The Effects of Japanese Exports on Wholesale Beef and Live Cattle Prices

by

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Has the rapid growth in the exports of wholesale beef affected U.S. beef and cattle prices? The short-term impact of U. S. beef exports to Japan, the dominant export destination, is estimated via econometric analysis of the relationship between monthly wholesale beef prices and export volumes of wholesale cuts to Japan. Rib and loin prices were significantly affected by Japanese exports, and the multiplier effects on U.S. cattle prices were higher than anticipated.

Introduction

U.S. beef exports in 1994 equalled $2.3 billion, a 15 percent increase over the previous year. (USDA). While the percentage growth in exports has been impressive, the *share* of U.S. beef that is exported has increased by only about 0.5 percent per year. For example, in 1990 the United States exported 4.1 percent of production, compared to 6 percent in 1994. The rapid growth in exports has created enthusiasm among producers for funding export promotions, and an interest in how effectively these producer dollars are spent.

It is not clear whether a 1.2 percent yearly increase in demand for U.S. beef would have a significant effect. First, there are other ongoing trends such as changes in tastes in the United States, and increases in domestic beef promotions that may offset or enhance any export driven effect on prices. Second, producers can and will respond to any export drive price increase, which in turn means that the influence of exports on profitability will be short-lived.

In this study, we measure the short-term impact of U.S. beef exports to Japan. We chose Japan because it is the dominant export destination, and the Japanese beef trade pattern with the United States has been extremely volatile with very large month-to-month swings in volume. U.S. beef exports to Japan have consisted primarily, of the more expensive middle cuts such as loins and ribs. Our expectation was that Japan's impact on the loin or rib market would be more important than its impact on the beef market as a whole.

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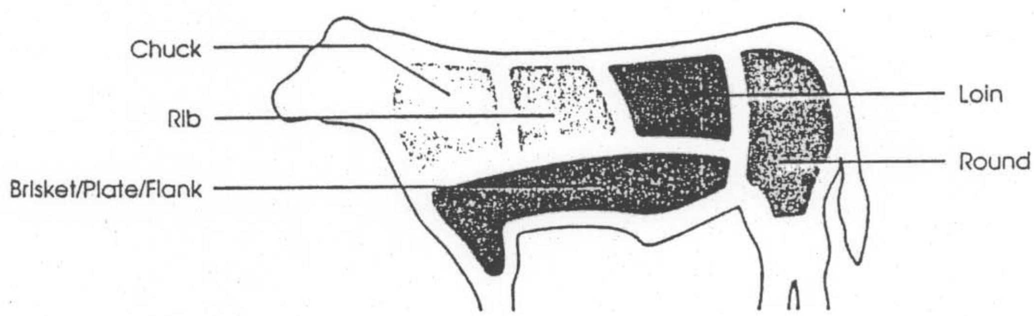
Two models were developed to determine the relationship between U.S. beef exports and beef wholesale cuts. The first model was a set of wholesale beef primal price equations expressed as a function of U.S. beef exports to Japan and other market variables. Then export effects were traced back to the live cattle price via a live cattle price equation which was a function of prices of the beef primal cuts. The second model was an expenditures-shares model, in which the effects of U.S. beef exports to Japan and other market variables on the relative expenditures shares of selected individual beef cuts were analyzed. One would expect that exports would have positive effects on relative shares of the more expensive beef cuts (e.g. loin and ribeye cuts) typically exported in larger volumes, and negative effects on the relative shares of the other cuts (e.g. chuck, round, brisket cuts). For each model, we used both the total U.S. beef exports to Japan, and the exports of each primal cut as alternative explanatory variables. We present results of all four models, in part to show that our results are robust with respect to model specification, and also because they offer guidance as to how these impacts should be measured.

Data Collection and Sources

Selection of the Representative Beef Wholesale Cut Price Series[1] ($P_{i,t}$)

The beef carcass is divided into five major sections or primal cuts: chuck, rib, loin, round, and the brisket/plate/flank. Trimmings from these five major sections of the carcass are also very important in assessing the total value of the carcass.

Figure 1: The Major Sections of the Beef Carcass



The Livestock Industry Promotion Corporation (LIPC), a Japanese government agency, reports Japanese beef imports in the following four categories: (1) loins; (2) chuck, clod, and round; (3) ribs; and (4) others, which are the brisket/plate/flank cuts. Single cuts of beef were selected to be representative of each of the four categories based upon several criteria. First, the cut must have been heavily traded with very few or no missing observations in the selected time period, January 1988-April 1994. Monthly carload averages of the number of reported trades to the USDA *Livestock Market News* reporters were used to identify those cuts with the heaviest trading volumes. Second, the price

[1] All weighted weekly average prices of individual cuts and beef trimmings were provided by the *Livestock Market News*, USDA, Federal Building, Des Moines, IA.

behavior of the cut should be representative not only of the primal cut, but also of the other cuts that fall into that major category. Third, the price correlations and covariances of three to four cuts in each major category were used to determine the strengths of the interrelationships among cuts. Fourth, the selected cut should also be one that is exported to Japan.

The criteria outlined above suggested the following cuts: 112A ribeye; 2" lipon, 11 lb. and up; 115 chuck; 2 piece boneless, 50-80 lb.; 168 top inside round, 14-26 lb.; 174 short loin 2x33, 16-30 lb.; and 189A full tenderloin muscle, 5 lb. and up. We also chose the 120 brisket and 50 percent fresh trimmings for comparison, even though they are not important in the export market.

Export Variables ($X_{i,t}$)

All U.S. monthly beef export data to Japan for the period January 1988-April 1994 were provided by the LIPC. Total U.S. beef exports to Japan were known throughout the entire time period. The LIPC reported Japanese beef imports by cut and country of origin in four different individual cut categories: loins; chuck, clod, and round; ribs; and others. However, the data were reported in different formats during this time period. The changes in monthly exports were converted into weekly data by interpolating the changes between consecutive months.[2]

Table 1: Annual U.S. Beef Exports to Japan (Metric Tons)[3]

Calendar Year	Total Exports	Loin Cuts	Chuck, Clod, and Round Cuts	Rib Cuts	Other Cuts
1988	109,024	18,432	19,147	58,511	903
1989	144,998	27,173	28,160	80,589	1,268
1990	158,049	30,253	31,303	85,586	1,365
1991	154,204	40,853	37,320	67,412	1,453
1992	184,958	45,726	46,756	82,030	1,236
1993	217,052	50,694	51,589	106,610	2,315

There has been an upward trend in the volume of total U.S. beef exports since 1988 (Figure 2 and Table 1). Total U.S. beef exports usually peaked in April and October of each year. The April rise in exports could be attributed to the beginning of the Japanese fiscal year when the gradual lifting of quota volumes before April, 1991, and the annual reductions

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[2] A full description of the data adjustments we used is available in a longer version of this paper, available upon request from Dr. Dermot J. Hayes, Iowa State University, Center for Agriculture and Rural Development, Ames, IA, 50011-1070.

[3] Note that the cuts categories do not sum to total exports because U.S. exports of carcasses, bone-in cuts, and edible offal are not reported, but are included in total exports. The individual cuts categories for 1988-1991 are estimated annual exports.

in the tariffs on beef imports after April, 1991 had taken place. The peak in exports around October might be caused by the beginning of the sukiyaki and mizudaki (hot pot dishes which use beef) seasons which correspond with the beginning of cold weather in Japan.

Rib cuts were the largest volume of U.S. beef cuts exported to Japan (averaging 46 percent of total exports), while the loin and the chuck, clod, and round cuts categories were both approximately 25 percent of total exports. As shipping and refrigeration technology improved, U.S. exports of fresh beef rose from 8 percent of total beef exports to Japan in 1988 to 25 percent of total beef exports to Japan in 1993. During 1988-1994, the percentages of the loin cuts and the chuck, clod, and round cuts rose, while the percentages of rib cuts fell. Rib cuts made up the majority of the frozen U.S. beef exports to Japan (62 percent), but only one-quarter of the fresh beef exports. Loin cuts and the chuck, clod and round cuts were approximately 37 percent of fresh and 18 percent of frozen U.S. beef exports to Japan, respectively.

