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# ECONOMICS OF SIZE IN AUSTRALIAN FARMING

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**Economics of size is an important but relatively neglected aspect of Australian agriculture. The theory and methodology for analysis of economics of size are summarized and a survey made of evidence for Australian agricultural industries. The conclusion is reached that economies of size exist, particularly for small to medium farms and diseconomies appear to be absent. Further research is needed and some important areas are indicated.**

## *Introduction*

Given the historical importance of 'home maintenance area' policies in Australia, it could be expected that a wealth of information would be available on economics of size—information that might have been consulted frequently with the increasing attention being given to reconstruction measures aimed at encouraging growth and amalgamation of farms. The desirability of reconstruction measures depends importantly on the existence of economies of size, but, to our knowledge, no such information is readily available—at least in condensed form—and so our present purpose is to attempt an overview of pertinent evidence.

## *Theory*

The theory of production as it relates to economics of size is only briefly recapitulated here. Given short-run and long-run production functions, firms which combine their resources in cost-minimizing fashion will face corresponding short and long-run cost functions with the latter enveloping the former. Conventionally the derived average cost (AC) curves are depicted as being U-shaped on the basis of technical considerations. In the short run, average costs decline as fixed costs are spread over more output but eventually increase as marginal returns to variable factors diminish. In the long run when no factors are fixed, average costs decline, are constant or increase with output according as total elasticity of production exceeds, is equal to or less than unity [29]. Study of economics of size in practice means an examination of the shape of the long-run average cost (LRAC) curve.

Traditional expositions of the theory of production have seldom been concerned with practical implementation of the theory of costs and it

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has been customary to abstract from the real-world features of uncertainties, resource fixities and difficulties in imputing costs. This is in line with the general situation wherein theoreticians have not been very concerned with questioning the fundamental relevance of production economics to analysis of real phenomena [18, 40]. Madden [22] has conveniently reviewed the theoretical relevance in the context of studying cost-size efficiency in farming. Our position is that the traditional framework is a useful one for exploring policy questions and for viewing production on individual farms. However, empirical work conducted within the framework requires cautious interpretation in the light of theoretical limitations and empirical difficulties.

## *Methodology*

Methods employed for study of economics of size have been almost as diverse as the productive enterprises studied, but have really changed little since Bressler's 1945 review [8]. Four main groups of methods can be identified, namely, in decreasing order of popularity:

(1) synthetic firm approaches;
(2) direct analysis of cost-output observations;
(3) indirect analysis based on estimated production functions;
(4) indirect analysis based on survival and growth of firms of different sizes.

The latter method, called by Stigler [37] and Saving [30] the 'survivorship' technique, is not very useful in studying farming [23] and is hardly analytical in that direct inferences are not made about the LRAC curve. Thus, only the first three groups of methods are considered and are now briefly sketched.

### *Synthetic firm methods*

Madden [22] has reviewed various approaches for studying economics of size through manipulation of models of firms. Budgets of composite or representative firms of varying size can be used to indicate cost-output relationships. The data for the budgets may be randomly or deliberately selected actual records or records adjusted in some way to yield 'efficient' or 'full utilization of capacity' relationships. Alternatively, synthetic models of firms employing some specified level of technology and operated by 'economic' men can be used to trace out short-run cost-output relationships for different sized plants and long-run envelope curves can be sketched around the short-run curves.[1] Since most firms (and farms) involve several productive activities, linear programming models have most often been used [39].

Planning curves derived by such completely synthetic methods are the empirical analogues closest to the theoretical concept of the LRAC curve and, as in the standard theory, questions of non-profit oriented objectives and accounting for risk are abstracted away. Some technical economies are relatively easy to identify, such as machinery utilization [28], while others such as the rationalization of labour use are more elusive. Pecuniary economies, such as bulk discounts, are also difficult to identify

[1] Commonly the 'best available' technology is assumed but 'average' technology could also be used.

as are the real costs in very large organizations [1, 41], especially those engaged in farming (e.g. problems of coordination and supervision such as experienced in the Peak Downs Scheme [15]). For these reasons synthetic studies must be interpreted with caution.

*Methods based directly on cost-output observations*

Methods in this second category do not involve the explicit modelling of firms' productive processes. Most often empirical studies have used cross-sectional data from a range of firm sizes, thus implying long-run analysis. Time series data from individual firms have seldom been used but depending on adjustments to the size of plant over time, could allow either short-run or long-run analysis. However, limited observations over time makes study of the LRAC curve faced by an individual firm difficult.

