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P. Paul, A. Abey and A. Ockwell

Australian Bureau of Agricultural Economics Canberra

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AN ANALYSIS OF INCOME AND PRODUCTIVITY CHANGE IN THE AUSTRALIAN PASTORAL ZONE

P.B. Paul, A. Abey and A.P. Ockwell
Bureau of Agricultural Economics

Changes in farm enterprise structure, profitability and productivity that have occurred on properties in Australia's Pastoral Zone are examined in this paper. Specific attention is given to some of the key factors which have accounted for past changes in productivity and restraints inhibiting productivity growth. These results are viewed within the framework of export dependence, the (limited) scope for productivity change resulting from the introduction of new technology, and the trade-off that producers made in maintaining income at the cost of possible damage to the basic range resource.

1. Introduction

In the discussion of land use in the Pastoral Zone much attention appears to have been focused on environmental issues, including the factors leading to land degradation. However, except for work by Musgrave (1983), little attention appears to have been given in recent years to economic factors which affect the use of the pastoral resource base.

The purpose is to report on the findings of an economic analysis of income and productivity change in the Pastoral Zone of Australia and to identify restraints inhibiting productivity gain. In providing industry and reseachers with estimates of productivity, the Bureau of Agricultural Economics (BAE) has also investigated factors underlying past changes in productivity. Such indicators of change may help to facilitate resource allocation decisions to ease current restraints on productivity gain and, hence, realise improvements in farm performance.

2.1 Characteristics of the Pastoral Zone and its Relationship to the Arid Zone

As can be seen from Figure 1, the Pastoral Zone includes not only the area of Australia defined by Nix (1976) as the Arid Zone, but also significant tracts of land in Cape York Peninsula, Arnhem Land and the Northern Kimberley region of Western Australia. Other boundary differences occur in South-East Queensland and New South Wales. Consequently, caution needs to be exercised when using Pastoral Zone data to represent the Arid Zone, particularly in regard to the beef industry which dominates the tropical north of Australia.

The Pastoral Zone is characterised by wide diversity in average area of grazing properties, rainfall, stocking rates and forage productivity. However, climatic characteristics generally favour extensive sheep and cattle grazing as the most feasible enterprise options.

2.2 Data

Aggregate data suitable for discussing the economic circumstances of the Australian Pastoral Zone are contained in the Bureau's survey of the Australian grazing industry which covers both the sheep and beef cattle industries. Since, however, aggregate grazing industry estimates by zone are available only back to the year of commencement of the combined survey in 1973-74 it is necessary to use separate Bureau data for each of the sheep and beef industries when analysing longer time periods.

Data time series for the beef industry were constructed for the period 1968-69 to 1980-81. This period represents the longest time series of survey data that can be used for the beef industry, since economic data were not collected for this industry on an annual basis prior to 1967-68. Estimates were interpolated for the beef industry in 1972-73 as no separate beef industry survey was conducted in that year.

The data used for the sheep industry relate to the period 1967-68 to 1980-81. Although sheep industry data have been collected annually since 1952-53, variable collections and definitions used prior to 1967-68 are increasingly difficult to reconcile with those used in surveys of later years, particularly in regard to derivation of consistent productivity estimates.

The results reported in this study were limited to a Pastoral Zone breakdown of sheep and beef industry data. Farms were included in the sheep industry if they had at least 200 sheep. Beef properties were defined as having at least 50 cattle. A fuller description of each industry grouping appears in Tucker (1981).

2.3 Methodology

The financial performance of sheep and beef producers in the Pastoral Zone was represented by a set of measures which have been used in recent years to provide an indication of cash flow and business and investment returns. Among the key indexes considered were farm cash operating surplus, rate of return to capital and management adjusted to full equity

(including and excluding nominal capital appreciation) and rate of return to capital and management including real capital appreciation. The interpretation of these farm performance measures and their limitations are discussed in detail in Campbell (1981) and Kingma et al. (1983).

In deriving these measures, it was necessary to adjust earlier definitions so as to make the income measures comparable as far as possible over time. Unfortunately, due to data limitations in earlier years, no account could be taken of capital trading gain or loss, changes in value of stocks and changes in capital appreciation in stocks in deriving estimates of rates of return. Where zonal boundaries were changed, notably in 1977-78, an attempt was made to reclassify farms, using the old zonal boundaries so that consistency could be maintained in data time series. The new boundaries reduced the area of the Pastoral Zone, especially in New South Wales and Queensland (see BAE 1983). In cases where constant dollar estimates were required, financial data were adjusted for changes in the consumer price index and were expressed in 1982-83 prices.

Trends in farm financial performance, in particular farm incomes, have been shown to be closely linked to movements in total productivity relative to the terms of trade, or the ratio of output prices to input prices (see Stoeckel and Miller 1982). Accordingly, attention is focused in this paper on the source and extent of productivity growth in the Pastoral Zone, relative to the changes in the terms of trade, and on the possible implications for future use of the land base.

In measuring total productivity of a multi-output multi-input industry, it is necessary to determine the movement in total output relative to total input (or total output per unit of total input). The most common procedure in forming a measure of total outputs and total inputs is to use an index number procedure. However, in aggregating individual inputs and outputs, consideration needs to be given to the underlying functional form assumed for the index number approach as well as other issues such as the measurement of the service flow from durable capital inputs such as plant, machinery and land.

The index number formula used to combine heterogeneous outputs or inputs, as well as total outputs and inputs, was that developed by Tornqvist (1936). The data used were expressed on a per-property basis and appropriately weighted to represent industry averages. A discussion of the suitability of the Tornqvist index for measuring farm productivity and some of the issues underlying the measurement of input and output groups is contained in Lawrence and McKay (1980) and USDA (1980b).

Sources of productivity growth can be investigated through the use of partial productivity measures. While such measures taken by themselves can be misleading, they can provide useful insights into the sources of productivity gain if considered in the context of trends in total productivity and trends in other inputs and outputs. The following range of partial productivity measures were investigated in the present study in relationship to the Pastoral Zone:

- the ratio of cash returns to total cash costs, representing productivity of purchased inputs;

- cash returns per man-week of labour, and stock equivalent per man-week, representing labour productivity;

- cash returns per dollar invested, representing capital productivity;

- stock equivalents per hectare, representing land productivity;

- cash costs per stock equivalent and dollars invested per stock equivalent, representing productivity in use of farm inputs;

- interest cost per stock equivalent, measuring relative costs of borrowed capital;

- wool cut per sheep shorn, representing wool enterprise productivity;

- lambs marked to ewes mated and sheep turnoff rates, representing sheep enterprise productivity; and

- calves branded to cows mated and cattle turnoff ratio, representing cattle enterprise productivity.

3.1 Farm Enterprise, Structure and Profitablity

Since the late 1960s, there have been some notable changes in the physical and enterprise characteristics of Pastoral Zone properties (see Tables 1 and 2). One such feature has been the expansion in the number of beef cattle properties in the beef industry by over 6 per cent a year. Much of this expansion occurred in the late 1960s and early 1970s, reflecting to a large extent the movement of resources out of sheep into beef cattle in response to favourable prices for beef (BAE 1975). At the same time, there was a drop in the average property size of Pastoral Zone beef properties of 2.3 per cent a year, which may reflect the smaller property sizes of new entrants to the beef industry during the late 1960s and early 1970s. By contrast, there has been no significant change in the number of sheep properties in the Pastoral Zone or in their average size.