Model Specification

Weekly average wholesale prices for the individual beef cuts are expected to be influenced by the per capita quantity of beef slaughtered, potential substitutes (the per capita quantity of pork slaughtered and the per capita quantity of poultry slaughtered), per capita consumer income, the volume of total and individual cut beef exports which would affect the supply of beef available for domestic consumption, seasonal patterns which are demand related, primarily weather related influences on demand, holiday influences on demand or on slaughter relationships, changes in taste and preferences, and last weeks wholesale price (due to price inertia[4]).

The conceptual model is shown below:

$P_{i,t} =$ f ($P_{i,t-1}$, $Trend_t$, $QBeef_t$, $QPork_t$, $QPoult_t$, Inc_t, X_t, X_{t+m}, M_1 ... M_{11}, Eas, Holiday, CS1, $SS1_i$, CS2, $SS2_i$, $e_{i,t}$)

where:

$P_{i,t}$ = the weighted weekly average wholesale price of selected cut i in week t ($/cwt.)
$Q_{B,t}$ = per capita aggregate weekly slaughter of all federally inspected U.S. beef (cwt.) (*Livestock, Meat and Wool Market News*).

$Q_{P,t}$ = per capita aggregate weekly slaughter of all federally inspected U.S. pork (cwt.) (*Livestock, Meat and Wool Market News*).

$Q_{POUL,t}$ = per capita aggregate weekly slaughter of all federally inspected weekly slaughter of young chickens, hens, and live turkeys in the U.S. (cwt.) (*Poultry Market News*).

I_t = weekly interpolated U.S. per capita disposable personal income in 1987 constant

[4] This one-week lag on wholesale prices was suggested by Oral Capps, Jr., Texas A&M University.

dollars[5] (*Survey of Current Business*).

$Trend_t$ = weekly trend term to capture changes in tastes and preferences

$P_{i, t-1}$ = the weighted weekly average wholesale price of selected cut i in week t - 1 ($/cwt.)

X_t = weekly interpolated total U.S. beef exports, or weekly interpolated U.S. beef exports to Japan by individual cut (cwt.)

X_{t+m} = weekly interpolated total U.S. beef exports or weekly interpolated U.S. beef exports to Japan by individual cut (cwt.), adjusted forward *m* time periods

M_1 , ... M_{11} = Monthly seasonal shifters, M_1 = 1 if February, zero if otherwise.

Eas = Easter Holiday shifter to capture possible substitution effects of increased quantities of pork (ham), Eas = 1 if the week is before Easter, zero if otherwise.

Holiday = Holiday shifter associated with fewer slaughter days in the week. This shifter also may reflect that holidays like Thanksgiving and Christmas may be more poultry or ham menu-intensive, Holiday = 1, if number of slaughter days per week are reduced due to a national holiday, zero if otherwise.

CS1 = Possible data measurement error constant shifter for first individual cut export estimation period, January 1988-Last week of December 1990, CS1 = 1 for all observations before the first week of January 1991, zero for all other observations.

$SS1_i$ = Possible data measurement error slope shifter for first individual cut export estimation period, January 1988 - Last week of December 1990, $SS1_i = 1*X_{i,t}$ for all observations before the first week of January 1991, zero for all other observations.

CS2 = Possible data measurement error constant shifter for second individual cut export estimation period, January 1991 - Last week of March 1992, CS2 = 1 for all observations from the first week of January 1991 to last week of March, 1992, zero for all other observations.

$SS2_i$ = Possible data measurement error slope shifter for second individual cut export estimation period, January 1991 - Last week of March 1992, $SS2_i = 1*X_{i,t}$ for all observations before the first week of January 1991, zero for all other observations.

One would expect that the lagged wholesale price $P_{i, t-1}$ will have a positive relationship with this weeks wholesale price due to price inertia (stickiness of prices from week to week. The effects of the quantities of substitutes on wholesale beef cut prices is

[5] Figures from 1988, 1989, and 1990 were represented in 1982 constant dollars, but have been adjusted to 1987 constant dollars by determining the relationship between the monthly 1982 and 1987 deflators for the time period of October 1990-October 1991. The 1987 deflator is approximately .84171 of the 1982 deflator.

