RURAL ECONOMY

The Canadian Demand for Meats

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CANADIAN DEMAND FOR MEATS

ABSTRACT

The demand for meat in Canada is examined in a manner similar to previous work by Chen and Veeman, Moschini and Meilke, and Reynolds and Goddard. The current effort differs from previous studies in two important ways. First, beef demand is disaggregated into ground beef and table cut beef. This should allow a more detailed understanding of beef demand and beef products' relation to other meats. Second, Canadian livestock production costs and trade are incorporated in the calculation of demand estimates. This is motivated by previous findings of significant shifts in Canadian consumers' meat preferences sometime in the 1970s. If shocks to the supply side during the decade of the 1970s are the culprits driving the findings of shifting preferences, then incorporating them in the calculation of demand estimates should reveal the structural change findings as artifacts caused by ignoring supply and trade.

Results show that, as they typically estimated, ground and table cut beef are very different products in consumption. Ground beef is more expenditure elastic and less own-price elastic than table cut beef. Both products compete about equally with pork, but ground beef is more substitutable for chicken. Demands also appear to have undergone a significant shift in 1978. Incorporating the supply side and trade in estimation of Canadian meat demands produces significantly better estimates and causes the apparent differences between ground and table cut beef and all structural shifts to disappear.

The implications for producers and processors of red meats are that it is in improved production and marketing efficiencies that the chicken producers and processors are winning

the battle for market share of the Canadian consumers' declining food budget.

INTRODUCTION

Agricultural economists have spent great efforts, attempting to understand the demand for meats. This is motivated by the relatively large portion of the consumer's budget which is allocated to meats. Over the last three decades, Canadian consumers have spent approximately 30% of their annual food budget on beef, pork, and chicken. Thus, an adequate understanding of the demands for these commodities is important to consumers, producers, processors, retailers, policy makers, and researchers, alike. The question is: Do we have an "adequate" understanding of the demand for meats? The answer depends upon the purpose for which that knowledge is to be used.

One usage of such knowledge is to improve the producers' and processors' understanding of consumers' desires, to help each gain in their competitive struggle for market share. Until the mid 70s, the proportion of meat expenditures spent on beef hovered between 0.49 and 0.51; by the last half of the 80s, it has fallen to 0.45. Likewise, expenditures on pork have dropped from 40% of meat expenditures in the first half of the 60s to under 35% in the last half of the 80s. Chicken was the beneficiary of these declines. Its share moved from 10% in the 60s to 20% by the later half of the 80s.

The context within which these developments must be viewed is one of a declining portion of expenditures on food (from about 18% of total expenditures in the early 60s to 11% in the late 80s) and a 2 - 3% real growth rate in consumer expenditures. Thus, chicken producers and processors appear to be winning the battle for market share amongst the meats. Meats as a group are holding their own against other foods, and foods as a group are declining.

One of the more frequently advanced arguments to explain these stylized facts, is that consumers' preferences for meats have shifted. The argument is that either because of health concerns caused by dissemination of information on the links between cholesterol and heart disease or an increased demand for convenience caused by rising opportunity costs in meal preparation, consumers have been substituting amongst the meats, with chicken winning market share from beef and pork.

Recent findings (Chen and Veeman; Reynolds and Goddard) have reconfirmed earlier studies (Young; Atkins, Kerr, and McGivern) that there has been a shift in the demand for meats in Canada. Using a dynamic Almost Ideal Demand System (AIDS) model Chen and Veeman found there had been a shift in meat preferences in the third quarter of 1976, when the per capita consumption of beef peaked. Reynolds and Goddard employed the same methodology used by Moschini and Meilke to examine US meat demands for structural change. They found that Canadian demands had undergone a gradual shift starting in the 1st quarter of 1975 and finally subsiding in the 1st quarter of 1984. The study by Chen and Veeman was more careful in the specification of the dynamics of Canadian meat demand, but allowed only an abrupt shift in trends in preferences. The study of Reynolds and Goddard used a more flexible model of the shift in consumer preferences, capable of discerning from the data whether the shift had been sudden or gradual. The common finding of both efforts is a reaffirmation of previous efforts that have found a shift in preferences starting sometime during the 1970s.

These studies suffer from two potential deficiencies. First, they examined aggregate meat products, such as "beef." Earlier work by Wohlgenant, Eales and Unnevehr (1988), and Brester and Wohlgenant, suggest that the own-price and expenditure elasticities of disaggregated beef products in the US are very different. Second, recent evidence (Wahl and Hayes; Eales and Unnevehr (1993)) suggests that prices and quantities of meats are simultaneously determined. This implies that what is interpreted as shifting consumer preferences for meats may actually be caused by North American supply shocks. That is, the high feed costs of the mid 70s resulted in a liquidation of the cattle herds and this causes demand estimates, which do not account for the supply side, to appear to have undergone a shift. In the case of Canadian meats, the cost of livestock production in both Canada and the US may have an affect on demand estimates, since US - Canadian border is relatively open to trade in beef and pork. Finally, Chalfant and Alston showed using revealed preference techniques, that there exists a utility function which would rationalize Canadian meat consumption data, implying the demands shifts found in parametric demand studies are suspect.

