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The factors influencing the price of beef, an econometric study

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THE FACTORS INFLUENCING THE PRICE OF BEEF, AN ECONOMETRIC STUDY

A Thesis

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Jessica Moon, Director, University Honors Program

The Factors that Influence the Retail Price Beef

Abstract: The beef industry in the United States is changing on a daily basis. Retailers across the country are always striving to increase profits and cut costs. Through econometric study, this paper looks at viewing different factors that influence the final price and cost of beef to the retailer. With good results, a retailer can use this knowledge to achieve their ultimate goal: to make more money.

I. Introduction

"Beef! It's what's for dinner," exclaims the old commercial slogan we all know and love. The average American consumes about sixty-seven pounds of beef per year [Davis and Lin, 2005, 1]. Without beef American's may be without many dietary nutrients provided by beef.

Price affects the consumption of any good. As beef moves through the supply chain from wholesaler to retailer, it stays relatively the same. In contrast, most goods change drastically at each stage in the supply-chain. Many factors affect the final price that consumers pay for beef at a grocery store, meat locker, or other retail outlet. These factors can be broken down into factors that influence supply and factors that influence demand. Using research on the beef market and regression analysis, this paper examines the relationships of each variable to the final beef price to determine which variables are the most important and significant influences on the retail beef prices. If a retailer of beef watches these factors, he may be able to turn larger profits or stay ahead of the changing market. This model will show which of the factors a retailer needs to pay closest attention to when selling beef to the consumer.

II. Background Information

Since the outbreak of Mad-Cow Disease, scares throughout Europe, the United States, and Canada have made the beef market very tough to predict because the market is volatile to change. Some outbreaks have had major effects on the United States industry, while others have not. For instance, Japan imposed a ban on imports from the United States after Mad-Cow was found in Washington State in December of 2003 [Thurtell, 2005, para.5]. This affects United

States exports. Australian exports to the U.S were down 4.2% for 2005 compared to the same period in 2004. Uruguayan exports to the U.S. are rising [Thurtell, 2005, para. 14]. Different prices and disease outbreaks often shift United States imports from one country to another.

Diet fads have made the demand for beef very unpredictable over the past few years. Different diets have different effects on demand. The Atkins Diet, which is a low carbohydrate diet, has driven the demand for beef higher because of the high amounts of protein found in beef.

> Obviously the beef industry is reaping the benefits of the diet. The increase in beef demand has helped make producers more optimistic about the future. They love it. The question, however, is just how much that increase should be contributed to the Atkins diet. It's not the only factor driving the beef demand. What we're seeing is the reversal of a long term trend. Although the Atkins diet has had a positive impact on the trend, other factors include introduction of new easy-to-prepare beef items to the market and the recent rebound of the U.S. economy [Mintert, 2004, para. 4-6].

The Atkins diet had a positive impact, but a diet that advises against the consumption of protein or red meat specifically, would have an adverse influence on the demand for beef.

These are a couple of the new issues that have affected the supply and demand for beef over the last few years. These new issues have added complexity to the analysis of the beef market along with all of the supply and demand factors that regularly affect the price of beef.

The goal of econometrics is to test theory against concrete data. Econometrics allows us to determine the influence of independent variables on the dependent variable chosen for each study. This paper's econometric analysis will look at how many different supply and demand factors affect the retail beef price that consumers pay.

The main tool used in econometric studies is regression analysis. Two types of regression analysis can be used in econometric studies: time series analysis and cross sectional analysis. Time-series analysis examines variables over a period of time while cross sectional analysis measures variables at a specific point in time. An example of time series analysis would

be a study of the variables that affect unemployment over three or four decades. An example of a cross-sectional study would be to analyze season statistics for all thirty-two NFL teams to determine which variables affect a team's winning percentage. This study is a time series analysis of beef prices over the last twenty-five years for the United States cattle industry and beef retail industry.

III. Determining the Supply Variables of the Regression Model

All else equal, as the supply increases, the price for a good will fall. The opposite is true as well; as the supply decreases, the price for a good rises. A supply factor that has influences the retail price of beef is the number of cattle slaughtered a quarter per capita. Two other supply variables to think about are the total number of cattle in the United States and the number of firms in the industry.

