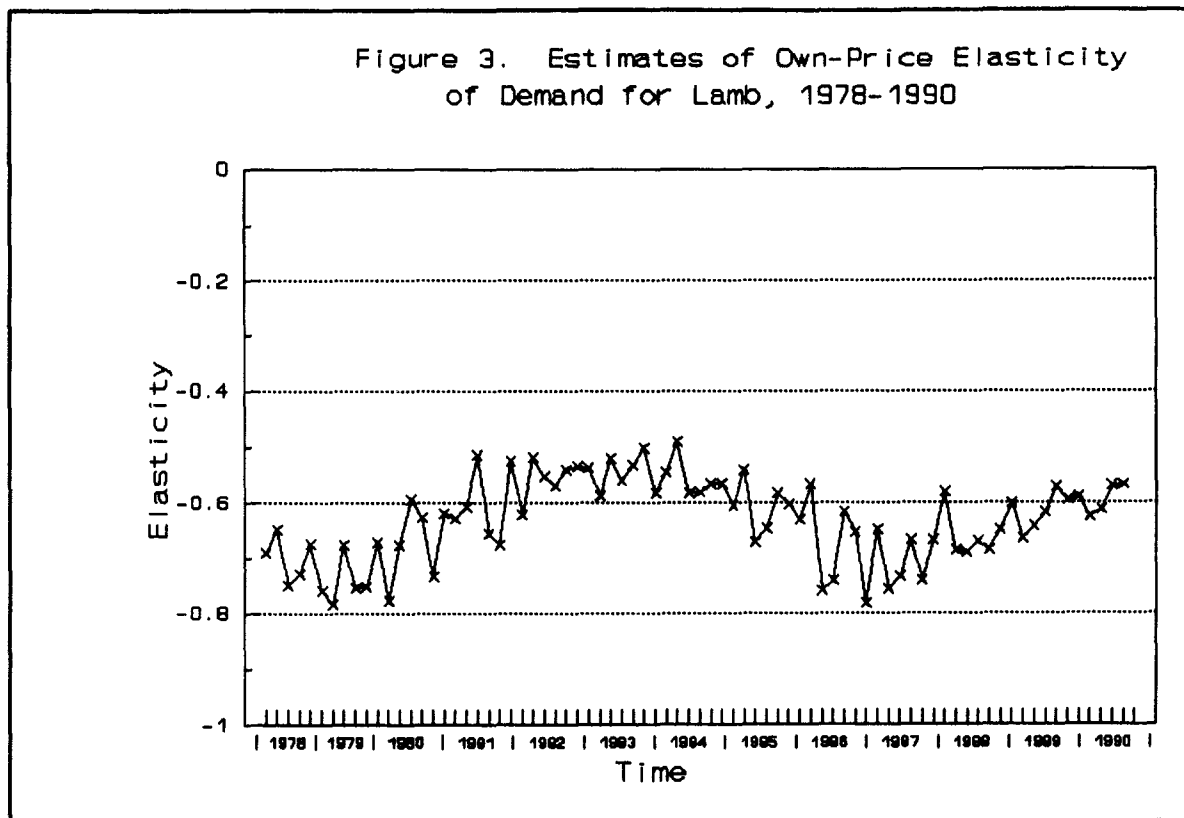
Asterisk indicates statistical significance.

- Traditional economic demand shifters (i.e., changes in price of substitutes, except pork, and changes in consumer income) generally do not significantly account for shifts in demand for lamb.
- Lack of significance for the trend variable indicates that current food consumption trends related to nutrition, away-from-home consumption, convenience, etc., may have little effect on lamb consumption.
- Inelastic demand for lamb infers that a retail price reduction strategy to increase market penetration and/or consumption is not appropriate. However, relevance of the elasticity parameter may be diminished by the spotty product availability. Hence, a quantitative response to a price special may be a result of the price change or simply the availability of the product.
- While lamb taste can often be compared to certain preparations of beef, beef was not a statistically suitable substitute. Lack of substitutability coupled with inelastic demand would support a non-price strategy of promoting consumption. Traits of lamb products need to be competitively postured with respect to appearance, fat content, trimming, and possibly convenience. Programs designed to increase the offerings of



lamb in the hotel, restaurant, and institutional (HRI) sectors may be in order. Attention should be given to changing lifestyles and demographics of consumers, as is done in the beef industry. Product development, which has paid sizable dividends for the broiler and turkey industries, should be emphasized for lamb.

- There is a pressing need for adequate databases to allow more effective analysis of demand for lamb. The databases need to extend beyond traditional price and quantity information to provide socio-economic profiles of consumers in different market areas so that product offerings can be tailored to specific markets. Finally, retail lamb prices must be publicized to increase awareness of price relationships at retail between lamb and competing products and to allow more effective demand analysis.



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