The U.S. Import of Beef: Substitute or Complement for Domestic Beef Production?

Sunil P. Dhoubhadel
West Central Research & Extension Center
University of Nebraska Lincoln
Sdhoubhadel2@unl.edu
(308) 696-6738

Mathew C. Stockton
West Central Research & Extension Center
University of Nebraska Lincoln
Mstockton2@unl.edu
(308) 696-6713

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U.S. beef producers have always been concerned that beef imports may depress prices. Consumer groups have held the opposite view. This research addresses this issue by assessing the impact of beef imports on wholesale domestic beef prices. This is done by estimating the flexibilities between domestic beef, choice and select grades, and imported beef at the wholesale level.

No statistical evidence is found to support either producer or consumer view. This may be resultant of small import volumes of beef. Beef exports, however, have a statistically measurable effect on domestic beef prices, especially the select grade.

Key Words: beef imports, flexibilities, inverse beef demand, substitutes, wholesale beef prices

Introduction

Controversy surrounding the U.S. import of beef from foreign countries has been an issue since 1958 which marked the beginning of major imports from Australia (Edward 1964). From the onset U.S. beef producers have always been concerned that unrestricted beef imports would depress prices in the domestic market by increasing supply. As a result of this pressure the U.S. Congress enacted the 1964 Meat Import law (P.L. 88-482). This law limited the import of red meat to approximately seven percent of the then current domestic red meat production (Nelson et al. 1982; Freebairn and Rausser 1975). Just as producers of beef are opposed to import of red meat, consumer advocate groups are of the opposite view and contend that provisions of a quota on meat imports have led to excessively higher beef prices (Chambers et al. 1981; Freebairn and Rausser 1975, and Nelson et al. 1982). The pressure from these consumer groups has led to periodic increases in the quota levels in both 1968 and 1977 (Nelson et al. 1982). In 1979 the old act was replaced by the Meat Import Act of 1979 which increased limited imports to 10 percent of base quantity. Base quantity was determined by the countercyclical adjustment factor based on current levels of production, an overall growth factor, and average annual imports from 1968 to 1977 (Nelson et al. 1982, and Brester 1996). This system was replaced by a beef Tariff Rate Quota (TRQ) as negotiated in the World Trade Organization's Uruguay Round (Doud 2007). Under this system, TRQ's have been established for all participating beef exporting countries.

During the period from 1960 to 1980, several economic studies examined the impact of beef imports on domestic beef production including Nelson et al. (1982); Chambers et al. (1981); Schmitz and Nelson (1977); Freebairn and Rausser (1975); Enrich and Usman (1974); Rausser and Freebairn (1974); Houck (1974); Hunts (1972); Jackson (1972); Corm (1970); Langemeir and Thompson (1967), and Edwards (1964). These literature address impact of beef imports on various issues such as welfare of consumers, domestic price, and domestic beef production cost. For example Nelson et al. (1982) reported import of beef led U.S. cattle industry towards the least cost optimum heard size. Chambers et al. (1981) reported a welfare loss of consumers as a result of import quota. Freebairn and Rausser (1975) and Houck (1974) found increased beef imports reduce retail price of beef with larger reduction occurring for lower quality of manufacturing beef products such as hamburger. Edwards (1964), however, argue that under the assumption of inadequate domestic supplies of equivalent grade beef, an increase in imports is not necessarily price depressing. Most of these studies address the impact at the consumer or farm levels, with little or no analyses focused at the wholesale or packer level. No recent work has addressed this issue and none at the wholesale level, which is the appropriate level since most of the imported product is incorporated into the supply chain at this level.