Analysis of direct cost-output observations has some inherent limitations for studying the conceptual LRAC curve. In terms of the implicit objective of profit maximization, managers are seldom likely to be using resources optimally, but even if they were, short-run output decisions would generally give observed short-run average costs (SRAC) above LRAC.[2] In practice, of course, observed output differs from planned expected output. Also, similar output levels can be achieved by firms of different size operating at different degrees of utilization of capacity, while identical technologies will not be employed by all firms. These limitations mean that direct observation can *never* lead the analyst to the conceptual LRAC curve—how close he can get depends to some extent on the analytical procedure adopted.

Procedures that have been used range from merely plotting a scatter of average costs against output [21], to the fitting of curves either through the scatter of points or enveloping them from below [20], and to least squares functional fitting or 'statistical cost analysis' [19]. Statistical cost analysis involves the possibility of two sources of bias in making inferences about the LRAC curve—(a) Stigler's [38] regression fallacy in which apparent economies of size arise because variability of output increases with size and (b) Heady's [13] regression fallacy of the non-correspondence of the general shape of fitted least squares curves with the conceptual LRAC curve. A partial correction of estimates towards the conceptual planning curves can be achieved by inclusion of capacity variables in the regression equations [9] and setting such variables at levels denoting full utilization.

*Using estimated production functions*

The estimation of empirical farm production functions involves difficulties similar to but probably more serious than are involved in statistical cost analysis. A similar limitation is that an analysis of data from a restricted range of firm sizes can at best indicate only part of the planning curve faced by firms. Additional difficulties concern the appropriate

[2] Exceptions where SRAC = LRAC, would occur at the output level corresponding to the minimum point of the LRAC curve, or in short run situations, where the optimal level happens to correspond to the level at which the SRAC curve is tangent (and therefore equal) to the LRAC curve. The latter optimal short run output level will not be optimal in the long run.

specification of the production function and the measurement of the specified factors.

In practice, investigators have resorted to the Cobb-Douglas function (for an Australian exception see [25]) with from three to ten aggregated factors of production. Failure to include managerial services explicitly and failure to account for quality of factors such as labour, lead to probable downward bias in the estimated total elasticity of production [12]—the key estimate as far as study of economics of size is concerned. However, the Australian experience summarized in Table 1, suggests that total elasticity is robustly close to unity no matter what combination

TABLE 1

*Summary of Australian Cross-sectional Cobb-Douglas functions*[a]

| Farm type | State | Period | Sample size | No. of factors[b] | Estimated elasticity[c] | Signif-icance[d] | Refer-ence |
|---|---|---|---|---|---|---|---|
| Dairy | | | | | | | |
| milk | W.A. | 54-55 | 51 | 4 | ·986 | — | 31 |
| butter | S.A. | 55-56 | 48 | 5 | 1·028 | — | 17 |
| butter | S.A. | 55-56 | 48 | 5 | 1·187 | — | 17 |
| butter | VIC. | 59-62 | 43 | 4 | 1·044 | — | 16 |
| butter | VIC. | 57-58 | 20 | 6 | 1·381 | — | 10 |
| butter | VIC. | 57-58 | 20 | 5 | 1·526 | — | 10 |
| butter | VIC. | 57-58 | 20 | 6 | 1·694 | — | 10 |
| butter | VIC. | 57-58 | 17 | 5 | ·701 | — | 10 |
| butter | VIC. | 62-63 | 20 | 5 | ·714 | — | 10 |
| milk | VIC. | 62-63 | 18 | 6 | 1·210 | — | 10 |
| Wheat-sheep | | | | | | | |
| l'stock | N.N.S.W. | 54-55 | 55 | 5 | 1·197 | — | 11 |
| l'stock | S.N.S.W. | 54-55 | 58 | 5 | 1·240 | — | 11 |
| l'stock | VIC. | 54-55 | 87 | 5 | ·897 | — | 11 |
| l'stock | S.A. | 54-55 | 74 | 5 | 1·223 | — | 11 |
| crop | N.N.S.W. | 54-55 | 55 | 4 | ·959 | — | 11 |
| crop | S.N.S.W. | 54-55 | 58 | 4 | ·706 | — | 11 |
| crop | VIC. | 54-55 | 87 | 4 | 1·150 | — | 11 |
| crop | S.A. | 54-55 | 74 | 4 | 1·023 | — | 11 |
| mixed | W.A. | 60-67 | 52 | 4 | 1·168 | > 1 | 33 |
| mixed | N.S.W. | 66-67 | 22 | 3 | 1·171 | — | 36 |
| mixed | N.S.W. | 66-67 | 26 | 4 | 1·086 | — | 36 |
| mixed | N.S.W. | 66-67 | 32 | 3 | 1·197 | — | 36 |
| mixed | N.S.W. | 67-68 | 22 | 3 | 1·034 | — | 36 |
| Sheep | | | | | | | |
| Pastoral | N.S.W. | 54-55 | 49 | 5 | 1·286 | > 1 | 11 |
| Pastoral | QLD. | 54-55 | 37 | 5 | 1·340 | > 1 | 11 |
| Pastoral | S.A. | 54-55 | 25 | 5 | 1·274 | = 1 | 11 |
| h.r'fall | N.S.W. | 54-55 | 75 | 4 | ·967 | = 1 | 11 |
| h.r'fall | W VIC. | 54-55 | 57 | 4 | 1·030 | = 1 | 11 |
| h.r'fall | E VIC. | 54-55 | 40 | 4 | 1·070 | = 1 | 11 |
| h.r'fall | TAS. | 54-55 | 46 | 5 | 1·221 | > 1 | 11 |
| h.r'fall | VIC. | 63-64 | 19 | 6 | ·901 | — | 10 |