The objective of this paper is to examine the impacts of disaggregation of beef into table cuts and ground beef on demand estimates and to incorporate determinants of North American livestock production costs in the calculations of those demand estimates. The next section discusses disaggregation of Canadian beef consumption. This is followed by a description of the rest of the data and the demand model estimated. The fifth section gives results. The final section summarizes and draws some conclusions.

DISAGGREGATION OF BEEF CONSUMPTION

People do not consume "beef" or "chicken" or "pork." People consume ground beef, sirloin steak, chicken breasts, ham, bacon, etc. The difficulty faced by researchers is that time-series data on meat consumption is generated by calculating how many cattle, chickens, and hogs "disappeared" in a particular time period and then converting these disappearance numbers into "apparent" per capita beef, chicken, and pork consumption.

One objective of this research is to try and further refine our understanding of Canadian meat consumption by disaggregating beef into what will be called ground beef and table cut beef. The advantage of such an approach is that it will allow the development of a more detailed picture of the structure of consumer preferences. Is chicken substituting for ground beef or table cut beef in consumer diets? Is ground beef less own-price and expenditure elastic than table-cut beef? Do the commonly found changes in preferences amongst consumers affect both beef demands equally?

One would, of course, like to disaggregate all the meats into their constituent components. Unfortunately, such is not possible using the time-series data currently gathered in Canada. This has caused researchers to examine other data sources, such as the family expenditure survey data and scanner data from retail outlets. The difficulty with survey data is that there is reason to suspect the variability of prices implied in such data. This makes estimation of demands problematic. The scanner data is difficult to obtain and then seldom includes information on consumer characteristics, especially income.

The method utilized to disaggregate beef consumption is similar to that which has been employed in analyzing US beef product consumption. It requires information on the makeup of animal slaughter in terms of steers, heifers, cows, and bulls and assumptions about how much of each type of carcass ends up as ground beef. Wohlgenant was one of the first to utilize this sort of approach in meat demand analysis. He found the major interaction between beef and poultry occurred between ground beef (nonfed beef) and poultry and attributed this to the rise in importance of chicken in fast-food outlets. Eales and Unnevehr (1988) used the fed-nonfed disaggregation for beef along with chicken disaggregated into whole-bird chicken and parts/processed chicken. They looked at how to group these products to best reflect consumer decisions and found that the data supported grouping fed beef (table-cut beef) with parts/processed chicken and nonfed beef (ground beef) with whole-bird chicken rather than by animal origin. They, also, found initial growth and then decline in fed beef consumption and continuous growth in parts/processed chicken demand. In neither ground beef nor whole-bird chicken was growth or the mid-70s shift significant. Brester and Wohlgenant developed a more sophisticated methodology for disaggregating beef and found that it was a significantly better representation of demand for beef products.

A difficulty with disaggregation of Canadian beef consumption is that while data on the distribution of numbers of animals slaughtered by type has been kept since the early 60s, averaged dressed weights for each type has only been kept since mid 1975. Prior to that only the average dressed weight for all slaughtered animals is available. Hence, the following procedure was adopted. The available data was used to estimate models of the following form:

(1) $$ADW_{it} = \beta_{0i} + \beta_{1i}\, ADW_t + \beta_{2i}\, NST_t + \beta_{3i}\, NHE_t + \beta_{4i}\, NCOW_t + \beta_{5i}\, TIME + \varepsilon_{it}$$

where: ADW_{it} is the average dressed weight for animal type i (steers, heifer, cows, and bulls) in year t, ADW_t is the average dressed weight for all cattle in year t, NST_t is the number of steers slaughtered in year t, NHE_t is the number of heifers slaughtered in year t,

$NCOW_t$ is the number of cows slaughtered in year t, TIME is a time trend, and ε_{it} is an error term. The rationale behind this formulation is: if it is adequate to explain the variation in ADW by animal type, then it can be used to forecast, actually in this case "backcast," the dressed weights by animal type. ADW_t is included, since it is the only dressed weight measure available over the entire sample period. The numbers of animals slaughtered by type is included, since one would expect the ADW_t figure to be higher if there were a larger number of steers slaughtered and lower if the numbers of cows and heifers were high. Finally, time is included to capture the trends in slaughter weight for each animal type. Results of these estimations are given in Table 1. All models were estimated by OLS and fit well, although many of the coefficients are not significant.

