Structural Change in the Demand for Differentiated Meat Products in Sydney

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Concerns about the recent trends away from the consumption of red meat have led to tests for structural change in demand. These tests have typically treated the individual meats as homogeneous commodities. This article uses disaggregated data to test for structural change in the demand for differentiated meat products in Sydney over the seasons from winter 1987 to autumn 1991 using a revealed preference approach. The results fail to provide any evidence of structural change.

1. Introduction

A key facet of Australian meat consumption is the competition among beef, lamb, pork and poultry as alternative sources of protein. Over the past decade, poultry meat consumption has been increasing, whilst that of lamb and beef has been declining. More specifically, per head annual consumption of poultry meat has increased by 4 kilograms since 1980, whilst beef consumption dropped from a high of 50 kilograms per head in 1982 to an estimated 38 kilograms per head in 1990 (Australian Bureau of Agricultural and Resource Economics (ABARE) 1989). In addition to changes in price and income, factors associated with the lifestyle of consumers may also have affected meat consumption. As a result of the increase in the number of working women and busier lifestyles, there is a growing demand for convenience foods (McKinna 1984) and an increase in consumption of "fast" foods. Evidence of this trend has been found in the United States (see Senauer 1990). The demand for different meat products is being met by the supply of a new and diverse range of products. For example, prepared and pre-packaged meats have become more readily available (Australian Meat and Live-stock Corporation (AMLC) 1990). Meat consumption may also be influenced by climate and season. Consumption of roasts and casseroles may prevail in winter, whilst in the summer cold meats, or those which are easy to barbeque, may be popular.

Concerns about health may also impact on the consumption of meat. Red meat has been targeted as a major source of dietary saturated fat, and thus reduction in its consumption has been recommended (Brook 1990). However, the information given to Australian consumers about the characteristics of meat has often been based on studies conducted in the United States, and may not apply here. Nutritional data on meat consumption compiled since 1987 have shown that Australian meat has a very low fat content compared to that of the United States (Australian Nutrition Foundation (ANF) 1989). Promotion may be useful in correcting misguided information concerning the health and nutritional value of red meat and thus may be able to increase market share and revenue (Quilkey 1986). For example, the AMLC's "Shouldn't you lean towards beef" campaign was based on the ANF (1989) findings that lean beef and lamb had low levels of fat in comparison to chicken.

It is of significant importance to test for structural change in the demand for meat and to identify factors influencing this change. To that end, a revealed preference approach is applied to a disaggregated set of data on meat demand in Sydney over the seasons from winter 1987 to autumn 1991. The results of the analysis and their policy implications are discussed prior to conclusion.

2. Tests of Structural Change

In testing for structural change, the approach usually adopted is to study changes in the parameters of the demand function. This approach can be

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This article stems from Gorny's BAgEc (Hons.) thesis submitted to the University of Sydney and supervised by Ahmadi-Esfahani. The authors wish to thank Paul Jensen for research assistance, Bill Tolisson for providing the data, the Editor and three anonymous referees for insightful comments and suggestions.

Review coordinated by the Editor.

criticised on account of its reliance on the specification of a particular functional form to represent consumer utility or demand. While there are difficulties involved in modeling consumer demand for meat, a number of useful attempts have been made (see, for example, Fisher 1979; Murray 1984; Cashin 1991). Most tests for structural change assume that any departure from consistent preferences on behalf of the representative consumer is reflected in the alteration of the parameters of the demand function. The rejection of stable preferences, however, may in fact be the rejection of a specific functional form, as noted by Thurman (1987) and Chalfant and Alston (1988).

An alternative approach is to study consumer behaviour directly without specifying the form of demand, and to test for the consistency of consumer purchasing patterns using revealed preference theory. The theory of revealed preference was originally developed by Samuelson (1938, 1948) and later expanded by Houthakker (1950). The theory postulates that the costs of different bundles of goods at different relative prices need to be compared in order to determine whether a given bundle of goods is revealed preferred to another. Accordingly, this theory is based on observed data and not on an underlying algebraic specification of the utility function.