[a] All estimates reported are based on ordinary least squares regressions.
[b] The number of factor aggregates included in each reported function.
[c] The sum of partial elasticity estimates for all factors.
[d] Testing if the sum of partial elasticities differs from unity. A dash indicates the test was not originally reported.

or subset of factors is eventually included in the function. Few authors have tested whether estimated total elasticity differs from unity but, since real factors of production must inevitably be omitted in empirical work, this failure is probably defensible.

With the commonly used Cobb-Douglas production function, at least two limitations must be noted: (a) Expansion paths are restricted to scale lines and (b) since empirical Cobb-Douglas functions yield only an unchanging value of elasticity, derived AC curves cannot take the classical U-shape. If we regard AC curves derived from Cobb-Douglas functions with elasticity of between 0·8 and 1·2 as being relatively horizontal, of the 31 Australian functions 18 imply more or less constant average costs, ten indicate economies of size and three indicate diseconomies of size—recalling, of course, that the fitted functions relate to a limited range of observed outputs.

*Methodological summary*

This brief review of the methodology used for studying economics of size in farming has emphasized that no one method is entirely satisfactory and choice of technique, as in most research, must depend on the analytical objectives. Thoroughgoing analysis may well involve simultaneous use of several approaches [20]. A study concentrating on efficiency in a farm management context will make most use of synthetic methods whereas a study oriented towards aggregative policy would emphasize directly observed performance. A further consideration that does not seem to have been given due attention is the relative cost of the alternative approaches. Synthetic firm methods are likely to cost considerably more per unit of information than alternative methods—especially when a bank of relevant cross-sectional data is already available.

