BEEF PRICE SPREADS ACROSS STATE CAPITALS

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Considerable research has been conducted into meat price spread behaviour in the Sydney market, but little is known about this behaviour in the other major city markets. In this paper, a short run model of meat price spread behaviour is used to examine differences in beef price spread responses in the five mainland State capital cities. With few exceptions the results showed that price levelling and the cost of providing wholesale and retail marketing services were common determinants of beef price spread behaviour at both wholesale and retail levels in the different States. The level of throughput was not significant in any model. The price levelling and cost responses in Brisbane, Melbourne, Adelaide and Perth were found to be significantly different from those in Sydney.

1. Introduction

Beef producers are often concerned about the high costs of marketing services, especially in terms of their share of the consumers' dollar. There has been considerable theoretical work undertaken into the incidence of marketing margins or price spreads both in Australia and overseas. Parish (1967), Gardiner (1975), Naughtin and Quilkey (1979), Fisher (1981), Tomek and Robinson (1981), Campbell and Fisher (1982) and Piggott (1990) among others have explained some of the misconceptions relating to price spreads. That is, price spreads are not simply the result of greedy middlemen but are the price of a collection of marketing services necessary for the transformation of the raw farm product into a form required by final consumers. This price is the outcome of the demand for and the supply of these services.

Producers believe in particular that prices are not accurately transmitted through the marketing chain as retail prices do not appear to fall in times of low farm prices. That is, the suppliers of marketing services are impeding the process of price transmission between different market levels. Empirical analyses have been undertaken to estimate these spreads and provide some insights into the practices of price levelling and price averaging (Griffith 1974; Naughtin and Quilkey 1979; Griffith *et al.* 1991). Price levelling and averaging have been explained by Piggott (1990) as the changing of price spreads on a product though time in order to keep retail prices relatively constant, and the varying of the spread taken on different types of meat to keep retail prices and volume more stable, respectively. However most of the

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Australian analyses have been based on the Sydney market, and while the Melbourne-based Naughtin and Quilkey (1979) study did also find price levelling, there have been no comparative studies encompassing the other states (a comparative study of beef spreads for all state capitals was conducted by Hodan (1972) but that study emphasised the differences in the annual costs of supplying particular services, not the short run behavioural responses of those suppliers). Some policy makers and farm organisations are concerned that policy discussions and decisions relating to the national scene are being based on studies conducted only in the Sydney region when it has not been ascertained whether or not other Australian state beef markets reflect this behaviour.

There are some *apriori* indications that differences may occur in the pattern of beef price spread behaviour in each state. Different levels of beef production and exports occur in each state, and the marketing arrangements are not uniform throughout Australia. Another factor which is expected to influence the spreads is the composition of the retail sector. All this information is detailed below, and indicates that there may be reason to believe that beef prices and spreads will be different in each state.

1.1 Overview of the Australian Beef Industry

Beef is the most important meat in the Australian diet and dominates the meat industry in terms of production and exports. In 1991, beef and veal constituted about 47 per cent of the apparent consumption of red meat and red meat products (or about 36 per cent if poultry is included). The domestic market accounts for approximately 40 per cent of beef production (AMLC 1992). Recently, retail beef sales have suffered from the impact of the recession and per person utilisation of beef has fallen below 40 kg per head (ABARE 1992a).

Cattle production is widely spread across the continent and is carried out in all states. In the northern half of Australia, cattle properties and herd size are very large, pastures are generally unimproved, fodder crops are rare and beef is usually the only product. The industry is more intensive in the south because of the more favourable environment including more improved pasture. Beef cattle production is often combined with cropping, dairying and sheep. Beef constitutes some 64 per cent of all red meat produced in Australia. The cattle industry is also very dependent on international trade in beef. Over half of national beef and veal production is exported, with the United States and Japan being the main outlets. Beef accounts for about 80 per cent of all meat exported (AMLC 1992).

New South Wales is now the second largest beef producing state with Queensland having become the largest in the last decade (Table 1). Queensland now contains some 45 per cent of the nation's beef cattle numbers (ABS 1989a). Victoria is currently Australia's third largest producer of beef and veal. South Australia is a relatively small meat producer, providing approximately eight per cent of the total Australian production. In 1988 is was estimated that 93 per cent of the West Australian cattle herd was made up of meat cattle (ABS 1989b), however West Australian remains one of Australia's smallest meat producing states. Queensland is highly dependent on export markets for beef, shipping about two-thirds of production offshore. The other states typically export less than half of the output, with Victoria being under 40 per cent (Table 1).

Price formation in the beef industry is relatively free of domestic government intervention as is the case with Australian meat markets in general. The industry is relatively competitive across Australia with no one state having higher levels of government intervention than another. Prices at saleyards are affected by export prices, especially in Queensland, and at the retail and wholesale level prices may be affected by developments in the major competing products.

Table 1. Australian Beef Production and Exports by State

	NSW	QLD	VIC	SA	WA
Beef and Veal Production			(Thousand Tonnes)		
1980	571.0	560.0	463.6	106.9	141.6
1985	333.4	514.4	327.2	92.7	113.9
1990	385.2	588.1	308.3	87.0	97.7
Beef and Veal Exports as a Proportion of Production				(%)	
1980	48.7	72.5	42.6	42.3	50.1
1985	39.2	71.8	39.7	48.9	48.2
1990	46.9	75.3	39.7	54.7	43.0

*All figures given are averages for five years ended June in quoted year.
Source : AMLC (1992)

In terms of processing and marketing arrangements, the slaughter industry in New South Wales comes under the control of the NSW Meat Industry Authority which is responsible for many sections of the marketing chain including slaughtering and processing. The Livestock and Meat Authority of Queensland is responsible for licensing all abattoirs, slaughterhouses and public meat markets. Similar bodies exist in South Australia and Victoria who have the responsibility of processing of meats in those states. The local West Australian market is supplied mainly by abattoirs in Fremantle, Waroona, Harvey, Bunbury, and Katanning among others. No state has a marketing arrangement which intervenes in production or price formation.

Retail sector composition is quite diverse across the states. Butchers in the New South Wales market retain over 80 per cent of the total retail meat market with the remainder made up by the larger supermarket style outlets (*Australian Meat Industry Bulletin*, December 1987). In Queensland butchers have managed to retain 75 per cent of the retail market share in opposition to supermarkets. In Victoria supermarkets have 37 per cent of the retail meat market, while South Australian butchers have been able to maintain a 59 per cent share of the retail meat market. West Australian butchers have the lowest share of the retail meat market of any of the states covered by the study, with only 43 per cent of the market.