There are two basic axioms underlying revealed preference theory. The weak axiom of revealed preference (WARP) postulates that if a bundle of goods q_i is revealed preferred to q_j and q_i is not equal to q_j, then q_j cannot be revealed to be preferred to q_i. The strong axiom of revealed preference (SARP) postulates that if q_i is revealed preferred to q_j and q_j is revealed to be preferred to q_k, then q_k is not revealed to be preferred to q_i. Both of these axioms imply that a unique demanded bundle exists at each budget. The SARP (Houthakker 1950) implies a kind of transitivity in the relation of revealed preference. It strengthens the WARP proposed by Samuelson (1938, 1948). Both the SARP and WARP are necessary conditions for utility maximisation but only the SARP is sufficient. If the SARP is satisfied it is always possible to find well-behaved preferences that could have generated the observed choices (Varian 1984, 1987). An indifference map could then be constructed with a high degree of accuracy by confronting the consumer with various appropriately chosen price sets and quantities.

This theory gives rise to a nonparametric test for structural change which is free from the problems associated with the requirement that the consumption pattern be explained by a particular functional form. The major weakness of the nonparametric approach is that the power of the test is unknown. This does not necessarily imply that the power of a nonparametric test is lower than that of a parametric test since the nonparametric approach does not test the joint hypothesis that preferences are stable and of a particular form. If expenditure varies a lot relative to price, it may be difficult for either approach to detect structural change (Alston and Chalfant 1991a).

A problem which is common to both parametric and nonparametric tests involves aggregation. Eales and Unhevehr (1988) have noted that the use of aggregated data, where consumers actually choose among meat products rather than meat of particular origin, could bias the estimation of demand parameters and hence tests for structural change. Landsburg (1981), Varian (1982) and Chalfant and Alston (1988) note that when the nonparametric approach to analysing demand is applied to aggregate consumption, the revealed preference axioms are unlikely to be rejected because aggregate consumption is rising through time, so each subsequent bundle of goods is revealed preferred to the previous bundle.

Chalfant and Alston (1988) suggest that quantities consumed do not all rise uniformly with time and that price variation relative to variation in real expenditure is likely to be greater for disaggregated commodities than for more aggregated bundles of goods. The use of disaggregated data in this study may assist in eliminating the effects of increasing real expenditure thereby enhancing the power of the test and the plausibility of the results. However, this test is based on the assumption that the expenditure elasticity for all commodities equals one. Although this may be a restrictive assumption, Chalfant and Alston (1988) argue that it may not be any more of a constraint than the imposition of a functional form that is necessary in parametric tests

for structural change. While some more recent research (see, for example, Alston and Chalfant 1991b; Piggott and Griffith 1992) indicates that expenditure elasticities are not equal to one, it is difficult to account for this in a study with disaggregated data because of the sheer number of observations, all of which would have to be assigned a different elasticity.

3. Data and Procedures

In order to conduct the revealed preference test, time series data on quantities of the commodities consumed and their prices in the corresponding period are required. For this study, survey data on the quantities and prices of meat cuts were made available by the AMLC. This data set was collected by A.C. Nielsen using stratified sampling procedures in order to cover the purchasing patterns of different social groups. Monthly observations comprised of a two-month average of quantities of primal cuts (carcase weight in kilograms) of beef and veal, lamb and mutton, poultry and pigmeat purchased by butchers in the Sydney metropolitan region for the period June 1987 to May 1991 were available. Due to interest in seasonal trends in consumer buying preferences, the data were averaged over the three months corresponding to the seasons summer, autumn, winter and spring, from winter 1987 to autumn 1991. In addition, A.C. Nielsen collected price observations on the retail cuts sold over the counter to consumers by these butchers in the corresponding periods. The data set included observations on approximately 500 primal cuts and 1200 retail prices. An analysis of the standard deviations of price and quantity data used in this study suggests that there was little seasonal variation. The reason for the short sample period is that data of a disaggregated nature were not available prior to 1987. However, given that a nonparametric test was utilised, this is not as restrictive as in the case of regression analysis.