The trend toward larger beef herds in the Pastoral Zone was also evident on sheep properties, at least until the late 1970s. For example, during the period 1967-68 to 1980-81, there was a rise of 8 per cent a year in the number of cattle on sheep properties while sheep numbers declined by 1.4 per cent a year.

A further change that has occurred in the Pastoral Zone is the increase in cropping activities. For example, over the period 1967-68 to 1980-81, there has been an increase of 7.5 per cent a year in crop area harvested in the sheep industry. Corresponding crop data are not available for earlier years for the beef industry. However, crop area sown in the beef industry rose by 5.5 per cent during the 1968-69 to 1980-81 period. Despite the rate of growth in cropping activities, however, the area under crops in both industries represented less than 1 per cent of average land area of each industry in 1980-81.

Averages and trends in measures of financial performance for Pastoral Zone properties are also noted in Tables 1 and 2. Nominal cash receipts increased more rapidly than nominal cash costs in both industries. On the other hand, there was no significant change in the level of real farm cash operating surplus. However, it should be noted that the sheep industry figures are, in part, influenced by the choice of 1967-68 as the starting date since this year was affected by drought, particularly in the southern

half of Australia. Moreover, farm cash operating surplus in both industries has also been boosted by the switch from hired labour to family labour and the increased level of capital inputs, since family labour, depreciation and opportunity costs of capital are not included in cash costs.

A further measure of financial performance is the rate of return to capital and management, which averaged 3.6 per cent in the sheep industry over the period 1967-68 to 1980-81, and 1.2 per cent for the beef industry for the period 1968-69 to 1980-81. If the rate of return to capital is further adjusted to take account of real capital appreciation on livestock and land, then the average rate of return over the respective periods is -0.8 per cent in the sheep industry and -2.6 per cent in the beef industry. This implies that the increase in capital values of farms has not kept pace with inflation as measured by the consumer price index.

3.2 Recent Estimates of Farm Financial Performance in the Pastoral Zone

Comparable estimates of farm financial performance for the sheep and beef industries in the Pastoral Zone for 1981-82 to 1983-84 are not available. However, estimates at an aggregate level for the Australian agricultural and grazing industries are available for the Pastoral Zone for 1982-83 and 1983-84 using the zonal boundary definitions that were established by the Bureau in 1977-78 (see BAE 1983). These estimates are presented in Table 3, along with comparable survey results for 1980-81.

The financial preformance figures for 1980-81 and 1982-83 reflect the effects of drought which severely affected wide areas of the Pastoral Zone. The relatively small change in real farm cash operating surplus in 1983-84 can be attributed to the continuation of relatively depressed livestock prices coupled with the decline in slaughter levels and the increase in livestock purchases associated with herd buildup following the breaking of the drought. In addition, the relatively low level of farm cash operating surplus in 1983-84 is influenced by the sharp increase in interest payments associated with carryover loans and restocking activities following the drought. Despite these influences, it is anticipated that improved economic conditions will contribute to an increase in real levels of capital appreciation, with an associated improvement in the real rate of return to capital in the Pastoral Zone in 1983-84.

4.1 Movements in Input and Output Prices

Fluctuations in measures of financial performance can, in part, be linked to movements in commodity prices which have been characterised by considerable variability over the past fifteen years. Much of this variability stems from the degree of export dependence which is a key feature of each major industry. For example, in 1982-83, greasy wool, mutton and beef exports accounted for over 85 per cent, 75 per cent and 50 per cent of Australian production of these commodities, respectively. The high degree of export dependence of these industries means that market prices in Australia are strongly susceptible to changes in factors such as overseas demand, market competition, availability of substitutes, exchange rates, changes in foreign domestic policies and import restrictions (see Bond et al. 1983).

Upturns in world market conditions since 1967-68 have, in some years brought about a substantial lift in mutton, beef, wheat and wool prices during the 1970s (see Figure 2). On the other hand, subsequent downturns have meant that real commodity prices have displayed no significant trend over the period 1967-68 to 1982-83. Recent appraisals of the outlook for each of these commodities in the light of anticipated developments in the export and domestic markets have tended to affirm that prices received by growers will continue to fluctuate around a possible short-term improvement in trend, except for wheat, for which prices are expected to decline (see BAE 1984a,b,c).

Although there was no significant trend in real output prices in the Pastoral Zone, there was a rise in input prices relative to the consumer price index of 1.9 per cent a year. An examination of movements in real input prices for the sheep industry in the Pastoral Zone showed that the upward trend in real total input prices was accounted for by significant increases in capital input prices, hired labour input prices and service input prices (see Table 4). There was no significant trend in real input prices for livestock, land or materials.

The rise in real input prices of 1.9 per cent a year means that the terms of trade in the sheep industry in the Pastoral Zone showed a decline, falling on average by 4.3 per cent a year between 1967-68 and 1980-81 (see Table 4 and Figure 3). By comparison, the rate of decline in the terms of trade for the Australian rural sector as a whole was only 3 per cent a year for the same period.

5.1 Productivity Trends in the Australian Pastoral Zone

An index of total factor productivity was derived for the sheep industry by taking the ratio of the total output quantity index to the total input quantity index (see Table 5). Results showed that total factor productivity displayed an annual rate of increase of 2.4 per cent over the period 1967-68 to 1980-81 compared to an estimate of 4.1 per cent growth for the Australian rural sector taken as a whole over a similar time period, using BAE indexes of volume of rural outputs and inputs. If the drought-distorting year 1980-81 is removed from the series, it is found that the increase in output averaged 3.1 per cent a year while productivity increases averaged 3.4 per cent. Despite this adjustment, however, it can be concluded that increases in the rate of productivity growth in the sheep industry were not sufficiently large to offset the decline in the terms of trade.

An important feature noted in earlier studies is the negative correlation between the terms of trade and total productivity (see Lawrence and McKay 1980; Easter et al. 1977). In particular, it has been observed that adverse trends in the terms of trade often result in significant input deferral, resulting in a temporary increase in productivity. A study of the relationship between the terms of trade and total productivity confirmed that negative correlation existed between the two measures (see Figure 4). In fact, there was a negative correlation of 0.73 between the two measures over the fourteen-year period. However, it is also apparent that input use was reasonably stable and that the significant increase in productivity was achieved primarily through a rise in outputs (see Figure 5 and Table 5).

One factor contributing to the rise in output levels was the increase in crop output. It is apparent from Table 5 that there was a significant rise in crop production of some 10 per cent a year, especially of wheat and other grains. There was also a rise in livestock output. However, it is important to note that beef production expanded by 4.6 per cent a year, while sheep production declined by 3.2 per cent a year. This suggests that the increase in output can be to a large extent attributed to substitution and broadening in the output mix rather than through a simple expansion of farm activities.

Associated with the rise in output level was an increase in intensity of land use. A study of selected partial productivity ratios revealed that, over the period 1967-68 to 1980-81, stock equivalents per hectare rose by 1.7 per cent a year (see Table 6). Despite the increased intensity of land utilisation, there did not appear to be a corresponding increase in the quantity of inputs per stock equivalent as evidenced by a significant decline in capital invested per stock equivalent and in cash costs per stock equivalent.