Thus for all these reasons prices may well be different in the short run at the auction, wholesale and retail level in each state. As the price spread is defined as the difference between the auction and wholesale price (wholesale spread), or between the wholesale and retail price (retail spread), then it is conceivable that the different prices in each state could lead to different spreads. This point is shown in Table 2, for the month of January 1980. Both the wholesale and retail spreads vary substantially across the different state markets.

Table 2. Prices and Spreads for January 1980 by States

	Auction Price	W/sale Spread	W/sale Price	Retail Spread	Retail* Price
NSW	162.4	28.6	191	250	441
QLD	175	8	183	273	456
VIC	161	12	173	294	467
SA	161.2	29.8	191	258	449
WA	170.4	10.6	181	287	468

All prices quoted in c/kg, identical carcase categories
*Composite retail price - See Appendix 1
Source : Auction prices from the Australian Meat and Livestock Corporation (AMLC), wholesale and retail prices from the Meat and Allied Trades Federation of Australia (MATFA)

1.2 Aims of the Study

The aims of this study are to measure the price spreads for beef that occur in the various Australian state capital cities; to determine the types of marketer behaviour which explain the patterns in these price spreads; and to test if any differences found in the behaviour of the spreads in the various states, are significant.

Monthly price spread equations for beef at the wholesale and retail levels, and at the aggregate farm-retail level, in each of the state capitals are estimated econometrically. The following hypotheses are tested:

(a) there is no price levelling;
(b) wholesale (retail) spreads are unrelated to the cost of providing wholesale (retail) market services;
(c) wholesale (retail) spreads are independent of wholesale (retail) turnover; and
(d) there is no difference in beef price spread behaviour between Australian state capital cities, especially in the incidence of price levelling.

The study covers the beef markets in Sydney, Melbourne, Brisbane, Adelaide and Perth. The data required for the Northern Territory and the ACT are not available, and although the information for Tasmania are available it is considered to be a small and basically self contained market too far removed from the other markets in terms of transport costs to provide a useful comparison.

2. Previous Research

In a previous study conducted by Griffith (1974), simultaneous equation techniques were used to examine the behaviour of wholesale and retail spreads for beef, lamb, mutton and pork in Sydney. He found that price levelling existed at wholesale and retail levels for all meat. Price averaging existed for all meat types except mutton at wholesale and retail levels. In the longer run though, retail and wholesale prices were found to be positively responsive to auction price changes. The costs of providing retail marketing services were significant in determining all retail spreads while wholesale costs were significant for beef.

In a later study (Griffith *et al* 1991), updated empirical evidence was provided on the monthly retail and wholesale meat marketing behaviour in Sydney. Again the absence of price levelling was rejected in the short-run at both wholesale and retail levels. Spreads at both levels were found to respond positively to auction price changes in the long term. In contrast to the earlier study, price averaging was no longer found to be a significant determinant in retail or wholesale prices. The costs of providing retail market services were found to be a significant determinant of the beef retail spread and wholesale costs were significant at the wholesale level. It was also noted that the beef wholesale spread was significantly negatively influenced by turnover.

Naughtin and Quilkey (1979) attempted to model the pricing behaviour of a sample of Melbourne retail butchers using an economic model consistent with that used in Parish (1967). The main conclusion drawn from the paper was that the detrimental effects of price levelling and averaging on pricing efficiency may have been understated in the past.

It is clear then that price levelling has been a major determinant of these spreads in the markets where it has been examined, especially in the short term. Most of the research has related to the Sydney market though, and as pointed out above, there may be some differences in beef marketing behaviour in other states.

3. Model Specification and Data

3.1 Price Changes in the Beef Industry

The movements in auction, wholesale and retail prices for each state from January 1980 to July 1989 are shown in Figures 1 to 5. Auction and wholesale prices generally have the greatest price fluctuations. These fluctuations often seem independent of the more stable retail prices, although the general trend of an increase over time is mirrored at all three levels. It appears retailers tend to absorb the short term fluctuations which may occur at the auction and wholesale level. The wholesale prices generally seem to be marginally more stable than the auction prices and this may reflect the wholesalers tendency to absorb auction price fluctuations and to continue to match supply and demand from auction and retail levels. Both the wholesalers and retailers seem to be offsetting losses in one period by setting higher spreads in the next, or by practising price levelling.

The major variations in auction prices seem to have occurred in the last six months of the time period in all states except Victoria which has demonstrated a more stable price series at