The 34 primal cuts used in this study are detailed in Appendix 1. Because only wholesale quantities were available, it was necessary to aggregate the data to some extent. Primal cuts were aggregated to the extent that an average retail price could be allocated to the specific quantity of each cut traded through the butcher in this period. It was assumed that all the meat purchased by butchers was sold to consumers in the period of purchase. Thus, the consumption of meat through supermarkets, restaurants and fast-food outlets was not considered.

Total annual sales of beef/veal, lamb, pork and poultry through butchers in Sydney represent approximately 10 per cent, 18 per cent, 7 per cent and 2 per cent of actual consumption, respectively (ABARE 1991). Actual consumption (or disappearance) data include those quantities consumed through supermarkets, restaurants and the food services and manufacturing industries as well as through butchers. As the sample studied does not give an equal representation to each meat analysed, some bias may have been introduced.

Price data posed a more difficult problem. It was required that the prices of retail cuts derived from the purchased primal cuts be allocated, as an average price, to the time period corresponding to when the commodities were purchased and sold by the butchers. Prices of relevant cuts were averaged as an indicator of the relative price of the primal cut purchased by the butcher when sold over the counter. Some of the prices in the data set included those prices for less important cuts, like stroganoff, teriyaki, kebabs, etc. which form a minor portion of retail sales (A.C. Nielsen). These cuts tend to be value-added types and made from trimmings of meat which are not readily saleable in another form. Therefore, the prices of these cuts and others such as tongue and brain, offal and trimmings were not considered in the analysis.

The procedures discussed below are based on that used by Chalfant and Alston (1988). Two m*n matrices, P and Q, containing n price and quantity observations on m commodities were formed. A matrix of expenditure on different bundles valued at prices in different periods was obtained by multiplying P' by Q. Each element, $p_i q_j$, of the matrix P'Q represents the expenditure on bundle j at time i prices. Thus, each row values the bundles purchased in different periods at a constant price i. Similarly, each column designates the cost of the jth bundle of goods at the prices of different periods.

Direct comparison of relative expenditures in dif-

ferent time periods indicates whether the WARP has been violated. However, a weakness of this approach, as discussed by Thurman (1987), is that incomes increase over time and budget lines shift outwards. As a result, it is unlikely that budget lines will cross and hence violation of the WARP will not be identified. The cost of a bundle later in the sample is likely to exceed that in the current period and the cost of a bundle in the future, valued at current prices, is likely to be less. Each future bundle, therefore, will be found to be preferred to the past as it results in a higher level of utility.

In order to rectify this problem, Chalfant and Alston (1988) suggest a detrending procedure which is as follows. Real expenditure in each period is calculated by dividing the actual expenditure in the period by the consumer price index (CPI), which was obtained from the Australian Bureau of Statistics (1991). The percentage deviation of real expenditure in period i from the minimum in the sample is derived using $\{p_i q_i \text{ real} - p_j q_j \text{ real(min)}\}/p_j q_j \text{real(min)} = Z_i$. The quantity matrix Q is adjusted for changes in the level of meat consumption through time. The quantities q_i consumed in each period i are transformed using $q_i^+ = q_i(1 - Z_i)$. The expenditure matrix $P'Q^+$ is then formed. In order to enable easier comparison of relative expenditure, the elements in each row of the matrix are weighted by the actual expenditure on goods in that period to form the ratio $p_i q_j^+ / p_i q_i^+ = p_i q_j^*$. In order to test for structural change, the ratio $p_i q_j^*$ is compared to $p_j q_i^*$. If q_i is revealed preferred to q_j then $p_i q_j^* \leq p_i q_i^*$. This is evident if $p_i q_j^*$ is less than one. If q_j is also revealed preferred to q_i, the WARP has been violated.