Results of these equations are of little direct interest. Their value is in their use to "backcast" average dressed weights by type which are then combined with slaughter numbers to allocate total slaughter amongst the types by weight. Assuming that a fixed portion of each type of carcass becomes ground beef, total beef disappearance is allocated to ground and table cut beef. Finally, the proportion of ground and table cut disappearance is applied to per capita consumption to derive retail beef product per capita consumption. This is similar to the methodology recommended by Brester and Wohlgenant. It is an adaptation of that used by the Western Livestock Marketing Information Project to allocate US per capita consumption to ground and table cut beef. The procedure for Canadian consumption is somewhat simplified, since due to climatic differences the fed-nonfed distinction in production is not significant in Canada. The procedure is as follows:

TABLE 1. Backcasting Equations for Average Dressed Weights by Type*

	Total	Numbers Slaughtered					
	ADW	Steers	Heifers	Cows	Time	CONST	R^2 / DW
Steers	1.154	-222.4	-105.7	42.2	-1.604	3269.7	.992
	(0.165)	(668.2)	(681.5)	(631.0)	(1.090)	(2385.0)	2.130
Heifers	1.118	831.5	858.6	961.4	1.792	-4538.3	.998
	(0.125)	(507.7)	(517.8)	(479.5)	(0.828)	(1812.1)	1.908
Cows	0.982	-1092.4	-940.6	-1077.6	-0.152	1289.8	.986
	(0.216)	(876.1)	(893.4)	(826.3)	(1.429)	(3126.7)	2.224
Bulls	3.100	4423.3	4123.0	5302.6	10.741	15779.0	.937
	(0.986)	(3997.3)	(4076.6)	(3774.7)	(6.519)	(14267.0)	2.614

* Figures in parentheses are standard errors.

1. Use the estimates in Table 1 to estimate the average dressed weights of steers, heifers, cows, and bulls, annually, from 1961 through 1975.
2. Combine those estimates of dressed weights with the published dressed weights for 1976 through 1990 and with the numbers slaughtered in each category from 1961 through 1990 to calculate the total dressed weight produced from each animal type.
3. Assume that 25% of heifer and steer carcasses, 90% of cow carcasses, and 100% of bull carcasses become ground beef.
4. Adjust for imports and exports, assuming that 30% of imports are from the US and 80% of exports go to the US, both of which are assumed to be high quality, that is imports would produce 25% ground beef. The residual imports from the rest of the world are assumed to be 100% ground, while exports to the rest of the world are also high quality, producing 25% ground beef.
5. Combining all ground production from these sources and dividing by total production gives the proportion of ground beef production. This proportion is then applied to the per capita retail consumption of beef to produce a per capita consumption of ground beef. Table cut beef is the difference between total and ground beef consumption.
6. Ground beef price is obtained by converting the consumer price index (CPI) for ground beef to a price using the prices published in the *Handbook of Food Expenditures, Prices, and Consumption.* Similarly, a price for all beef is created from the CPI for beef and the prices in the *Handbook.* Finally, a price for table cut beef is calculated such that the expenditures on ground beef and table cut beef are equal to the total expenditure on all beef in each year.

The results of these calculations are given in Table 2. The proportions of total beef that end up as ground beef range from a low of .393 in 1979 to a high of .472 in 1962. The average over all 30 years is .424. Brester and Wohlgenant published their disaggregation of US beef consumption. The proportion of US beef that was ground from 1962 through 1989 averaged .399 with a low of .374 in 1972 to a high of .445 in 1975. As another check on the validity of this procedure for disaggregation of Canadian beef consumption, the same methodology was applied to US beef consumption for the period 1961 through 1990. That is, even though average dressed weights were available by class over this entire period, only those from 1976 through 1990 were used to estimate the same models estimated for Canada. The resulting models were used to calculate estimates of US average dressed weights by animal type for 1961 through 1975. Ground beef proportions were then estimated from both the estimated and the actual average dressed weight data. The root mean square percentage error between the estimated and actual proportion of US ground beef consumption was 1.5%, showing that the "backcasting" of average dressed weights does not adversely affect estimates of the proportion of beef that is ground.[1]

DATA

The resulting disaggregated data on beef consumption is then combined with prices and quantities of pork, chicken, non-meat foods, and all other goods to estimate demand models for Canadian meats. The CPIs and quantities of pork and chicken are taken from the 1992 edition of the *Handbook of Food Expenditures, Prices, and Consumption* (HFEPC). CPIs for food and non-food, total personal expenditures on goods and services, food