Figure 1

NEW SOUTH WALES PRICE SERIES

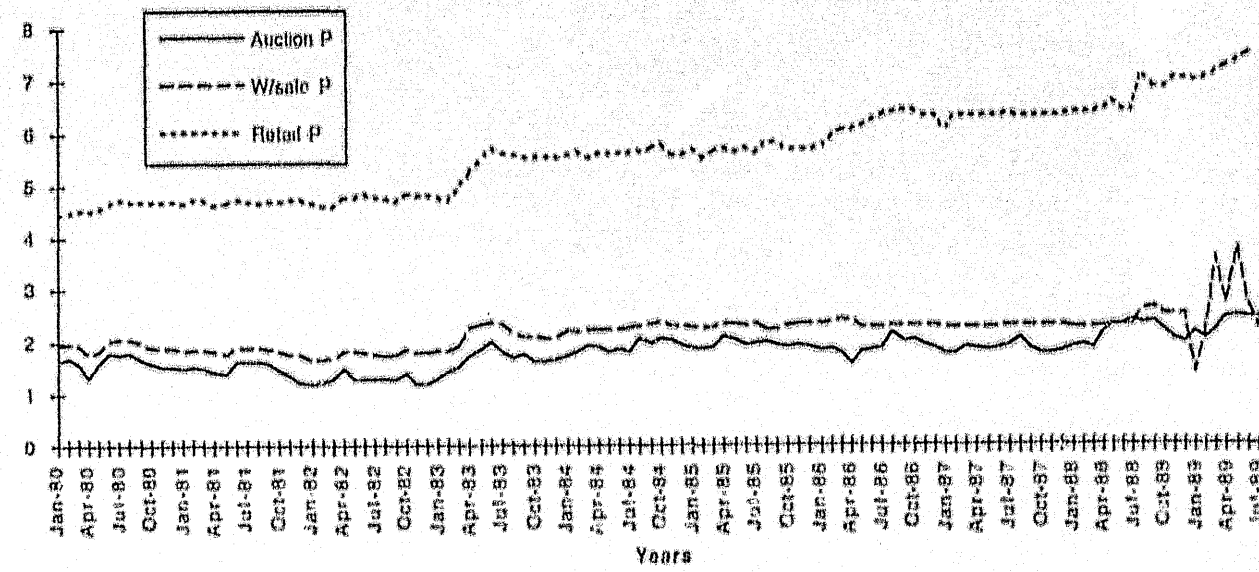


Figure 2

QUEENSLAND PRICE SERIES

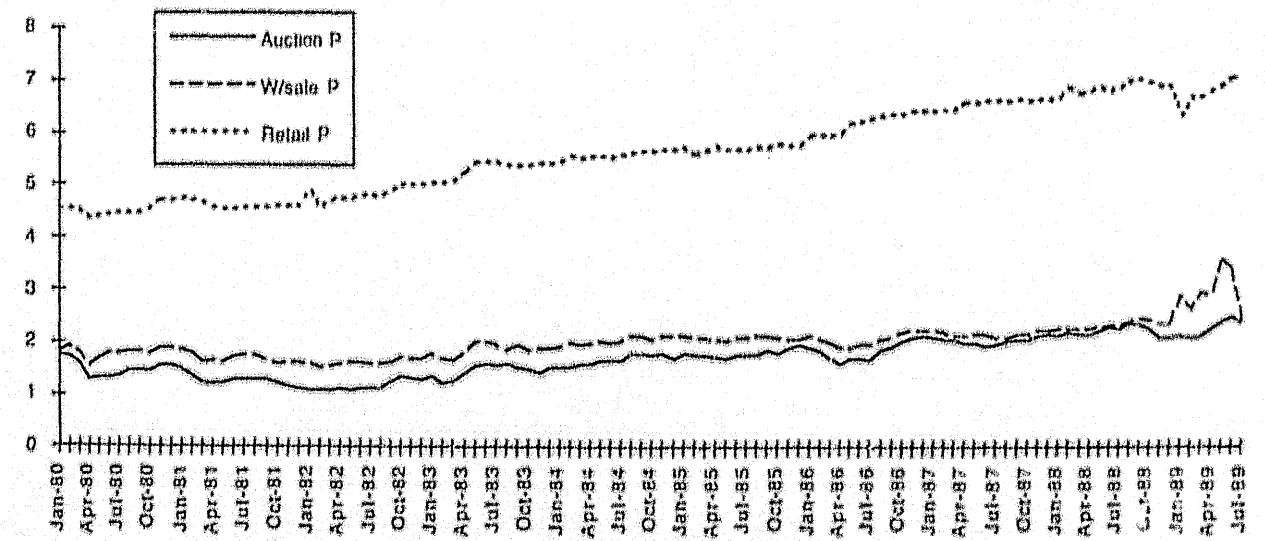


Figure 3

VICTORIA PRICE SERIES

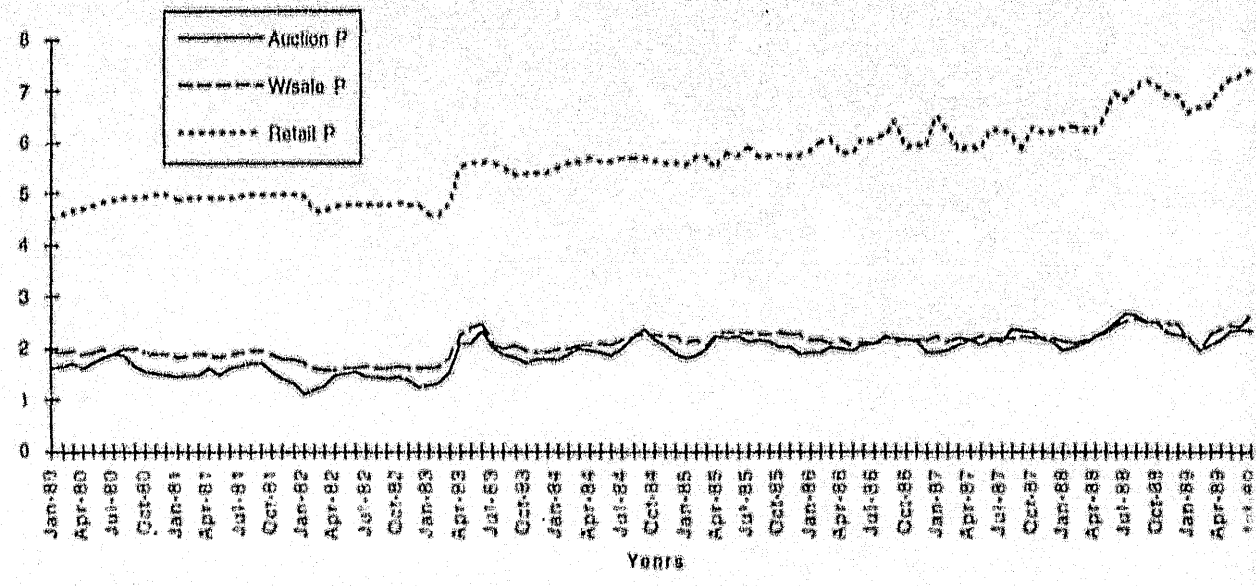


Figure 4

SOUTH AUSTRALIAN PRICE SERIES

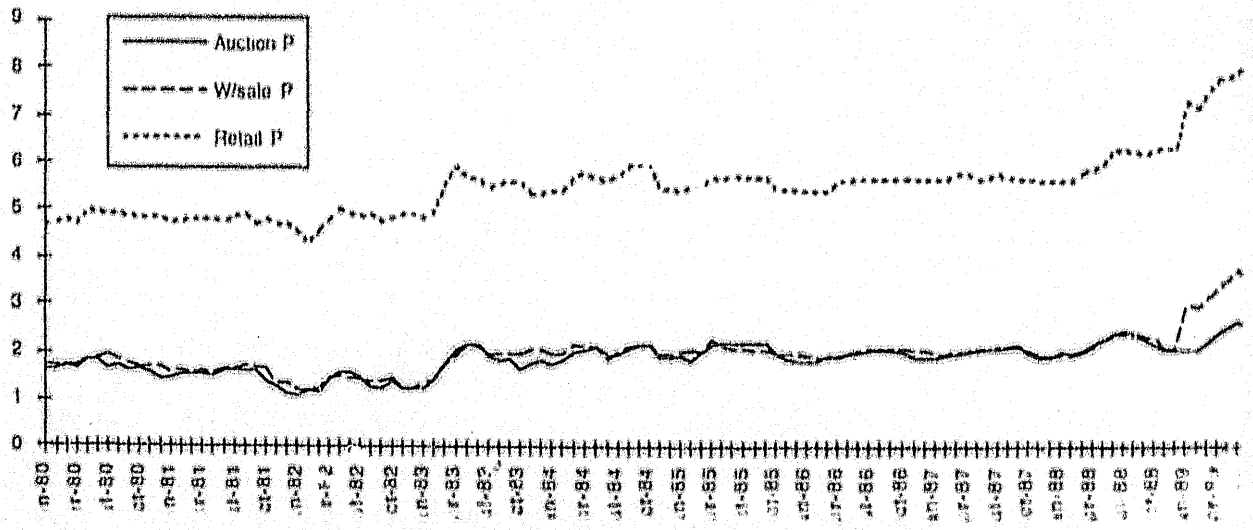
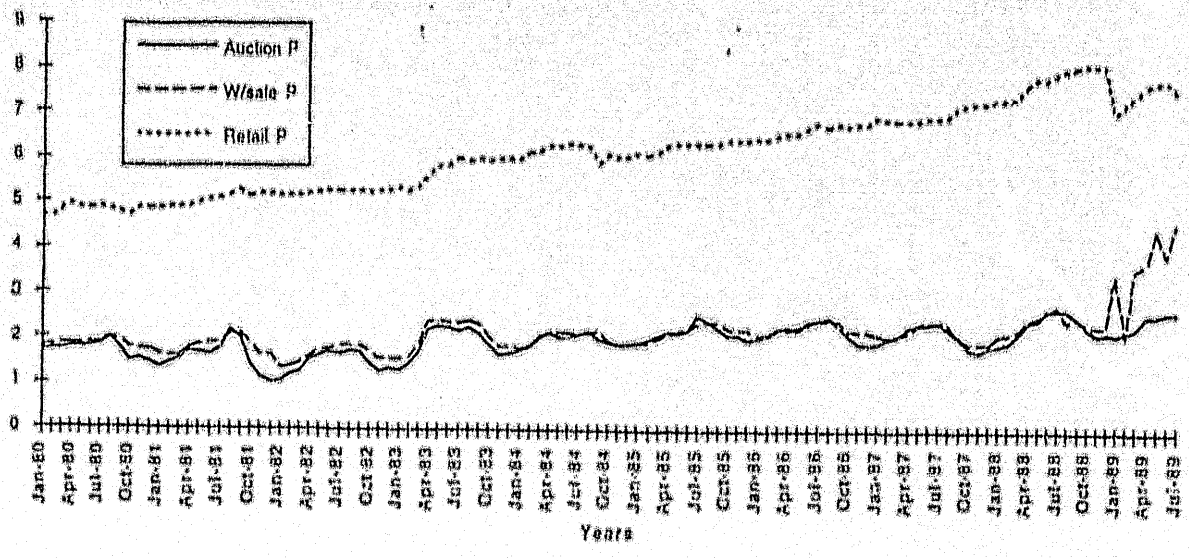


Figure 3

WESTERN AUSTRALIAN PRICE SERIES



that level. Retail prices have shown a general upward trend with no major fluctuations except in the case of Victoria and South Australia. Queensland appears to have the more stable prices at all levels. All states show a very close relationship between auction and wholesale prices. In some states the auction price is seen to fall below that of the wholesale. The reasons why this may occur are discussed below.

3.2 Specification of the Model

The study is based on an econometric approach used by Griffith (1974) and Griffith *et al* (1991) to estimate equations explaining the monthly spreads for beef, lamb, mutton and pork at wholesale and retail levels in the Sydney market.

In a study such as this, price averaging would normally be examined in the hypotheses tested by the model. It has not been included here for two reasons. The first is simply a reflection of the limited resources available for the study and the infeasibility of collecting all the relevant price data for all meat types considered to be substitutes for beef in all of the states encompassed in the study. The second is based on a conclusion reached in Griffith *et al* (1991) that price averaging is no longer prominent in the Sydney market.

