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Modelling the meat consumption patterns in Australia ☆

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ABSTRACT

Meat plays an important role in Australia's food intake as Australians currently allocate 40% of their food expenditure on meat. This paper attempts to model the demand for the various types of meat in Australia using data from 1962 to 2011 and the system-wide approach to modelling. The paper considers a number of alternate models, verifies the validity of the demand model hypotheses and selects a preferred model using the information inaccuracy criterion. The paper then uses the preferred model to forecast meat demand in Australia under various economic policy scenarios. The results show that between 1962 and 2011, meat budget share has more than halved and that consumer taste plays a significant role in shifting the meat consumption in Australia to chicken and pork at the expense of beef and lamb. Beef is a luxury, while mutton, lamb, chicken and pork are necessities. Demand for mutton is price elastic and, beef, lamb, chicken and pork is price inelastic.

1. Introduction

Meat consumption plays a major role in consumers' daily food intake. Australian consumers currently allocate about 10% of their income on food and 40% of their food expenditure on meat. This accounts for about 4% of their total consumption expenditure on all goods and services. Within the meat group, Australian consumers currently allocate 44% of the meat expenditure on beef, 12% on lamb, 20% on chicken, 24% on pork and very little on mutton. Furthermore, over the last 50 years, the Australian meat consumption pattern has changed significantly between the meat types due to changes in consumer taste as well as some supply-side regulations such as trade restrictions, change in meat classifications, etcetera. Australian consumers have increased their consumption of chicken and pork at the expense of beef, mutton and lamb. Therefore, an economic analysis using more recent data on the demand for meat in Australia to explain such changes in the consumption patterns is crucial to the meat producers, meat sellers, as well as meat consumers. This paper attempts to model the demand for the different types of meat, namely beef, lamb, mutton, chicken and pork, in Australia over the last five decades spanning the period 1962 to 2011. This study adopts the well-known system-wide approach (Theil and Clements, 1987) to achieve this purpose.

Several publications that have appeared in the literature analyse the demand for meat in Australia, for example, see Alston and Chalfant (1991), Fisher (1979), Martin and Porter (1985), Cashin (1991), Piggott et. al. (1996) and, Hyde and Perloff (1998). Our study differs from most of these studies in a number of ways: (1) The current study focuses on modelling the demand for meat by considering the systemwide approach and a number of alternate models; (2) time series properties of all variables used in the models are investigated before estimation; (3) tests various demand theory hypotheses for each model considered; (4) uses the most recent available data; and (5) uses simulations to predict what could happen to meat consumption in Australia under different policy scenarios.

There are three basic reasons for the selection of a system-wide approach in this study. Firstly, the implication of the consumer's budget constraint is that any increase in expenditure on one good can only arise from a decreased expenditure of at least one other good. This underlying interrelationship between the consumption of the different types of meat can only be studied when the demand equations for all meat types are considered simultaneously.

Secondly, there are certain constraints arising from consumption theories that necessitate the utilisation of a system of demand equations. The first is that demand equations are homogeneous of degree zero in income and prices, termed *demand homogeneity*. This property stipulates that an equal proportional change in a consumer's income and prices of the different meat types should have no effect on the quantities consumed; this translates to the assumption that the consumer is not subject to money illusion.

The next is that, when the consumer's real income is held constant, the quantity change in the consumption of a good, arising from a one-dollar increase in the price of a different good, will be exactly the same as the change in the consumption of the first good brought about by a one-dollar increase in the price of the latter good. This is termed *Slutsky symmetry* and when represented algebraically becomes a cross-equation constraint. As such, it is evident that only a system-wide approach will satisfy the constraints under Slutsky symmetry.

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Besides, economic theories should not accept the taking of one good in isolation from the rest; thus, this study hopes to tell a common story for the five types of meat. It is only then that we can paint a complete picture of the demand conditions for all the five meat types. This study's aim is to model and present a detailed economic analysis of meat consumption patterns of Australian consumers.

This paper is structured in the following manner. In Section 2, we present the data source and a preliminary analysis of the Australian meat data. In Section 3, under the system-wide framework, we use three popular demand systems, the Rotterdam Model, the Working's model and the Almost Ideal Demand System (AIDS) to model the meat consumption patterns in Australia. In Section 4, we select the preferred demand model among the three, using the goodness-of-fit measure, the information inaccuracy; and model consistency with the demand theory hypotheses. Section 5 presents the estimation results and the implied income and price elasticities from the preferred model. Using the estimated results from Section 5, we analyse the change in consumption patterns of the five meat types and show how these results can be used in policy related issues in Section 6. Finally, Section 7 provides the concluding comments.

2. Preliminary data analysis

In this section, we present the sources for the Australian meat consumption data together with a preliminary data analysis. In the next section, we investigate a number of empirical regularities in Australian meat consumption patterns.

2.1. The data

We use annual data for the five types of meat, namely, beef, lamb, mutton, chicken and pork, for the period 1962–2011. For the period, 1962–1977, the per capita consumption and price data are from Roberts (1990) and, for 1978–2011[1], from various issues of publications of the *Meat and Livestock Australia* and the *Australian Bureau of Agricultural and Resource Economics and Sciences* (ABARES). The continuity of the two data sets was checked and found to be consistent. Data for the consumer price index (6401.0 — *Consumer Price Index*, Australia), the total private final consumption expenditure (5206.0 — *Australian National Accounts: National Income, Expenditure and Product*) and Australian population (3101.0 *Australian Demographic Statistics*) are all from various issues of the *Australian Bureau of Statistics* publications.

