RESEARCH NOTE: DECOMPOSITION OF SHEEP PRICE TIME SERIES.

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1. Introduction

The beef price time series components has been decomposed into trend, cyclical and seasonal components (Lubbe, 1990). Corresponding decomposition of the sheep producer price time series was done using the same techniques and methods. Deterministic price cycles and seasonality in prices of sheep have been reported on in South Africa (Adendorf, 1958; Lubbe, 1983; Lubbe 1989). This research is aimed at identifying, isolating and estimating seasonal, cyclic and trend components of sheep producer prices for the Witwatersrand controlled market. The purpose is to develop a suitable basis for predicting cyclical price movements by isolating the components in the time domain, and also relating cycles in other variables, such as the rainfall and wool prices, to the predictive base.

2. Data, Techniques and methods

The trends and cyclic components of sheep prices (1970 - 1989) were isolated from yearly data, while monthly data (1970 - 1989) were used for the seasonal components. The price data are for the Witwatersrand controlled market and were supplied by the Meat Board. Average annual wool auction prices (1961 - 1989) were obtained from the Abstract of Agricultural Statistics (Directorate of Agricultural Trends, 1990). The model specifications, techniques and methods of Lubbe (1990) were used.

3. Results

Significant trends were isolated for sheep (all grades and super lamb) as well as for the national averaged wool auction prices. In all these cases, the exponential functional form gave the best estimates. Coefficients of the derived functions are summarised in Table 1. The original price time series data of all grades, sheep prices, predicted prices (1990 to 1996) and the estimated trend (extrapolated to 1996), are illustrated in Figure 3. A larger price difference exists between the all grades and super prices for sheep than for beef (Lubbe 1990), but does not show a fixed pattern.

Table 1: Trend functions for sheep prices (all grades and supers) at the Witwatersrand market and the average wool price, with year as the predictor variable.

Series	Coefficients and statistics			
	B_0	B_1	R^2_{adj}	Time Period
Sheep all grades	0.0069298*** (12.66)	0.1275787*** (25.90)	0.9739	70 - 89
Super Lamb	0.0137683*** (13.34)	0.1212803*** (32.59)	0.9805	70 - 89
Wool price	0.0049953*** (7.71)	0.1346276*** (15.61)	0.9312	61 - 89

Note: Exponential function fitted $Y_t = B_0.EXP(B_1.T_t) + E_t$. Absolute T-values in brackets.

Significant seven year price cycles were isolated for both sheep grades. These cycles were however not as statistically significant as the previously isolated beef cycles. This could be due to concealed cycles with amplitudes longer than seven years. Initial inspection of the residuals revealed such a possibility, but the lack of sufficient data prevented an analysis thereof. It could also be the result of sheep prices that react to changes in beef prices. According to Van Heerden (1987:93) sheep prices follow beef prices, which is the meat market price leader, with an approximate two month lag. Wool prices in relation to sheep prices and rainfall cycles could also influence the cyclic behaviour of sheep prices. The estimated cycle indices and coefficients are summarised in Table 2, while the specific and typical cycles are illustrated in Figures 1 and 2 respectively.

Table 2: Summary of cycle estimates for sheep prices (supers and all grades) at the Witwatersrand market (with adjusted coefficients and means).

Seven year sheep price cycle				
Year	All grades		Super lamb	
	j^b	Z_j^b	C_j^a	Z_j^a
1	0.980	-0.020	0.940	-0.060
2	0.919	-0.081	0.914	-0.086
3	0.934	-0.066	0.929	-0.071
4	1.026	0.026	1.027	0.027
5	1.139	0.139	1.153	0.153
6	0.981	-0.019	1.035	0.035
7	1.021	0.021	1.002	0.002
Parameters				
U_i	1.000		1.000	
F_{model}	2.17^b		2.96^a	
R^2	0.6501		0.7176	
R^2_{adj}	0.3502		0.4756	
S^2	0.0050		0.0047	
df	13		13	

a Significant at $p<0.10$
b Significant at $p<0.15$

It is evident that, although small differences exist between the shapes of beef and sheep price cycles, the lowest and highest years (minima and maxima) correspond to exactly the same years for all the cycles. From Figures 1 and 2 it is evident that the price cycles for super and all grades sheep conform to basically the same pattern. The only significant difference between these cycles is that during the declining phase of the cycles, there is a one year change in direction of the all grades cycle. This could be due to the individual or combined influences of rainfall and wool prices. Static forecasts of the all grades sheep prices, the forecasted trend and the actual prices realised are illustrated in Figure 3. The illustrations for 1970 to 1989 represent a graphical evaluation of the precision of the model, while

the 1990 to 1996 illustrations represent static forecasts. From Figure 3 it is evident that the actual price for 1989 was higher than estimated with the model.