A similar pattern emerged in the beef industry when Pastoral Zone figures were analysed for the period 1968-69 to 1980-81. Stock equivalents per hectare rose by over 3 per cent a year during the period, while capital invested per stock equivalent and cash costs per stock equivalent both declined (Table 6).

A further factor contributing to increases in output levels was an apparent increase in livestock enterprise efficiency. Although there was no general rise in stock turnoff rates or wool yields, there was a statistically significant increase in calving rates of 1.1 per cent a year in the beef industry. The improvement in calving rate may possibly be linked to improved disease control measures as evidenced by increases in inputs of livestock supplies including dips, drenches and other material items. It is also possible that increased calving rates reflect the introduction of new breeding stock better suited to a hot arid environment, as well as improved stock management methods. The latter include increases in the number and distribution of watering points on properties, systems of closer management, and more efficient transportation (see Condon 1982).

With respect to input use in the sheep industry, there has been a considerable substitution of family labour for hired labour and an overall decline in labour input of 1.2 per cent a year (Table 1). Plant and machinery capital input has increased significantly, by over 24 per cent a year between 1967-68 and 1980-81, reflecting at least in part, the shift to crop production. There was no significant change in total materials and total services inputs although within these groups there was evidence of changes in input usage and input substitution. For example, in the services group, increases in electricity and administration inputs were

offset by declines in subscriptions, insurance and rates and taxes inputs. Adjustments in the materials group included rises in seed, pesticides and sprays inputs counterbalanced by a drop in packaging materials input, which again may well reflect the change in output mix with increased emphasis on crop production.

5.2 An International Comparison of Productivity Trends in Pastoral Areas

For comparative purposes, it is useful to consider the means by which Pastoral Zone grazing systems in other countries have been adjusted to changing market conditions. Unfortunately, data limitations and differences in enterprise structure inhibit comparisons of pastoral grazing systems with regions such as Africa, the USSR and South America. However, detailed economic indicators are available for the mountain region of the United States, which accounts for about one-quarter of the area of that country (USDA 1980a) and covers the States of Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona and New Mexico - and includes an extensive area of arid and semi-arid land.

An examination of the indexes provided in USDA (1980a) for the mountain region over the period 1967-68 to 1979-80 revealed that productivity increases averaged about 1 per cent a year during the period. The rise in productivity was due mainly to increases in the volume of physical output which averaged 1.4 per cent. Input levels remained relatively constant over the period, rising by only 0.4 per cent. Consistent with Pastoral Zone trends in the Australian sheep industry, output increases were achieved by increases in crop output which grew by 2.4 per cent a year. There was no significant increase in livestock output. As a reflection of the increase in cropping activities, there was a 2 per cent increase in plant and machinery input, while farm labour input declined by 3.1 per cent over the period. The results obtained in both the Australian Pastoral Zone and the mountain regions of the United States illustrate the similarity in adjustment patterns which have occurred in pastoral regions in response to adverse terms of trade pressures.

6. Restraints Effecting Productivity Growth and Land Use in the Pastoral Zone

Overall, the total quantity of inputs employed in the Pastoral Zone in Australia has remained relatively stable (ignoring input substitution) while output has risen at almost 2 per cent a year in the past 14 years. The question remains, however, whether such increases in output can be sustained in the future without damage to the basic range resource. To some extent, this will depend on the degree to which the various economic, social, physical, biological and institutional constraints can be eased.

Economic constraints include price and cost movements as well as a number of other factors which are not explored here, such as access to capital and borrowed funds, risk, and on-farm and off-farm investment. Due to the competitive market structure for livestock and wool products, there is no scope for individual producers to influence market prices. However, the substitution and broadening in output mix which occurred in the Pastoral Zone suggests that at least some producers had sufficient flexibility to be able to adjust their production decisions to accord with changes in relative output prices. In any case, producers have responded to movements in the relative prices of farm inputs by the substitution of inputs. There is little evidence to suggest that economic restraints regarding input use have caused producers to significantly reduce land maintenance expenditures such as repairs to fences, yards, roads or fertiliser input. However, the extent of investment in land impovement is more difficult to gauge with the data available. Certainly, there has been an increase in the quantity of irrigation and water supply plant used, which may reflect improvements in the number and distribution of watering points for stock. However, this aspect requires further investigation.

Social constraints to productivity growth and effective land use in the Pastoral Zone have commonly been identified as labour shortages arising from difficulties of retaining and attracting people in the Pastoral Zone, given the costs of maintaining or even providing a suitable infrastructure and comparable living standards (Williams 1983). The importance of this constraint in relationship to pastoral production is

difficult to assess with the data available. The trend toward substitution of family labour for hired labour may well reflect the increase in relative cost of hired labour resources relative to other inputs rather than the lack of availability of hired or contract labour.

One important consideration is the extent to which physical restraints such as climate, soil and terrain are likely to inhibit the expansion of future cropping activities. Developments in wheat breeding, farming systems, cultivation and seeding technologies have increasingly allowed crop production to take place in arid pastoral regions. However, continued expansion will be conditional on further developments in plant breeding and crop management research and on the extent of future regulation of land use.

A further consideration is the extent to which livestock productivity can be improved in arid pastoral areas through the easing of biological constraints such as control of animal disease and improvement in reproductive performance. It has recently been noted that suppression of major pest infestations such as worm parasites and blowflies can result in substantial payoff in weight gains and animal reproductive capacity (Johnston and Girdlestone 1983). These results highlight the need for more research into the potential economic gains associated with the development of more comprehensive animal health programs.

A major point to be considered in regard to pastoral grazing systems is whether more intensive production per unit of land can be sustained without significant soil degradation. Menz (1984) notes that climatic conditions in the Pastoral Zone of Australia have not been conducive to the profitable implementation of pasture improvement. On the other hand, some gains in pasture productivity may be possible through improved management of native pastures by increasing plant density and increasing the proportion of desirable species by better grazing management.

Increased intensity of land use may also be a product of institutional restraints such as the restrictive tenure conditions applying to much of the pastoral land base as noted by Young (1982), Sheldon (1980) and Musgrave (1983). It would be worth investigating whether restrictive land tenure conditions have prevented pastoralists

from achieving economies of size and whether land tenure regulations have prompted graziers to increase the intensity of farm operations to maintain productivity and real incomes in the short term at the expense of the basic range resource.

7. Conclusions

The financial performance of properties in the Pastoral Zone has been affected by a number of factors including fluctuations in commodity prices and changes in the level and composition of output. Changes in relative prices of livestock products particularly on export markets, has influenced the types of adjustments that occur in land use in Pastoral Zone properties, both in terms of output mix and input usage.

The steady trend in real output prices coupled with a rise in real input prices over the period 1967-68 to 1980-81 resulted in a significant decline of 4.3 per cent a year in the terms of trade for Pastoral Zone properties in the sheep industry. However, to a large extent, producers have been successful in mitigating the decline in the terms of trade through output increases while input levels have remained relatively constant. A similar pattern was also observed in the arid mountain region of the United States.