The number of cattle slaughtered per quarter per capita varies each quarter of the year. The slaughter per capita variable is calculated by taking the total number of cows slaughtered per quarter and dividing by the population. It is best to show this per capita because then when looking at how much disposable income has it can be shown how many cattle are available per household to consume. This variable should be more important in determining the retail price then any of the other supply variables. The more cattle that are getting to the packing plants, the lower the price should be for the consumer. This variable should be more significant then the actual number of cattle on feed because it is a step later in the supply-chain than the farms where the cattle are raised. This makes this variable closer to the retailer where the consumer makes the final purchase of beef.

The total number of cattle available in the United States is provided by the National Agricultural Statistic Service, which is a program funded by the United States Department of

Agriculture. All else equal, an increase in the number of cattle raised would cause prices to go down if basic economic theory applies. As mentioned above, this variable should be less significant than the number of cattle slaughtered. The basis for this prediction comes from a study found in the *American Journal of Agricultural Economics* done by Ronald Ward and Thomas Stevens. Most of the major pricing differences in the supply chain occur near the retail markets between the retail outlets and the providers of the beef to the retailer. It is between retailer and the beef providers that less price response is seen and the greatest change in price linkage is measured. This is to say that the further the beef moves down the supply chain, the more affected the retail price is by changes at that stage in the supply chain [Ward and Stevens, 2000, 1121]. Because the total number of cattle is at the beginning of the supply chain and further away from the final retail price then the number of cattle slaughtered, it stands to reason that the slaughter number would have a larger impact than the total supply of cattle.

The final supply variable examined is the number of firms in the industry. This tells us something about the competitiveness in the industry. The more firms there are in an industry, the more competition there will be, which drives down prices. If a monopoly or oligopoly is in place in that industry, prices will tend to be higher. It is difficult to determine which place along the supply chain to determine the number of firms. The data that is most readily available is the number of farm operations that house cattle for slaughter for sale to the beef industry. If the number of farms decreases over time it would stand to reason that the retail price of beef would be driven up because the industry is becoming less competitive. A decrease in the number of farms could signal a move towards corporate cattle ranching. That could also help drive prices up as corporations are likely to drive up prices along the supply chain. The major problem with using the number of farms is that it is not the most concentrated point on the supply chain. It

might be better to use the number of meat packing plants across the country, but it is difficult to find the number of packing plants dating back twenty-five years. This forces the study to resort to the statistics that we have with the number of farms raising cattle for slaughter.

Determining the Demand Variables of the Regression Model

As demand increases, all other things equal, the price will increase. The opposite is also true. There are three variables that my regression model will look at and analyze in relation to retail beef prices. These four variables are the price of substitutes, the real per capita disposable income, diseases, and seasonal factors.

Prices of substitute goods can have a major influence on the demand for a product. Substitute goods are two goods for which an increase in the price of one leads to an increase in the demand for the other [Mankiw, 2004, 834]. Substitutes for beef are chicken and pork. These three types of meat are the main groups of meat that Americans consume. An analysis of their prices will lead to better analysis related to the retail price of beef. The prices that will be used are the real prices. Real prices are determined by taking the actual price divided by the GDP deflator. That answer is then multiplied by 100 to give a better percentage to work with and show results more clearly. This process will give real (relative) prices so inflation does not directly influence the rising prices from 1980 through 2005. With relative prices, it is easier to study and determine results because each price is put on equal ground. Also, these substitutes are viewed as healthier than beef. This plays into some of the social factors that can influence demand. Health information suggesting that red meat may not be as good for you will potentially drive people away from beef, lowering its price.

The measure of real per capita disposable income is a measure of wealth. This is calculated by taking the real disposable income value and dividing it by population. Doing this

helps to show how much disposable income, on average, each household in the country has to spend. Real disposable income is used because the prices for the substitutes are done in real prices instead of nominal prices. Disposable income is used because that is the amount of money that people have to spend on extra things. In this case that good is beef. If there is a drop in disposable income it should signal that less beef will be consumed. If there is a smaller demand for beef then the price should fall to try and get consumers back to eating beef. If disposable income is increasing from quarter to quarter then demand should increase. As demand rises the price of beef should then be driven upward. However, it could be the case that beef might not be the top end good that this model predicts it to be. It may be an inferior good, which is a good that as wealth increases, people consume less of it. Another possibility is that people are just substituting to more expensive cuts of beef, which is factored into the price of beef being used in this study.

The presence of diseases in the industry will also affect the demand for beef. If there are diseases present, such as Mad Cow Disease, then the demand for beef should fall. If demand is falling then the price of beef should be falling. Mad Cow Disease was first discovered in the United States in December of 2003. Since that event, consumers have been more aware of the potential diseases that could be affecting the beef supply.