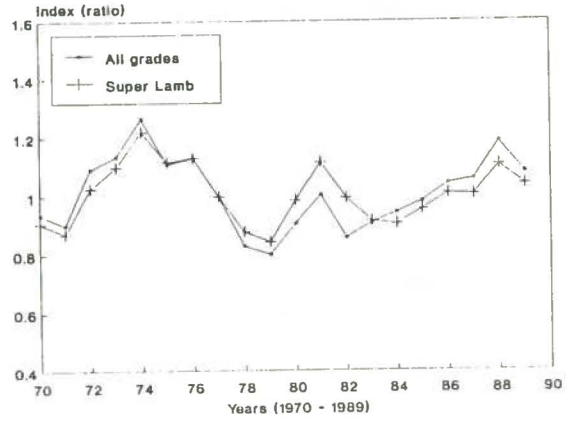

Figure 1: Specific cyclic indices for super and all grades sheep prices at the Witwatersrand controlled market.

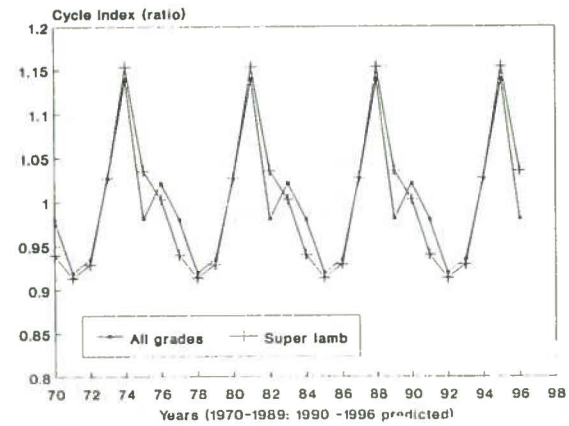

Figure 2: Typical seven year cycles for all grades and super sheep prices at the Witwatersrand controlled market (predicted 1990 - 1996).

Significant seasonal indices were estimated for all grades sheep and super lamb prices. The indices and coefficients are summarised in Table 3 and graphically illustrated in Figure 4.

From Figure 4 it is evident that quite different seasonal price cycles exist for super lamb and all grades sheep. The super lamb cycle is smoother and has a near opposite pattern to the all grades cycle. These seasonal price cycles are results of the combined short term demand and production effects. The super lamb cycle peaks in December and April to June, while the all grades cycle peaks in April, August and December. The December and Easter peaks are the result of seasonal demand for mutton, while the August peak is the result of the sheep production cycle. Variation of the typical seasonal patterns over time is also possible.

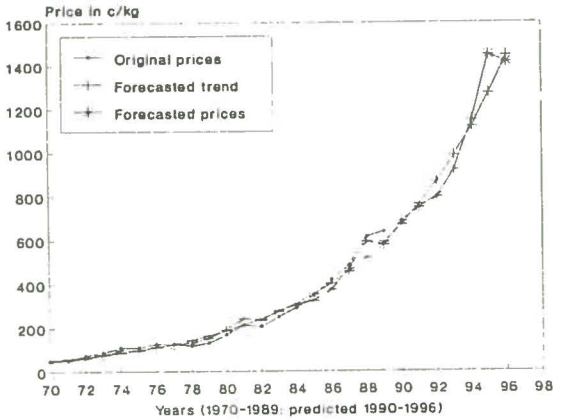

Figure 3: Prices and trends (data and forecasted) for all sheep grades at the Witwatersrand controlled market.

Table 3: Summary of seasonal estimates for sheep prices (supers & all grades) at the Witwatersrand market (adjusted coefficients and means of monthly data).