The rise in output levels in the Australian Pastoral Zone can be largely attributed to three factors, namely increases in cropping activity, improved calving rates and increased land-use intensity. The question of concern here is the extent to which increases in output levels can be maintained, given the restraints to production which exist in the Pastoral Zone.

It is possible that additional research into cultivation and seeding technologies will help to ease cropping restraints further so that increased cropping activity will continue to be successful in the Pastoral Zone. It is also possible that continued adoption of improved livestock management systems, including superior breeding stock and animal health measures, will help to secure future productivity gains. However, the prospects remain less clear regarding the trend toward increasing land-use intensity and the consequent effect on the range resource, particularly if profitable implementation of pasture improvement or development of arid lands is limited. This issue warrants further investigation.

Table 1: SHEEP INDUSTRY: SELECTED VARIABLES AND TRENDS IN THE PASTORAL ZONE: 1967-68 TO 1980-81

Item	Unit	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	Annual growth rate(a)
																%
Physical Measures																
Total farms	no.	7 214	7 214	7 214	7 214	6 760	6 495	6 538	6 455	6 224	5 941	7 354	7 212	7 107	6 426	0.1
Farm size	ha	23 483	23 437	23 544	22 792	23 085	24 334	21 739	25 254	23 793	25 845	28 345	24 176	23 234	20 533(13)	0.2
Crop harvested	ha	57	97	93	34	82	39	106	110	147	95	126	141	149	143(24)	7.5***
Sheep	no.	5 212	5 627	5 619	4 940	5 055	4 947	4 797	5 198	5 321	5 111	5 863	4 780	4 386	3 961(7)	-1.4**
Beef	no.	107	129	146	173	225	248	315	316	365	308	461	376	258	244(15)	8.0***
Stock equivalents	no.	6 734	7 818	7 908	6 725	7 840	7 395	8 658	9 052	10 002	8 717	10 868	9 472	8 230	7 508(8)	0.8*
Labour	man-weeks	100	134	134	128	121	115	116	126	117	134	127	140	142	132(5)	-1.2*
Capital (excl. land and livestock)	index	100	97	103	95	76	83	123	94	79	100	119	112	123	116	1.8*
Plant, machinery and water capital	index	100	96	100	93	68	77	110	87	74	107	127	121	150	140	3.3**
Capital-to-labour ratio	index	100	101	109	114	95	104	136	110	100	124	137	134	149	149	3.0***
Capital-to-labour price	index	100	101	103	103	105	103	97	90	89	89	89	88	91	97	-1.2***

(Continued on next page)

Table 1 (continued)

Item	Unit	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	Annual growth Rate(a)
Financial Measures																%
Nominal cash receipts	$	30 897	39 356	34 656	23 864	31 302	54 207	57 787	45 991	54 655	63 577	75 669	98 702	105 783	102 209(6)	10.4***
Nominal cash costs	$	24 480	25 234	25 213	22 397	23 098	24 605	36 495	32 837	37 735	37 133	49 700	51 998	68 147	68 442(7)	8.8***
Nominal farm cash operating surplus	$	6 417	14 122	9 443	1 468	8 204	29 602	21 292	13 155	16 921	26 444	25 968	46 704	37 591	33 767(11)	15.5***
Real farm cash operating surplus (b)	$	24 000	51 545	33 428	4 962	25 925	88 214	56 211	29 730	33 842	46 541	41 549	69 122	50 748	41 533(11)	6.1
Rate of return to full equity	%	1.4	5.8	2.9	-1.3	2.4	12.0	5.3	1.5	2.9	4.2	2.1	7.5	2.8	1.5(245)	3.6(c)
Real rate of return to full equity including capital appreciation	%	-4.0	3.7	-1.9	-10.1	-5.6	17.2	-1.5	-29.6	-16.9	-3.2	2.2	25.2	7.3	5.0(38)	-0.8(c)

(a) Annual growth rate estimated by fitting semi-log regressions to the data, of the form log $y_t = a + bt + e_t$. (b) Adjusted by consumer price index expressed in 1982-83 dollars. (c) Expressed as average for period.

* Significant at 90 per cent level.
** Significant at 95 per cent level.
*** Significant at 99 per cent level.

Note: Figures in parentheses are relative standard errors, expressed as percentages of the estimates. When estimates are close to zero, high RSEs will result even though the size of the absolute sampling error may be small.

Table 2: Beef Industry: Total Number of Farms and Average per Property of Selected Variables and Trends for Pastoral Zone

Item	Unit	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	Annual growth rate(a)
															%
Physical Measures															
Total farms	no.	3 615	4 245	4 941	5 466	6 725	7 984	8 132	8 245	8 044	11 087	8 822	7 929	7 284	6.6**
Farm size	ha	57 211	51 240	46 694	43 544	43 986	44 428	44 691	40 815	36 400	39 014	42 564	43 887	39 382(14)	-2.3**
Crop area sown	ha	67	85	128	161	168	174(b)	181	171	146	147	154	183	180(19)	5.5**
Improved pasture area	ha	834	736	658	593	527	462(b)	396	457	498	446	429	476	na(na)	-5.3**
Sheep	no.	2 670	2 685	2 589	2 380	2 632	2 883	2 902	3 045	2 850	3 344	3 275	2 912	2 437(11)	1.1
Beef	no.	1 307	1 204	1 107	1 102	1 140	1 178	1 210	1 381	1 114	1 364	1 330	1 348	1 156(13)	0.7
Stock equivalents	no.	13 927	13 311	12 983	13 128	13 472	13 815	13 898	15 866	13 132	15 481	15 463	15 010	13 365(10)	0.9
Labour	man-weeks	166	165	144	153	150	148	145	139	143	143	157	162	147(6)	-0.5
Financial Measures															
Nominal cash receipts	$	44 501	43 501	35 692	39 145	48 958	63 890	42 349	49 464	57 243	66 535	112 977	129 951	119 061(8)	9.7**
Nominal cash costs	$	33 020	32 567	26 948	28 563	33 816	42 303	33 169	38 123	41 482	46 543	56 203	75 404	79 405(8)	7.8**
Nominal farm cash operating surplus	$	11 481	10 934	8 744	10 582	15 142	21 588	9 179	11 341	15 761	19 991	56 774	54 547	39 656(14)	13.4**
Real farm cash operating surplus(c)	$	41 906	38 706	29 555	33 439	45 123	56 992	20 745	22 682	27 739	31 986	84 026	73 638	48 777(14)	3.4
Rate of return to full equity	%	1.9	1.4	0.6	1.1	2.2	3.0	-1.6	-1.7	-2.3	-1.3	7.2	4.0	1.0(654)	1.2(d)
Real rate of return to full equity including capital appreciation	%	0.2	-3.5	-3.3	4.2	-3.1	-16.4	-30.0	-25.6	-9.8	-1.6	38.1	18.5	-1.2(36)	-2.6(d)

(a) Annual growth rate estimated by fitting semi-log regressions to data of the form log $y_t = a + bt + e_t$. (b) Interpolated figure(s). (c) Adjusted by consumer price index. (d) Expressed as average for period. ** Significant at 99 per cent level.

