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A Note on Measuring Income Instability and Inequality on Australian Sheep Farms

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Introduction

Agricultural economists typically place emphasis on issues of micro-economic efficiency and macroeconomic growth, while distribution issues are pushed into the background. This has not been a conscious effort by economists to avoid the distribution question; rather it has been an inherent inability to grapple with these issues within the realms of conventional theory. This study attempts to examine empirically some aspects of instability and inequality in the Australian sheep industry. We do not purport to explain, or even examine, the implications of income distribution in Australian agriculture. This is done more adequately elsewhere (IAC 1975; Vincent 1975). Our aim is simply to provide information on patterns of farm income distribution and the dynamic process of income movements within a distribution. The technique used considers the Lorenz curve within a Markov process to examine the stochastic movement of farm incomes through time. While preliminary in nature, we hope that this study might stimulate further empirical work in the examination of distribution issues.

The incomes used in the analysis are the incomes of the whole farm enterprise and not the farmers themselves. They are analogous to the household income levels and can be directly compared to these figures. In the rural welfare context there are limits to the studies use as no account is taken of other sources of wealth. For example, farm and non-farm assets. However, with these limitations in mind the study can be used to determine the relative instability of overall farm profitability.

The Scope and Nature of the Issues

The issues addressed in this study fall into two categories:

(a) The level of income inequality in the Australian sheep industry; and

(b) The extent to which individual farm incomes move within the total distribution from one year to the next.

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Theoretical Aspects

The theoretical underpinnings of this study are embedded in two fundamental techniques of economic analysis. These are the measures of income inequality and the Markov technique of transition probabilities.

In simplistic terms, the objectives of this study are met by:

(a) expressing the aggregate outcome of the income movement in terms of Gini ratios; and

(b) using 1st order Markov distributions to characterize the movement of farm-firm income from one time period to another.

The Lorenz curve traces the cumulative percentage of farms earning a ranked cumulative percentage of aggregative income. The income ranking is from low to high. Most income distributions are characterized by a small number of individuals in low income levels with a large majority in the mid-income ranges followed by a small number in high income levels. This leads to the Lorenz curve being "half U-shaped". The Gini coefficient is twice the area between the Lorenz curve and the line of perfect equality or the situation where all individuals have equal incomes. The closer the Gini ratio is to one the greater the inequality. The Gini ratio has in the past generally been applied to household incomes and thus the problem of negative incomes has not arisen. A farm may not necessarily have a positive income and in order to facilitate the estimation of the Gini ratios negative incomes were assumed to be zero. Although this will result in the estimated Gini ratios being biased downwards they still provide a good indication of farm inequality levels in the sheep industry. The extent of downward bias depends on the number of farms whose incomes are in the negative range. However, all other inequality indicators would be faced with a similar bias problem. The decision to use the Lorenz curve and its related Gini ratio is based on its close link with the method of forming the transition probability matrix used in the income stability analysis.

The appeal of the Markovian techniques of transition matrices lies in their ability to express the probability of a farm-firm moving from one state of nature (class of income) in one time period to another state of nature in the next time period. Although the Markov chain methodology has been criticized, the arguments against it have centred around the ergodic nature of projections of the transition probability matrix and not the transition probability matrix itself.

An extensive search of the literature reveals that the formation of a transition probability matrix using the Lorenz curve as a basis for the formation of states of nature has not been used before. Hence there is neither evidence for nor against its use. There is of course extensive literature both on measures of income distribution (Morgan 1962; Champornowe 1974; Pyatt 1978) and on Markov chain techniques (Bostwick 1962; Krenz 1964; Scobie and Rowe 1967; Butler 1974; Keane 1976).

Data

Use is made of the BAE Australian Sheep Industry Survey (ASIS)[1] data from 1963–64 to 1977–78. The data is net farm income from all ASIS farms for which two consecutive years income information is available. The survey uses a stratified sample[2] of sheep farms and if in any one year a farm leaves the survey it is replaced by one of similar size. In this way the sample remains relatively stable from year to year.

Over the selected 14 year period 1963–64 to 1977–78, a total of 8 869 observations on consecutive year income movements were available for analysis. Table 1 shows the number of observations and the sample average incomes for each sample year.