Seasonal factors also affect the demand for beef. Summer is barbeque season and that means more steaks and burgers will be getting bought at local retail outlets. This should drive the demand upward, which then increases the price during these grilling seasons. It is tough to estimate this impact on retail pricing when doing a regression analysis. A dummy variable will be used to show the impact of the grilling season. Dummy variables are used to show the effects of qualitative data like seasons of the year or yes no answers to question. Dummy variables are

shown in regression analysis as a binary "0" for no answers or a binary "1" for yes answers. In this regression analysis, there will be a dummy 0 and 1. There will be three separate sets of seasonal grilling dummy variables. The first, second, and third quarter will each have a set of data where that quarter is given a "1" and the rest of the quarters will be given zeros. This is done to help eliminate the potential for a high correlation between quarters, which may necessarily not be true. This can lead to false signs of coefficients and other errors that will throw off the analysis of the model.

IV. Regression Analysis

The basic multiple regression equation is: $Y= a + b1*X1 + b2*X2 + b3*X3 + \ldots + bn*Xn$. The Y variable represents the dependent variable or the variable that we are trying to explain. In my model the dependent variable is the retail beef price value. This retail beef price value is an average of different cuts of beef prices pulled together. The constant, a, is the Y intercept of the regression line. The b is the slope of the line caused by the independent variable X. After the regression is run analysis will be provided to determine which X variables hold statistical significance in influencing the dependent variable Y.

The following is the regression analysis based on the development of the model in this paper with the best fitting variables being used. Cattle on feed and total number of firms in the industry were not included because of multi-colinearity issues they created with the slaughter variable. The slaughter variable was kept because it is closest to the consumer on the supply chain. The idea for this model is related to an example found in *Learning and Practicing Econometrics* by William Griffiths, Carter Hill, and George Judge.

Variables Defined:
*RPRBF: The real price of beef. Calculated (beef price/gdp deflator)*100*
*RPRPOR: The real price of pork. Calculated (pork price/gdp deflator)*100*
*RPRCH: The real price of chicken. Calculated (chicken price/gdp deflator)*100*
PCRDI: The real per capita disposable income. Calculated (Real Disposable Income/population).

PCSLA: The per capita # of slaughtered cows each quarter. Calculated (# slaughtered/population).
MADC: Dummy variable for presence of mad cow disease in the United States.
GRILLO: Grilling season dummy variable for quarter one.
GRILLT: Grilling season dummy variable for quarter two.
GRILLTH: Grilling season dummy variable for quarter three.

```
|_SAMPLE 1 104
|_READ RPRBF RPRPOR RPRCH PCRDI PCSLA MADC GRILLO GRILLT GRILLTH
   9 VARIABLES AND      104 OBSERVATIONS STARTING AT OBS       1

|_stat/all pcor
NAME         N    MEAN         ST. DEV      VARIANCE     MINIMUM      MAXIMUM
RPRBF        104   3.3527      0.34232     0.11718       2.6983       4.3622
RPRPOR       104   2.5645      0.17382     0.30212E-01   2.1881       3.1021
RPRCH        104  0.57706      0.25890     0.67029E-01  0.18321       1.0814
PCRDI        104  0.21998E-01 0.31037E-02 0.96332E-05  0.16712E-01  0.27653E-
01
PCSLA        104  0.32892E-01 0.30486E-02 0.92938E-05  0.25509E-01  0.41141E-
01
MADC         104  0.86538E-01 0.28252     0.79817E-01   0.0000       1.0000
GRILLO       104  0.25000     0.43511     0.18932       0.0000       1.0000
GRILLT       104  0.25000     0.43511     0.18932       0.0000       1.0000
GRILLTH      104  0.25000     0.43511     0.18932       0.0000       1.0000

 CORRELATION MATRIX OF VARIABLES -      104 OBSERVATIONS


RPRBF      1.0000
RPRPOR    0.42941       1.0000
RPRCH     0.46192      0.50087       1.0000
PCRDI    -0.39458     -0.36705     -0.82012       1.0000
PCSLA     0.15039      0.30260      0.70300     -0.76290       1.0000
MADC      0.30951     -0.63150E-01 -0.40378      0.52174     -0.50132
          1.0000
GRILLO   0.73429E-02 -0.36131E-01  0.12036E-01 -0.25777E-01 -0.20083
        -0.19745E-01   1.0000
GRILLT   0.62807E-01 -0.12457     -0.90597E-02 -0.11823E-01  0.57789E-01
        -0.19745E-01 -0.33333       1.0000
GRILLTH  0.24184E-02  0.13398      0.21715E-01  0.86450E-02  0.14798
        -0.19745E-01 -0.33333     -0.33333       1.0000
            RPRBF        RPRPOR       RPRCH        PCRDI        PCSLA
            MADC         GRILLO       GRILLT       GRILLTH

|_OLS RPRBF RPRPOR RPRCH PCRDI PCSLA MADC GRILLO GRILLT GRILLTH/LIST ANOVA

REQUIRED MEMORY IS PAR=      18 CURRENT PAR=    4000
 OLS ESTIMATION
     104 OBSERVATIONS     DEPENDENT VARIABLE= RPRBF
...NOTE..SAMPLE RANGE SET TO:      1,    104

 R-SQUARE =    0.6333     R-SQUARE ADJUSTED =    0.6025
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.46585E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.21584
SUM OF SQUARED ERRORS-SSE=   4.4256
MEAN OF DEPENDENT VARIABLE =   3.3527
```