The descriptive statistics on the U.S. beef imports indicate that the primary product imported as beef consists of grass fed lean beef trimmings (mainly 90 percent lean trimmings, known as 90s). These 90s are imported primarily from Australia, New Zealand, Brazil, and

Argentina[1]. Imported beef is generally mixed with trimmings from grain fed beef produced in the U.S. to make a lean ground beef (Doud 2007; Elam 2005, and Nelson et al. 1982). Given the fact that the imported beef is used to mitigate fat content of the final product it is plausible that it is a compliment rather than a substitute of domestic grain fed beef at wholesale level. However, no analysis has been done at wholesale level addressing this issue. This research addresses this gap in knowledge by estimating the relevant own price and cross price flexibilities among domestic cuts of beef products and imported beef at the wholesale level. Thus the question as to whether imported beef may impact U.S. beef prices at wholesale level will be initiated. Specifically, this research investigates the relationship of choice beef, select beef, 50 % lean beef trimmings sold in the U.S. with respect to imported beef from the major importing countries.

Model Development and Specification

To estimate the appropriate flexibilities which is the inverse of elasticity, it is necessary to specify several inverse demand relationships or equations. The literature is replete with the estimation of demand for meat (beef and other meat) at the retail level, Kinnucan et al. (1997); Brester and Schroeder (1995); Farris and Holloway (1990); Capps (1989); Lemieux and Wholgenant (1989); Chalfant and Alston (1988); Eales and Unnevehr (1988); Moschini and Meilke (1988); Chavas (1983); Nyankori and Miller (1982); Funk, Melke and Huff (1977), and Marion and Walker (1978), to cite a few. However, studies at wholesale level are far less common. Some of the more relevant demand studies at the wholesale level include Lusk and Marsh (2000); Namken, Farris and Capps (1994); Capps et al. (1994); Marsh (1991), and Brester and Marsh (1983).

One of the more pertinent works is Capps et al. (1994) which uses an inverse demand system in their study of determinants of wholesale beef-cut prices. Their model uses wholesale

[1] U.S. imports from these four countries represent almost 60% of total beef imports.

level monthly time series information, where individual wholesale beef-cut prices are a function of their own-quantities and quantities of other meat including beef, pork, and chicken. They assume prices are endogenous and quantities exogenous justifying their premise based on the fact that beef production are not adjusted in the short term of a month. In addition the model used by Capps et al. was augmented to account for price seasonality and wholesale marketing costs as well as the inclusion of a lagged dependent variable to measure price inertia. Namken , Farris and Capps (1994) use a similar approach to model the demand for wholesale beef cuts by season and trend. They, however, use a modified dependant variable consisting of the monthly price ratio of 12 individual wholesale cuts to the carcass composite boxed beef price.

Brester and Marsh (1983) in their model of the primary and derived demand at various levels of the market in the U.S. beef industry use a two-stage least square procedure. They represent carcass price as a function of retail beef price, carcass-to-retail marketing margin, price of carcass by-products and expectation of carcass price lagged *j* time periods. Because retail price of beef and carcass-to-retail marketing margin are endogenous in the model they are modeled as instrumental variables. Their equation models retail beef prices as a function of per capita fed and non-fed beef, pork and poultry consumption, per capita disposable income, and expectations of retail beef price lagged *j* time periods. The instrumental variables for carcass-to-retail marketing margin is specified as a function of hourly wages for meat packers, packaging cost, time trend and expectation of carcass-to-retail margin lagged *j* time periods.

Marsh (1991) in his comparison of three methods of estimating derived demand elasticities i.e. traditional marketing margin approach, modified marketing margin approach, and price dependent function approach conclude that the price dependent approach is representative of beef prices. He modeled slaughter beef price as a function of the quantities of imported beef and veal, quantities of domestic pork and poultry, per capita disposable income, by-product value and farm-to-retail marketing cost.