Based on the procedure outlined above, two (34*16) matrices, one of the price observations and the other of quantity observations on the various cuts, were formed following the manipulation of data as discussed above. The (16*16) matrix of expenditure, P'Q, was then formed by multiplying these matrices so that expenditure at relative prices could be compared. The individual rows of this matrix represent the cost or expenditure of the bundle of goods purchased in each of the seasons winter 1987 to autumn 1991 valued at constant prices. The columns of the matrix represent the cost of a particular bundle valued at each season's prices.

Following reformation of the expenditure matrix, each cell of this matrix was divided by the actual expenditure on the bundle in the period in question. That is, each observation in a row was divided by the corresponding diagonal element in that row to form the matrix P'Q*. This matrix enables easy appreciation of preference changes. In the case where there was violation of the WARP and preferences had changed, both ratios would be less than unity.

The procedures suggested by Koo (1963) were used to test the SARP. On the basis of these procedures, a complete set of consistency conditions had to satisfy various bundles ensuring transitivity of consumers' choice. A matrix whose entries were either ones or zeros was constructed. All ones were below the diagonal and all zeros above the diagonal. The necessary and sufficient conditions under which this matrix was obtained are detailed in Koo (1963) and will not be reproduced here.

Data on the demand for meat at a more disaggregated level are generally not available in Australia, although interest exists in the consumption patterns of differentiated products in response to health concerns, promotion and a hectic lifestyle. This study makes a first attempt to meet this need. However, a number of additional qualifications on the quality of the data are in order.

The butchers selected in the sample were required to keep details of the quantities of each of the primal cuts of beef, veal, lamb, mutton, pork and poultry that they purchased as well as the prices of the cuts they sold in each month. This same procedure was used over the four years of data. If a participant could no longer be included in the sample, another butcher was chosen with similar characteristics in order to prevent distortion of the results. The data were then aggregated according to cut. The final results of this analysis are therefore dependent on the care taken by the butchers in the collection of data, the method of aggregation used by A.C. Nielsen and the accuracy of those involved in recording the data.

Whilst collecting the data from the AMLC, some discrepancies were noted. The data were presented in cycles of four months. The observations corre-

sponding to the last month of the four month cycle appeared as the first month of observations in the next set of four months of data. It was often observed that the prices and quantities in corresponding months were not identical. It is possible that this was a consequence of the collection technique averaging over two periods. These inconsistencies may also have impacted on the results.

Categories of cuts, detailed for both prices and quantities, changed over the period under consideration. For example, in June 1988, the collection categories changed and the data became more aggregated. This change in format may have affected the results during this period, especially if the logical aggregation used here did not follow that used by A.C. Nielsen. Also, it is possible that preference changes were being tested for commodities that might have actually been changing form over time. Another problem is that butchers may not have used a standardised description for cuts other than the most common ones. The description of cuts sold over the counter to consumers may also have varied depending on the individual butcher.

Additionally, dressing percentages were used where quantities of a primal cuts had to be broken down into secondary primal cuts in order to aggregate the relevant data. Chalfant and Alston (1988, p. 395) note that "if the proportion of wholesale to retail weights is the same for all meats through time, this is not a problem, only a redefinition of units of measurement. To the extent that dressing percentages do vary, potential bias is introduced into empirical analysis". This could be a major weakness in the technique used in the analysis of the data. Also, in order to allocate the average price of all the retail cuts to their primal source it was necessary to identify this source. The analysis therefore focussed on the major retail cuts and not all the 'value-added' varieties. It is possible that bias was introduced through discrepancies in accumulation of products and also that preference changes were masked due to the need to aggregate across prices and quantities to a greater extent than was desirable.

