U.S. Lamb Demand

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Summary

Understanding major determinants of, and trends in consumer demand for lamb is critical for the industry to develop appropriate production and marketing strategies. Little research has empirically determined aggregate lamb demand. This study estimates a quarterly lamb demand model to assess major determinants over time. Per capita lamb consumption appears to be more responsive to lamb price than previous studies have concluded. When retail lamb price increases, comparable percentage declines in per capita consumption are likely. Beef is a significant substitute for lamb suggesting continued efforts to make lamb price competitive with other meats is important. Lamb demand tends to decline when consumer incomes and associated lifestyles change. This suggests that, in order to increase lamb demand, lamb products that are compatible with high-income consumer lifestyles are essential.

Key Words: Lamb demand, Demand index, U.S. lamb demand

Introduction

A major challenge facing the U.S. sheep industry is consumer demand for lamb. Purcell (1989) concluded that during the 1970-80 period, after accounting for changes in lamb and beef prices, per capita consumption of lamb declined significantly. Per capita consumption of lamb over time is illustrated in Figure 1. Lamb consumption has declined from about 3 lb. per person per year in the early 1970s to just over 1 lb. per person in the late 1990s. Although consumption changes do not necessarily demonstrate demand changes, the graph nonetheless illustrates the dramatic reduction in lamb consumption over time. Recently, U.S. policy makers have enacted programs to try to reverse the trend of declining lamb demand, including earmarking $5 million annually to develop and promote lamb products to increase demand. This is part of an overall $100 million multi-year effort to revitalize the domestic lamb industry (American Sheep Industry Association). Whether this investment will be successful remains to be seen, but this clearly demonstrates the importance placed on increasing lamb demand by policy makers.

To efficiently allocate limited resources to programs intended to stimulate lamb product demand, an understanding of lamb demand over time is required. In particular, a better understanding is needed regarding demand determinants for lamb. The lamb industry has at least some control over several of the factors presumed to influence demand such as relative price of lamb and product offering. However, industry participants have less control over other factors such as consumer income or lifestyle changes. The most efficient management strategy for the industry is to understand the major determinants of lamb demand over time to develop strategic plans to address issues that they can influence.

The purpose of this study is to estimate major determinants of demand for lamb. In particular, factors including retail lamb, beef, pork, and broiler prices, consumer income, and changing consumer lifestyles will be examined for their impact on long-run lamb demand. In addition, a history of the demand for lamb over the last 20 years is examined and strategies for the industry to influence demand are identified.

Previous Research

There is a noticeable lack of research regarding lamb demand. Purcell (1998a) defined the term "demand" and suggested that it is a complex interaction of quantity and price that is often misun-

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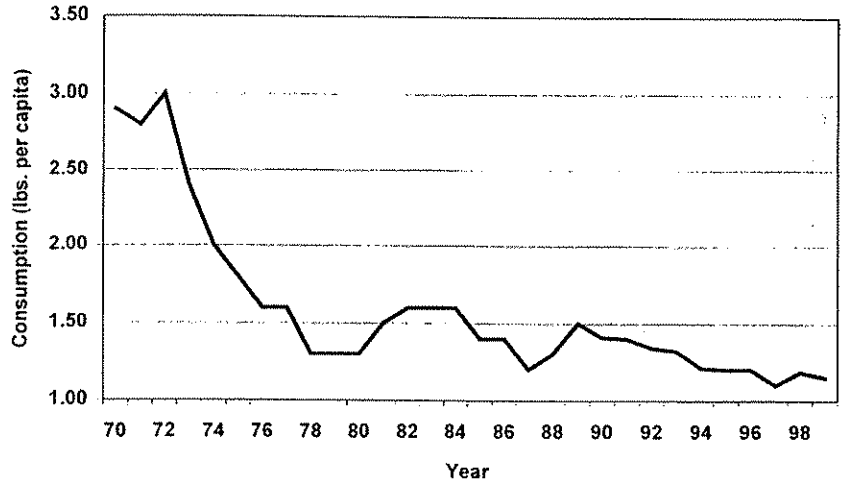
Figure 1. Annual Per Capita lamb Consumption, 1970-99



derstood. He clearly demonstrates the fallacies of drawing inferences regarding demand changes from just observing prices or per capita consumption alone.