Price levelling, and the possible differing patterns across the State capital cities, is therefore the major focus in this study. The existence of price levelling can be tested by including the current and lagged auction prices in wholesale and farm-retail equations and the current and lagged wholesale prices in retail equations. The existence of this practice would show an increase in the price spread when the current price at auction or wholesale level falls.

The models are specified as follows:

Wholesale Spreads

$MW_i = f(PA_i, CW_i, LPA_i, T_i)$

where i=p, m, a, s, b. The wholesale spreads (MW) for Perth (p), Melbourne (m), Adelaide (a), Sydney (s), and Brisbane (b) are a function of the respective auction prices in each city, both current (PA) and past (LPA), and wholesale costs (CW) and turnover (T) for each of the respective states.

Retail Spreads

$MR_i = f(PW_i, CR_i, LPW_i, T_i)$

Thus retail spreads (MR) for beef in each capital city are specified to be dependent on the present (PW) and past (LPW) wholesale prices in these cities, and turnover (T) and retail costs (CR) for each of the respective states.

Farm-Retail Spreads

$MFR_i = f(PA_i, CR_i, LPA_i,$)

It is expected that the equations will show some price levelling in the current period and this will be indicated by a negative coefficient for the current auction (wholesale) price. However most studies have found that in the longer term prices at wholesale (retail) level are responsive to changes in the auction (wholesale) price. It is therefore expected that the lagged auction (wholesale) price will have a positive sign. Cost is also expected to have a positive relationship with the spread. The effects of production are uncertain. Griffith (1974) found that for beef, turnover was significant at the wholesale but not the retail level. In the 1991 study though turnover was only significant at the wholesale level, and had a negative relationship with the spread. It is therefore difficult to predict the effects on turnover on the equations estimated in this study.