Note: Figures in parentheses are relative standard errors, expressed as percentage of the estimates. When estimates are close to zero, high RSEs will result even though the size of the absolute sampling error may be small.

Table 3: PASTORAL ZONE ESTIMATES OF INVESTMENT RETURNS IN 1982-83 PRICES

Item	Unit	1980-81	1982-83 (p)	1983-84 (p)
Total cash returns	$	154 384(12)	114 487(5)	121 199(5)
Total cash costs (a)	$	114 379(10)	98 900(5)	105 246(5)
Farm cash operating surplus	$	40 005(22)	15 587(32)	15 954(35)
Buildup in trading stocks	$	- 15 537(52)	- 8 599(101)	- 2 639(85)
Depreciation	$	14 942(9)	17 501(8)	18 239(8)
Operator and family labour	$	16 202(8)	17 728(7)	17 966(7)
Return to capital and management	$	- 6 683(94)	-28 241(na)	-22 890(na)
Return adjusted to full equity	$	305(2097)	-20 551(na)	15 180(na)
Imputed capital appreciation (b)	$	-72 865(130)	- 7 537(na)	6 780(na)
Full equity return incl. capital appreciation	$	- 5 311(152)	48 948(na)	39 826(na)
Total opening capital	$	721 141(11)	669 881(10)	689 926(11)
Rate of return excl. capital appreciation	%	-0.04(2100)	-3.07(na)	-2.20(na)
Rate of return incl. capital appreciation (c)	%	-10.15(11)	-4.19(na)	3.18(na)

(a) Excluding operator and family labour. (b) Derived by deducting an annual estimate of the capital stock (opening capital x inflation rate in consumer price index) from capital appreciation. (c) Return adjusted to full equity plus real capital appreciation, expressed as a percentage of opening total capital.
(p) Preliminary estimates.

Note: Figures in parentheses are relative standard errors, expressed as percentages of the estimates. When estimates are close to zero, high RSEs will result even though the size of the absolute sampling error may be small.

Table 4: PASTORAL ZONE TRENDS IN REAL INPUT PRICES AND TERMS OF TRADE FOR THE AUSTRALIAN SHEEP INDUSTRY: 1967-68 TO 1980-81

Variable	Parameter estimates(a)			
	Trend	t value	R^2	DW
	%			
Livestock input prices	-2.08	- 0.78	0.05	0.67
- sheep	3.02	1.82	0.03	1.31
- cattle	-6.29	- 1.76	0.21	0.64
Capital input prices	1.58**	12.03	0.92	1.20
Land input prices	-0.61	- 0.27	0.01	1.22
Hired labour input prices	3.02**	7.54	0.83	0.99
Materials input prices	1.33	2.01	0.35	0.36
Service input prices	0.92**	5.11	0.69	0.68
Total input prices (IP)	1.87**	2.57	0.35	1.03
Total output prices (OP)	-2.44	- 1.62	0.18	0.97
Terms of trade (OP/IP)	-4.31**	- 3.49	0.50	1.18

(a) Annual trend figures have been obtained by fitting the following logarithmic trend line by regression: $\log y_t = a + bt + e_t$: where y is the variable being considered and t is time. The trend value was derived by multiplying the b value obtained by 100.

* Significant at 95 per cent confidence level.
** Significant at 99 per cent confidence level.

Table 5: PASTORAL ZONE ESTIMATES OF PRODUCTIVITY CHANGE FOR THE AUSTRALIAN SHEEP INDUSTRY: FITTED TRENDS IN SELECTED VARIABLES 1967-68 TO 1980-81(a): (Average per property)

Selected variables	Parameter estimates			
	Trend	t Value	R^2	DW
	%			
Aggregate Groups				
Outputs (O)	1.98	1.93	0.24	1.07
Inputs (I)	- 0.45	-0.84	0.06	1.55
Productivity (O/I)	2.42**	2.37	0.32	1.10
Terms of trade	- 4.31**	-3.49	0.50	1.18
Outputs				
Crops	10.14**	3.06	0.44	1.82
- wheat	9.85**	2.48	0.34	1.73
- other grains and oilseeds	30.82**	9.14	0.87	1.58
Livestock	1.12	0.97	0.07	1.64
- sheep	- 3.17*	-2.39	0.32	1.48
- cattle	4.56*	2.27	0.30	1.58
Wool	- 1.18	-0.78	0.05	1.78
Other farm products	-27.10**	-5.01	0.68	1.24
Other outputs	1.12	0.53	0.02	2.31
Inputs				
Livestock (including livestock capital)	2.48*	2.47	0.34	0.94
- sheep	- 1.52*	-2.66	0.37	1.83
- cattle	6.96**	4.04	0.58	1.01
Capital (excluding land and livestock)	1.78	1.83	0.22	1.74
- plant, machinery and vehicles	24.42**	3.88	0.56	1.05
- irrigation and water supply plant	3.31*	2.54	0.35	1.13
Land	0.17	0.31	0.01	1.57
Labour	- 1.21*	-3.03	0.43	1.20
- family	8.67**	9.74	0.89	1.27
- hired	- 4.91**	-5.67	0.73	2.44
- shearing and crutching	- 3.66**	-5.03	0.68	0.84
Contracts	- 2.94	-1.65	0.18	1.52
- mulesing and other livestock	-13.26*	-2.96	0.42	1.11
Materials	0.62	0.69	0.94	1.31
- pesticides, sprays and pickling	8.18**	3.32	0.48	2.63
- livestock supplies	2.83*	2.99	0.43	2.89
- fertiliser	8.52	1.84	0.22	1.58
- seed	8.01**	3.26	0.47	1.21
- packaging materials	- 9.52**	-7.75	0.83	1.88
- fuel, oil and grease	0.06	0.12	0.00	2.82

(Continued on next page)

Table 5 (continued)

Selected variables	Parameter estimates			
	Trend	t value	R^2	DW
	%			
Services	- 0.52	-0.65	0.03	1.75
- electricity	5.91**	6.31	0.77	2.18
- insurance	- 4.83**	-6.73	0.79	1.46
- rates and taxes	- 3.75**	-4.90	0.67	2.17
- administrative	6.80**	3.44	0.50	0.63
- motor vehicle expenses	1.54**	4.27	0.60	1.11
- subscriptions	- 3.99**	-3.76	0.54	3.23

(a) Annual trend figures have been obtained by fitting the following logarithmic trend line by regression: ($\log y_t = a + bt + e_t$, where y is the variable being considered and t is time. The trend value was derived by multiplying the b value obtained by 100.

* Significant at 95 per cent confidence level.
** Significant at 99 per cent confidence level.