LOG OF THE LIKELIHOOD FUNCTION = 16.5938

MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
AKAIKE (1969) FINAL PREDICTION ERROR - FPE = 0.50616E-01
(FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
AKAIKE (1973) INFORMATION CRITERION - LOG AIC = -2.9839
SCHWARZ (1978) CRITERION - LOG SC = -2.7551
MODEL SELECTION TESTS - SEE RAMANATHAN (1998,P.165)
CRAVEN-WAHBA (1979)
GENERALIZED CROSS VALIDATION - GCV = 0.50998E-01
HANNAN AND QUINN (1979) CRITERION = 0.55509E-01
RICE (1984) CRITERION = 0.51460E-01
SHIBATA (1981) CRITERION = 0.49919E-01
SCHWARZ (1978) CRITERION - SC = 0.63605E-01
AKAIKE (1974) INFORMATION CRITERION - AIC = 0.50595E-01

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	7.6443	8.	0.95554	20.512
ERROR	4.4256	95.	0.46585E-01	P-VALUE
TOTAL	12.070	103.	0.11718	0.000

ANALYSIS OF VARIANCE - FROM ZERO

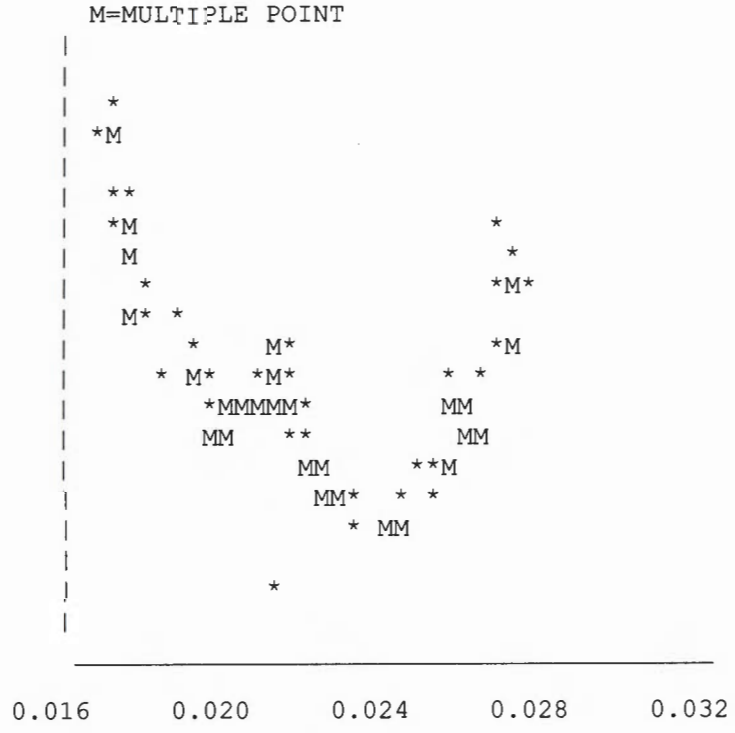
	SS	DF	MS	F
REGRESSION	1176.7	9.	130.74	2806.497
ERROR	4.4256	95.	0.46585E-01	P-VALUE
TOTAL	1181.1	104.	11.357	0.000