Only two relatively recent studies have empirically estimated demand for lamb over time. Purcell (1989) estimated quarterly demand using various models over the 1970-1987 period. He found that few of the typical economic factors considered relevant in demand models were important lamb demand determinants. In particular, lamb price was only a marginally significant lamb consumption determinant (and, its significance was sensitive to model specification) and no effective substitutes existed. Lamb consumption declined as consumer income increased.

Byrne, Capps, and Williams (1993) estimated a quarterly lamb demand model over the 1978-1990 period.[1] They concluded that per capita lamb consumption was significantly related to lamb price with a short run elasticity of –0.63 and a long-run elasticity of –0.79. Pork price was marginally significant suggesting it was a weak substitute for lamb.

These time series demand estimates were important because they suggested that few of the typical demand determinants (i.e., prices of substitutes, consumer incomes, etc.) were important in lamb. However, more information is needed regarding lamb demand. First, both of these studies relied on data that are now at least 10 years old. Given the rapid changes in the U.S. economy and consumer lifestyles, an updated demand analysis is past due. Second, consistent retail lamb price series were problematic in both studies, making results conditional on questionable price data that were available at the time. Additional analysis with a more consistent retail lamb price series is needed. Third, results of the two studies are not entirely consistent (e.g., Purcell found lamb demand declined as income increased it had no substitutes, whereas, Byrne, Capps, and Williams found income to have no impact and pork to be a weak substitute) warranting further analysis. Using more detailed weekly retail scanner data over a shorter time period (January 1987 – November 1988), the TAMRC lamb study team (1991) concluded that aggregate retail lamb prices were important lamb consumption determinants. More importantly, they concluded that individual lamb cuts had elastic demands, suggesting consumers readily switch between cuts of lamb based upon relative prices.

Methods

Demand for lamb products can be modeled in a quantity-dependent framework as: $LQ = \beta_0 + \beta_1 LP + \beta_2 BP + \beta_3 PP + \beta_3 CP + \beta_4 INC + \beta_5 W + \epsilon$, (1) where, LQ is per capita lamb consumption, LP is retail lamb price, BP is retail beef price, PP is retail pork price, CP is retail chicken price, INC is per capita disposable income, and W is the percentage of women employed in the labor force. The β 's are parameters to be estimated and ϵ, is an error term.

The model includes standard demand components of lamb price, prices of substitute meats (beef, pork, and chicken), and per capita income. Lamb price is expected to have a negative impact on per capita consumption, prices of competing meats are expected to be positively associated with lamb consumption, and income may be positive or negative depending upon how income affects lamb consumption. The percentage of women employed in the workforce is included in the model to capture changing demographics over time. This variable attempts to capture the impact of food eaten away from home, demand for product preparation convenience, and other related lifestyle changes (e.g., McGuirk et al. 1995 and Schroeder, Marsh, and Mintert 2000).

Data

The United States Department of Agriculture (USDA) stopped collecting retail lamb prices in 1981. Wholesale lamb price data are available, but these data are not appropriate for retail demand estimation because wholesale prices are not what consumers pay for retail product, and changes, over time, in the wholesale-to-retail price margin make the wholesale series a poor proxy for retail prices. Byrne, Capps, and Williams (1993) used wholesale prices, time trend variables, and seasonal dummy variables to generate proxies for retail lamb prices. How well this proxy mirrored actual retail prices is unknown but questionable. In this study, retail lamb price data were collected from the Bureau of Labor Statistics (BLS).[2] The BLS series was only available from 1978 forward. Therefore, the meat demand model (equation 1) was estimated using

1 This study was a formalization of earlier work by the TAMRC lamb study team (1991).

Table 1. Summary Statistics of Data Used in Lamb Demand Estimation, Quarterly 1978-1999.