Of all these methods the best for our purposes, to assess the impact of beef imports on domestic beef prices, is to adopt a derived inverse demand structure. Given this structure we used the following equations in the model specification.

$$(1)\; P_{wch} = \alpha_1 + \beta_{11}\, QP_{bf} + \beta_{12}\, QP_{fz} + \mu_{11}\, QP_{im} + \mu_{12}\, QP_{ex} + \pi_{11}\, QP_{pk} + \pi_{21}\, QP_{ch} + \varphi_1\, ICT + \psi_1 D_{i=1,2\ldots\ldots\ldots\ldots 11} + \psi_2 D_{j=1,2\ldots\ldots\ldots\ldots 7} + u_1$$

$$(2)\; P_{wsl} = \alpha_2 + \beta_{21}\, QP_{bf} + \beta_{22}\, QP_{fz} + \mu_{21}\, QP_{im} + \mu_{22}\, QP_{ex} + \pi_{21}\, QP_{pk} + \pi_{22}\, QP_{ch} + \varphi_2\, ICT + \psi_3 D_{i=1,2\ldots\ldots\ldots\ldots 11} + \psi_4 D_{j=1,2\ldots\ldots\ldots\ldots 7} + u_2$$

$$(3)\; P_{50t} = \alpha_3 + \beta_{31}\, QP_{bf} + \beta_{32}\, QP_{fz} + \mu_{31}\, QP_{im} + \mu_{32}\, QP_{ex} + \pi_{31}\, QP_{pk} + \pi_{32}\, QP_{ch} + \varphi_3\, ICT + \psi_5 D_{i=1,2\ldots\ldots\ldots\ldots 11} + \psi_6 D_{j=1,2\ldots\ldots\ldots\ldots 7} + u_3$$

where,

P_{wch} , P_{wsl} , and P_{50t} are real wholesale prices of choice and select beef primals and 50% lean beef trimmings measured in cents per pound; QP_{bf} and QP_{fz} are per capita wholesale quantities of fresh and frozen beef in pounds; QP_{im} is per capita total quantity of fresh lean beef imported from Australia, New Zealand, Brazil and, Argentina collectively measured in pounds; QP_{ex} is per capita total pounds of beef exported from U.S.; QP_{pk} and QP_{ch} are domestic per capita wholesale pounds of pork and chicken. The control variables such as ICT is the index of marketing cost at the wholesale level, with the D_i representing seasonality, monthly indicator variables and D_j representing the yearly difference and long term cyclical variation. Both cyclical and seasonal variations are commonly observed in cattle industry.

Like Capps et al., supply quantities are assumed to be perfectly inelastic for any given month, and are thus treated as exogenous. The use of the double logarithmic functional form allows interpretation of the parameter estimates as flexibility estimates, where flexibility is defined as percentage point change in dependent price variables because of 1 percentage change in independent quantity variables. The coefficients associated with seasonal control variables are interpreted as the percentage point change in the wholesale price relative to a base month, in this case December. This interpretation is the result of transforming B_i into $(e^{Bi} – 1)$ x 100, where B_i represents the coefficient associated with the i^{th} month or seasonal variable. Similar interpretation is true for the yearly dummy variables; in this case 2008 is the base year. The model is estimated as system of equations using a seemingly unrelated regression (SUR) procedure. It is expected that the SUR procedure provides estimation efficiency relative to the ordinary least square procedure (Capps et al. 1994). The serial correlation issues caused by the long term lag effect of the dependent variables is addressed by applying appropriate autoregressive (AR) process as indicated by the Box-Ljung statistic.

Data

Price and quantity information on individual whole cuts of beef are available, however, the average price and quantity of choice and select beef as categories are not directly observed. Wholesale beef, both choice and select, are generally marketed as boxed beef cuts or primals, such as ribs, chucks, briskets, rounds, butts, loin, sirloin, and tender loin. Thus the price of carcass as a whole is the result of aggregation of carcass component prices. It should be noted that these prices represent price of the sales from the USDA boxed beef report. This report includes only negotiated domestic sales which deliver within 21 days of slaughter. It does not include all beef sales but it contains only a portion which is assumed to be representative of the market. Based on these reported prices, the average price of choice and select beef categories is calculated as a weighted average of the primals using monthly prices and quantities of the individual carcass components as reported by the USDA Agricultural Marketing Service (AMS) meat reports. The individual prices of each primal is weighted by their respective quantities during that month with sum of all component prices equaling the average price of either choice or select beef categories as shown in equation 4.

$$(4) \qquad AWP_j = \sum_{i=1}^{N} q_i p_i \Big/ \sum_{i=1}^{N} q_i$$

Where AWP_j is the average weighted price of the j^{th} category for $j = \{1, 2\}$ and p_i and q_i are the price and quantity of i^{th} primal cut, $i = \{1,2,3,,, N\}$. All prices are normalized using the Consumer Price Index (CPI), with the base year being 1982-84. The data used began in 2001 and continued throughout 2008.