Table 1: *Sample Farm Numbers and Average Incomes of Sample Farms*

Financial year	Sample	Average income
	No.	$
1963–64	471	17,691
1964–65	637	10,452
1965–66	613	7,489
1966–67	517	12,077
1967–68	700	6,155
1968–69	685	14,118
1969–70	619	8,737
1970–71	535	6,022
1971–72	578	9,665
1972–73	533	24,809
1973–74	678	32,382
1974–75	710	16,235
1975–76	682	12,835
1976–77	911	17,507
1977–78	911	6,776

Two measures of farm income are available from the ASIS. These are net cash income and net farm income. Both income measures have on the returns side livestock, crop and other sales whilst on the cost side there are livestock purchases and cash costs. The major difference between the income measures is that net farm income takes account of livestock and capital operating gain on the returns side and on the cost side depreciation and imputed labour, whilst net cash income ignores these components. As a result the farm cash income measure represents the more narrow definition of income. Thus in this analysis net farm income is used as the indicator of farm income movements from one year to the next.

[1] To be eligible for inclusion in the ASIS the only criterion is that the farm must run more than 200 sheep.

[2] The strata are on sheep numbers.

Method of Analysis

Ten states of nature (or classes of income) have been defined for each year over a period of 15 years (1963–64 to 1977–78). In this case, each state of nature represents 10 per cent of the total income for each year. This means that, while the actual income classes (in absolute terms) varies for each year, each income class represents exactly 10 per cent of the income distribution for that year. Each of these divisions can be directly interpreted to be points on the derived Lorenz curve. In this way the problem of varying incomes due to inflation, seasonal conditions and changing prices for differing years is eliminated. As mentioned previously, an important assumption in using this method of decile or income class formation is that all farms with negative incomes are assumed to have zero incomes for the purposes of summing. Effectively farms with negative income start in the lowest income decile. The calculated transition probabilities are an arithmetic mean of a sum of 15 year-to-year movement matrices (the number of farms in each cell before averaging is shown in Table 3). The magnitude of each transition probability indicates the chances of a farm-firm moving from one income class to another between two consecutive time periods. Of course, transition probabilities along the diagonal of the matrix indicate the probability of a farm-firm remaining in the same state from one time period to the next. Similarly, the magnitude of transition probabilities in the off-diagonal cells indicate the relative instability of farm incomes in relation to the total distribution.

Income Class Movements

The diagonal elements of the transition matrix (see Table 2) indicate the probability that there is *no* movement between income classes from one period to the next. An "average" chance of no movement between any two periods (averaging all the diagonals) shows that there is 0.252 probability that farms do not move from the income class in which they started. Using Table 3 there are 3 991 farms of the sample total of 8 879, or 44.9 per cent, that do not change income class from one period to the next. Therefore, 55.1 per cent of all farms will change the relative position in the total distribution. Furthermore, the transition probability matrix reveals that there is an average probability of 0.548 that farms do not move more than one decile either way and a probability of 0.715 that farms do not move more than two deciles. Similarly, 6 267 or 70.6 per cent of farms, do not change classes by more than one decile and 7 428, or 83.7 per cent of farms, do not move by more than two deciles. That is, only a smaller percentage of farms (about 16 per cent), on average, experience movements within the distribution of more than two deciles in any two year period. There is, however, a tendency for farms to move towards a lower income class rather than a higher income class. In general, then, we conclude that while there is a reasonable degree of income instability (in the sense that farm incomes move about the distribution), this instability is not characterized by violent fluctuations. Only a small percentage of farms experience large relative changes within the distribution. The degree of stability within the top two and bottom two deciles of the distribution, however, is quite high relative to the middle deciles.

Table 2: Transition Probability Matrix (Averaged for 14 Years): Showing Probabilities of Class Movements from One Year to Next