	Average[1]	Standard Deviation	Minimum	Maximum
Lamb Consumption (lb./capita)	0.34	0.05	0.20	0.40
Lamb Price (cents/lb.)	481.88	56.17	434.47	668.00
Beef Price (cents/lb.)	362.87	60.84	281.35	539.61
Pork Price (cents/lb.)	264.93	36.27	208.17	376.42
Chicken Price (cents/lb.)	119.81	19.02	98.87	177.76
Disposable Income ($/capita)	20,264.13	2,003.72	16,737.05	24,550.01
Women in Work Force (%)	52.25	3.56	45.30	57.70

[1] Prices and Income are in cents per retail pound in constant 1999 dollars, deflated using the Consumer Price Index. Lamb Consumption is retail weight equivalent.

quarterly data from 1978 through 1999.

Retail prices of beef, pork, and chicken and per capita lamb consumption were obtained from USDA. Personal disposable income per capita was collected from the U.S. Department of Commerce and the percentage of women employed in the labor force was obtained from the Bureau of Labor Statistics. All prices and income were deflated to constant 1999 dollars using the consumer price index (Bureau of Labor Statistics). Summary statistics of the data are reported in Table 1.

Results and Discussion

Demand Model Estimates

The demand equation specified in equation (1) was estimated with ordinary least squares regression using quarterly data over the 1978 to 1999 period. Quarterly dummy variables were added to the model to account for seasonal differences in demand. The model was initially estimated including both the disposable income (INC) and the women in the work force (W) variables in the model. Neither of the coefficients was statistically different from zero and because both variables exhibit similar upward trends over the time period, multicollinearity problems were suspected. Therefore, the model was estimated two more times dropping one of the variables each time and retaining the other. Comparisons of the estimates indicated that the model including income (and excluding W) better explains lamb consumption than the model including women in the labor force, therefore, W was dropped from the final model. Therefore, degrading multicollinearity was apparent between women participation in the workforce and disposable income during this time period.

Two partial adjustment models were also estimated; one using one-quarter lagged lamb consumption and another using a one-year (same quarter a year earlier) lag on the dependent variable. These models were estimated to determine whether habit-persistence found by Byrne, Capps, and Williams (1993) was present. The lagged dependent variables were not statistically different from zero suggesting habit-persistence was inconsequential during this time period.[3]

Demand model parameter estimates are presented in Table 2. The model explains 57 percent of the variability in lamb consumption. The Durbin-Watson statistic indicates that autocorrelation, often present in time series regression analysis, is not a problem in the model, suggesting a well-specified model. Several important findings are revealed. First, lamb price is an important determinant of lamb consumption. The own-price elasticity estimate indicates that a one percent increase in lamb price reduces per capita consumption by 1.09 percent. This elastic demand response differs from those estimated by other studies. Byrne, Capps, and Williams (1993) found a short-run elasticity of –0.62 and a long run elasticity of –0.79. Purcell (1989) estimated the elasticity to be –0.51.

Several factors likely make the elasticity measures estimated here different from those of earlier studies. First, our study is the only one to use recent lamb retail price data (Purcell's data only went through 1980 with a consistent price series and through 1987 with a modified series using wholesale prices and Byrne, Capps, and Williams used a modified series based on wholesale prices through 1990). If our elasticity estimate reflects more recent behavior, lamb consumers are becoming more sensitive to price than has been suggested by previous research. Thus, lamb producers will benefit from increased production efficiency both from the standpoint of being more price competitive in world markets as well as helping to keep retail lamb prices lower relative to competing meat prices. Alter-

2 The BLS reports a monthly retail lamb price index (and they also reported a U.S. city retail lamb price average from January 1991 to August 1991 and August 1993 to December 1993). The index was converted to a retail price by using the January 1991 retail lamb price. The monthly data were averaged to obtain quarterly average lamb prices.

3 Parameter estimates of these model variations are not reported here but are available from the authors upon request.

Table 2. Parameter Estimates of Quarterly Lamb Demand Model, 1978-1999.