While price information was obtained from USDA ARS reports, fresh meat quantities for beef, pork and chicken are obtained from the National Agricultural Statistics Service (NASS) commercial slaughter data. Frozen beef quantities obtained through the Livestock Marketing Information Center (LMIC) data series. Import volume of beef from Australia, New, Zealand, Brazil, and Argentina are published by the USDA Economic Research Service (ERS) in their livestock and meat trade report. Similarly, beef, pork and chicken export information came from the ERS reports. Wholesale quantities of pork and chicken represent net availability of pork and chicken at wholesale level where

(5) *Net pork or chicken quantity = Pork or chicken slaughter quantities – pork or chicken export quantities + pork or chicken import quantities*

All meat quantities are adjusted for population changes and are expressed in terms of per U.S. capita. Other costs indigenous to the U.S. beef industry such as wages, transportation, energy and etc, are approximated with the Food Marketing Cost Index developed by ERS.

Descriptive statistics of selected variables are presented in table 1. As expected, the mean real price of choice beef cuts is the largest followed by select cuts and 50% lean trimmings. Average per capita quantity of poultry is the greatest, followed in order by fresh beef, pork, frozen beef, beef imports, and beef exports.

Results

The results are summarized in the tables 2, 3, and 4. The goodness of fit pertaining to equation 1, 2, and 3 obtained by using E-Views 6 econometric package are 0.69, 0.74, and 0.84. A 95% confidence level is used for all statistical significance determinations or individual p-values of 0.05 or less. As expected the flexibilities related to fresh and frozen beef are negative and statistically significant except for select prices where fresh beef is negative but statistically insignificant. These negative relationships are consistent with a substitution effect, an increase in quantity results in decrease in price, or vice versa (tables 2, 3 and 4). The magnitudes of the flexibilities, however, are quite different among the three prices. Select is affected least, followed by choice with less than unitary effect. However, the effect on 50% lean trimmings is greater than one, indicating an amplifying effect. This is consistent with the expectations during a decline in overall beef prices which may be due to increases in quantities of fresh and frozen beef. At the lower prices consumers may prefer a higher quality product such as a steak or roast, which would be choice or select grade, as compared to a lower quality ground beef produced from 50% lean trimmings.

Increase in import or export volumes have no statistically significant effect on beef prices except in the case of select prices where exports have a statistically significant positive effect. Interestingly the imports are estimated as being negative for choice and select, but positive for 50% lean trimmings. Other meats such as pork and chicken do not have statistically significant effect on any of the three beef prices. The only effect that is close to statistical significance is chicken quantity on 50% lean trimmings. This positive relationship is counter to the expected substitution result and warrants closer investigation. Effects of marketing and fabrication cost, *ICT*, on the wholesale prices for all three meat groups are very small in magnitude, less than 0.003 and not significant. The seasonal effect on the wholesale price of choice beef is significantly different from the base month (December) for the months of January and September, while select beef is significantly different in January and February, and 50% lean trimmings has no statistically different months. Differences among years for each category are different. Five out of seven years i.e. 2003, 2004, 2005, 2006, and 2007 are significantly different from the base year 2008 for choice beef. Select beef has only one statistically different year, 2007 and 50% lean trimmings has no statistically significant years. The autoregressive terms for one and two lagged periods are added to the choice and select models, but only a one period process is needed for 50% lean trimmings model.

Conclusion

Both fresh and frozen beef have significant influence in determining prices of choice, select and 50% lean beef trimmings. This is true especially in the case of select beef, which is significantly affected by changes in quantities of frozen beef.