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 95 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
RPRPOR	0.34002	0.1462	2.326	0.022	0.232	0.1726	0.2601
RPRCH	0.45910	0.1592	2.884	0.005	0.284	0.3472	0.0790
PCRDI	-67.889	14.18	-4.786	0.000	-0.441	-0.6155	-0.4454
PCSLA	-35.838	12.17	-2.945	0.004	-0.289	-0.3192	-0.3516
MADC	0.75980	0.9153E-01	8.301	0.000	0.648	0.6271	0.0196
GRILLO	0.18484E-01	0.6204E-01	0.2979	0.766	0.031	0.0235	0.0014
GRILLT	0.11831	0.6030E-01	1.962	0.053	0.197	0.1504	0.0088
GRILLTH	0.74458E-01	0.6063E-01	1.228	0.222	0.125	0.0946	0.0056
CONSTANT	4.7695	0.7210	6.615	0.000	0.562	0.0000	1.4226

OBS. NO.	OBSERVED VALUE	PREDICTED VALUE	CALCULATED RESIDUAL		
1	4.2737	3.7807	0.49305	I	*
2	4.2737	3.7950	0.47875	I	*
3	4.3622	3.9467	0.41544	I	*
4	4.2446	3.7879	0.45675	I	*

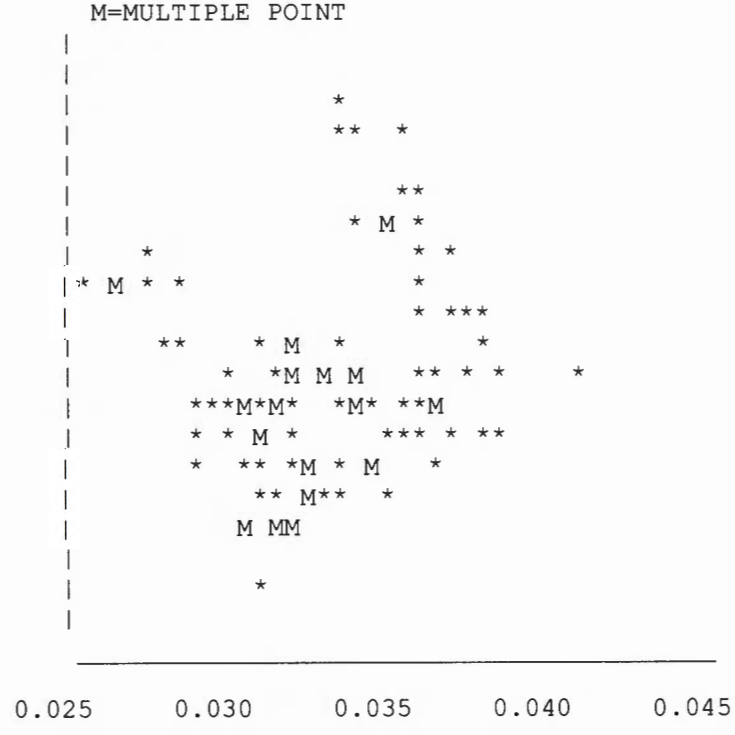
5	4.0684	3.7437	0.32462	I *
6	3.9421	3.7953	0.14679	I *
7	4.0073	3.7552	0.25209	I *
8	3.8697	3.6156	0.25409	I *
9	3.7852	3.6523	0.13295	I *
10	3.9004	3.8015	0.98903E-01	I *
11	3.8619	3.7647	0.97186E-01	I *
12	3.6484	3.6470	0.14557E-02	*
13	3.6342	3.7077	-0.73435E-01	* I
14	3.7161	3.7219	-0.57675E-02	*
15	3.5716	3.5959	-0.24338E-01	*I
16	3.4388	3.3454	0.93412E-01	I *
17	3.5609	3.5288	0.32069E-01	I*
18	3.5304	3.5178	0.12634E-01	*
19	3.4141	3.4256	-0.11460E-01	*
20	3.4072	3.3460	0.61202E-01	I*
21	3.3982	3.4073	-0.90868E-02	*
22	3.3070	3.4403	-0.13337	* I
23	3.1931	3.3865	-0.19344	* I
24	3.2153	3.3783	-0.16302	* I
25	3.2412	3.4557	-0.21442	* I
26	3.1402	3.3758	-0.23562	* I
27	3.1641	3.5401	-0.37603	* I
28	3.1853	3.5011	-0.31581	* I
29	3.1868	3.4355	-0.24872	* I
30	3.2793	3.5215	-0.24224	* I
31	3.2959	3.4677	-0.17186	* I
32	3.2721	3.3893	-0.11715	* I
33	3.2445	3.3717	-0.12720	* I
34	3.3201	3.5031	-0.18305	* I
35	3.3491	3.4515	-0.10242	* I
36	3.3241	3.2748	0.49315E-01	I*
37	3.3643	3.4902	-0.12594	* I
38	3.4089	3.4724	-0.63438E-01	*I
39	3.3976	3.4217	-0.24106E-01	*I
40	3.3617	3.3330	0.28697E-01	I*
41	3.3966	3.4309	-0.34346E-01	*I
42	3.4559	3.5132	-0.57320E-01	*I
43	3.4133	3.5448	-0.13146	* I
44	2.6983	3.5016	-0.80338 X	I
45	3.5157	3.4992	0.16417E-01	*
46	3.5050	3.5343	-0.29267E-01	*I
47	3.3624	3.5017	-0.13939	* I
48	3.2744	3.4085	-0.13409	* I
49	3.2897	3.3691	-0.79345E-01	* I
50	3.3299	3.4330	-0.10315	* I
51	3.2687	3.4050	-0.13632	* I
52	3.2978	3.3370	-0.39246E-01	*I
53	3.3293	3.2079	0.12141	I *
54	3.4471	3.2147	0.23238	I *
55	3.2968	3.1848	0.11207	I *
56	3.2458	3.1632	0.82572E-01	I *
57	3.1593	3.1709	-0.11671E-01	*
58	3.1794	3.1821	-0.26818E-02	*
59	3.0929	3.1290	-0.36137E-01	*I
60	3.0676	2.9357	0.13189	I *
61	3.1028	3.1586	-0.55761E-01	*I

```
      62    3.0808       3.0844     -0.36004E-02                *
      63    3.0881       2.9145      0.17366                    I    *
      64    3.0733       3.0129      0.60440E-01                I*
      65    2.9895       3.0418     -0.52357E-01               *I
      66    2.9575       3.0637     -0.10618                 * I