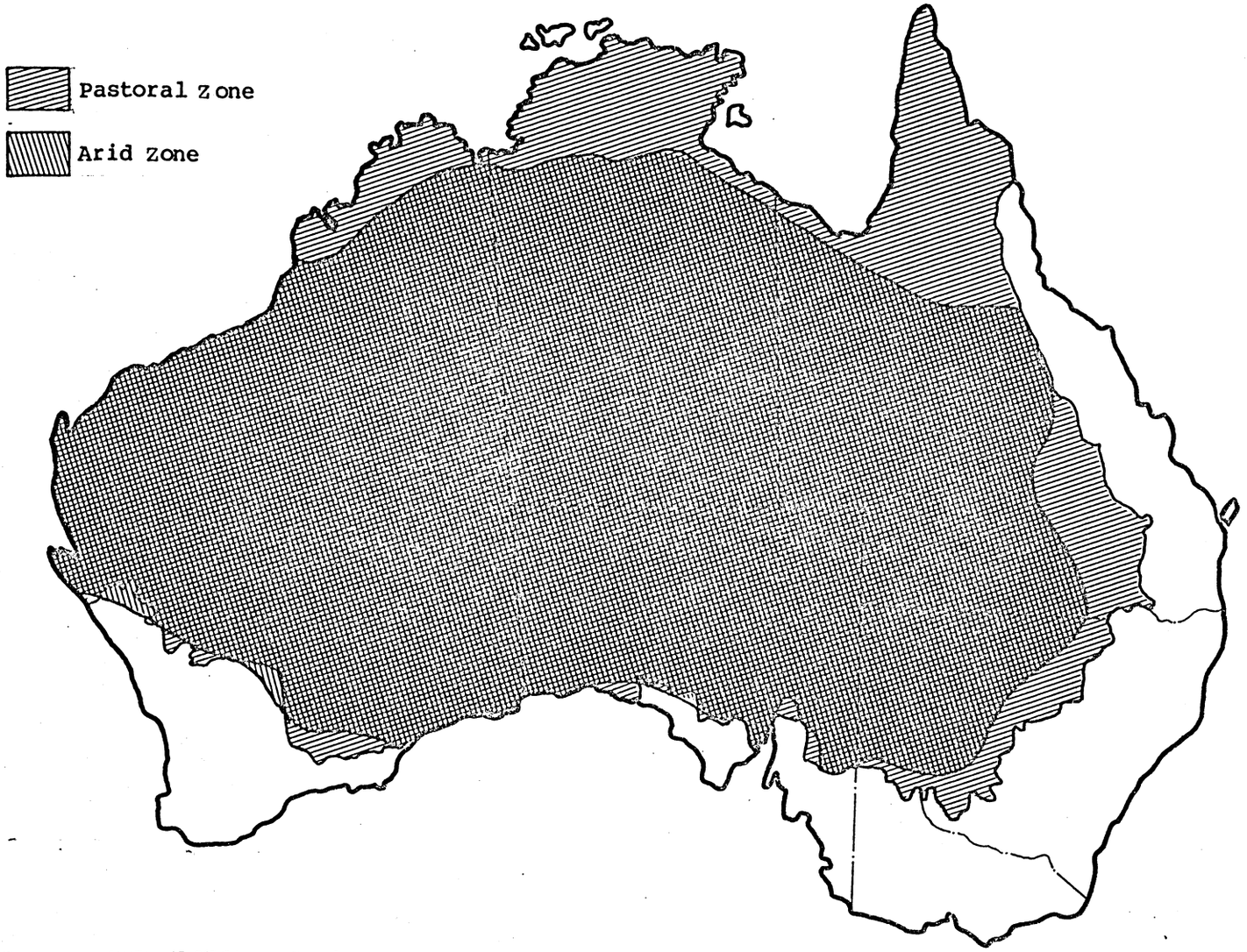
Table 6: PASTORAL ZONE PARTIAL PRODUCTIVITY RATIOS FOR THE AUSTRALIAN SHEEP AND BEEF INDUSTRIES(a): FITTED TRENDS IN SELECTED VARIABLES(b): Average per property

Ratio	Unit	Sheep industry			Beef industry		
		Trend	t value	R^2	Trend	t value	R^2
		%			%		
Cash returns to cash costs	$	1.60	1.45	0.15	1.89	2.38	0.34
Cash returns per man week	$	-0.77	-0.16	0.00	0.25	0.17	0.00
Cash returns per dollar invested	$	3.73**	3.17	0.46	3.27**	2.63	0.39
Stock equivalents per hectare	no.	1.73*	2.85	0.40	3.19**	4.99	0.69
Cash costs per stock equivalent	$	-2.50	-2.09	0.27	-3.01*	-2.22	0.31
Capital invested per stock equivalent	$	-4.61*	-2.97	0.42	-4.51*	2.60	0.38
Interest cost per stock equivalent	$	-3.90*	-2.60	0.36	-0.42	-0.40	0.01
Wool cut per sheep shorn	kg	0.62	0.43	0.02	0.80(c)	1.04(d)	1.61(d)
Sheep turnoff ratio (c)	%	-0.66	-0.42	0.01	-0.86	-1.60	0.18
Calves branded to cows mated	%	-0.42(d)	-0.47(d)	0.04(d)	1.11**	3.85	0.57
Cattle turnoff ratio (c)	%	0.42	0.23	0.00	0.87	0.70	0.04

(a) Estimated for period 1967-68 to 1980-81 for sheep industry and 1968-69 to 1980-81 for beef industry. (b) Annual trend figures have been obtained by fitting the following logarithmic trend line by regression: $\log y_t = a + bt + e_t$, where y_t is the variable being considered and t is time. The trend value was expressed by multiplying the b value obtained by 100. (c) Stock sales as a proportion of average stock numbers. (d) Estimated for period 1973-74 to 1980-81.

* Significant at 95 per cent level of significance.
** Significant at 99 per cent level of significance.

Figure 1: A COMPARISON OF THE AUSTRALIAN ARID ZONE WITH THE AUSTRALIAN PASTORAL ZONE



Source: BAE (1976) and Nix (1976)