Figure 2

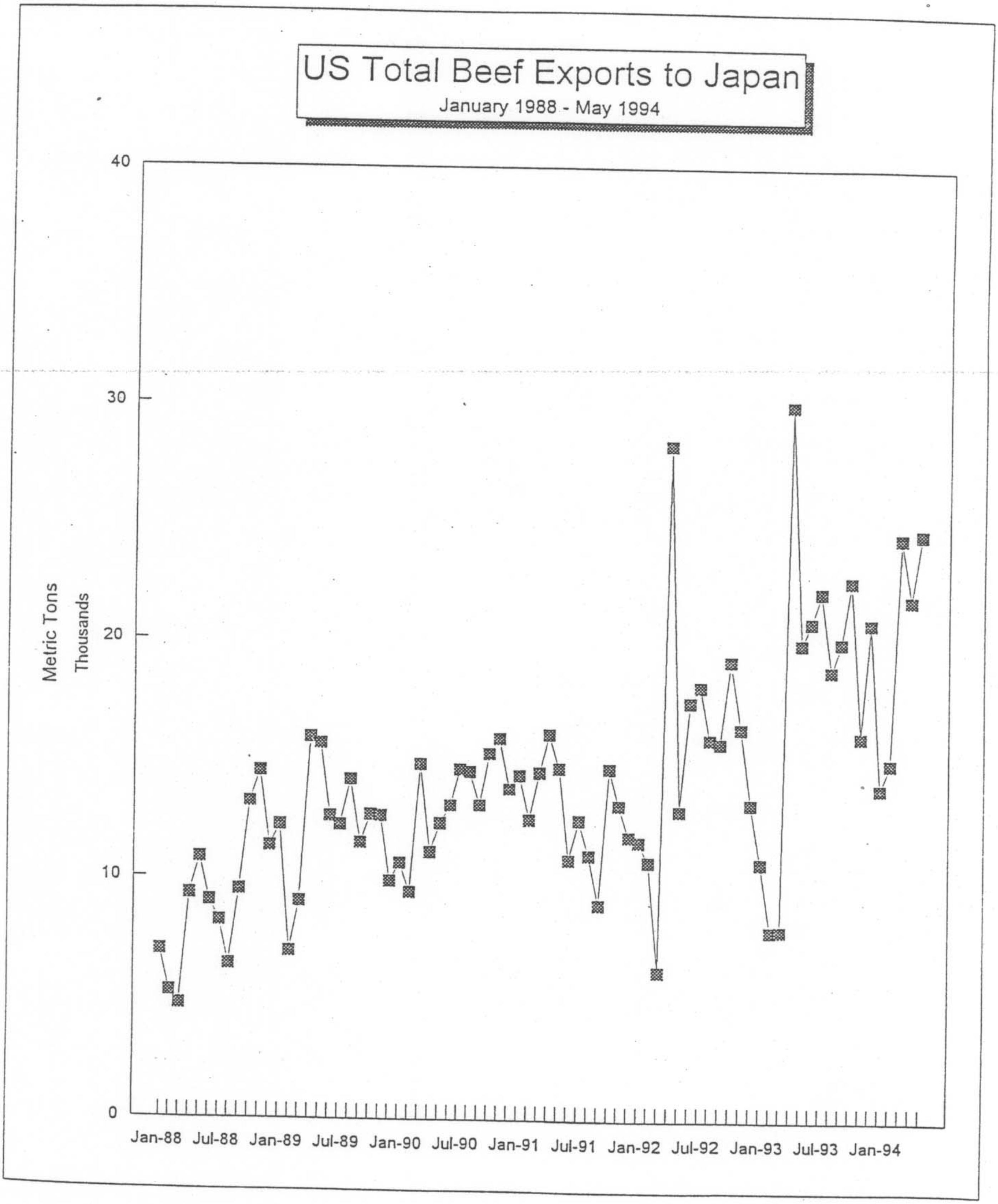
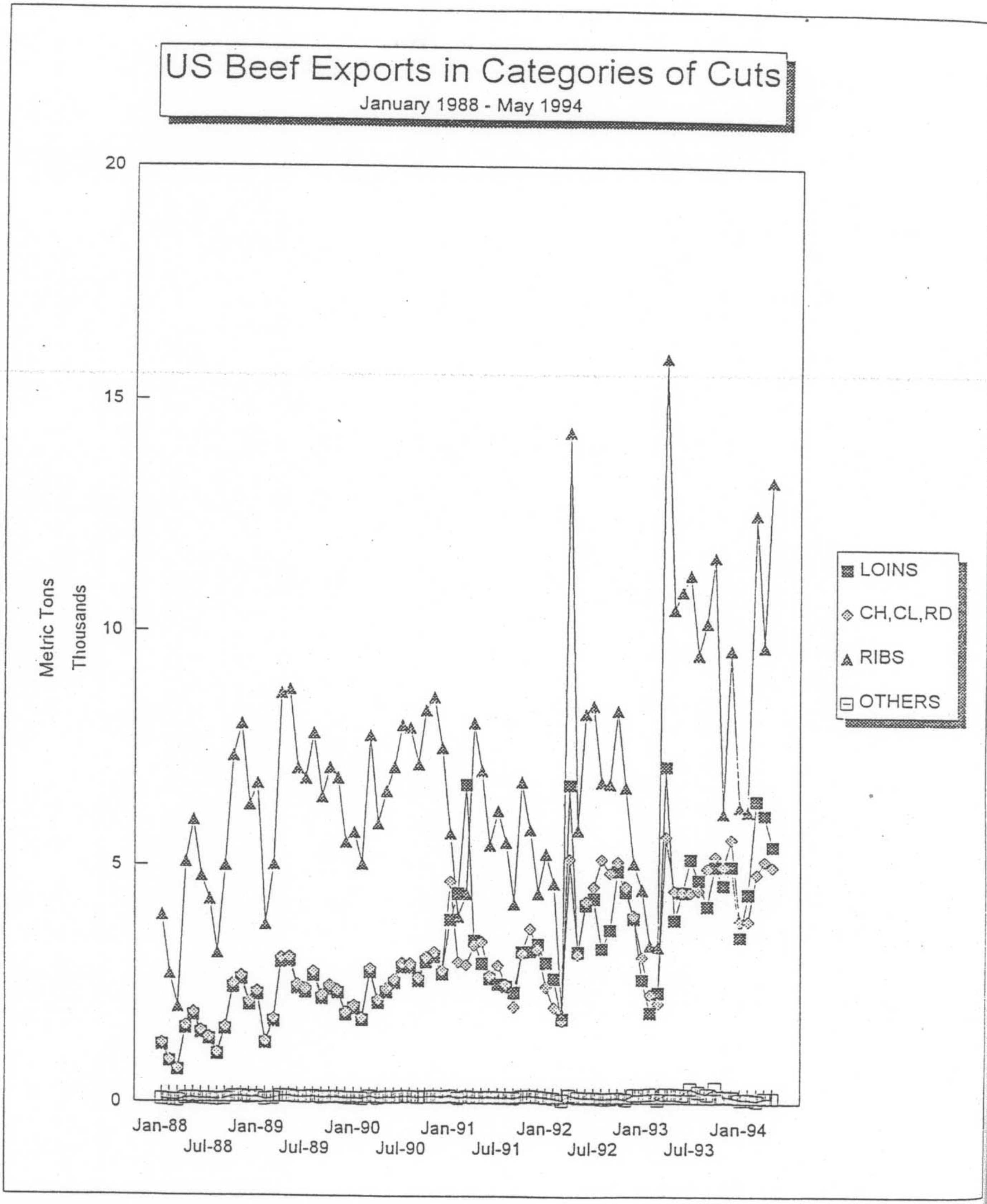

US Total Beef Exports to Japan
January 1988 - May 1994
Metric Tons
Thousands
40
30
20
10
0
Jan-88
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94

Figure 3


US Beef Exports in Categories of Cuts
January 1988 - May 1994
20
15
10
5
0
Metric Tons
Thousands
Jan-88
Jul-88
Jan-89
Jul-89
Jan-90
Jul-90
Jan-91
Jul-91
Jan-92
Jul-92
Jan-93
Jul-93
Jan-94
LOINS
CH,CL,RD
RIBS
OTHERS

somewhat ambiguous. Substitutes should have negative price relationships, but Koontz, Trapp, and Meyer found that slaughter levels of substitute meats had no effect on weekly wholesale boxed beef prices. Eales and Unnevehr found most beef-poultry substitution was between hamburger (trimmings) and whole birds, and that changes in preferences have led to the substitution of chicken parts for higher valued beef table cuts.

January was selected as the base month for the monthly seasonal shifters, $M_1, \ldots M_{11}$. Seasonal patterns between the different cuts are expected, with the summer barbecue season having a positive effect on wholesale prices of cuts (steaks) which are commonly grilled, whereas wholesale prices of cuts which are used for roasts and other non-grill purposes (chuck, round) should be positively affected by winter months. Wahl, Hayes, and Hennessy found that the expenditure shares of more expensive beef cuts (loins and ribeyes) were greatest in mid summer while the share of ground beef reached a maximum in early winter.

U.S. beef exports to Japan, whether total or by cut, should have a positive relationship on wholesale beef cut prices due to the reduction in supply of beef available for domestic consumption. All regressions incorporated either the total U.S. exports, $X_{Total,\,t}$, or U.S. beef exports to Japan by individual cut group, $X_{i,t}$, and all other cuts, $SX_{j,\,j \neq i,\,t}$. In those regressions where $X_{Total,\,t}$ was used, the slope and constant shifters were not used as there was no potential estimation error in the export data.

Dickey-Fuller tests for stationarity were performed on all price series. For the majority of the price series (112A ribeye, 115 chuck, 168 top inside round, and 50 percent trimmings at the 5 percent level and 120 brisket and 189A full tenderloin at the 10 percent level), the random walk hypothesis can be rejected at either the 5 percent or the 10 percent significance levels; thus the price series were stationary. We failed to reject the random walk null hypothesis that the variable was not a random walk for the live cattle and 174 short loin price series. Since the stationarity tests are weak and the preponderance of these related series were stationary, standard estimation techniques were employed for all the equations.

Price Equations for Wholesale Beef Cuts

Two basic approaches were used to develop the appropriate model to determine the net impact of exports on wholesale beef and live cattle prices. The first method employed regressed the independent variables, including exports of individual wholesale beef cut *i* in week *t* and week *t + m* and the sum of all other individual cuts *j* exports ($SX_{j,\,j \neq i}$) in week *t* and week *t + m* against each individual cuts weekly price series

(1) $P_{i,t} = a + b_{1,t}P_{i,t-1}, b_{2,t}Trend_t + b_{3,t}QBeef_t + b_{4,t}QPork_t + b_{5,t}QPoult_t + b_{6,t}Inc_t + b_{7,t}X_{i,t} + b_{8,t}X_{i,t+m} + b_{9,t}SX_{j,\,j \neq i,\,t} + b_{10,t}SX_{j,\,j \neq i,\,t+m} + b_{11}M_1 + \ldots + b_{22}M_{11} + b_{23}Eas + b_{24}Holiday + b_{25}CS1 + b_{26}SS1_i + b_{27}CS2 + b_{28}SS2_i + e_t$

or using total exports,

(2) $P_{i,t} = a + b_{1,t}P_{i,t-1}, + b_{2,t}Trend_t + b_{3,t}QBeef_t + b_{4,t}QPork_t + b_{5,t}QPoult_t + b_{6,t}Inc_t + b_{7,t}X_{Total,t} + b_{8,t}X_{Total,\,t+j}, + b_{9,}M_1 + \ldots + b_{20}M_{11} + b_{21}Eas + b_{22}Holiday + e_t$

These wholesale beef cut prices were in turn related back to the live cattle price[6].