3.3 Data Requirements and Variable Definitions

PA - monthly average auction price in $/kg of beef carcases sold at major livestock markets in each state capital;
LPA - weighted monthly average auction price determined by weighting prices in the three previous periods. Griffith (1974) used: $LPA = PA_{t-1} * 0.5 + PA_{t-2} * 0.33 + PA_{t-3} * 0.17$ for both the wholesale and retail lagged variables;
CW - wages in the wholesale sector were used as a proxy for cost in the wholesale sector;
T - production in each state was used as a proxy for turnover;
PW - monthly average wholesale price in $/kg of beef carcase sold to retail butchers in each state capital;
LPW - as for wholesale spread; and
CR - wages for the retail trade sector as a proxy for retail costs.

There was a substantial amount of data required to calculate the spreads and then to estimate the models. Firstly, carcase prices at auction and wholesale levels are required for comparable types of beef. Secondly, a composite retail price must be formulated to give an aggregate price across the different beef cuts in the proportions that they cut from the whole carcase. The formula for calculating the composite price was obtained from MAFFA and represents the proportion of each retail cut of beef in a whole beef carcase (see Appendix 1). From this composite retail price and the wholesale and auction prices the monthly beef price spreads in each state were calculated. The time period for the analysis was from January 1980 to June 1989, the period over which the wholesale and retail prices were available.

All wholesale and retail prices for each state were obtained from the MAFFA publication *Australian Meat Industry Bulletin*. Auction prices have been compiled by a Livestock Market Reporting Service in each state and then collated by the AMLC's market intelligence division over the relevant period. From discussions with this division it was decided to use the beef class 280-370 kg liveweight with grade score C3, specified by the AMLC as "all classes to 20", as this is indicative of the average beef animal slaughtered for the domestic market.

It was also necessary to obtain a throughput figure in the wholesale and retail sector in each city. Obtaining the exact figures for this was not possible due to time limitations so a monthly production figure for each state has been used as a proxy. These figures have also been obtained from the AMLC. No consistent measure of wholesale and retail costs is available, so in this study wage rate figures are used as a proxy for wholesale and retail cost. Wage rates were collected for the different states in the wholesale and retail trade categories from the Australian Bureau of Statistics (ABS).

3.4 Data Problems, Limitations and Adjustments

The major data problem occurred in the auction price series. In Queensland, the auction price category "all classes to 20" was completely inadequate for the time period covered by this study, so it was decided to use the closest available data series. The category "all classes to 26" was chosen. This price series was the closest in absolute terms and seemed to show the closest trends, however the prices were consistently lower because this class represents a lower grade of animal. In West Australia, eight monthly prices from the series "all classes to 20" were missing, so a regression equation was used to forecast those figures from the "all classes to 26" series. The results of this forecast can be seen in Appendix 2. In the New South Wales series "all classes to 20" the figure for April 1984 was missing and it was simply estimated using the auction, wholesale and retail price figures for that and the surrounding months.

Monthly auction price figures were also adjusted for the value of bone, hide and other non-meat products so that they more accurately reflected the prices given for wholesale and retail levels (compared to the unadjusted auction prices graphed in Figures 1 to 5). This byproducts price series was that used by Griffith *et al* (1991).

During the time period covered by this study (ABS 1989c) changed the base year twice in their recording of wage data. This was taken into account and all wage figures were changed to a 1985 base year. Wages have only been recorded in separate categories in the retail and

wholesale sector since September 1982, so it was necessary to use the same figures for January 1980 to August 1982. However trends in wages in the two categories have been very close so it is not seen as a major problem.

4. Results

4.1 Estimation Techniques

The models were estimated over the period January 1980 to July 1989 using monthly time series data. Ordinary Least Squares (OLS) were used to estimate the retail, wholesale, and farm-retail spreads in each state as specified in Section 3.2. All equations showed autocorrelation problems. To correct for this two methods were applied. The first was the incorporation of a lagged dependent variable (LDV), justified on the basis of the Partial Adjustment Theory. The hypothesis of this theory is that participants in the marketing chain do not completely adjust their production decisions in one period in response to a price change. This may be due to costs, capital of other constraints (Doran and Guise 1984). The LDV tends to correct for autocorrelation because it takes account of period to period changes. The second was to run the OLS estimations with an autocorrelation correction.

The three levels of spread equations were then estimated using Seemingly Unrelated Regression (SUR). This method is used to determine whether the equations would be better estimated as part of a system rather than separately using OLS. SUR is relevant rather than 3SLS (as used in Griffith *et al* 1991) because in the models analysed here there are no right hand side endogenous variables (no price averaging variables) (Pindyck and Rubinfeld 1981). The equations were estimated in three systems, but not all results are reported here. The first system incorporated the retail and wholesale spread equations within each state (so five systems); the second incorporated the wholesale spreads for each state in one system, and the same for retail and farm-retail (so three systems); while the third incorporated all wholesale and retail equations in the one system. Again a LDV or autocorrelation correction were compared in each system.

4.2 Regression Results

In the **OLS wholesale spread equations** it was found that high levels of autocorrelation were present and the equations appeared to be better estimated using the autocorrelation correction than with the LDV being incorporated into the model. The results of this are seen in Table 4.1.

It was clear that in all cases the wholesale spread had a significant negative relationship with the current auction price and that significant positive relationships existed for the lagged auction price. Cost was a significant variable in all cases and possessed a positive relationship with the spread. Production had mainly a negative influence but was not shown to be at all significant. Therefore all coefficients estimated carried the expected signs and most were significant.