Table 2. Disaggregated Beef Prices and Consumption 1961-1990*

	Prices			Consumption		
Year	Ground Beef	Table Cut Beef	All Beef	Ground Beef	Table Cut Beef	All Beef
1961.	.91	2.19	1.61	11.02	13.30	24.32
1962.	.98	2.46	1.76	11.57	12.94	24.51
1963.	.98	2.30	1.71	11.43	14.19	25.62
1964.	.95	2.19	1.65	11.88	15.49	27.37
1965.	.97	2.37	1.72	13.32	15.49	28.81
1966.	1.10	2.55	1.90	13.10	15.86	28.96
1967.	1.16	2.63	1.99	12.38	16.29	28.67
1968.	1.16	2.69	2.03	12.71	16.64	29.35
1969.	1.26	2.87	2.19	12.44	17.09	29.53
1970.	1.32	2.92	2.26	11.98	17.12	29.10
1971.	1.35	2.59	2.07	12.79	17.73	30.52
1972.	1.55	2.76	2.26	13.41	19.10	32.51
1973.	1.98	3.27	2.74	13.20	18.76	31.96
1974.	2.05	3.69	3.02	13.56	19.63	33.19
1975.	1.51	3.86	2.86	15.65	21.23	36.88
1976.	1.49	3.53	2.68	16.33	22.70	39.03
1977.	1.58	3.73	2.85	15.23	21.90	37.13
1978.	2.52	5.30	4.16	14.19	20.56	34.75
1979.	3.77	6.57	5.47	11.60	17.93	29.53
1980.	3.85	7.32	5.94	11.66	17.59	29.25
1981.	3.88	7.55	6.10	11.91	18.14	30.05
1982.	3.60	7.78	6.05	12.30	17.55	29.85
1983.	3.58	7.87	6.10	12.23	17.50	29.73
1984.	3.43	8.83	6.50	12.21	16.20	28.41
1985.	3.37	9.22	6.67	12.59	16.23	28.82
1986.	3.30	9.39	6.81	12.20	16.60	28.80
1987.	3.59	10.25	7.43	11.82	16.08	27.90
1988.	3.60	10.37	7.55	11.66	16.34	28.00
1989.	3.65	10.78	7.71	11.81	15.59	27.40
1990.	3.90	10.98	8.01	11.09	15.31	26.40

* Prices are given in dollars per kilogram. Quantities are in kilograms per year.

expenditures, and population are taken from Cansim. As indicated, above, CPIs for meats are converted to prices using 1986 city average retail prices for various cuts (HFEPC, 1990; Table 44) and combining them using the weights used in calculating the overall CPI (HFEPC, 1990; Table 45).

The inclusion of the categories, non-meat foods and all other goods, is due to an objection raised by LaFrance. He showed that if one were to exclude these categories and estimate a conditional demand model for meats with meat expenditures as an explanatory variable, that the resulting estimates are biased and inconsistent, since meat expenditures are endogenous to such a conditional demand system. Including non-meat foods and all other goods requires the use of total per capita expenditure as a right-hand-side variable, which it is reasonable to take as predetermined. This avoids a potential source of inconsistency in estimation.

A second data requirement is a set of variables which characterize livestock production costs. The set employed was the following: price indexes for fuel and electricity, wages of farm and meat-packing labour, barley and corn price (both on a calendar year basis), interest rate, average dressed weight of slaughter cattle, fat removed per 100 pounds of pork carcass, and US-Canadian exchange rate. These variables do not constitute an exhaustive list in the sense that, if one were interested in building livestock supply models, these variables would be inadequate. However, the interest here is in characterizing the cost of production and marketing of livestock well enough to produce consistent estimates of the demands for meats. The variables listed should capture the essence of livestock production and processing costs, as well as the technological innovation which has increased livestock production efficiency over the last three decades.

A final data need is suggested by previous researchers' assumption that meat prices in Canada are determined by US meat and/or livestock prices (Tryfos and Tryphonopoulos; Hassan and Katz). Trade in chicken has been restricted since the implementation of the chicken marketing boards in the mid 70s. However, even in chicken, net imports were 47.71 kilotonnes in 1990 versus a production of 572.87 kilotonnes. Beef and pork are more clearly subject to the influence of foreign markets. The net imports of beef constituted about 12% of Canadian production in 1990, while net exports of pork were 10% of Canadian production. Since a majority of this trade was with the US, this implies that it will be important to incorporate variables which characterize the US market for meats in the list of instruments. Therefore, US beef, pork, and chicken prices are included.

MODELLING DEMAND

The data will be used to estimate a model similar to that of Moschini and Meilke and of Reynolds and Goddard. It is called a gradual-switching AIDS model by Reynolds and Goddard. The form of the demands is:

$$\Delta\, w_{it} = \alpha_i + \theta_i\, tn_t + \sum_j \left(\gamma_{ij}\, \Delta \ln p_{jt} + \mu_{ij}\, tn_t\, \Delta \ln p_{jt} \right) + \beta_i\, \Delta \ln \left(X_t / P_t \right) + \mu_i\, tn_t\, \Delta \ln \left(X_t / P_t \right) \tag{2}$$

where:

Δ is the first difference operator, i.e. $\Delta\, x_t = x_t - x_{t-1}$
w_{it} is the budget share of the *i*th commodity in period t.
ln p_{jt} is the natural logarithm of the price of *j*th good.
ln (X_t / P_t) is the log of the ratio of total expenditure on all goods in the demand system to Stone's price index ($\ln P_t = \Sigma_j\, w_{jt} \ln p_{jt}$).
tn_t is a generalization of a dummy variable, which can change quickly from one regime to the next or may make the transition slowly. It is defined as follows:

$$tn_t = 0 \qquad \text{for } t = 1,...,t_1$$
$$tn_t = (t - t_1) / (t_2 - t_1) \qquad \text{for } t = t_1 + 1,...,t_2 - 1$$
$$tn_t = 1 \qquad \text{for } t = t_2 ,...,T$$

where

t_1 is the end of the first regime.
t_2 is the beginning of the second regime.