There is not enough statistical evidence that imports of beef have any significant influence in determining prices of domestic beef. It is plausible that import volumes of beef in the U.S. are not significantly large enough to affect domestic beef prices due to the current level of imports. This explanation is consistent with results noted in a study on the economic impact of BSE incidents on the U.S. beef production by Mathews, Vandeveer, and Gustafson (2006). Their conclusion is that BSE events did not triggered higher prices following a ban on the U.S. import of beef from Canada during the 2003 BSE event. This is true because U.S. reliance on beef imports from Canada is small, about 10 percent of domestic beef production. This conclusion is further supported by the findings of Dhoubhadel, Castillo and Capps (2009). In their analysis of the U.S. beef industry, they found marketing margins are not altered by Canadian BSE events.

Exports do not influence the price of choice beef; however, they do statistically influence prices of select beef. Other quantities of meat, at the wholesale level, such as pork and chicken do not have statistical influence in determining prices of any of the three beef prices.

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Table 1: Descriptive Statistics of Selected Variables in the Model

Descriptive Statistics	QP_{bf}*	QP_{fr}*	QP_{im}*	QP_{ex}*	QP_{pk}*	QP_{ch}*	P_{wch}**	P_{wsl}**	P_{50t}**
Mean	7.35	1.46	0.53	0.45	5.39	8.29	122.54	111.74	28.47
Median	7.37	1.46	0.55	0.44	5.44	8.37	122.20	112.00	28.01
Maximum	8.71	1.82	0.81	0..89	6.36	9.35	157.00	126.80	48.53
Minimum	6.00	1.08	0.24	0.02	4.44	6.74	104.00	92.15	12.62
Std. Dev.	0.60	0.15	0.12	0.23	0.41	0.60	10.49	7.77	8.38

*Pounds/per capita/month ** Cents/pounds (in 1982-84 prices)

Table 2: A Summary of Results for Average Wholesale Price of Choice Beef

Independent Variables	Coefficient	Std. Error	t-Statistic	Prob.
QP_{bf}	-0.404217	0.187426	-2.156679	**0.0322
QP_{fr}	-0.402884	0.129405	-3.113350	**0.0021
QP_{im}	-0.011802	0.036911	-0.319746	0.7495
QP_{ex}	0.029559	0.023842	1.239781	0.2165
QP_{pk}	0.266750	0.224012	1.190783	0.2352
QP_{ch}	-0.039087	0.209411	-0.186650	0.8521
ICT	0.002554	0.001443	1.770068	*0.0783
January	0.095015	0.035169	2.701682	**0.0075
February	0.077025	0.039824	1.934102	**0.0545
March	0.059280	0.039436	1.503200	0.1344
April	0.017098	0.042131	0.405840	0.6853
May	0.069817	0.060877	1.146852	0.2528
June	0.065835	0.059103	1.113890	0.2667
July	0.031775	0.055223	0.575385	0.5657
August	0.072591	0.046100	1.574646	0.1169
September	0.090150	0.034426	2.618693	**0.0095
October	0.055369	0.029047	1.906177	*0.0581
November	-0.036413	0.024489	-1.486901	0.1386
Year01	0.280600	0.180380	1.555607	0.1214
Year02	0.257730	0.167971	1.534376	0.1265
Year03	0.324792	0.150608	2.156541	**0.0322
Year04	0.325159	0.134710	2.413762	**0.0167
Year05	0.226479	0.103738	2.183178	**0.0302
Year06	0.221234	0.083734	2.642119	**0.0089
Year07	0.143348	0.054342	2.637880	**0.0090
AR1	0.254894	0.093300	2.731975	**0.0069
AR2	-0.173087	0.094232	-1.836811	*0.0677
R-squared	0.698896	*Mean dependent variable*		4.804086
Adjusted R-squared	0.573822	*S.D. dependent variable*		0.085252
S.E. of regression	0.055655	*Sum squared residue*		0.201333
Durbin-Watson stat	1.817503			