Finally, the assumption that the quantities of meat purchased by the butchers were redirected to consumers without waste or spoilage may be implausible. It was, however, a necessary assumption to make in order to bring the quantities and prices into direct relationship. As the amount of wastage is unlikely to change over time, this should not have any impact on relative changes in consumer behaviour.

4. Results and Policy Implications

The matrix formed as a result of the above procedure is presented in Table 1. It contains ratios marginally greater than or less than one, reflecting the relative cost of the bundles valued at the prices occurring in each of the seasons compared with the value of the actual bundle purchased in that season. There was no indication that violation of the WARP had occurred in this data series. Further, the data were found to be consistent with the SARP implying that there was a unique demanded bundle at each budget satisfying the sufficient condition of stable preferences. Assuming that the consumption of meat through butchers mirrors actual consumption, it is possible to conclude that the results are consistent with an absence of structural change in the demand for differentiated meat products in the Sydney metropolitan region over the seasons from winter 1987 to autumn 1991.

This finding is similar to that of Chalfant and Alston (1988) in their analysis of the demand for aggregated meat products in Australia. Thus, even though differentiated products are considered here, there is no indication that consumers have changed their purchasing habits over the past four years, in response to either concerns about health, lifestyle, promotion or seasonal changes. This result is, however, inconsistent with that of Martin and Porter (1985) with respect to consumer preferences for mutton. Mutton had to be aggregated with lamb as the retail cuts specified in the price data set used here did not explicitly define prices of all those mutton cuts sold to consumers. Accordingly, some changes may have been masked. The data set used by Martin and Porter (1985), however, also had weaknesses with respect to mutton prices. These prices were inferred from lamb prices, and hence the problem encountered here may not be major. Further, Martin and Porter (1985) used a parametric test to arrive at their result.

Table 1: Results of the Revealed Preference Test for Structural Change

WI 1987	SP 1987	SU 1987	AU1988	WI 1988	SP 1988	SU 1988	AU1989	WI 1989	SP 1989	SU 1989	AU 1990	WI 1990	SP 1990	SU 1990	AU1991
1.	0.94	0.98	0.94	0.90	0.95	0.97	0.98	1.00	1.05	1.03	1.03	1.03	1.01	1.03	1.02
1.06	1.	1.04	1.00	0.96	1.01	1.03	1.04	1.06	1.12	1.09	1.10	1.09	1.08	1.09	1.08
1.03	0.97	1.	0.96	0.92	0.97	1.00	1.00	1.02	1.08	1.05	1.05	1.05	1.03	1.05	1.03
1.07	1.00	1.04	1.	0.96	1.01	1.04	1.04	1.07	1.12	1.10	1.10	1.09	1.08	1.10	1.08
1.11	1.04	1.09	1.04	1.	1.05	1.08	1.08	1.11	1.17	1.15	1.15	1.14	1.13	1.15	1.13
1.06	1.00	1.04	0.99	0.96	1.	1.03	1.03	1.06	1.12	1.01	1.09	1.09	1.07	1.10	1.07
1.03	0.97	1.00	0.96	0.93	0.97	1.	1.00	1.03	1.08	1.01	1.06	1.05	1.04	1.06	1.05
1.03	0.97	1.01	0.96	0.93	0.97	1.00	1.	1.03	1.08	1.07	1.06	1.05	1.04	1.07	1.04
1.00	0.94	0.97	0.94	0.90	0.94	0.97	0.97	1.	1.05	1.03	1.03	1.03	1.01	1.03	1.01
0.96	0.89	0.93	0.89	0.86	0.90	0.92	0.93	0.95	1.	0.98	0.98	0.98	0.96	0.98	0.96
0.97	0.91	0.95	0.91	0.88	0.92	0.94	0.94	0.97	1.02	1.	1.00	0.99	0.98	1.00	0.98
0.97	0.91	0.94	0.90	0.87	0.91	0.94	0.94	0.97	1.02	1.00	1.	0.99	0.98	1.00	0.98
0.98	0.92	0.95	0.91	0.88	0.92	0.95	0.95	0.98	1.03	1.01	1.01	1.	0.99	1.00	0.99
0.98	0.93	0.96	0.92	0.89	0.93	0.96	0.96	0.99	1.04	1.02	1.02	1.01	1.	1.02	1.00
0.97	0.91	0.95	0.91	0.87	0.92	0.94	0.95	0.97	1.02	1.00	1.01	1.00	0.99	1.	0.99
0.99	0.93	0.96	0.92	0.89	0.93	0.95	0.96	0.98	1.04	1.01	1.02	1.01	1.00	1.01	1.