	Sheep price seasonal index			
Month	All grades		Supers	
	S_j^*	V_j^*	S_j^*	V_j^*
1	0.976	-0.024	1.004	0.004
2	0.980	-0.020	0.981	-0.019
3	0.964	-0.036	0.984	-0.016
4	0.997	-0.003	1.002	0.002
5	0.979	-0.021	1.007	0.007
6	0.994	-0.006	1.009	0.009
7	1.026	0.026	1.002	0.002
8	1.037	0.037	0.988	-0.012
9	1.007	0.007	0.975	-0.025
10	1.009	0.009	0.991	-0.009
11	0.988	-0.012	0.997	-0.003
12	1.042	0.042	1.059	0.059
Parameters				
U_i	1.000		1.000	
F_{model}	3.6^{***}		2.5^{**}	
R^2	0.1549		0.1129	
R^2_{adj}	0.1119		0.0677	
S^2	0.0033		0.0035	
df	227		227	

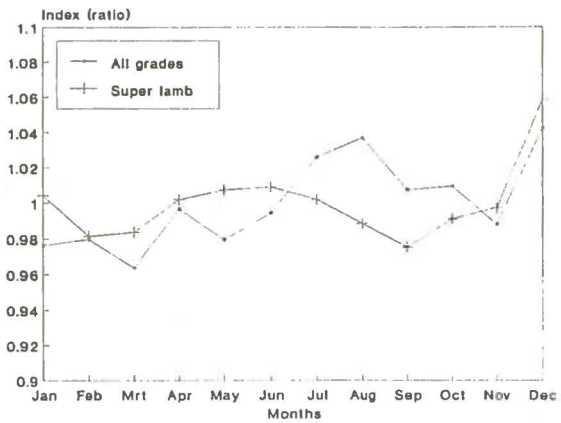

Figure 4: Seasonal indices of sheep prices for the Witwatersrand controlled market (averaged indices for 12 months).

The seven year cycles of beef and sheep prices (all grades for both) and the seven year rainfall cycle are illustrated in Figure 5. From Figure 5 it is evident that the minima of the price cycles coincide with the second highest year of the seven year rainfall cycle, while the two minima of the rainfall cycle coincide with the first and second year after the price cycle minima. The maximum of the rainfall cycle coincides with the maxima of the price cycles. From Figure 5 it is also evident that the decline in sheep prices during the downswing and the increase in sheep prices during the upswing is less than for beef. Mutton is thus relatively more expensive during the low phase of the price cycles and *vice versa*. All grades sheep prices apparently also follow the rainfall closely from the price cycle maxima for two years. This explains the difference between super and all grades sheep price cycles during the downswing (see Figure 2).

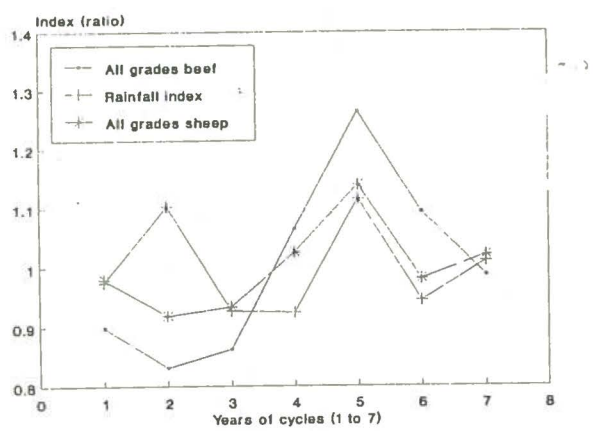

Figure 5: Seven year cycles (typical) for all grades sheep and beef prices and average rainfall.

The ratio of the detrended wool price to the typical all grades sheep price cycle (W/S), the slaughter index of sheep (total at the Witwatersrand controlled abattoir as a ratio of the mean) and the seven year all grades price cycle are illustrated in Figure 6. The sheep slaughter index follows a anti-cyclical behaviour simultaneously to both the sheep price cycle and wool-price/sheep-price index. If the W/S ratio is more than unity slaughterings tend to be relatively low and *vice versa*. From Figure 6 it is apparent that the direction in which the W/S ratio changes could actually exert a stronger influence on slaughterings than the absolute W/S value.