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

Table 3: A Summary of Results for Average Wholesale Prices of Select Beef

Independent Variables	Coefficient	Std. Error	t-Statistic	Prob.
QP_{bf}	-0.139815	0.130364	-1.072499	0.2848
QP_{fr}	-0.290831	0.112302	-2.589726	**0.0103
QP_{im}	-0.003799	0.025921	-0.146568	0.8836
QP_{ex}	0.042463	0.020511	2.070293	**0.0397
QP_{pk}	-0.010437	0.159286	-0.065521	0.9478
QP_{ch}	0.108642	0.142814	0.760728	0.4477
ICT	0.001205	0.001229	0.981045	0.3278
January	0.076512	0.027199	2.813106	**0.0054
February	0.069893	0.031110	2.246619	**0.0258
March	0.038855	0.032481	1.196241	0.2330
April	-0.002778	0.034793	-0.079840	0.9364
May	-0.025232	0.047388	-0.532458	0.5950
June	-0.020913	0.045869	-0.455927	0.6489
July	-0.002822	0.042610	-0.066229	0.9473
August	0.003013	0.036326	0.082944	0.9340
September	0.022629	0.027812	0.813643	0.4168
October	-0.006750	0.022557	-0.299245	0.7651
November	-0.029267	0.017263	-1.695326	*0.0916
Year01	0.110197	0.155169	0.710174	0.4784
Year02	0.080527	0.143786	0.560048	0.5761
Year03	0.153881	0.129252	1.190545	0.2353
Year04	0.200261	0.116240	1.722829	*0.0865
Year05	0.136506	0.088428	1.543701	0.1243
Year06	0.124188	0.069870	1.777419	*0.0770
Year07	0.096004	0.046237	2.076335	**0.0392
Ar1	0.538919	0.080940	6.658228	**0.0000
Ar2	-0.236617	0.081483	-2.903866	**0.0041
R-squared	0.746290	*Mean dependent variable*		4.712366
Adjusted R-squared	0.640903	*S.D. dependent variable*		0.070701
S.E. of regression	0.042368	*Sum squared residue*		0.116676
Durbin-Watson stat	1.952924			

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

Table 4: A Summary of Results for Average Wholesale Prices of 50% lean trimmings

Independent Variables	Coefficient	Std. Error	t-Statistic	Prob.
QP_{bf}	-1.315712	0.439441	-2.994060	**0.0031
QP_{fr}	-1.333959	0.386974	-3.447155	**0.0007
QP_{im}	0.025723	0.087300	0.294651	0.7686
QP_{ex}	0.113426	0.072960	1.554644	0.1216
QP_{pk}	-0.048984	0.515484	-0.095025	0.9244
QP_{ch}	0.809510	0.474692	1.705337	*0.0897
ICT	0.002764	0.004082	0.677161	0.4991
January	0.035311	0.090641	0.389572	0.6973
February	-0.056555	0.103799	-0.544854	0.5865
March	-0.064415	0.106503	-0.604817	0.5460
April	0.059962	0.115991	0.516953	0.6058
May	0.046619	0.155723	0.299370	0.7650
June	0.064686	0.150498	0.429810	0.6678
July	0.046976	0.138341	0.339567	0.7345
August	0.205529	0.115544	1.778788	*0.0768
September	0.039515	0.084677	0.466661	0.6413
October	0.043528	0.071490	0.608877	0.5433
November	0.086480	0.055687	1.552945	0.1220
Year01	0.045234	0.518624	0.087220	0.9306
Year02	-0.120691	0.469949	-0.256818	0.7976
Year03	0.092103	0.425290	0.216565	0.8288
Year04	0.126530	0.375792	0.336702	0.7367
Year05	-0.014401	0.297717	-0.048372	0.9615
Year06	-0.089102	0.227080	-0.392380	0.6952
Year07	-0.050237	0.148386	-0.338559	0.7353
Ar1	0.597945	0.093286	6.409787	**0.0000
R-squared	0.845754	*Mean dependent variable*		3.305053
Adjusted R-squared	0.786778	*S.D. dependent variable*		0.302647
S.E. of regression	0.139750	*Sum squared residue*		1.328051
Durbin-Watson stat	1.828111			

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