The advantage of this definition of the transition function is that it allows a gradual or abrupt shift from one regime to the next. If demand shifts are the result of changes in consumer tastes and preferences then a pattern more in keeping with the typical reasons given for such changes is one which occurs gradually. That is, as information on the ties between cholesterol and heart disease disseminates through the population of meat consumers or the opportunity cost of meal-preparation time rises as the number of households headed by two wage earners,single parents, and women increase in the population, demands move slowly from the old regime to the new.

The difficulty with such a transition function is that one must specify t_1 and t_2. The technique employed by Moschini and Meilke and by Reynolds and Goddard was to examine the likelihood values, as t_1 and t_2 were varied over their data and pick the values for t_1 and t_2 which maximized the likelihood function. This technique will be employed here, as well.

There are several differences between the gradual switching AIDS model specified here and those of Moschini and Meilke and of Reynolds and Goddard. First, a constant is included in the equation, even though differencing the AIDS model, as in equation 2, would cause the constant to fall out. This follows Deaton and Meullbauer who also include a constant when estimating their differenced AIDS model. Second, the model above, will be applied to annual data, rather than the quarterly data employed by Moschini and Meilke and by Reynolds and Goddard. This is because the data necessary to disaggregate beef was only available on an annual basis. Third, the model includes ground and table-cut beef, pork, chicken, non-meat foods, and all other goods, while the previous studies looked at beef, pork, chicken, and fish (Moschini and Meilke) or at beef, pork, and chicken (Reynolds and Goddard). Fourth, the transition function tn_t is applied after the differencing and so is not differenced itself. Finally, the model will be estimated twice, once without accounting for the supply side and meat/livestock trade and then again, taking account of the supply/trade instruments. The first estimation is by Seemingly Unrelated Regressions (SUR) with homogeneity and symmetry imposed. This is similar to what was done by Moschini and Meilke and by Reynolds and Goddard. The second estimation will be by Three Stage Least Squares (3SLS) using the set of instruments which characterizes the cost of livestock production and US meat markets, again, with homogeneity and symmetry imposed.

RESULTS

The first step is to identify the beginning and ending points of the transition function, i.e. t_1 and t_2. As indicated, above, this is done by varying t_1 and t_2 over all possible combinations and picking the values which maximize the likelihood function.[2] These values turned out to be 1978 and 1979, respectively. Thus, even though the transition was allowed to be gradual, the data prefers a rapid transition in the late 70s. This is similar to Moschini and Meilke's findings for the US, where the transition took place between the last quarter of 1975 and the first quarter of 1976. It differs from the findings of Reynolds and Goddard for Canada. They found that the change in demand began in the first quarter of 1975 and subsided in the first quarter of 1984.

Once the transition points have been identified, the next step is to estimate the gradual switching AIDS model conditional of the identified regimes and then test for the significance of the shift in consumer preferences. The results of these tests are given in the top half of Table 3.[3] They show that all parameters change with the exception of those associated with expenditure. Thus, in taking the typical approach, a significant shift was identified starting in 1978 and ending in 1979.

Next, the gradual switching AIDS model is re-estimated with 3SLS using the supply/trade instruments. The tests for a shift in structure are recalculated with these estimates and results are given in the bottom half of Table 3. After accounting for supply/trade, none of the parametric shifts are now significant.

Two questions arise in examining these results. First, is the difference between the two sets of estimates statistically significant? That is, does the data really show evidence that the consideration of the supply side is important? Second, if it is significant, does it make a "real" difference?

To answer the first of these questions, the two sets of estimates are used to calculate a Wu-Hausman test. This test compares the estimates which are best if accounting for supply/trade is not important in calculating demand estimates (SUR in this case) to those which are consistent whether the meat prices are predetermined or not (3SLS). The intuition of the test is that the two sets of estimates should be similar if supply and trade are unimportant when calculating demand. The results of the test are distributed chi-square with 40 degrees of freedom (five equations each of which contains four meat prices and four interactions between the transition and the meat prices). The 0.05 cutoff of this distribution

Table 3. Tests for Structural Change

Without Supply/Trade Instruments

No Structural Change	Wald Statistic	Degrees of Freedom	.05 CutOff
All Parameters	54.20	25	37.66
Price Parameters	32.56	15	25.00
Expenditure Parameters	3.69	5	11.07
Intercepts	18.46	5	11.07