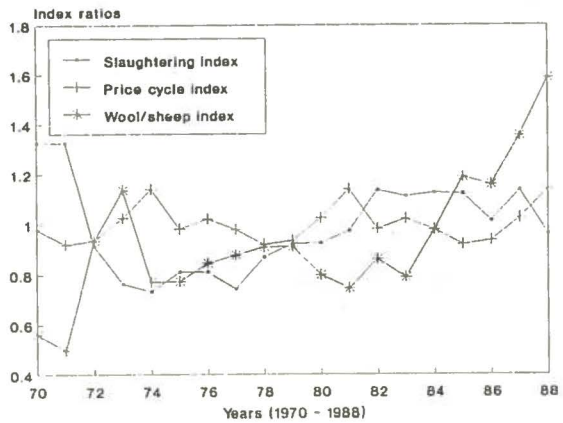

Figure 6: Index of sheep slaughterings, 7 year all grades sheep price cycle and the detrended wool/sheep price index.

4. Discussion

From the results it is evident that the presence of sheep price cycles (less significant than beef price cycles) is the result of various external influences. This implies that the cycles are probable not self generating processes to the same extent as the beef price cycles. The influence of external factors on the sheep price cycle could be either direct (wool price) or indirect (rainfall via beef price cycle) or both as is the case for rainfall. The simultaneous multivariate influences on sheep prices explain the difficulties that are experienced with the estimation of the supply of sheep to the controlled markets (Du Toit, 1982: 68-88).

Apart from the influence of the control measures, price support and regulations of the red meat scheme, sheep prices are also influenced by rainfall, production and supply aspects, beef prices, the wool price, consumer demand and price expectations. The production cycle for sheep is shorter than for beef, which renders producers more flexible towards price signals. Producers react to both current and previous prices of sheep, beef and wool. Expectations of future prices (wool, beef and sheep) also influence the slaughterings of sheep.

The short term influence of rainfall during the downswing of the price cycle is to lower supply the year after good rains and to increase supply in the same year if rainfall is low. The opposite is also true during the upswing of the price cycle. In the long term, rainfall and sheep prices have a combined effect that results in production expansion during the high price period and liquidation of stock during the low price period. This is

basically the same cycle generation process that was found for beef (Lubbe, 1990), but it is weakened or strengthened by the W/S ratio of the previous two years.

Consumer demand can also affect the sheep price cycles. The demand for mutton is relative price-elastic and strong substitutes, such as beef, poultry and pork exist (Du Toit, 1982; Hancock *et al*, 1984). During the high price period sheep substitutes beef as a result of sheep price increases being relative lower in comparison with beef price increases (Figure 5) and also the unavailability of beef due to production expansion. The opposite process occurs place during low price periods.

5. Conclusion

Although producer prices of sheep are erratic over the long, medium and short terms, relative stable price patterns exist. These price patterns were successfully isolated as significant trends, seven year cycles and seasonal indices. Sheep prices are influenced by wool and beef prices. The supply of sheep is related to both wool and sheep prices simultaneously, as well as to rainfall, beef price cycles, price expectations, demand effects and marketing policy. This multi-variable influences on sheep prices render substantial variation which influence any obvious identification of cycles without special analysis thereof.

References

ADENDORF, J. (1958). Ekonomiese neigings, die produksie, verbruik en pryse van vleis in die Unie van Suid Afrika. DCom. thesis, University of Pretoria.

DIRECTORATE OF AGRICULTURAL TRENDS. (1990). Abstract of agricultural statistics. Department of Agricultural Marketing and Economics, Pretoria.

DU TOIT, JPF. (1982). 'n Ekonometriese ontleding van die vraag na en aanbod van vleis in Suid Afrika. MBA thesis, University of Pretoria.

HANCOCK, PJ, NIEUWOUDT, WL and LYNE, MC. (1984). Vraaganalise van vleissoorte in Suid Afrika. Agrekon Vol 23, No 2.

LUBBE, WF. (1983). Prysanalise. Unpublished research report, Agrifen, Pretoria.

LUBBE, WF. (1989). Analise en voorspelling van bees- en skaapvleis pryssiklusse. Unpublished research report, University of Pretoria.

LUBBE, WF. (1990). The decomposition of price time series components of the red meat industry for efficient policy and marketing strategies. Paper read at the 28th annual AEASA conference in Durban, 1990.

VAN HEERDEN, AF. (1987). Prys interverwantskappe in die Suid Afrikaanse vleismark. MSc. thesis, University of Pretoria.