      67    2.9803       3.1545     -0.17419               *   I
      68    3.0175       3.1227     -0.10520                 * I
      69    2.9352       3.1096     -0.17440               *   I
      70    2.9305       3.1580     -0.22752              *    I
      71    2.9414       3.1203     -0.17890               *   I
      72    2.9109       3.1064     -0.19548              *    I
      73    2.8411       3.0978     -0.25673             *     I
      74    2.8883       3.1169     -0.22859              *    I
      75    2.8675       3.0482     -0.18075               *   I
      76    2.8886       3.0320     -0.14341                *  I
      77    2.8563       3.0206     -0.16432               *   I
      78    2.9179       3.1534     -0.23554              *    I
      79    2.9486       3.0626     -0.11406                *  I
      80    3.0376       3.0081      0.29558E-01               I*
      81    2.9804       3.0118     -0.31476E-01              *I
      82    3.0979       3.0892      0.87211E-02               *
      83    3.1020       2.9642      0.13777                   I  *
      84    3.0894       3.0148      0.74637E-01               I *
      85    3.2519       3.0800      0.17191                   I    *
      86    3.3740       3.1225      0.25157                   I      *
      87    3.3212       3.0621      0.25909                   I      *
      88    3.2464       3.0580      0.18845                   I    *
      89    3.1863       3.0562      0.13010                   I  *
      90    3.1942       3.0644      0.12978                   I  *
      91    3.1727       2.9959      0.17683                   I    *
      92    3.1742       2.9526      0.22169                   I     *
      93    3.2916       2.9845      0.30707                   I       *
      94    3.4320       2.9422      0.48980                   I           *
      95    3.4706       2.8796      0.59097                   I
*
      96    3.8810       3.4887      0.39222                   I         *
      97    3.6882       3.7299     -0.41712E-01              *I
      98    3.7559       3.7295      0.26351E-01               I*
      99    3.7547       3.7691     -0.14321E-01               *
     100    3.6618       3.6931     -0.31245E-01              *I
     101    3.7117       3.7404     -0.28680E-01              *I
     102    3.7694       3.7877     -0.18329E-01               *
     103    3.5095       3.7155     -0.20595                *     I
     104    3.5253       3.6036     -0.78338E-01              * I

 DURBIN-WATSON = 0.4683    VON NEUMANN RATIO = 0.4729    RHO =  0.73870
 RESIDUAL SUM = -0.34417E-13  RESIDUAL VARIANCE =  0.46585E-01
 SUM OF ABSOLUTE ERRORS=   15.894
 R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.6333
 RUNS TEST:   24 RUNS,   43 POS,    0 ZERO,   61 NEG  NORMAL STATISTIC = -
5.5769

 |_PLOT RPRBF PCRDI

 REQUIRED MEMORY IS PAR=      10 CURRENT PAR=    4000
       104 OBSERVATIONS
                   *=RPRBF
```