With Supply/Trade Instruments

No Structural Change	Wald Statistic	Degrees of Freedom	.05 CutOff
All Parameters	27.61	25	37.66
Price Parameters	19.97	15	25.00
Expenditure Parameters	2.44	5	11.07
Intercepts	6.55	5	11.07

is 55.76. The calculated value of the Wu-Hausman statistic is 714.97, suggesting there is a significant difference between the two sets of coefficients. This implies that the typically applied SUR estimator of meat demand models produces estimates which are suspect due to the probable endogeneity of meat prices.[4]

The second question is more fundamental. If there is a significant difference in the coefficients, is this difference enough to affect the decisions made by producers or processors of livestock products? To address this question, it is most natural to examine the elasticity estimates. The SUR estimates are given in Table 4 and the 3SLS estimates Table 5. For the SUR estimates, there are two relevant sets of elasticities, those before and after the structural change.[5] The 3SLS estimates showed no significant shifts, so the 3SLS estimates were recalculated without the transition or interactions, and elasticities are calculated over the entire sample period.

First, examine the SUR elasticities, before and after the structural change. Ground beef remains unaffected in terms of own-price and expenditure elasticities. Table cut beef becomes both more own-price and expenditure elastic. While chicken becomes less own-price and expenditure elastic. The substitutability between ground beef and chicken lessens. Pork's own-price elasticity is unaffected, but it becomes less expenditure elastic. These results might suggest to producers and processors that it is the increased demand for convenience that is driving consumers away from table cut beef and to chicken products, since the more convenient-to-prepare product, ground beef, is little affected by the shift, while table cut beef demand changes dramatically.[6] The shift in chicken demand is in part due to

Table 4. Elasticities Based on SUR Estimates[1]

Without Supply/Trade Instruments - Before the Structural Change

	Ground Beef	Table Cut Beef	Pork	Chicken	Non-Meat Food	Other	Expenditure
Ground	-0.325	-0.133	0.142	0.310	-0.566	-0.091	0.663
Table Cut	-0.046	-0.353	0.079	-0.006	0.000	-0.396	0.723
Pork	0.048	0.079	-0.689	0.140	-0.481	0.281	0.621
Chicken	0.337	-0.042	0.440	-1.297	0.771	-2.157	1.948
Non-Meat	-0.037	-0.004	-0.095	0.049	-0.324	-0.514	0.925
Other	-0.003	-0.015	-0.001	-0.010	-0.076	-0.915	1.021

Without Supply/Trade Instruments - After the Structural Change

	Ground Beef	Table Cut Beef	Pork	Chicken	Non-Meat Food	Other	Expenditure
Ground	-0.336	0.121	0.004	0.216	-1.059	0.410	0.644
Table Cut	0.034	-0.812	0.101	-0.018	0.057	-0.510	1.148
Pork	0.003	0.123	-0.634	0.150	-0.268	0.294	0.333
Chicken	0.138	-0.034	0.286	-0.704	0.888	-1.390	0.816
Non-Meat	-0.054	0.020	-0.044	0.074	-0.328	-0.116	0.448
Other	0.000	-0.007	-0.005	-0.012	-0.063	-0.976	1.064

1. Elasticities are calculated using elasticity formulae in endnote 5. The "before change" elasticities are calculated using the sample mean shares from 1961 through 1978. The "after change" elasticities are calculated using the sample mean shares from 1979 through 1990. No standard errors are calculated, since the elasticities are based on the inconsistent SUR estimates.

Table 5. Elasticities Based on 3SLS Estimates[1]

With Supply/Trade Instruments - No Structural Change

	Ground Beef	Table Cut Beef	Pork	Chicken	Non-Meat Food	Other	Expenditure
Ground	-.281*	-.106	.218*	.225*	-.531*	-.412	.882*
	(.076)	(.134)	(.076)	(.094)	(.278)	(.408)	(.357)
Table Cut	-.035	-.411*	.140*	.019	-.164	-.450	.896*
	(.045)	(.113)	(.055)	(.065)	(.208)	(.306)	(.289)
Pork	.075*	.150*	-.633*	.111*	-.481*	.320	.440
	(.026)	(.055)	(.064)	(.044)	(.153)	(.293)	(.295)
Chicken	.206*	.051	.295*	-.803*	.727	-1.378*	.899
	(.088)	(.182)	(.123)	(.254)	(.464)	(.552)	(.461)
Non-Meat	-.029	-.023	-.086*	.049	-.138	-.332*	.545*
	(.016)	(.037)	(.027)	(.033)	(.128)	(.167)	(.138)
Other	-.003	-.013	-.006	-.012	-.089	-.941	1.063

1. The elasticities are based on the consistent estimates of the AIDS model and use mean shares over the entire sample. Standard errors are calculated assuming the mean shares are fixed. A * indicates significance at the 0.05 level.