(3) $P_{Live\ Cattle\ ,\ t} = a + b_{1,t}P_{112\ Ribeye,\ t} + b2_{,t}P_{115\ Chuck,\ t} + b_{3,t}P_{120\ Brisket\ ,\ t} + b_{3,t}P_{168\ Round,\ t} + b_{4,t}P_{174\ Short\ Loin,t} + b_{5,t}P_{189\ Tenderloin,\ t} + b_{6,t}P_{50\%\ Trimmings\ ,\ t} + e_t$

By using this approach, one can determine the effects of U.S. beef exports to Japan through the flexibilities in each wholesale cut' s price equation and then back to the live cattle price through the wholesale cut-live animal price relationships in equation (3).

The export data were adjusted to reflect the time difference between the actual purchase of the beef to be exported and its arrival in Japan. Fresh or chilled beef exports are transported very quickly and the effects of these purchases on the wholesale beef cuts are fairly immediate. However, frozen U.S. beef exports arriving in Japan in week *t* would most likely have been purchased several weeks earlier. The combination of current exports and exports adjusted forward four weeks yielded the best fit. The wholesale beef cut price effects of Japanese purchases of U.S. beef were strongest approximately four weeks before the U.S. beef exports arrived in Japan.

The sum of all other individual cuts exports variables ($SX_{j,\,j\,\prime\,i}$) in week *t* and week *t* + *m* were used in the model where individual exports were used; which should account for substitution effects among beef cuts. There were several periods during the data set where there was a high correlation among the various cuts exports (see Figure 3) and this correlation may cause biased estimates of the export variables.

There was a high degree of correlation between per capita income and the weekly trend variable (0.94). Regressions were run with per capita income excluded, with trend excluded, and with both variables excluded. With the trend term removed, the multicollinearity was reduced and the significance of some variables was increased. The Easter and holiday dummy variables proved to be insignificant in the total and individual cut export models so they were excluded. The data measurement error constant and slope shifters for the second individual cut export estimation period proved to be insignificant in the individual cuts export models so they were dropped in the results presented.

Many different functional forms were considered, with little difference in results. The log-log model results using total exports are shown in Table 2 and the log-log model results using individual cuts exports are shown in Table 3. In estimating the models where individual export variables were used, the seemingly unrelated regression method was applied to correct for the possibility of correlation of the errors from each equation. The equations using the total exports variable had all of the same right-hand side variables, so the OLS method of estimation was employed.

The models' explanatory powers ranged from 40 to 70 percent, with poorer fits noted for the 112A ribeye, the 168 top inside round, and the 189A full tenderloin. There was no apparent difference in the fits of the total export and the individual export equations in Tables

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[6] Weekly average of daily quotations of Iowa-Southern Minnesota choice steers (11-13 cwt.). These prices were adjusted for 3 percent shrinkage to reflect plant prices.

2 and 3. The addition of more detailed information on export data added little to the ability to explain U.S. price behavior.

The estimated coefficients of the lagged wholesale price of cut *i* were significantly positive in all of equations using individual exports and in six of the seven equations using total exports. While significant, the carryover effect of wholesale prices was quite low (usually around 10 percent) with the exception of 50 percent trimmings (over 3 percent). Four of the seven equations in both models had significant beef slaughter coefficients; they were negative (with the exception of the 174 short loin in the model with individual exports). The 50 percent trimmings price was most affected by changes in the quantity of beef slaughtered. With the exception of the 189A full tenderloin equations (negative signs, but not significant), the pork slaughter coefficients were all significantly negative in both models (which is the expected relationship between substitute products).

Table 2: Price Equations for Wholesale Beef Cuts with Total Exports

	112A Ribeye	115 Chuck	120 Brisket	168 Round	174 Short Loin	189A Full Tenderloin	50 percent Trimmings
D-W	0.45	0.66	0.61	0.62	0.39	0.41	0.68
Intercept	15.5**	18.6**	9.7**	19.5**	15.1**	38.6**	22.1**
Lag $P_{i,t-1}$	0.05**	0.04**	0.07**	0.04**	0.05**	0.05	0.31**
QBeef	0.01	-0.28**	-0.29**	-0.24**	0.07	0.16	-0.70**
QPork	-0.16**	-0.21**	-0.27**	-0.17**	-0.14**	-0.11	-0.33**
QPoult	-0.04	0.33**	0.33**	0.23**	-0.01	-0.01	0.67**
Inc	-1.25**	-1.58**	-0.75**	-1.6**	-1.2**	-3.7**	-2.2**
X_{Total}	0.06**	0.05**	0.03	0.02	0.05**	0.16**	NA
$X_{Total,t+4}$	0.10**	0.02	0.05**	0.04**	0.09**	0.13**	NA
Feb	-0.02	-0.10	0.01	-0.01	0.02	0.00	0.01
Mar	-0.02	-0.03**	-0.02	0.03**	0.02	-0.03	0.05
Apr	-0.04**	-0.09**	-0.08**	0.02	0.07**	-0.10**	0.07**
May	-0.00	-0.11**	-0.13**	0.04**	0.15**	-0.05*	0.11**
June	-0.02	-0.15**	-0.18**	-0.01	0.11**	-0.08**	0.03
July	-0.07**	-0.16**	-0.22**	-0.06**	0.02	-0.14**	0.03
Aug	-0.03	-0.13**	-0.17**	-0.03*	0.00	-0.02**	0.01
Sep	-0.07**	-0.06**	-0.16**	-0.04**	-0.06**	-0.16**	-0.04
Oct	-0.03*	-0.04**	-0.14**	-0.06**	0.08**	-0.14**	-0.07**
Nov	0.03*	-0.03**	-0.10**	-0.06**	-0.08**	-0.06**	0.01
Dec	0.08**	-0.03**	-0.06**	-0.03**	-0.05**	-0.03	0.02

** Significant at 5 percent level, * Significant at 10 percent level

The estimated income coefficients were all negative in both models (seven of seven in the total export equations and six of seven in the individual export equations were significant); this may be due to the fact that the trend term is excluded. With the trend term excluded, the income variable may be capturing adverse changes in taste and preferences due to health concerns related to cholesterol and saturated fats.

Table 3: Price Equations for Wholesale Beef Cuts with Individual Cuts Exports

	112A Ribeye	115 Chuck	120 Brisket	168 Round	174 Short Loin	189A Full Tenderloin	50 Percent Trimmings
D-W	0.68	0.82	0.74	0.80	0.63	0.69	0.75
Intercept	3.79	13.31**	9.21**	8.43**	16.41**	23.04**	18.41**
Lag $P_{i, t-1}$	0.11**	0.08**	0.11**	0.09**	0.12**	0.12**	0.34**
QBeef	0.06	-0.13**	-0.28**	0.05	0.22**	-0.05	-0.57**
QPork	-0.14**	-0.20**	-0.24**	-0.21**	-0.22**	-0.10	-0.39**
QPoult	0.03	0.25**	0.36**	0.11**	-0.06	0.19**	0.65**
Inc	-0.04	-0.92**	-0.60*	-1.61**	-1.4**	-2.12**	-1.77**
$X_{i, t}$	0.07**	-0.01	0.05**	-0.02	0.07**	0.15**	NA
$X_{i, t+4}$	0.06**	-0.02	-0.03	0.04**	0.08**	0.12**	NA
$SX_{j, j \neq i, t}$	0.05	0.01	0.01	0.04	0.16**	0.26**	NA
$SX_{j, j \neq i, t+4}$	0.11**	0.03**	-0.02**	0.05**	0.07**	0.04*	NA
Feb	-0.03**	-0.01	0.02	-0.021	0.01	-0.03	0.01
Mar	-0.02	-0.02	0.01	0.01	0.02	-0.06**	0.04
Apr	-0.04**	-0.07**	-0.06**	0.01	0.04**	-0.12**	0.06*
May	-0.00	-0.11**	-0.11**	0.01	0.10**	-0.07**	0.08**
June	-0.02	-0.15**	-0.16**	-0.42**	0.06**	-0.11**	-0.01
July	-0.07**	-0.15**	-0.20**	-0.09**	-0.03	-0.15**	-0.00
Aug	-0.03*	-0.13**	-0.15**	-0.06**	-0.04*	-0.17**	-0.02
Sep	-0.07**	-0.06**	-0.13**	-0.06**	-0.09**	-0.18**	-0.06*
Oct	-0.03*	-0.04**	-0.12**	-0.07**	-0.11**	-0.15**	-0.08**
Nov	0.02	-0.03**	-0.08**	-0.06**	-0.09**	-0.08**	0.00
Dec	0.06**	-0.03**	-0.06**	-0.03**	-0.06**	-0.05**	-0.03
CS1	0.48*	-1.32**	-0.31	-0.92**	-0.05	1.21**	NA
$SS1_i$	-0.04*	0.12**	0.03	0.08**	-0.00	-0.11**	NA