In the **OLS retail and farm-retail spread equations** the incorporation of the lagged dependant variable gave the best explanation in the equations. The results are seen in Tables 4.3 and 4.5 respectively. Both retail and farm-retail spreads showed the expected negative

Table 4.1 OLS Wholesale Margin Equations

	Cons.	PA	LPA	Cost	Prod'n	Stan EE	R2	DW	Rho
NSW	0.41	-0.76	0.39	0.0097	1E-07	0.058	0.68	1.77	0.76
Stan Err.	0.18	0.067	0.083	0.0016	1.7E-06				0.063
t statistic	2.29	-11.48	4.66	6.19	0.067				11.92
VIC	0.707	-0.58	0.23	0.0051	-2.5E-06	0.064	0.502	1.99	0.7
Stan Err.	0.17	0.062	0.074	0.0014	2.2E-06				0.07
t statistic	4.22	-9.22	3.15	3.54	-1.11				10.03
QLD	0.68	-0.45	0.16	0.0049	-4.4E-07	0.043	0.44	2.004	0.76
Stan Err.	0.11	0.067	0.083	0.0014	5.2E-07				0.063
t statistic	6.38	-6.66	1.88	3.51	-0.84				12.02
SA	0.064	-0.45	0.26	0.0082	-7.5E-06	0.064	0.36	2.207	0.77
Stan Err.	0.19	0.068	0.084	0.0018	5.8E-06				0.062
t statistic	0.33	-6.07	3.06	4.64	-1.304				12.32
WA	0.33	-0.45	0.31	0.0058	-9.6E-06	0.071	0.5	2.08	0.56
Stan Err.	0.14	0.049	0.059	0.0012	6.04E-06				0.082
t statistic	2.38	-9.18	5.15	4.65	-1.58				6.84

Table 4.2 SUR Wholesale Margin Equations

	Cons.	PA	LPA	Cost	Prod'n	Stan EE	R2	DW	Rho
NSW	0.54	-0.85	0.32	0.01	4.2E-07	0.059	0.88	1.63	0.75
Stan Err.	0.18	0.056	0.077	0.0017	1.46E-06				0.056
t statistic	2.89	-15.11	4.14	6.19	0.29				13.43
VIC	0.76	-0.68	0.22	0.0062	-2.7E-06	0.063	0.69	1.89	0.697
Stan Err.	0.16	0.057	0.072	0.0015	1.97E-06				0.064
t statistic	4.64	-11.86	3.14	4.05	-1.37				10.89
Hyp (d) t		7.07	9.67	17.09					
QLD	0.75	-0.49	0.15	0.0048	-4.2E-07	0.043	0.71	1.74	0.73
Stan Err.	0.11	0.063	0.081	0.0018	4.9E-07				0.061
t statistic	6.98	-7.77	1.89	3.24	-0.84				11.97
Hyp (d) t		-43.55	15.51	21.42					
SA	0.065	-0.51	0.21	0.0096	-5.6E-06	0.063	0.82	2.13	0.77
Stan Err.	0.21	0.063	0.082	0.00199	5.34E-06				0.057
t statistic	0.31	-8.06	2.49	7.85	-1.05				13.64
Hyp (d) t		-41.14	9.97	1.56					
WA	0.296	-0.46	0.299	0.0061	-7.3E-06	0.069	0.74	1.96	0.51
Stan Err.	0.13	0.046	0.055	0.0012	5.78E-06				0.0797
t statistic	2.21	-9.81	5.41	5.12	-1.26				6.44
Hyp (d) t		-54.88	2.26	19.11					

Table 4.3 OLS Retail Margin Equations

	Cons.	PW	LPW	Cost	Prod'n	LDV	R2	D H	Stan EE
NSW	-0.19	-0.0703	0.21	0.005	2.95E-06	0.82	0.97	-2.56	0.0937
Stan Err.	0.12	0.12	0.12	0.002	2.1E-06	0.057			
t statistic	*-1.62*	*-0.601*	*1.69*	*2.35*	*1.39*	14.19			
VIC	-0.09	-0.101	0.38	0.009	3.5E-06	0.595	0.89	0.35	0.148
Stan Err.	0.26	0.16	0.16	0.003	4.5E-06	0.08			
t statistic	*-0.35*	*-0.63*	*2.43*	*3.84*	*0.78*	7.403			
QLD	0.00099	-0.36	0.36	0.0036	4.1E-08	0.91	0.986	-2.27	0.0698
Stan Err.	0.065	0.11	0.11	0.0017	5.97E-07	0.038			
t statistic	*0.015*	*-3.46*	*3.28*	*2.32*	*0.069*	23.87			
SA	0.61	-0.032	0.022	0.0054	5.02E-06	0.68	0.8005	0.65	0.1156
Stan Err.	0.22	0.13	0.11	0.0017	0.000011	0.082			
t statistic	*2.797*	*-0.25*	*0.197*	*3.11*	*0.48*	8.22			
WA	1.89	0.25	-0.197	0.011	0.000018	0.088	0.71	7.51	0.1408
Stan Err.	0.17	0.091	0.098	0.0031	9.6E-06	0.054			
t statistic	*11.14*	*2.75*	*-2.004*	*3.38*	*1.84*	1.63			

Table 4.4 SUR Retail Margin Equations

	Cons.	PW	LPW	Cost	Prod'n	LDV	R2	D H	Stan EE
NSW	-0.16	-0.14	0.28	0.0051	1.9E-06	0.81	0.97	2.2	0.0914
Stan Err.	0.11	0.11	0.11	0.00197	1.95E-06	0.054			
t statistic	*-1.498*	*-1.26*	*2.48*	*2.56*	*0.98*	*15.07*			
VIC	0.014	-0.23	0.49	0.0097	1.6E-06	0.57	0.898	0.55	0.145
Stan Err.	0.24	0.15	0.15	0.0023	4.2E-06	0.075			
t statistic	*0.058*	*-1.55*	*3.34*	*4.34*	*0.38*	*7.63*			
Hyp (d) t		4.91	11.51	9.43					
QLD	-0.0045	-0.44	0.44	0.0058	-7.7E-08	0.86	0.987	1.04	0.0689
Stan Err.	0.063	0.098	0.1	0.0015	5.5E-07	0.036			
t statistic	*-0.071*	*-4.51*	*4.35*	*3.93*	*-0.14*	*23.74*			
Hyp (d) t		20.77	10.98	2.88					
SA	0.57	-0.035	0.018	0.0052	4.6E-06	0.698	0.81	0.25	0.112
Stan Err.	0.21	0.12	0.11	0.0017	9.95E-06	0.077			
t statistic	*2.78*	*-0.29*	*0.17*	*3.13*	*0.459*	*9.03*			
Hyp (d) t		6.58	2.38	0.392					
WA	-0.05	-0.56	0.6	0.0052	-3.7E-06	0.89	0.98	-0.6	0.0924
Stan Err.	0.11	0.056	0.061	0.00197	5.9E-06	0.034			
t statistic	*-0.48*	*-9.97*	*9.83*	*2.64*	*-0.62*	*26.25*			
Hyp (d) t		34.7	3.598	3.72					