* Indicates the elasticity is significant at the five percent level.

the change in the makeup of "chicken." While figures for Canada are not available, the makeup of US chicken consumption has gone from 74% of purchases being whole-bird chicken in the mid-1960s, to over 85% being parts and processed chicken by the late 1980s. Assuming similar trends are operating in Canada, the competition between ground beef and chicken, especially in fast-food consumption, can be seen as a lessening of their substitutability for one another.

However, these observations are artifacts of the estimation technique employed in the calculation of the SUR estimates. When the supply and trade are taken into account, none of these shifts are significant (bottom half of Table 3). This implies that what many have identified as shifts in consumer preferences for meats is in reality contamination of demand estimates which fail to account for livestock supply and the relative openness of the Canadian markets. Note, also, in Table 5 the significant substitution relationship between chicken and ground beef, while that between chicken and table cut beef is comparatively weak and insignificant. A possible explanation of this finding, which is similar to that found for the US by Wohlgenant, is that the major competition between beef and chicken is being driven by increased development of the fast-food market. Finally, ground and table cut beef appear to have become very different products after the "change in structure," when examined using the SUR estimates, showing differing sensitivity to their own prices and expenditures, as well as differing substitutability for chicken and for pork. Again, the story is very different when the 3SLS estimates are used. While the own-price, cross-price, and expenditure elasticities all differ, all have the same sign and none of the differences is significant.

CONCLUSIONS

Canadian demand for meats is examined in a gradual switching AIDS model similar to earlier work by Moschini and Meilke for the US and Reynolds and Goddard for Canada. The current work differs from these two previous studies by including disaggregated beef products, ground and table cut beef, and non-meat food and all other goods. It differs, as well, by estimating demands for meats in two ways; first, by SUR as was done in these earlier studies and, second, by 3SLS where instruments include variables which characterize the costs of livestock production and conditions in US meat markets.

The disaggregation of beef into ground and table cut beef allows the examination of the competition between chicken and the two beef products. Competition between chicken and ground beef is larger than that between chicken and table cut beef. This suggests that the growth of the fast-food industry is playing a key role in determining the relationship between chicken and beef demand. Several cautions are in order, however. First, cross-price elasticities are notoriously difficult to estimate. Second, because of data limitations, the ground beef proportion of beef consumption was calculated from "backcasts" of average dressed weights for slaughter steers, heifers, cows, and bulls in Canada. While this procedure was shown to do well for US data where it could be checked, results from such data must be regarded as suggestive.

Comparison of the two sets of estimates was done in two ways. A Wu-Hausman test shows that the models differ significantly, suggesting that the typical SUR estimates should be viewed with caution. Also, tests for structural change were done on both models. In the SUR framework, significant structural change was found, as in Moschini and Meilke and in

Reynolds and Goddard. However, when the livestock supply and trade are taken into account, no significant structural shift is detected.

The debate over whether consumer preferences for meat have shifted continues. It has even spilled over into more popularly oriented venues, e.g. the exchange between Purcell, Dahlgran, and Lambert in *Choices*. Results from this study suggest previous findings of changes in consumer preferences in Canadian meat demands may be artifacts of estimation techniques which ignore the supply side and openness of the markets. If consumer preferences have not shifted, then there is little sense in attempting to woo back disaffected consumers through persuasive advertizing. They have been lured away by more attractive prices for goods which embody more appealing characteristics.

ENDNOTES

1. This procedure underestimates US ground beef proportion, since it makes no allowance for nonfed steers and heifers, which are significant for US production. It does show that "backcasting" of average dressed weights for steers, heifers, cows, and bulls does well in determining the overall portion of beef which is ground.

2. The search was carried out using iterative SUR. All calculations are done with the SHAZAM program (White, 1978).

3. Coefficient estimates are not easily interpreted. Therefore, they and the diagnostics for the SUR estimates of the gradual switching AIDS model (as well as the 3SLS estimates of the model) are given in an appendix.

4. Due to the interconnectedness of the US and Canadian meat markets, some possibility exists that US meat prices may cause problems when employed as instruments. To address this, the Wu-Hausman test was recalculated leaving the US meat prices off of the list of instruments. The calculated value was 79.60. Thus, Canadian livestock production costs were enough, by themselves, to identify the dangers of treating meat prices as predetermined when estimating meat demands.

5. Elasticities are calculated as follows:

$$\varepsilon_{ij} = \frac{\gamma_{ij} + \mu_{ij} - (\beta_i + \mu_i)\, w^k_j}{w^k_i} - \delta_{ij}$$

where ε_{ij} is the price elasticity of demand of the *i*th good with respect to the *j*th price, γ_{ij} and γ_i are either the SUR of 3SLS estimates, μ_{ij} and μ_i are the estimates of the change in the price and expenditure coefficients for the SUR model or 0 for the 3SLS model, δ_{ij} which is one if $i = j$ and zero otherwise, and w^k_j is the average share (before or after the structural change for the SUR model and over the entire sample for the 3SLS model). The expenditure elasiticities are:

$$\varepsilon_i = \frac{\beta_i + \mu_i}{w^k_i} + 1$$

where ε_i is the expenditure elasticity, and others are as previously defined.