|_PLOT RPRBF PCSLA

REQUIRED MEMORY IS PAR= 10 CURRENT PAR= 4000
104 OBSERVATIONS



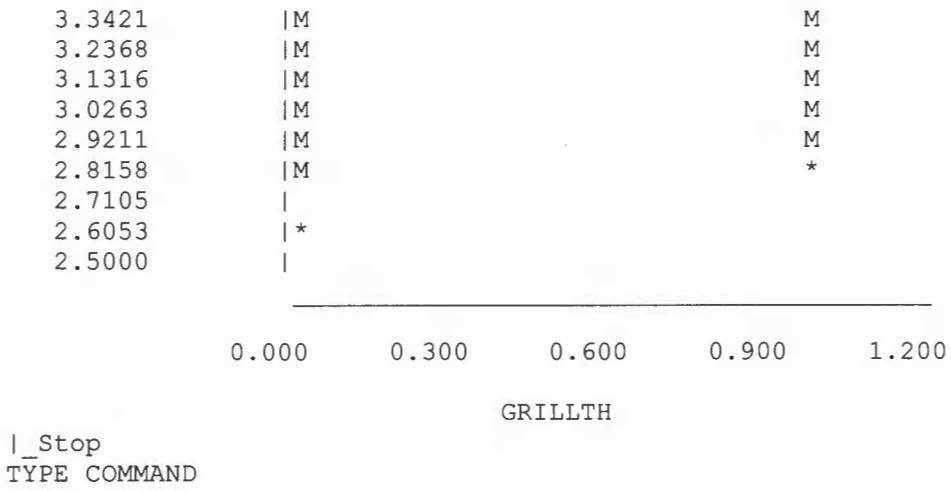
PCSLA

```
|_PLOT RPRBF MADC

REQUIRED MEMORY IS PAR=      10 CURRENT PAR=    4000
      104 OBSERVATIONS
                  *=RPRBF
                  M=MULTIPLE POINT
   4.5000         |
   4.3947         |
   4.2895         |*
   4.1842         |M
   4.0789         |
   3.9737         |M
   3.8684         |M                                *
   3.7632         |M                                *
   3.6579         |*                                M
   3.5526         |M
   3.4474         |M                                M
   3.3421         |M
   3.2368         |M
   3.1316         |M
   3.0263         |M
   2.9211         |M
   2.8158         |M
   2.7105         |
   2.6053         |*
   2.5000         |
                  ---------------------------------------------------
              0.000      0.300      0.600      0.900      1.200
```

MADC

```
|_PLOT RPRBF GRILLO

REQUIRED MEMORY IS PAR=      10 CURRENT PAR=    4000
      104 OBSERVATIONS
                  *=RPRBF
                  M=MULTIPLE POINT
   4.5000         |
   4.3947         |
   4.2895         |*
   4.1842         |M                                *
   4.0789         |
   3.9737         |*                                *
   3.8684         |M
   3.7632         |M                                *
   3.6579         |M                                M
   3.5526         |M                                M
   3.4474         |M                                *
   3.3421         |M                                M
   3.2368         |M                                M
   3.1316         |M                                M
   3.0263         |M                                *
   2.9211         |M                                M
   2.8158         |M                                M
```

```
   2.7105         |
   2.6053         |*
   2.5000         |
                  ---------------------------------------------------
               0.000      0.300      0.600      0.900      1.200

                                GRILLO

|_PLOT RPRBF GRILLT
REQUIRED MEMORY IS PAR=      10 CURRENT PAR=    4000
      104 OBSERVATIONS
                  *=RPRBF
                  M=MULTIPLE POINT
   4.5000         |
   4.3947         |
   4.2895         |*
   4.1842         |M                                    *
   4.0789         |
   3.9737         |M
   3.8684         |M                                    M
   3.7632         |M                                    *
   3.6579         |M                                    M
   3.5526         |M
   3.4474         |M                                    M
   3.3421         |M                                    M
   3.2368         |M                                    M
   3.1316         |M                                    M
   3.0263         |M                                    M
   2.9211         |M                                    M
   2.8158         |M                                    M
   2.7105         |
   2.6053         |*
   2.5000         |
                  ---------------------------------------------------
               0.000      0.300      0.600      0.900      1.200

                                GRILLT

|_PLOT RPRBF GRILLTH

REQUIRED MEMORY IS PAR=      10 CURRENT PAR=    4000
      104 OBSERVATIONS
                  *=RPRBF
                  M=MULTIPLE POINT
   4.5000         |
   4.3947         |
   4.2895         |                                     *
   4.1842         |M
   4.0789         |
   3.9737         |*                                    *
   3.8684         |M
   3.7632         |M                                    *
   3.6579         |M                                    *
   3.5526         |M                                    *
   3.4474         |M                                    M
```