** Significant at 5 percent level, * Significant at 10 percent level.

In the total export model, the estimated export coefficients, current and adjusted forward four weeks, were all positive. Four of the six equations had significant export variables in week *t* and five of the six equations had significant export variables in week $t + 4$. The individual cuts export models had only five coefficients with negative signs, but four variables of the five were insignificant and all had low values. Four of the six equations with exports of individual cut *i* in week *t* and in week $t + 4$ were positive and significant. The other export variables were all positive and significant in week $t + 4$ (except 120 brisket was negative), but only two were significant in week *t*.

The wholesale prices of high-value cuts (the 112A ribeye, the 174 short loin, and the 189A tenderloin) were impacted the most by U.S. beef exports to Japan using either total or individual exports. Wahl, Hayes, and Hennessy found that the demand for these cuts were more inelastic than the demand for low-value cuts, thus a reduction in the supply of domestic beef due to increased total exports would have a greater impact on these high-value cuts' wholesale prices than the low value cuts' wholesale prices.

Exports had the greatest impacts on wholesale beef cuts prices in the week adjusted forward four weeks, with the most notable exception being export impact on the price of the 189A tenderloin which was greater in the current week. This was probably because the 189A tenderloin is exported fresh more often than frozen, thus the export impact would be more immediate.

Coefficients of 112A ribeye seasonal dummies were highest in November and December, perhaps due to the prime rib season, then lower in other months. The 115 chuck and 120 brisket followed a predictable seasonal pattern, being strongest in the winter months during the roast season and being weakest in June and July when compared to the base month of January. The 168 top inside round peaked in the spring and then declined through the summer and winter months. As expected, the 174 short loin seasonal shifts were highest in the summer grill season and lowest in the winter. The 189A full tenderloin was strongest in January and weakest in the late summer and early fall months.

The constant and slope shifter dummy variables, CS1 and $SS1_i$, were used for the possibility of data measurement error due to the estimates of U.S. exports of individual cuts' categories to Japan from January, 1988 to December, 1990. Four of the six equations using individual exports had significant coefficients for these dummy variables. The constant shifter was positive and the slope shifter was negative for the 115 chuck and the 168 top inside round, while just the opposite signs occurred for the 189 full tenderloin. This might indicate an overestimation of the chuck, clod, and round cuts' exports and an underestimation of the loin and rib cuts' exports. This is a reasonable assumption because during this time period the Japanese had a quota on the volume of beef imports, and it is likely that high value items were preferred to fill the quota (the 189A full tenderloin is much more valuable than the 115 chuck and the 168 top inside round).

The introduction of the lagged dependent variable improved the Durbin-Watson statistics, but they remained low, indicating positive autocorrelation among the residuals[7].

The results of the live cattle price equation (3) are shown in Table 4. A log-log model was used, and Cochrane-Orcutt and OLS estimations are reported. The Cochrane-Orcutt results appeared to be much better than the OLS results in terms of R^2, Durbin-Watson statistics and the signs and significance of the variables. One would not expect that the ribeye price would have a negative effect on the price of live cattle. The coefficient of the 189A full tenderloin was not significant; that was not surprising, considering that the 189A is a rather small cut (10 lb.), its price was not correlated highly with other loin cuts' prices, and its price series was very erratic.[8]

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[7] The Cochrane-Orcutt procedure to correct for autocorrelation was used, however most of the β-coefficients proved not to be significant; thus the Cochrane-Orcutt method of estimation was not chosen.

[8] The standard deviation of the 189A full tenderloin was $63 which is more than double any of the other cuts' standard deviation.

The coefficients for the 115 chuck, 168 top inside round, and 50 percent trimmings appeared to be reasonable considering the weight of each cut and the cutŝ value when compared to the value of the live animal. It was surprising that the 120 brisket at an average weight of 10 lb. and an average price of $100/cwt. had approximately the same impact as the 174 short loin on live cattle prices. The 174 short loin is over double the weight of the 120 brisket, averaging 23 lb., and over two-and-a-half times more valuable with an average price of $259/cwt.

Relative Expenditure Shares Modeling

This modeling procedure involved regressing the independent variables against the share of each wholesale cutŝ value relative to the value of the carcass[9]. The effects of U.S. beef exports, either total or by cut, on the share of the specified wholesale cut, were related back to the value of the beef carcass to show what potential benefits beef exports have generated. The first relative expenditure shares model related the value of the wholesale beef cut, $P_{i,}Q_i$, (the wholesale price of the beef cut ($/cwt.) times the weight of the respective cut in cwt., to the value of the entire carcass, SP_iQ_i , as the dependent variable.

Table 4: Live Cattle Price Equations

	OLS Results	Cochrane-Orchutt Results
Durban-Watson	0.57	1.98
Rho	NA	-0.01
Intercept	0.42**	1.46**
$P_{Live\ Cattle,\ t-1}$	0.02**	0.00
$P_{112\ Ribeye}$	-0.03*	0.78**
$P_{115\ Chuck}$	0.18**	0.22**
$P_{120\ Brisket}$	0.17**	0.07**
$P_{168\ Round}$	0.14**	0.09**
$P_{174\ Short\ Loin}$	0.11**	0.07**
$P_{189\ Tenderloin}$	0.13**	0.01
$P_{50\ percent\ Trimmings}$	0.07**	0.03**

**** Significant at 5% level, * Significant at 10% level**

The value of the wholesale beef cut Pi Qi was related to the value of all *other* wholesale beef cuts, SPjQj , j¹i. This eliminated the numerator from the denominator of the dependent variable. The equation is:

(6) $P_{i,\,t}Q_i\,/SP_{j,\,t}Q_{j,\,j\,'\,i} = a + b_{1,t}P_{i,\,t-1}Q_i/SP_{j\,,\,t-1}Q_j + b_{2,\,t}QBeef_{\,t} + b_{3,t}QPork_t + b_{4,}\,{}_tQPoult_t + b_{5,\,t}Inc_t + b_{6,\,t}X_{i,\,t} + b_{7,t}X_{i,\,t+4} + b_8M_1 + \ldots + b_{19}M_{11} + b_{20}CS1 + b_{21}SS1_i + e_t$

Again the equation was estimated using individual or total exports, similar to the

[9] The boxed beef cutout value as calculated by the USDA is used as the value of the carcass.

procedures outlined above. The Qi's were the average weights in cwt. of each representative wholesale beef cut used in the model, i.e. the 115 chuck cut is defined as 50-80 lb. by the USDA, thus the average weight is 65 lb. The weight of each beef cut in lb. is 23 lb. for the 112A ribeye, 65 lb. for the 115 chuck, 10 lb. for the 120 brisket, 20 lb. for the 168 top inside round, 23 lb. for the 174 short loin, 10 lb. for the 189A full tenderloin, and 60 lb. for 50 percent trimmings.[10] In the models using individual cuts exports, the other cuts exports variable was not used, as the cross-price substitution effects of increased exports *j* would affect the share of cut *i* through the increases in the prices of cuts *j*.

A log-log functional form yielded either the best, or approximately the same results of the different functional forms estimated. Adjusting the export variable $t + j$ forward four time periods yielded the most significant results in both models using either total exports or individual cut exports. The Seemingly Unrelated Regressions (SUR) method of estimation was applied to both shares models where the individual cut export categories varied to correct for the possibility of correlation of the errors from each equation. The SUR and OLS equations had approximately the same fits, and the signs of the estimated coefficients were consistent among the estimated equations. Only the OLS results are reported below.