Variable	Parameter Estimate	Standard Error	t-statistic	Elasticity[1]
Intercept	0.679*	0.132	5.16	-
Lamb Price	-0.00076*	0.0013	-5.81	-1.09
Beef Price	0.000523*	0.000202	2.59	0.57
Pork Price	0.000215	0.000189	1.13	0.17
Chicken Price	-0.000135	0.000464	-0.29	-0.05
Income	-0.000009*	0.000004	-2.06	-0.54
Q2DUM	-0.0368*	0.0101	-3.66	-
Q3DUM	-0.0439*	0.0100	-4.37	-
Q4DUM	-0.0238*	0.0100	-2.37	-
R-squared	0.57			
Durbin-Watson	1.95			
Observations	88			

[1] Elasticities are calculated at the averages of the variables over the time period.
* indicates that the parameter is statistically different from zero at the 0.05 level.

natively, if U.S. producers do not improve production efficiency, and import restrictions continue to curtail cheap imports (supporting higher domestic than world prices), per capita consumption is likely to continue to decline.

The only statistically significant substitute for lamb is beef (Table 2). A one percent increase in the price of beef increases per capita lamb consumption 0.57 percent. This suggests that recent high retail beef prices likely have helped strengthen lamb demand relative to what it would have otherwise been. In addition, this indicates lamb price relative to beef price is an important demand determinant. Lamb price must be competitive with beef prices if cost is to be used to enhance lamb demand.

Pork price is marginally statistically different ($p<0.26$) from zero with an elasticity of 0.17 (similar to Byrne, Capps, and Williams (1993) estimate of 0.13). Purcell (1989) found no substitutes and Byrne, Capps, and Williams (1993) found only pork to be a weak substitute. Using our more recent data time period, pork remains a weak substitute and chicken is not a substitute for lamb.

Lamb is what economists refer to as an "inferior meat product". This refers to lamb demand declining when consumer income increases. The income elasticity indicates a one percent increase in per capita disposable income, reduces lamb consumption by 0.54 percent, with all else constant. Purcell (1989) similarly found lamb demand to be inversely related to income in one of his models whereas, Byrne, Capps, and Williams (1993) found income not to be statistically different from zero. If our estimate and that of Purcell are correct, this does not bode well for lamb demand as real U.S. consumer incomes have grown consistently for many years. Schroeder, Barkley, and Schroeder (1995) found that in low-income countries, lamb consumption responds strongly in a positive direction to consumer income growth. However, they also determined that as income growth continued over time, or when compared to countries with higher income levels, lamb demand declined at lower income levels than did demand for pork, beef, and poultry (i.e., additional increases in income led to substitution away from lamb consumption to other meats). This is consistent with our results indicating lamb demand tends to decline as U.S. consumer income increases.

These results suggest aggregate lamb demand is likely to decline during periods of economic strength like those experienced of late in the U.S. One important point regarding the income elasticity is worthy of further consideration. Income was positively correlated with the percentage of women in the workforce variable, and likely with other consumer lifestyle changes over time. Therefore, the negative income elasticity estimate could reflect the effect of changes in income, as well as changes in other demographic factors, over time. Thus, the magnitude of the income elasticity could be over-stated. But, if similar trends continue among these factors, which is likely because they are all related, the overall impact of income growth on lamb demand is likely to be consistent with our estimate.

Statistically significant seasonal dummy variable estimates indicate lamb demand varies seasonally. Strongest demand is in the first quarter of the year during holiday seasons traditionally favoring lamb consumption (e.g., Easter). Weakest demand is during the third quarter of the year when beef demand is typically strong (Schroeder, Marsh, and Mintert, 2000).