Table 4.5 OLS Farm-Retail Margin Equations

	Cons.	PA	LPA	Cost	Prod'n	LDV	R2	D H	Stan EE
NSW	-0.18	-0.501	0.61	0.012	4.05E-06	0.73	0.97	-0.76	0.115
Stan Err.	0.14	0.102	0.104	0.0026	2.6E-06	0.058			
t statistic	*-1.31*	*-4.91*	*5.801*	*4.39*	*1.52*	*12.65*			
VIC	0.202	-0.42	0.61	0.00996	1.9E-06	0.65	0.91	0.36	0.1524
Stan Err.	0.24	0.12	0.12	0.0024	4.9E-06	0.069			
t statistic	*0.83*	*-3.46*	*5.18*	*4.13*	*0.39*	*9.43*			
QLD	0.082	-0.55	0.59	0.0067	3.5E-07	0.83	0.98	-1.95	0.0763
Stan Err.	0.057	0.0998	0.102	0.00198	6.7E-07	0.0497			
t statistic	*1.43*	*-5.49*	*5.74*	*3.39*	*0.53*	*16.66*			
SA	0.54	-0.16	0.2	0.0076	2.3E-06	0.67	0.88	-1.12	0.1206
Stan Err.	0.22	0.11	0.098	0.00203	0.000011	0.079			
t statistic	*2.48*	*-1.43*	*2.03*	*3.75*	*0.22*	*8.47*			
WA	-0.032	-0.56	0.64	0.0038	-4.9E-06	0.92	0.988	-0.16	0.0925
Stan Err.	0.11	0.049	0.054	0.0021	6.4E-06	0.034			
t statistic	*-0.29*	*-11.54*	*11.78*	*1.83*	*-0.76*	*27.45*			

Table 4.6 SUR Farm/Retail Margin Equations

	Cons.	PA	LPA	Cost	Prod'n	LDV	R2	D H	Stan EE
NSW	-0.12	-0.57	0.67	0.013	2.3E-06	0.71	0.97	0.12	0.112
Stan Err.	0.13	0.094	0.096	0.0025	2.5E-06	0.053			
t statistic	*-0.94*	*-6.08*	*7.03*	*5.17*	*0.94*	*13.25*			
VIC	0.28	-0.49	0.67145	0.011	6.7E-07	0.63	0.91	0.57	0.1484
Stan Err.	0.23	0.11	0.11	0.002	4.5E-06	0.063			
t statistic	*1.26*	*-4.39*	*6.12*	*4.65*	*0.15*	*9.92*			
Hyp (d) t		5.64	0.09	6.37					
QLD	0.13	-0.55	0.58	0.0097	2.3E-07	0.76	0.985	-0.53	0.0751
Stan Err.	0.055	0.089	0.091	0.0018	6.05E-07	0.045			
t statistic	*2.36*	*-6.17*	*6.39*	*5.38*	*0.38*	*16.83*			
Hyp (d) t		1.58	10.03	10.92					
SA	0.54	-0.16	0.21	0.0081	5.2E-06	0.65	0.89	-0.598	0.1172
Stan Err.	0.203	0.11	0.094	0.0019	1.01E-05	0.074			
t statistic	*2.66*	*-1.55*	*2.24*	*4.21*	*0.51*	*8.85*			
Hyp (d) t		28.897	34.91	15.91					
WA	-0.044	-0.5723	0.64	0.0044	-3.6E-06	0.912	0.988	0.102	0.0899
Stan Err.	0.103	0.045	0.05	0.0019	5.9E-06	0.031			
t statistic	*-0.43*	*-12.75*	*12.74*	*2.29*	*-0.604*	*29.104*			
Hyp (d) t		0.22	2.83	29.23					

relationship with the current wholesale price and positive relationship with the lagged price, except in the case of the West Australian retail spread where the signs are reversed. Furthermore many of the retail spread price coefficients are not significant. Cost again shows a positive relationship and is significant in all cases except the West Australian farm-retail spread. Production seems to have little significance in either spread except at the 90 per cent level for the West Australian retail spread. Again in the case of both of these sets of spread equations the coefficients appear to indicate what was expected in most cases.

The preferred sets of OLS equations were then set into the SUR systems. The second set of SUR equations combining all the states spread equations at each level are the ones reported here. There were three of these systems, one for each type of equation. These results can be seen in Tables 4.2, 4.4 and 4.6. In general the SUR estimates were similar to the OLS estimates in terms of signs and levels of significance, with the exception of the West Australian retail spread equation.

To determine whether the OLS or SUR equations are best, the adjusted R^2, the significance of the exogenous variables, the appropriate Durbin-Watson test and the standard error of the regression for each state are compared. SUR equations should be no worse than those estimated separately using the OLS estimation (Pindyck and Rubinfeld 1981). In all cases it can be seen from comparing the pairs of tables, 4.1 and 4.2, 4.3 and 4.4 and 4.5 and 4.6, that the standard errors are lower and the adjusted R^2's are higher in the SUR equations, suggesting that these equations better estimate the spreads. The state system equations generally show lower levels of autocorrelation than the separately estimated equations, using the Durbin-Watson statistic for the wholesale spreads and the Durbin H statistic for the retail and farm-retail spreads. In the case of the retail spreads it is possible to reject the presence of autocorrelation that was present in the OLS equations when using the state system equations. In the farm-retail spreads the effect of autocorrelation is not significant in either set of equations however it does appear to be lower in the state systems. It was therefore decided to use the state system equations to conduct the hypotheses tests.

4.3 Hypothesis Tests

Hypothesis (a) - there is no price levelling:

In the wholesale spreads the current auction price was negative and highly significant in all states, while the lagged auction price was significant and positive. This means that prices and spreads will move in opposite directions in the short run but as time passes the spread responds to the change in price in a positive fashion. In the farm-retail equations the same basic trends were evident. However the result for South Australia's response to the current auction price was that the t-test was insignificant at the 90 per cent level. This indicates an absence of price levelling behaviour in the short term in that state when determining the farm-retail spread.

In the retail spreads although a negative relationship was evident for the current wholesale price, the t-statistics for New South Wales, Victoria and South Australia were insignificant. All states showed the long term absence of price levelling, although the t-statistic for the lagged auction price was insignificant in the case of South Australia.