The share equations results were not reported as many of the export variables, total and individual cut categories, were not significant. This may be caused by the fact that exports would effect both the numerator's P_iQ_i and the denominator's SP_iQ_i with the same magnitude, thus partially canceling out any impact that exports might have on the cut's share. The $P_{i,t}Q_i / SP_{j,t}Q_{j,j \neq i}$ shares equations results using the total exports variable are reported in Table 5 and the results using the individual cut exports are reported in Table 6.

The results of the shares models are reported in two different groups: shares of higher value cuts (the 112A ribeye, the 174 short loin, and the 189A full tenderloin) and shares of lower value cuts (the 115 chuck, the 120 brisket, the 168 top inside round, and 50 percent trimmings). The estimated coefficients of the lagged share of cut *i* were significant and positive in all equations and usually showed a strong impact (ranging between 7 percent and 40 percent) between week *t - 1*'s share and week *t*'s share.

In the share equations with total exports, the quantity of beef slaughtered coefficients were all significant, the signs positive for the higher value cuts, and negative for the lower value cuts. Where individual cuts exports were used, two of the seven beef slaughter estimated coefficients were significant. The slaughter coefficients from the wholesale cuts price equations were all negative and significant for the lower value cuts, but were not significant for the higher value cuts. Pork slaughter had negative and significant impacts on the 50% trimmings share in both equations, a positive effect on the 189A full tenderloin share in the equation using individual cuts exports, and a negative impact on the 120 brisket share in the equation using individual cuts exports. This coefficient was negative in all of the other equations. This indicates that pork products were net substitutes with the 120

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[10] The weights for the 112A ribeye, 189A full tenderloin, and 50 Percent trimmings were calculated using the percentage of the individual cut relative to the primal, and the percentage of the primal relative to a 714 lb. carcass. For example, the 112A ribeye is 30.16 percent of the rib primal cut and the rib primal is 11.11 percent of the carcass, thus the 112A ribeye is approximately 3.35 percent of a 714 lb. carcass or 23 lb.

brisket and 50 percent trimmings and they did not compete with the higher value 189A full tenderloin. In comparison, the pork slaughter coefficients from the wholesale price equations indicated that pork was a net substitute for all of the beef cuts, except the 189A full tenderloin which had an insignificant estimated coefficient.

The net effects of the export variables were positive on the shares of the higher value cuts and were negative on the shares of the lower value cuts. In the equations where total exports were used, three export variables for week *t* were significant and all of the export

Table 5: $P_iQ_i / SP_jQ_{j, j \neq i}$ Share Equations for Wholesale Beef Cuts with Total Exports

Shares of	112A	115	120	168	174	189A Full	50 percent
D-W	0.72	0.86	0.49	0.46	0.61	1.00	0.87
Intercept	-7.63**	-3.12	-12.34**	-5.21**	-8.61**	11.14**	3.5
$P_{i, t-1}Q_i/SP_{j, t-1}$	0.26**	0.39**	0.07**	0.10**	0.20**	0.36**	0.38**
QBeef	0.18**	-0.20**	-0.30**	-0.15**	0.15**	0.179 **	-0.648 **
QPork	0.00	0.01	-0.04	0.025	0.030	0.06	-0.28**
QPoult	-0.21**	0.13**	0.19**	0.07*	-0.18**	-0.12**	0.50**
Inc	0.68**	0.29	0.95**	0.41*	0.75**	-1.34**	-0.71*
X_{Total}	-0.01	-0.017	-0.04**	-0.05**	-0.02	0.60**	NA
$X_{Total, t+4}$	0.03**	-0.04**	-0.02*	-0.04**	0.03*	0.07**	NA
Feb	0.00	-0.01	0.03*	-0.01	0.23	0.02	0.08 **
Mar	0.00	-0.02	0.00	0.04**	0.03**	-0.02	0.08**
Apr	0.01	-0.05**	-0.04**	0.05**	0.12**	-0.04**	0.10**
May	0.02	-0.09**	-0.11**	0.04**	0.16**	-0.03*	0.12**
June	0.05**	-0.08**	-0.12**	0.02	0.16**	-0.03	0.07**
July	0.04**	-0.04**	-0.12**	0.02	0.11**	-0.03	0.10**
Aug	0.07**	-0.03**	-0.08**	0.04**	0.08**	-0.06**	0.08**
Sep	0.04**	0.04**	-0.06**	0.04**	0.03*	-0.06**	0.04
Oct	0.07**	0.04**	-0.04**	0.02	-0.01	-0.04**	0.01
Nov	0.09**	0.02	-0.05**	-0.03**	-0.05**	-0.01	0.06**
Dec	0.11**	-0.01	-0.05**	-0.02	-0.04**	-0.01	0.02

** Significant at 5 percent level, * Significant at 10 percent level

variables for week $t + 4$ were significant. Individual export equations had three significant export of cut *i* variables in week *t*, and all of the variables in week $t + 4$ were significant. The majority of the shares were impacted more in week $t + 4$ by exports, whether total or individual.

Table 6: $P_iQ_i / SP_jQ_{j, j \neq i}$ Share Equations for Wholesale Beef Cuts with Individual Cuts Exports (OLS)

Shares of	112A	115	120	168	174 Short	189A Full	50 percent
D-W	0.71	0.88	0.48	0.46	0.67	1.00	0.89
Intercept	-10.07**	-2.91	-11.7**	3.10	-1.33	0.93	6.46
$P_{i,t-1}Q_i/SP_{j,t-}$	0.26**	0.35**	0.71**	0.08**	0.17**	0.32**	0.39**
QBeef	0.10	-0.06	-0.11	0.05	0.27**	-0.12	-0.71**
QPork	0.04	0.01	-0.12*	-0.01	-0.02	0.17**	-0.21*
QPoult	-0.15**	0.04	0.11**	-0.05	-0.23**	0.31	0.49**
Inc	1.00**	0.33	0.86**	-0.42**	-0.02	-0.31	-1.01*
$X_{i,t}$	-0.01	-0.04**	-0.00	-0.07**	-0.00	0.04**	NA
$X_{i,t+4}$	0.023*	-0.06**	-0.04**	-0.03**	0.03**	0.07**	NA
Feb	-0.01	0.00	0.03 *	-0.00	0.03**	-0.02	0.07**
Mar	-0.02	-0.01	0.04	0.04**	0.05**	-0.05**	0.09**
Apr	-0.00	-0.06**	-0.06**	0.05**	0.12**	-0.03**	0.10**
May	0.01	-0.10**	-0.14**	0.03**	0.17**	-0.00	0.13**
June	0.04**	-0.10**	-0.15**	0.15	0.16**	0.00	0.09**
July	0.03*	-0.05**	-0.15**	0.01	0.11**	0.00	0.12**
Aug	0.06*	-0.04**	-0.11**	0.03**	0.08**	-0.04**	0.10**
Sep	0.03**	0.03**	-0.08**	0.04**	0.03**	-0.04**	0.05*
Oct	0.06**	0.03**	-0.07**	0.02	0.00	-0.03	0.02
Nov	0.09**	0.00	-0.06**	-0.02	-0.04**	-0.01	0.06**
Dec	0.10**	-0.01	0.05**	-0.00	-0.03**	-0.02	0.02
CS1	0.50**	-1.26**	-0.38**	-0.96**	0.30	1.35**	NA
$SS1_1$	-0.04**	0.11**	0.05**	0.08**	-0.03**	-0.12**	NA

** Significant at 5 percent level, * Significant at 10 percent level

The 189A share was positively affected by both current exports and adjusted forward exports for the models using total exports and individual cuts exports, while the 112A and the 174 had significantly positive estimated coefficients for exports that were adjusted forward. The shares of the 115 chuck, the 120 brisket, and the 168 top inside round, lower value cuts, were all negatively affected by exports in the current period and the period adjusted forward. This is not to say that U.S. beef exports to Japan have a negative effect on the price of these cuts, but that the value of these cuts relative to the other cuts in the carcass fell. These results were consistent with the results reported earlier from the wholesale cuts price equations. The estimated export coefficients were significant and positive in nearly all of the higher value cuts price equations, while in the lower value price equations a few of the estimated export coefficients were not significant or were negative.