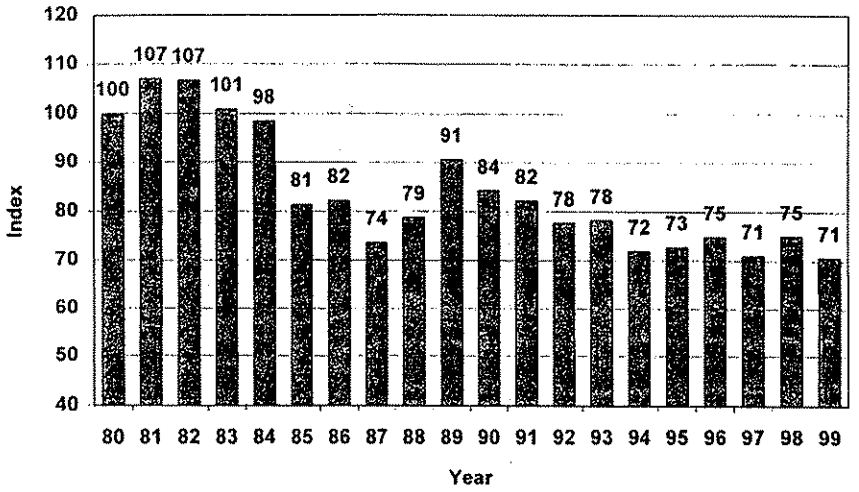
Lamb Demand Index

The demand model estimates are important for assessing factors that have

caused aggregate-lamb demand to change. To examine how lamb demand has changed over the past twenty years, a lamb demand index was constructed. The index summarizes the complex interaction of price and quantity discussed by Purcell (1998a) into a single number for each year. The index was calculated by assuming a constant own-price demand elasticity of –1.09 and calculating the annual percentage vertical shift in demand that occurred.[4]

An index value of 100 is the level of lamb demand in the base year 1980 (Figure 2). An index value greater than 100 indicates lamb demand increased relative to 1980 and an index value less than 100 indicates lamb demand was lower that year relative to 1980. For example, the 1990 index is 84 indicating that in1990, lamb demand was only 84% of its 1980 level. What is most revealing about the index is that 1999 had the lowest demand level of the past 20 years at 71% of 1980. In other words, the lamb industry experienced a 29% decline in demand over the past 20 years. Interestingly, a similar demand index calculated for beef indicates that beef demand declined more consistently and severely over the 1980-1998 period than lamb, dropping from 100 to 52. However, the beef demand index rebounded for the first time in 1999 to a value of 54 (Schroeder, Marsh, and Mintert, 2000) and was higher again in 2000. Thus, the beef industry appears to be developing an effective multi-faceted strategy to reverse its long run demand decline.

Figure 2. Lamb Demand Index, 1980-99 (1980=100)



Conclusions

Historically, lamb has represented a minor component of U.S. meat consumption. In recent years, lamb demand declined such that by 1999, lamb demand was only 71% of what it had been in 1980. Poor demand, together with stiff competition from foreign supplies are significant challenges facing the domestic lamb industry (Purcell 1998b). Results of this study reveal several strategies for the lamb industry:

•The quantity of lamb consumed is sensitive to lamb price. Reductions in lamb price will result in comparable percentage increases in per capita consumption. This together with world market pressure, suggests that production cost reduction is critical for survival of the domestic lamb industry.

•Beef is a substitute for lamb. If domestic lamb producers do not improve production efficiency at least at the rate achieved by the beef industry, relatively cheaper beef will replace expensive lamb in consumer diets.

•Demand for traditional lamb as an aggregate commodity declines as consumer income rises. The industry must recognize that as consumer income has increased, traditional aggregate lamb demand has declined. The lamb industry cannot change consumer income. However, this result indicates that lamb products must be adapted to fit modern high-income consumer lifestyles. Development of lamb products that are convenient to prepare, offer a high-quality eating experience, and that are well suited for food-away-from home consumption (with products targeted for lower-priced as well as higher-priced restaurant markets), is essential for halting declining lamb demand.

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4 The index is calculated by dividing price in the year of interest that would have existed (assuming –1.09 constant demand elasticity) had per capita consumption been at the 1980 level (instead of the actual) by the actual 1980 price. The index was also calculated using the average elasticity for each year over the 1980-1999 period and results were qualitatively identical to those holding the elasticity constant, so only the results holding the elasticity constant are reported.

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