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|_Stop
TYPE COMMAND
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V. Results

Looking at this econometric model, it is determined that five of the variables analyzed have significance, while three are close to having a significant impact warranting discussion. The five variables that turned out to be significant are the real price of pork, the real price of chicken, the real per capita disposable income, the per capita slaughtered variable, and the made cow disease variable. Significance is determined with a T-Ratio above two. The seasonal dummy variables turned out not to have strong enough significance, but are close to showing some impact on the real price of beef. The model has a strong adjusted R-squared value of .6025. This shows how well the regression analysis fits the best fitting line. Too high or too low of an adjusted R-squared can lead to analysis that can be false or misleading.

The real price of pork has a significant impact on the real price of beef. The T-Ratio of 2.326 is a solid number when looking to determine significance. The positive sign on the coefficient shows that as the price of beef increases then the price of pork will also rise. This makes sense because as the price of pork increases the demand for a substitute good. If the demand for beef increases then the price will also rise.

The real price of chicken is also significant with a positive sign on the coefficient. The T-Ratio of 2.884 is a solid number for analysis. The positive sign is as predicted. This is also due to the face of beef being a substitute good to chicken. This means that as the price of chicken goes up demand for beef increases. The increase in demand moves the price up.

Next, the real per capita disposable income has significance with a T-Ratio of -4.786. This negative sign can be puzzling because it would stand to reason that as the wealth of a family increased that the price of beef would also increase. However, according to this model the opposite is true. This could mean that beef is an inferior good. An inferior good is a good that as income increases then a consumer consumes less of that good. This variable may be misleading because the real price of beef is determined using a bundle of beef goods with varying range of price with higher quality products like porterhouse steaks and beef tenderloin and lower end products such as ground beef or charcoal steak. People substitute up the quality of beef goods as income increases so beef may not be an inferior good after all. These are the two explanations for why the negative sign is occurring.

The per capita slaughter variable is also significant with a negative sign on the coefficient and a T-Ratio of -2.945. This makes sense because if the supply of cattle being slaughtered increases then the price of beef would fall if demand stays constant. Suppliers of slaughtered cattle will lower the price of beef with the excess supply which allows retailers to sell at a lower price to the consumer. This is why packing plants must watch the demand so they slaughter the proper amount of cattle to meet the excess demand or possible falling demand and keep prices in the appropriate range.

Mad Cow Disease also has a significant impact with a positive coefficient and a T-Ratio of 8.301. This may seem high but with a dummy variable a larger T-Ratio is possible. The sign

makes sense because as the presence of Mad Cow Disease exists, there will be a decrease in the demand for beef. As demand decreases so does the price of beef. The presence of mad cow disease will also decrease the supply of beef however it appears the demand may have a more significant impact then that supply shift.

The seasonal variables turned out to not have the impact that was originally predicted. This could be due to not as big of seasonal demand factors as originally thought. Also, the study includes the entire United States and because of the varying geographic regions in the United States it is possible to have regions where grilling is possible all year long, three-fourths of the year, half of the year, one-fourth of the year, or not at all. This may lead to the insignificance of this seasonal variable. It may be that in quarters two and three of the year there are more people with the ability to grill then in the first and fourth quarters of the year.

VI. Conclusion

After analyzing background information, a model was constructed that helps determine some possible influences for retail beef prices. Looking at different supply and demand variables and applying the law of supply and demand it is shown that both supply and demand factors affect the retail price of beef. In this model, the real price of pork, the real price of chicken, the real per capita disposable income, the per capita slaughter, and the presence of mad cow disease had a significant impact on the final retail price of beef. This model can help retailers, but further analysis and study to tweak the regression equation would make the model a better predictor of things that can influence the retail price of beef.

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