The dummy variables for Easter, shorter slaughter weeks because of holidays, and the data measurement error constant and slope shifters for the second individual cut export estimation period proved to be insignificant in both shares equations. The trend variable was dropped due its high correlation with income.

The constant shifter dummy variable, CS1, and the slope shifter dummy variable, $SS1_i$, which were used for the possibility of data measurement error due to the changes in the way the data was reported, were significant for almost all cuts (except the 174 short loin and the 120 brisket). The lower value cuts' shares had negative estimated coefficients for the constant shifter dummy variable and positive estimated coefficients for the slope shifter dummy variable. The shares of the higher value cuts had the opposite signs for these dummy variables. This might indicate an overestimation of the lower value cuts' exports (chuck, clod, and round, and other cuts) and an underestimation of the higher value cuts' exports (the ribs and loin cuts). These results were consistent with the results from the wholesale cuts price equations.

Seasonal patterns for the shares of the 115 chuck and the 120 brisket were similar to seasonal patterns reported earlier from the wholesale cuts price equations; strength in the winter months with seasonal lows in the shares during the summer. The 174 short loin share also exhibited practically the same seasonal behavior as in the wholesale cuts price equations; it reached a maximum in May and June and declined in the winter months. There was basically no difference in seasonality in the 189A tenderloin share and the 189A wholesale cuts price equation. The share of the 112A ribeye took on a different seasonal pattern than the one previously exhibited. The share still peaked in December, however the share was stronger in the summer and fall months when compared with the pattern from the wholesale cuts price equations, which is consistent with the ribeye steak summer grill season. The 168 top inside round and the 50 percent trimmings seasonality were also different from the wholesale cuts price equations seasonal patterns. The 168 top inside round share was strongest in spring and in early fall, while the 50 percent trimmings share was strongest in May and April, but was strong throughout the year except for September and October.

Autocorrelation was present in both models as evident in low Durbin-Watson statistics and residuals patterns.[11] The introduction of the lagged dependent share variable improved the models' autocorrelation, but was not able to correct for all of it.

The results between the relative shares and the wholesale price model cannot be easily compared due to the different structures of the models. The fits of the shares model equations cannot be compared due to the differences in the dependent variables. The signs and the significance of the export variables in the different models were generally consistent, and that was the particular emphasis in this analysis.

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[11] As with the price equations for wholesale beef cuts, the Cochrane-Orcutt procedure for correcting autocorrelation yielded very few significant variables. These estimates were not reported.

Applications of The Relative Shares and Wholesale Price Models

The models estimated can be used to examine the impact of an increase in total U.S. beef exports to Japan. Assume a scenario of a ten percent per week increase from the 1993 export volumes with the same percentage increase for all cuts. P_iQ_i/SP_jQ_j Shares Model Using Total Exports. An increase in total exports would have the most effect on the shares of the higher value cuts the most as indicated by the positive export coefficients, $b_{Exports}$. Thus the export impacts on the wholesale beef industry can be traced through these cuts. The relationship between the expenditure share and exports is expressed as: $b_{Exports}$ = (%D P_iQ_i/SP_jQ_j) / %DX_{Total} where %D P_iQ_i/SP_jQ_j is the percentage change in the expenditure share of cut *i* and %DX_{Total} is the percentage change in total U.S. beef exports. After solving for the percentage change in the share of cut *i* from the above relationship, the next step was to calculate how much the price of cut *i* would have to change, *ceteris paribus*, to cause this percentage change in the price share of cut *i*. It is important to note that the *ceteris paribus* assumption (that the prices of other cuts would not change due to the increase in total exports) has been used in order to focus on the change in the price of cut *i*[12].

As the selected individual cuts are representative of their respective primal cut, the change in the price of cut *i* was related to the change in the boxed beef carcass cutout value through the primal cuts percentage of the boxed beef cutout value.[13] Due to the low price correlations between the 189A full tenderloin and the other loin cuts, the 189A was not considered representative of the loin primal and was thus related to the boxed beef cutout value through its percentage of the value of the loin primal and then to the boxed beef cutout value. The change in the boxed beef cutout value was then multiplied by the 1993 average weekly slaughter of federally inspected cattle (in cwt.) at the wholesale level to estimate the total increase in revenues to the wholesale beef industry caused by the increase of U.S. beef exports to Japan. The $b_{ExportsTotal}$ coefficients associated with the 189A tenderloin, the 112A ribeye, and the 174 short loin shares are reported in Table 6.

The effect of a 10 percent increase in total U.S. beef exports in the current week would cause the 189A full tenderloin share to increase by 0.57 percent. The price of the 189A full tenderloin would have had to have risen, *ceteris paribus*, by $17.21/cwt.[14] to have caused this increase in its share. The 189A full tenderloin is 6.88 percent of the loin primal and the loin primal makes up 21.13 percent of the carcass value, thus the 189A full tenderloin is 1.45 percent of the carcass value. Based upon this relationship, a $17.21/cwt.

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[12] By holding the $\Sigma P_jQ_{j,\, j \neq i}$ constant, possible substition effects among the various beef cuts caused by the increase in exports are ignored. This may lead to an underestimation in the ΔP_i. For example, the price of the 112A ribeye would have to increase by $3.59/cwt. (holding $\Sigma P_jQ_{j,\, j \neq i}$ constant) to cause a 0.3 percent increase in its share due to a 10 percent increase in total exports. If the $\Sigma P_jQ_{j,\, j \neq i}$ is allowed to increase by 1 percent due to this increase in exports, then the price of the 112A ribeye would have to increase by $3.62/cwt. to cause this 0.3 percent increase in its share due to a 10 percent increase in total exports. Thus, estimated impacts using the above procedure are conservative illustrations of export price impacts.

[13] The individual cuts' percentages of the primal and the primals' percentages of boxed beef cutout value were USDA estimates.

[14] The ΔP_{189} = ($302 *.0057) / .1 cwt., $302 is the $\Sigma P_jQ_{j,\, j \neq 189}$ and Q_{189} is 10 lbs. or .1 cwt.

increase in the price of the 189A full tenderloin would cause a \$0.25/cwt. increase in the boxed beef cutout value. The average weekly federally inspected beef slaughter at the wholesale level in 1993 was 448,877,000 lb. or 4,488,770 cwt.[15] and this was multiplied by the \$0.25/cwt. increase in the carcass value to yield \$1,122,192 which is the dollar amount caused by the impact of the increase in exports in the current week. This 10 percent increase in total U.S. beef exports to Japan would cause the 189A full tenderloin share to increase by 0.65 percent in the week adjusted forward $t + 4$. The price of the 189A would have had to have changed, *ceteris paribus*, by \$19.63/cwt. to cause this increase in its share. The carcass value would increase by \$0.28/cwt. due to the increase in the price of the tenderloin; the total dollar increase in revenues would be \$1,256,855.

The weekly total impact on the carcass value via the 189A full tenderloin due to this increase in exports would be the sum of the two impacts is \$2,398,072. The net impact in week t and week $t + 4$ of the 10 percent increase in total exports would cause the price of the 112A ribeye to increase by \$1.93/cwt.[16] The rib primal cut is 11.11 percent of the carcass value, thus the carcass value would increase by \$0.21/cwt. and the weekly increase in wholesale beef revenues by \$954,039.

The net price change in the 174 short loin associated with the change in its share due to the 10 percent in total exports would be \$0.78/cwt.[17] The increase in the carcass value would be \$0.16/cwt. as the primal loin cut is 21.13 percent of the boxed beef cutout value. The weekly increase in wholesale beef revenues associated with the increase in total exports would be \$742,286.