BAE chart

Figure 2: REAL LIVESTOCK AND WOOL PRICES AT AUCTION AND NET WHEAT RETURNS PER GROWER In 1982-83 dollars

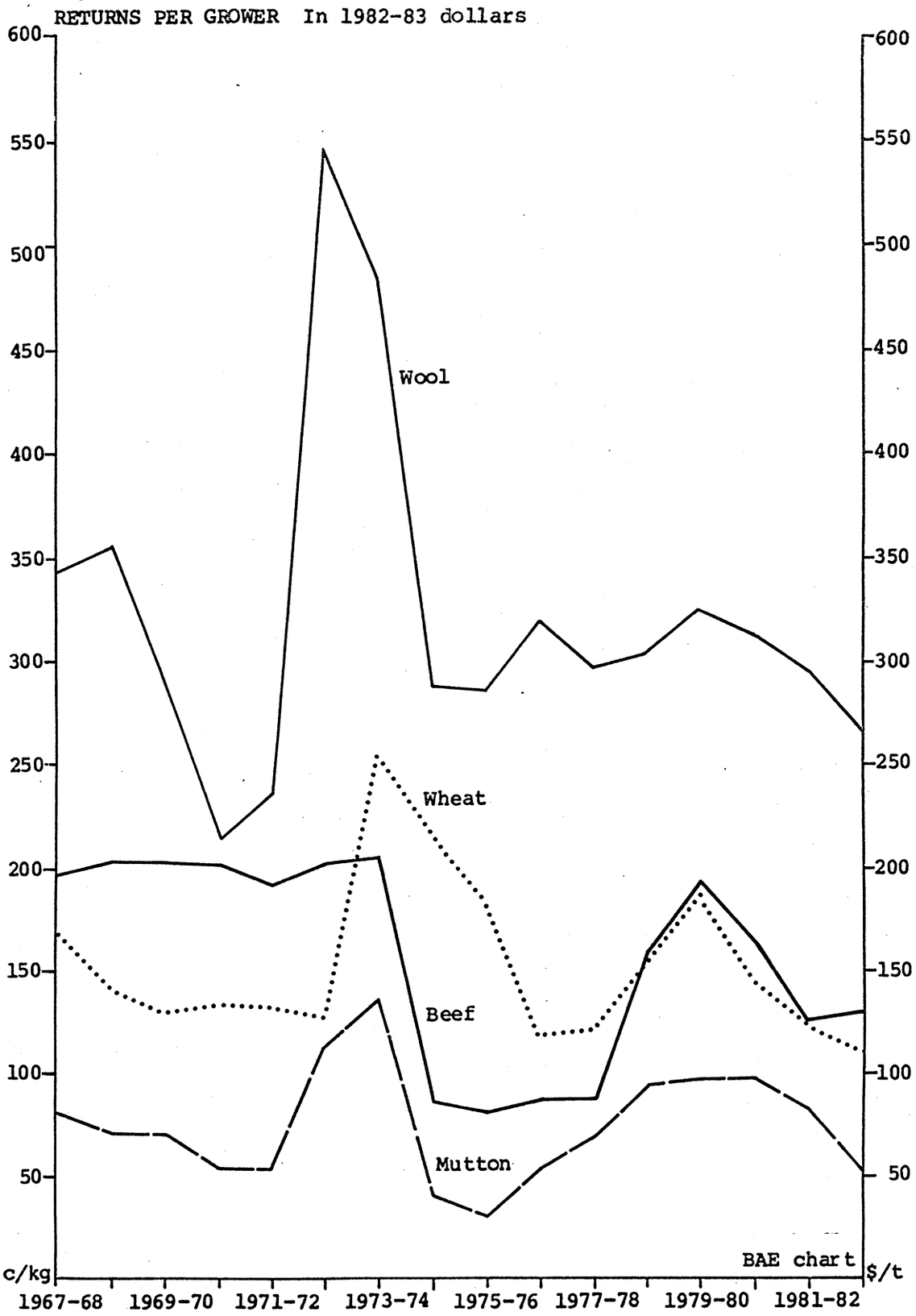


Figure 3: REAL OUTPUT PRICES, REAL INPUT PRICES AND TERMS OF TRADE: AUSTRALIAN SHEEP INDUSTRY: PASTORAL ZONE

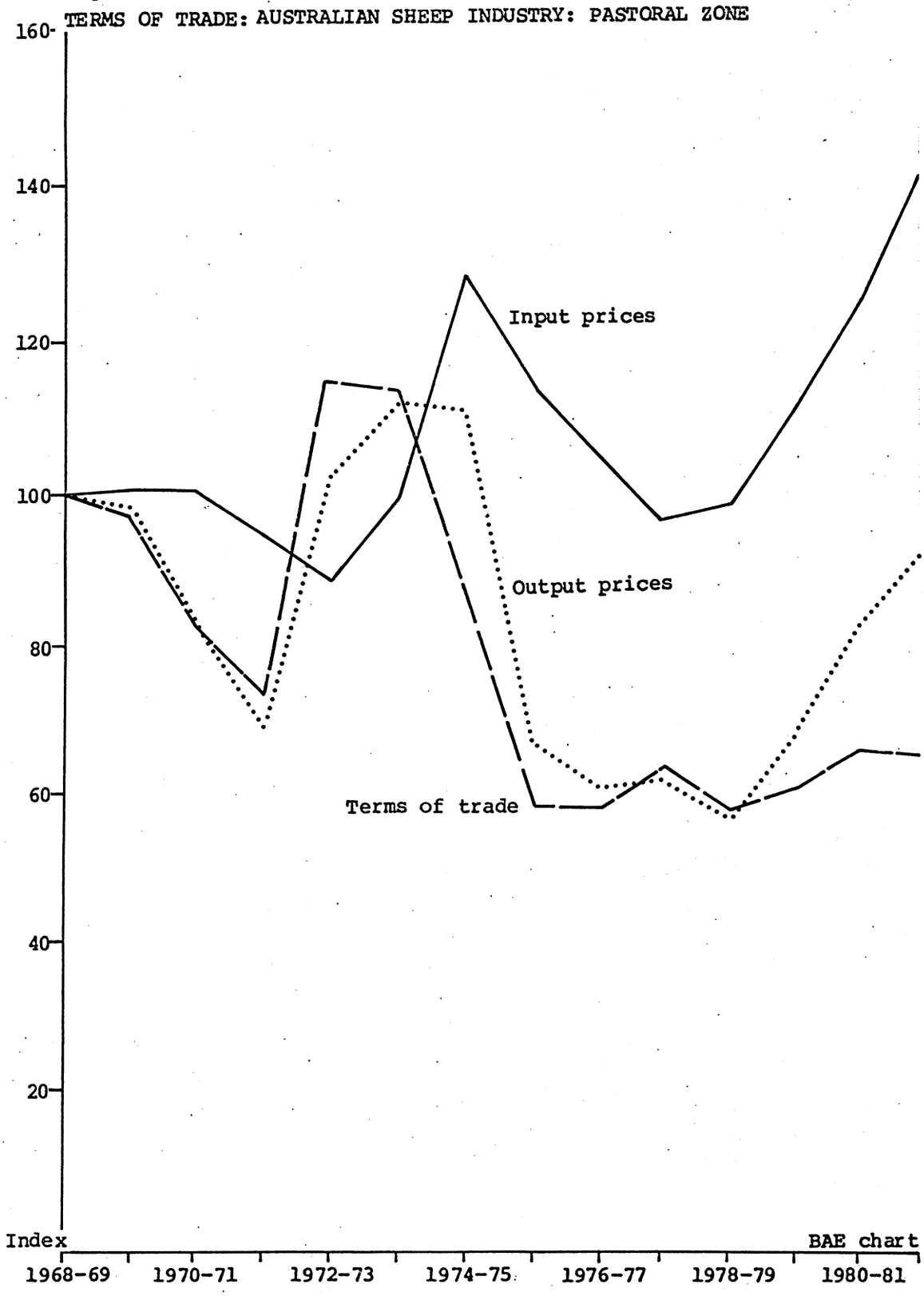