2.2. Consumption and prices

Table 1 presents the basic data for per capita consumption (q_{it}) and prices (p_{it}) for the five meat types for arbitrarily selected years. The left graph in Fig. 1 displays the per capita consumption of the five types of meat for the period 1962 to 2011. As can be seen, in general, overall meat consumption has increased over the period under study; consumption of pork and chicken have increased steadily and that of beef, lamb and mutton have fallen steadily. Australian per capita consumption of beef fell from 45.3 kg in 1962 to 38.6 kg in 1969; steadily increased to 70.4 kg in 1977; and then has again fallen steadily to 32.8 kg in 2011. This fall in domestic consumption in the sixties was due to strong world demand resulting in a high world price for beef which led to increased export; hence reducing the supply of beef to the domestic Australian market. This situation was reversed in the mid to late seventies due to the increased trade restrictions enacted by Australia's major export markets; resulting in increased supply of beef to the domestic Australian market.

[1] Disaggregate price data for beef, lamb, mutton, chicken and pork are available only up to 2011.

Table 1
Consumption, prices, expenditure and budget shares for five types of meat, selected years, 1962–2011.

Year	Beef	Lamb	Mutton	Chicken	Pork	Total meat
	(1)	(2)	(3)	(4)	(5)	(6)
Per capita consumption (kg)						
1962	45.30	19.30	25.21	4.44	8.80	103
1971	40.30	23.14	15.95	11.10	13.80	104
1981	47.60	16.49	2.71	20.20	15.30	102
1991	39.50	13.20	9.60	23.10	18.40	104
2001	34.50	11.75	5.12	30.90	18.80	101
2011	32.80	9.20	0.30	43.30	25.00	111
Prices ($/kg)						
1962	0.94	0.76	0.46	1.19	1.09	
1971	1.52	0.96	0.64	0.98	1.48	
1981	5.42	3.68	2.29	2.63	4.39	
1991	9.73	5.28	3.54	4.80	6.51	
2001	12.25	7.95	5.33	4.97	8.35	
2011	15.46	14.62	9.45	5.49	10.91	
Unconditional budget shares (w_{it})						
1962	4.27	1.48	1.16	0.53	0.96	8.41
1971	3.51	1.27	0.58	0.62	1.17	7.16
1981	4.23	0.99	0.10	0.87	1.10	7.29
1991	2.73	0.49	0.24	0.79	0.85	5.10
2001	1.92	0.42	0.12	0.70	0.71	3.87
2011	1.47	0.39	0.01	0.69	0.79	3.35
Conditional budget shares (w'_{it})						
1962	50.78	17.63	13.81	6.32	11.46	
1971	49.05	17.78	8.13	8.69	16.35	
1981	57.96	13.64	1.39	11.92	15.10	
1991	53.48	9.70	4.73	15.42	16.67	
2001	49.51	10.93	3.20	17.98	18.38	
2011	43.90	11.65	0.25	20.59	23.62	

Per capita lamb consumption increased from 19.3 kg in 1962 to 23.6 kg in 1970 and then steadily declined to 9.2 kg in 2011, less than half of what it was in the 1960s. In the early 1970s, improvement in wool prices and the introduction of guaranteed floor price for wool, lead to reduced supply of lamb and mutton to the local Australian meat market as lamb stocks were withheld from slaughter. Australians consumed more mutton than lamb in the 1960s, but have reduced mutton intake over the years, falling from 25.2 kg per person, in 1962, to a low of 0.3 kg per person in 2011. In 2011, the per capita consumption of mutton and lamb combined has fallen to almost one-fifth of what they were in the early 1960s. The fall in beef, lamb and mutton consumption has been mostly captured by chicken and pork. Per capita chicken consumption has increased by almost 10 times, from 4.4 kg in 1962 to 43.3 kg in 2011. Per capita pork consumption has also increased by about 3 times, from 8.8 kg in 1962 to 25.0 kg in 2011. While chicken consumption has increased steadily over the years, pork consumption has fallen slightly in the mid-1980s and increased steadily from then onwards.

The graph on the right-hand side in Fig. 1 displays the retail prices in index form with base 1962 = 100 for 1962 to 2011. From the second half of Table 1, which presents the prices for the five types of meat, we can see that the retail price of beef has increased steadily over the years from $0.94/kg in 1962 to $15.46/kg in 2011. Over the same period, lamb price has increased from $0.76/kg to $14.62/kg, mutton price from $0.46 to $9.45/kg and pork price from $1.09/kg to $10.91/kg. Similarly, chicken price has increased from $1.19/kg in 1962 to $3.02/kg in 1987. Before 1987, only frozen chicken was supplied for consumption but from 1987 it was mostly replaced by fresh chicken. The price of fresh chicken has increased steadily from $4.80/kg in 1991 to $5.49/kg in 2011. Another point worth noting is that, prices of beef, lamb and mutton have increased at a faster rate than the prices of chicken and pork. The increase in the price of chicken is only moderate compared to all other types of meat.