6. This insight seems further enhanced by the results in Table A1. The transition variable is significant and negative for table cut beef and signifcant and positive for chicken.

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Table A1. SUR Estimates of the Gradual Switching AIDS Model

	GBP	TCP	PKP	CKP	NMP	NFP	EXP	INT	R^2/DW
Ground Beef	.0045*	-.0009	-.0009	.0021*	-.0040*	-.0025	-.0023	.0000	.9080
	(.0004)	(.0007)	(.0005)	(.0006)	(.0014)	(.0014)	(.0035)	(.0001)	2.1434
	-.0016*	.0014	-.0009	-.0011	-.0007	.0029	.0007	-.0001	
	(.0008)	(.0014)	(.0011)	(.0009)	(.0030)	(.0033)	(.0048)	(.0002)	
Table Cut Beef	-.0009	.0125*	.0014	-.0001	-.0006	-.0123*	-.0054	.0000	.8799
	(.0007)	(.0016)	(.0010)	(.0010)	(.0027)	(.0029)	(.0070)	(.0003)	2.1464
	.0014	-.0098*	.0001	-.0001	.0015	.0068	.0076	-.0006*	
	(.0014)	(.0038)	(.0022)	(.0021)	(.0067)	(.0073)	(.0096)	(.0003)	
Pork	.0009	.0014	.0061*	.0028*	-.0104*	-.0007	-.0076	-.0002	.7177
	(.0005)	(.0010)	(.0015)	(.0008)	(.0027)	(.0033)	(.0100)	(.0004)	2.0308
	-.0009	.0001	-.0013	-.0008	.0061	-.0031	-.0013	.0000	
	(.0011)	(.0022)	(.0033)	(.0015)	(.0060)	(.0083)	(.0136)	(.0004)	
Chicken	.0020*	-.0001	.0028*	-.0017	.0052*	-.0081*	.0057	-.0003	.7261
	(.0006)	(.0010)	(.0008)	(.0014)	(.0023)	(.0021)	(.0046)	(.0002)	2.0213
	-.0011	-.0001	-.0008	.0038	-.0007	-.0024	-.0069	.0004*	
	(.0009)	(.0021)	(.0015)	(.0021)	(.0047)	(.0049)	(.0062)	(.0002)	
Non-Meat Food	-.0040*	-.0006	-.0104*	.0052*	.0720*	-.0622*	-.0081	-.0026*	.8118
	(.0014)	(.0027)	(.0027)	(.0023)	(.0097)	(.0103)	(.0206)	(.0008)	1.8252
	-.0007	.0016	.0061	.0007	-.0194	.0117	-.0384	.0021*	
	(.0030)	(.0067)	(.0060)	(.0047)	(.0222)	(.0253)	(.0283)	(.0009)	

Table gives SUR coefficients of Gradual Switching AIDS model. The first line for each commodity represents the effect before the "structural change." The second line for each commodity, gives the adjustment that must be made to these effects after the "structural change." A "*" indicates the coefficient exceeds it asymptotic standard error by a factor of two or more.

Table A2. 3SLS Estimates of the AIDS Model

	GBP	TCP	PKP	CKP	NMP	NFP	EXP	INT	R^2/DW
Ground Beef	.0040*	-.0006	.0012*	.0013*	-.0030	-.0028	-.0007	-.0001	.8813
	(.0004)	(.0008)	(.0004)	(.0006)	(.0016)	(.0016)	(.0021)	(.0001)	2.3086
Table Cut Beef	-.0006	.0099*	.0023*	.0003	-.0029	-.0091*	-.0017	-.0003	.7641
	(.0008)	(.0020)	(.0010)	(.0011)	(.0036)	(.0036)	(.0051)	(.0002)	2.0175
Pork	.0012*	.0023*	.0060*	.0018*	-.0089*	-.0024	-.0094	-.0001	.7398
	(.0004)	(.0010)	(.0011)	(.0008)	(.0026)	(.0030)	(.0052)	(.0002)	2.0726
Chicken	.0013*	.0003	.0018*	.0012	.0044	-.0089*	-.0006	.0000	.5944
	(.0006)	(.0011)	(.0008)	(.0016)	(.0029)	(.0025)	(.0029)	(.0001)	1.8573
Non-Meat Food	-.0030	-.0029	-.0089*	.0044	.0779*	-.0674*	-.0433*	-.0012*	.7098
	(.0016)	(.0036)	(.0026)	(.0029)	(.0126)	(.0126)	(.0137)	(.0005)	1.8047

Table gives 3SLS coefficients of the AIDS model. Since the "structural change" was found to be insignificant, the model was re-estimated without the "structural change" parameters. A "*" indicates the coefficient exceeds it asymptotic standard error by a factor of two or more.