Figure 4: SHEEP INDUSTRY TOTAL PRODUCTIVITY AND TERMS OF TRADE IN THE PASTORAL ZONE

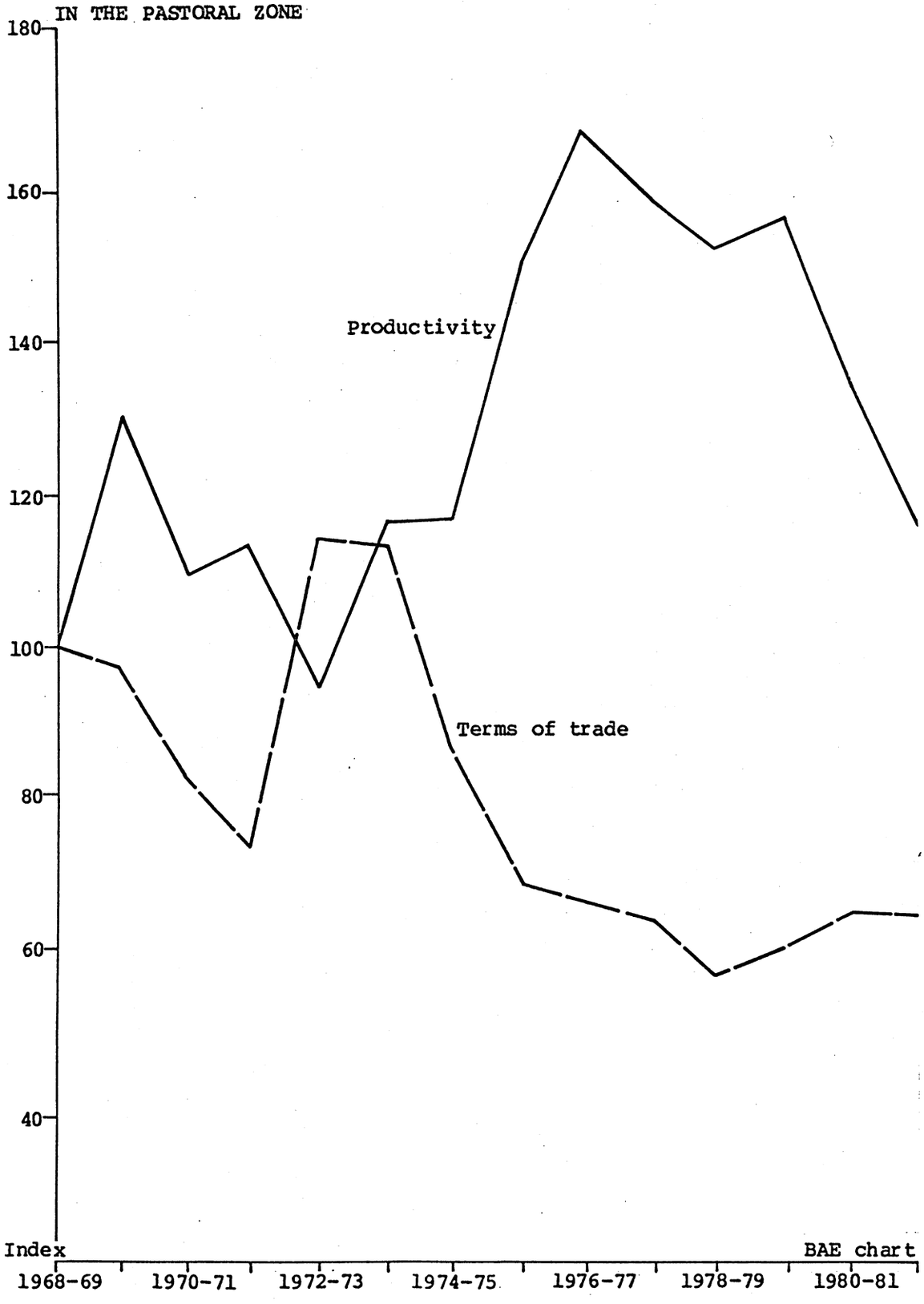
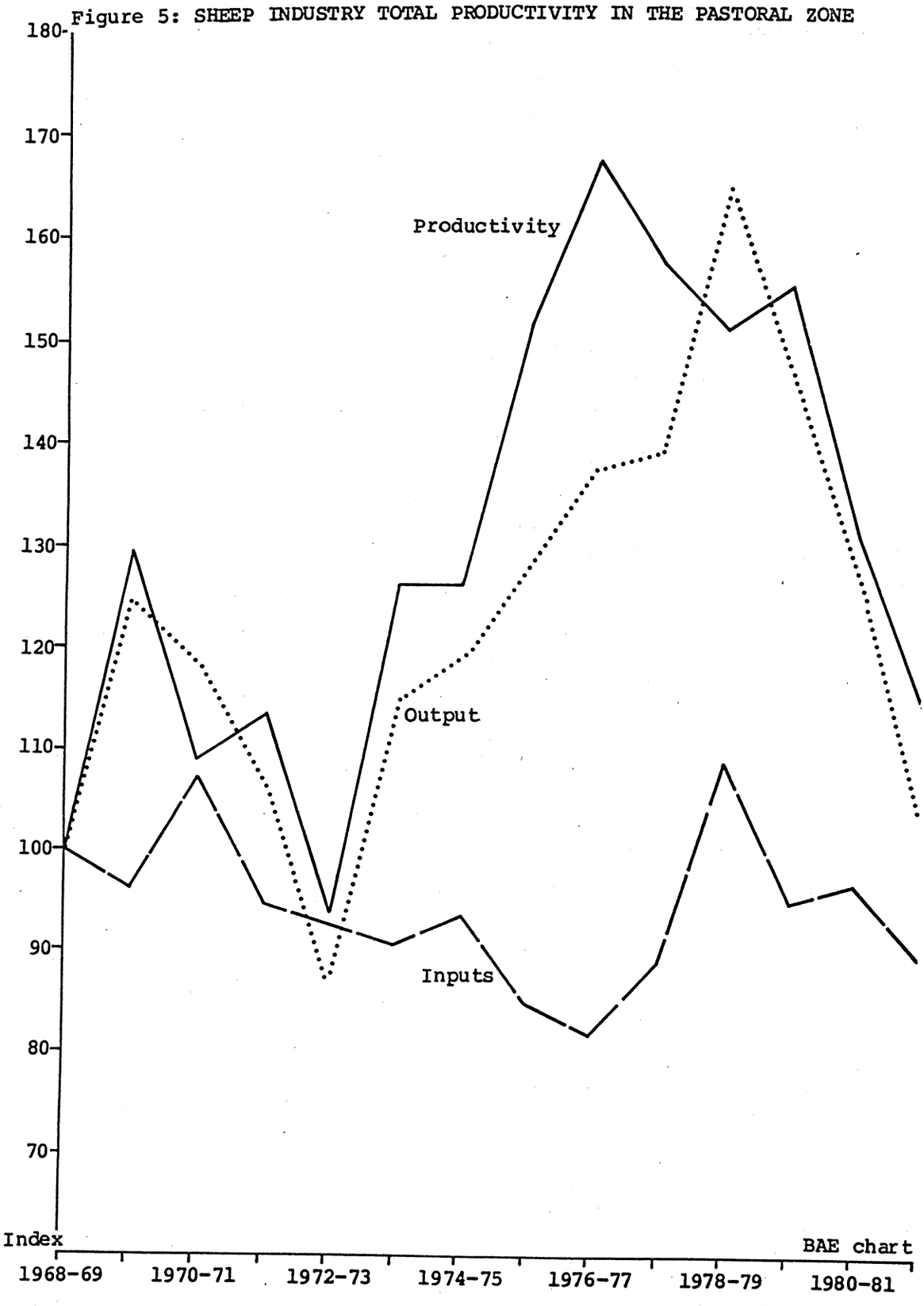


Figure 5: SHEEP INDUSTRY TOTAL PRODUCTIVITY IN THE PASTORAL ZONE



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