The total weekly increase in wholesale beef revenues caused by this sustained increase in total U.S. beef exports to Japan would be \$4,094,397. The 1993 average weekly revenues for the wholesale beef industry were \$532,592,561[18], so a 10 percent increase in total U.S. beef exports to Japan would increase wholesale beef revenues by approximately 0.77 percent. A similar procedure was used in the models where individual exports were used as dependent variables.

Wholesale Beef Price Model Using Total Exports

The effects of a 10 percent increase in total exports were related back to the wholesale price of cut i directly through the $b_{Exports,\ Total}$ coefficients[19], which were reported

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[15] 627,800, the average number of head of federally inspected cattle that were slaughtered per week in 1993, was multiplied by the average carcass weight of 715 lbs. to arrive at the weekly average beef slaughter at the wholesale level.

[16] The $\Delta P_{112} = \Delta P_{112}$ in week $t + \Delta P_{112}$ in week $t + 4$ = - \$1.67 + \$3.59 where ΔP_{112} in week t =(\$275*-.0014)/.23 and ΔP_{112} in week $t + 4$ = =(\$275*.003)/.23 \$275 is the $\Sigma P_j Q_{j,\, j \neq 112}$ and Q_{112} is 23 lbs. or .23 cwt.

[17] The $\Delta P_{174} = \Delta P_{174}$ in week $t + \Delta P_{174}$ in week $t + 4$ = -\$3.13 + \$3.91 where the ΔP_{174} in week t = (\$300*-.024)/.23 cwt. and ΔP_{174} in week $t + 4$ = (\$300*.003) / .23 cwt., \$300 is the $\Sigma P_j Q_{j,\, j \neq 174}$ and Q_{174} is 23 lbs. or .23 cwt

[18] Average weekly wholesale beef revenues = average weekly boxed beef carcass cutout value X average weekly slaughter of federally inspected cattle in cwt.; where the average weekly boxed beef carcass cutout value in 1993 was \$118.65 and the average weekly slaughter of federally inspected cattle in cwt was 4,488,770.

[19] All $\beta_{Exports,\ Total}$ coefficients were used.

in Table 5 and then back to the live cattle price via the Cochrane-Orcutt estimated b coefficients of the live cattle price equation which were reported in Table 7. The relationship between the live cattle price and the price of cut *i* is

$$b_{Pi} = \%DP_{Live\ Cattle} / \%DP_{Cut\ i}$$

The percent change in the live cattle price was converted into potential revenue gains by multiplying it by the average weekly live cattle price in 1993[20] and the average weekly federally inspected beef slaughter at the live cattle level (in cwt.).[21] The cumulative effects of the export shock were determined by summing the impacts of exports in week *t* and week *t + 4*.

Wholesale Beef Price Model Using Individual Cuts Exports

The procedure used for this section was almost identical to the one used in the previous section[22], except that the impact of a 10 percent increase in individual cut *i*'s exports and all other cuts *j* exports were calculated and the estimated exports b coefficients $X_{i,t}$, $X_{i,t+4}$, $SX_{j, j \neq i, t}$, and $SX_{j, j \neq i, t+4}$ reported in Table 5 were used. For example, the sum of the live cattle price changes due to the impact of a 10 percent increase in rib exports and all other cuts exports via price changes of the 112A ribeye in week *t* and week *t + 4*[23] would be $1.67/cwt. This would increase weekly live cattle revenues by $12,086,044.

The results of a 10 percent increase in U.S. beef exports to Japan utilizing the four equations are summarized below in Table 7. The expenditure shares models' figures are estimated increases to the wholesale beef sector and the wholesale price models' figures are estimated increases in revenues to the live cattle sector.

Table 7: Weekly Increases in Revenues to the Beef Industry due to a 10 percent Japanese Export Shock

	Expenditure Share Equation w/ Total Exports	Expenditure Share Equation w/ Individual Exports (OLS Estimates)	Wholesale Price Equation w/ Total Exports	Wholesale Price Equation w/ Individual Exports
Weekly Increases in Revenues	$4,094,397 (Wholesale)	$6,387,319 (Wholesale)	$8,981,054 (Live Cattle)	$14,494,741 (Live Cattle)
Percentage Increases	0.77 percent	1.2 percent	1.64 percent	2.64 percent

[20] The average weekly live cattle price in 1993 was $75.96/cwt.

[21] 627,800, the average number of head of federally inspected cattle that were slaughtered per week in 1993, was multiplied by the average live animal weight of 1100 lbs. to arrive at the weekly average live cattle slaughter.

[22] The calculations used here were exactly the same as those performed earlier with the exception that four export impacts were summed to arrive at the net price change. All of the numbers with the exception of the $\beta_{Exports,\ Cuts}$ coefficients were the same, so calculations in this section will not be footnoted.

[23] The effects of ribs exports and all other exports were positive in both time periods.

All of the models indicated that increased exports, whether total or individual cuts, would have positive benefits to the beef industry. Using individual cuts export models generated higher estimates of weekly increases to the beef industry, whether to the wholes or to the live cattle sectors, in both the expenditures shares and the wholesale price models with the exception of SUR shares estimates. Currently we export about 25 million dollars beef per week to Japan. (USDA) This means that with 1995 export volumes a 10 percent stock is equivalent to a 2.5 million dollar increase in exports. Taking the weekly increase revenues from Table 7 we see that a 2.5 million dollar increase in exports always results in greater than 2.5 million dollar increase in revenue. This multiplier factor ranges from 1.6 5.7 with an average of 3.36. The multiplier factor is smaller for the relative price model because: a) we ignore the positive cross primal effects (i.e., an increase in loin exports makes some consumers purchase chucks, thereby driving up chuck prices) and because we measure the impact at the wholesale and not the farm level. The analysis shown in Table 6 suggests that live cattle prices are particularly sensitive to ribeye prices, and because Japan imports so many ribeyes, the export effects are magnified when we translate them back to farm level prices in the two price based models.

At this stage we cannot differentiate among the models in terms of which is most realistic or accurate, and therefore we cannot be more specific about the exact multiplier effect. However, in all four cases this multiplier is greater than one, which in theory means that producers as a whole could purchase 1 million dollars worth of beef middle cuts, then destroy these cuts and be better off, at least in the short run.

Summary and Conclusions

Two models were developed relating wholesale beef cut prices or expenditures shares to beef, pork, and poultry supplies; income; and Japanese beef imports. The primary focus of this analysis was to determine the short-term effects of Japanese imports of U.S. beef on wholesale and live cattle prices and values. These estimated models were then used to calculate the short-term impacts of a 10 percent change in exports to provide a partial estimate of the potential value of export market development to the U.S. beef industry.

The wholesale price models showed a limited amount of price inertia in wholesale beef cuts. The relationship between wholesale beef prices and beef slaughter was negative (where significant, with one exception), with 50 percent trimmings being the most inelastic. The wholesale prices of high-value cuts (the 112A ribeye, the 174 short loin, and the 189A tenderloin) were impacted the most by U.S. beef exports to Japan, using either total or individual exports. The net effects of the export variables were positive on the shares of the higher value cuts and were negative on the shares of the lower value cuts. The majority of the shares were impacted more in week $t + 4$ by exports, whether total or individual.

The wholesale price model using total exports was the most reliable method of estimation among the four models analyzed. All of the export coefficients were positive, the relationships between wholesale beef prices and the other independent variables (while not entirely consistent with theory) were best explained by this model, and the method of estimating potential revenue growth due to increased beef exports to Japan was more parsimonious.

The models estimated were short-term in nature. No supply responses to the export impact were considered which could over time cause positive price impacts to be dissipated, i.e. more cattle put on feed, heavier weights sold, or increases in cow herds which would increase overall cattle production.

Averaging across all four models, the results suggest that a 1 million dollar increase in exports causes about 3.3 million dollars in producer income. This large multiplier effect suggests that producer funded export promotions that successfully increase exports are a profitable way to spend checkoff dollars. This is true because the short-term gains in increased producer revenues are greater than the costs associated with promotions. Note however, that we measure only the marginal impact of *increased* exports. If at some future point we see a 10 percent decrease in exports,y then some dynamics will work against the industry.

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