Thus H_0 is rejected in the current period for the wholesale and farm-retail levels in all states (although only at the 90 per cent level for the farm-retail spread for South Australia) but cannot be rejected for the retail spreads except in the cases of Queensland and Western Australia. In the longer term it is evident that spreads respond positively to changes in prices, at all marketing levels in all states, except for the retail level in South Australia.

Hypothesis (b) - wholesale (retail) spreads are unrelated to the cost of providing wholesale (retail) market services:

Cost was found to be significant in determining all spread equations in all states. Thus H_0 is rejected for all equations.

Hypothesis (c) - wholesale (retail) spreads are independent of wholesale (retail) turnover:

Production was not significant at the 90 per cent level in any case, thus H_0 is not rejected.

Hypothesis (d) - there is no difference in beef price spread behaviour between Australian state capital cities, with the emphasis on the incidence of price levelling:

The method used to test this hypothesis was a test of the significance of the difference between two sample means. That is, whether two random samples of size N_1 and N_2, with means X_1 and X_2 could have come from the same population. If the sample size is larger than thirty-two the distribution can be taken as normal (Karmel 1963). Using the 95 per cent level the differences in the means are significantly different if the t value is greater than 1.96.

The New South Wales equations for wholesale, retail and farm-retail spreads have been used as a base with which to compare the other states. The Sydney meat market has been the subject of a great deal of work on spread behaviour and it was therefore appropriate to use it when determining differences in spread response across the states. As the hypothesis was concentrating on the differences in price levelling behaviour across states, the tests on current and lagged auction (wholesale) prices were the focus. Thus if the t-statistics calculated for current and lagged auction (wholesale) prices are greater than 1.96 it will be concluded that there is a significant difference in the spread behaviour between that state and New South Wales. All the calculations from this t-test can be seen in the Tables 4.2, 4.4 and 4.6 for the relevant variables under the heading of "hyp (d) t".

In the wholesale (retail) spread equations there were very significant differences in the spreads' response to current auction (wholesale) price and the trend was the same for the lagged auction (wholesale) price. Thus H_0 is rejected at the wholesale and retail spread levels in the short-term and in the long-term for all states.

Tests on the farm-retail spreads show that price levelling behaviour was not as significantly different among states in the current period. Queensland and West Australia were not significantly different from New South Wales. However, in the case of lagged auction prices all states except Victoria were significantly different from New South Wales. H_0 is rejected in the long term for the farm-retail spread for all states (except for Victoria) however, it is not rejected in the short term for Queensland and West Australia.

The other exogenous variable which was generally found to influence the determination of the spreads at all levels was cost. The same t-test can be used to determine if cost had a significantly different effect on the spread behaviour in each state. From the tables it can be seen that there was only one case in which the states did not differ significantly from New South Wales in the way cost effects the spread. This occurred in the determination of the retail and wholesale spreads in South Australia.

5. Implications and Conclusions

As outlined earlier, there was some justification for believing that the beef markets in the various state capital cities would exhibit different price spread behaviour. Some of the reasons put forward included the different levels of beef production and exports in each state, the non-uniform marketing arrangements throughout Australia and the different composition of the retail sector in each state. This information indicated that short run price spreads might be different in each state. The aim of this study was to determine if these differences did occur, with a particular concentration on price levelling behaviour.

Although there were some exceptions, the study showed that price levelling was highly significant at most market levels in all states of Australia. Most equations for each state showed the existence of price levelling in the current period with the absence of the practice being evident in the longer term.

The study revealed in nearly all cases that variables which influence the spread behaviour are significantly different in each state. In South Australia no price levelling was evident in the current period at the farm-retail spread level and in the retail spread neither current nor lagged wholesale price was significant in determining the spread. The influence of cost on the spread determination does not appear to be significantly different at the retail or wholesale level between New South Wales and South Australia.

Queensland and West Australia did not differ significantly from New South Wales in their response to the current auction price in the determination of the farm-retail spread. Victoria showed insignificantly different behaviour in longer term response to auction prices in determination of the farm-retail spread. This conclusion leads to some interesting policy implications. Current policy decision making may be based on conclusions reached in studies only of the Sydney market. From this study it can be seen that these decisions may be relevant to all Australian states in that price levelling is pretty much a consistent practice in each major capital city meat market. However the form of the price levelling varies from city to city.

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APPENDIX ONE: Proportion of Retail Beef Cuts in Whole Carcase

CUT	PROPORTION OF WHOLE CARCASE	PROPORTION OF CUTS AVAILABLE	SYDNEY $/kg JAN. 1980
Fillet Steak	0.0125		
Rump Steak	0.045	.1463	6.54
Sirloin Steak	0.0575		
Topside Steak	0.055	.1789	5.02
Round Steak	0.0375		
Silverside	0.0575		
Rolled Brisket	0.06		
Rolled Roast	0.095		
Chuck Steak	0.09	.2927	3.66
Blade Steak	0.075	.2439	4.25
Gravy Beef	0.06		
Minced Beef	0.0425	.1382	3.24
Fat	0.159		
Bones	0.1535		
Total	1.00/0.3075*	1.0000	4.41**

* Proportion of Carcase represented in the data set

** Composite Retail Price for Sydney January 1980 = $4.41

Source : Meat and Allied Trades Federation of Australia.

DEPENDENT VARIABLE: APWA

STANDARD ERROR OF THE REGRESSION = 10.6387
MEAN OF DEPENDENT VARIABLE = 229.500
STANDARD DEVIATION = 28.6142
R-SQUARED = 0.867525
ADJUSTED R-SQUARED = 0.861766
DURBIN-WATSON STATISTIC (ADJ. FOR 1 GAPS) = 0.5805
NUMBER OF OBSERVATIONS = 25

VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC
C	-58.594	23.571	-2.4859
APWA1	1.3458	0.10966	12.273

FORECAST RESULTS
****

PLOT OF SERIES: APWAFIT

```
        190       197       203       210       217       223
        |+---------+---------+---------+---------+---------+|
1986:10 |                               *                   | 211.63883
1986:11 |     *                                             | 194.14370
1986:12 | *                                                 | 190.37551
1987:1  |     *                                             | 194.14370
1987:2  |               *                                   | 204.90923
1988:12 |                                         *         | 218.63687
1989:1  |                                     *             | 215.54158
1989:2  |                                                   *| 223.07795
        |+---------+---------+---------+---------+---------+|
        190       197       203       210       217       223
```