The effects of increasing real expenditure, however, may give rise to a problem in this analysis. A notable feature of the final matrix (see Table 1) is the predominance of ratios greater than unity above the diagonal and values less than unity below the diagonal. As elements along a row represent bundles purchased through chronological time, valued at the prices occurring in a specific period, increasing real expenditure is likely to increase the magnitude of these ratios, which occur above the diagonal, over time. Similarly, the cost at any time i of buying bundles purchased earlier in the sample will be less than the actual expenditure in time i. These points are represented below the diagonal. This indicates that Chalfant and Alston's (1988) 'detrending' procedure, designed to remove this effect, may not have been fully effective in the data set used here.

The analysis does not indicate that consumers respond seasonally in their purchase of meats from butchers. It is worth noting that the increase in the consumption of turkey at Christmas time was not identified by the procedure used here. This may be accounted for by the increase in supply to cope with expected demand and pre-ordering as well as price discounts. Furthermore, due to the mildness of seasons, consumers in Sydney may not respond to climatic changes.

Assuming that consumers face similar incentives across the country and that products are available nationally, the results of this study may have some implications for the Australian meat industry. In order for beef and lamb to maintain market share, the competitiveness of these products may need to be improved, possibly through the reduction of industry costs. This form of efficiency has been evident in the poultry industry where vertical integration and distribution on behalf of the major poultry producers exists (Bhati 1987) and is accompanied by lower prices. Enhancing technical efficiency is especially important in periods of recession when consumers move towards the purchase of cheaper cuts.

5. Conclusion

The analysis suggests that there has been no structural change in the demand for meat in Sydney over the seasons from winter 1987 to autumn 1991. Thus, it appears that the increase in poultry consumption in the metropolitan region in recent years has been primarily caused by changes in relative prices. In an attempt to maintain the market share of beef and lamb, the AMLC has endeavoured to improve and promote the versatility, convenience and healthy nature of lean red meat. This may still be an effective strategy for the AMLC to undertake. However, the analysis implies that market share may be won back largely as a result of changes in relative prices. This conclusion should be treated with caution as the sample is small, the period of the analysis is short and the power of the test may still be unknown. Nonetheless, the study provides an insightful illustration of the revealed preference approach to analysis of demand for differentiated meat products and, as such, extends previous research in this area.

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Appendix 1: Primal Meat Cuts

Beef	Poultry
Beef Chuck/Blade	Chicken Breast
Beef Butt/Silverside/Topside/Round	Chicken Rissoles
Beef Fillet	Chicken Fillets/Cutlets
Beef Ribs/Ribloin	Chicken Drumsticks
Beef Rump	Chicken Maryland
Beef Loin	Chicken Nuggets
Veal Loin	Chicken Cuts/Pieces
Veal Ribs/Rack	Chicken Thighs
Veal Leg	Whole Chicken
Veal Shoulder	Chicken Wings
	Turkey
Lamb	**Pigmeat**
Lamb Breast	Pork Spring/Ribs
Lamb Chump	Pork Forequarter
Lamb Forequarter	Pork Leg
Lamb Leg	Pork Fillet
Lamb Loin	Pork Loin
Lamb Neck	
Lamb Racks/Ribs	
Lamb Shank/Shin	