Bottom 10 per cent of income contributors in next year			increasing income levels →					Top 10 per cent of income contributors in next year		
.7284	.1250	.0589	.0354	.0196	.0109	.0092	.0065	.0037	.0023	Bottom 10 per cent of income class contributors in starting year
.4679	.2220	.1499	.0793	.0373	.0254	.0127	.0039	.0008	.0008	
.3173	.1947	.1615	.1409	.0928	.0481	.0252	.0160	.0121	.0000	
.2296	.1465	.1767	.1616	.1224	.0831	.0408	.0227	.0121	.0045	
.2471	.0914	.1284	.1420	.1439	.1284	.0661	.0331	.0422	.0097	
.1960	.0794	.0819	.0943	.1489	.1538	.1092	.0844	.0710	.0099	
.1710	.0742	.0613	.0645	.1161	.1226	.1839	.1161	.0710	.0193	
.1475	.0205	.0410	.0820	.0738	.1107	.1721	.1557	.1434	.0533	
.1676	.0162	.0324	.0216	.0649	.0595	.0811	.1730	.2324	.0973	
.0891	.0099	.0297	.0099	.0198	.0792	.0693	.1089	.2079	.3762	Top 10 per cent of income class contributors in starting year

↓ increasing income levels

Table 3: Summed Total Number of Farms in the 14 Income Class Year-to-Year Movement Matrices

	Bottom 10 per cent of income contributors in next year			increasing income levels →					Top 10 per cent of income contributors in next year		Total
Bottom 10 per cent of income class contributors in starting year	3 151	541	255	153	85	47	40	28	16	10	4 326
	590	280	189	100	47	32	16	5	1	1	1 261
	277	170	141	123	81	42	22	14	3	0	873
	152	97	117	107	81	55	27	15	8	3	662
	127	47	66	73	74	66	34	17	5	5	514
increasing income levels ↓	79	32	33	38	60	62	44	34	17	4	403
	53	23	19	20	36	38	57	36	22	6	310
	36	5	10	20	18	27	42	38	35	13	244
	31	3	6	4	12	11	15	32	44	18	176
Top 10 per cent of income class contributors in starting year	9	1	3	1	2	8	7	11	21	38	101
Total	4 505	1 199	839	639	496	388	304	230	172	97	8 869

The average probability that a farm remains in the top decile from one period to the next is 0.376 while the probability of a farm starting in the top 20 per cent of income contributors and remaining there in the next period is, on average, 0.457. Similarly, the average probability that farms in the bottom decile in the starting period remain there in the next is 0.728 and the probability that farms contributing to the bottom 20 per cent of the distribution remain in that group from one period to the next is 0.772. These results indicate that high-income farms tend to remain high-income farms, and low-income farms tend to remain low-income farms from one period to the next, relative to the total distribution.

Income Inequality

In contrast to the above conclusion that there is a movement to the lower income deciles, examination of the Gini ratios over the period 1963–64 to 1977–78 (see Table 4) does not indicate any substantial changes in income inequality. However there does appear to be an upward movement in the magnitude of the Gini ratios indicating a slight increase in inequality. We cannot come to any definite conclusions about the change in income inequality. For example, if the Gini ratios are divided into two equally sized groups, we find that the average Gini ratio prior to 1970–71 is 0.5852, with variance 0.00269, while the average Gini ratio after 1970–71 is 0.5989, with variance 0.002548. The larger average Gini ratios since 1974–75, however, do indicate an upward trend.

Table 4: *Gini Ratios for Each Financial Year*

Financial year	Gini ratio
1963–64	0.5200
1964–65	0.5756
1965–66	0.6458
1966–67	0.5494
1967–68	0.6806
1968–69	0.5332
1969–70	0.6020
1970–71	0.5750
1971–72	0.5456
1972–73	0.5712
1973–74	0.5236
1974–75	0.6242
1975–76	0.6328
1976–77	0.6150
1977–78	0.6796

The calculated Gini ratios are all much higher than those for household incomes in Australia as presented by Murray (1981). For example, in Murray (1981) for the year 1973–74 a Gini ratio of 0.376 is calculated for household incomes including non-family individuals compared with our figure of 0.5236 for farm incomes in that year. This indicates that sheep farm incomes are more unequal than household incomes.

Conclusions

This study has addressed the issue of income inequality and instability on Australian sheep farms. We have examined the dynamic process of movements of farms within the income distribution over time and the effect these movements have had on the relative equality of the distribution.

Our results applicable only to the Australian sheep industry in the period 1963–64 to 1977–78, indicate that:

- While there is substantial movement of farm incomes within the total distribution, this movement is not characterized by violent fluctuations.
- Only a small percentage of farms experience relatively large income changes within the distribution.
- Higher income earners tend to remain high-income earners and low-income earners tend to remain low-income earners relative to the total distribution from one period to the next.
- Income inequality on sheep farms is higher than that of income earning households.

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