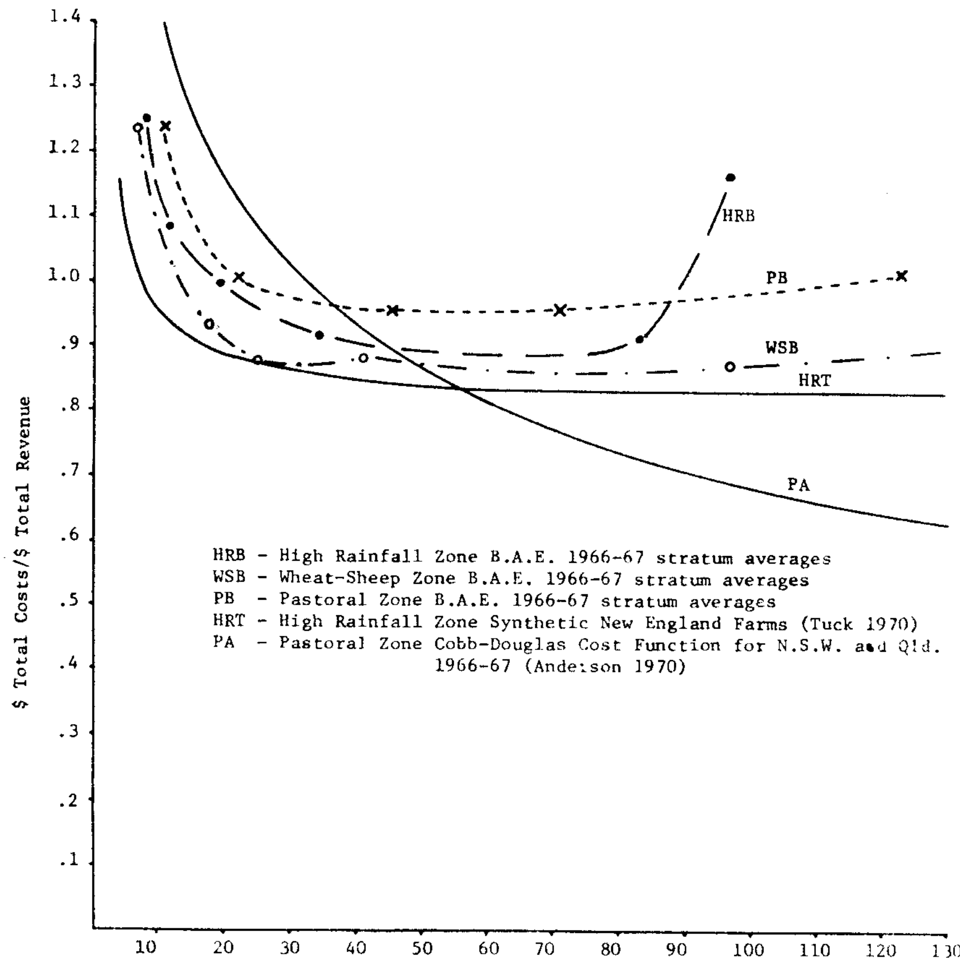
## *Economics of Size in Farming Outside Australia*

Brief mention of economics of size in farming outside Australia will serve to set the Australian evidence in context. Considering our history of farming and its present structure, the U.S.A. experience would seem to be most relevant. The U.S.A. has had a long and active tradition of research on economics of size in farming which has been reviewed by Madden [22] and more recently in a collection of papers edited by Ball and Heady [7].

A synopsis of the U.S.A. work indicates that most LRAC curves are L-shaped rather than U-shaped in such a way that only very small farms with high overheads from lumpy resources need have a relatively high cost structure. Relatively small farms such as traditionally-sized family farms can exploit most of the technical cost economies available to larger firms which means that LRAC curves tend to be horizontal over wide ranges of output. Change in the U.S.A. is in the direction of larger farms (beyond traditional family-size farms) while numbers of small farms decline [14, 24].

## *An Overview of Australian Evidence*

A general overview of evidence from a number of rural industries in Australia has been provided by Mackey [21]. His scatter diagrams derived from various B.A.E. industry surveys led him to conclude that 'These observations strongly suggest that long-run average cost curves for rural industries commonly are strongly downward sloping over the lower ranges of farm size and that thereafter unit costs remain more or less constant'. However, some of the evidence contained in the scatter diagrams is unconvincing. In particular, some industries show a substantial range of average costs for small farms. Reasons for this probably include the accounting difficulties of imputed costs. For example, there may be a greater tendency for imputed depreciation to exceed actual depreciation on small farms, or for imputed cost of owner-operator labour to exceed that warranted by actual labour inputs. Further examination of small farms to investigate these and other factors influencing the wide range of costs on small farms is necessary. Until this is carried out the apparent economies of size on small to medium sized farms should be interpreted cautiously.




Total Revenue $'000

FIGURE 1—Some average cost curves for the Australian sheep industry.

*The Sheep Industry*

The evidence available pertaining to sheep production is clear only on one aspect—namely the existence of substantial economies of size at relatively small sizes of sheep farms. To be more precise, as size increases to a revenue of about $20,000 (in 1966-67), average costs ($ per $ total revenue) decline fairly dramatically as lumpy overheads are spread. This level of revenue was obtainable from running of the order of 5,000 sheep in the late 1960s. This is supported by the observation of Scobie and Rowe [32] that from 1920-1960, small flocks declined in importance, medium-sized flocks expanded markedly and large flocks changed little in importance.

At greater outputs, the cost-size picture is not so clear. An important influence is the methodological approach adopted and in cross-sectional work geographical factors, such as climate, may confound the analysis [26]. The five curves depicted in Figure 1 highlight the different implications that can emerge from alternative methodologies. Except for curve PA, unit costs are fairly constant over intermediate ranges of output irrespective of zone.

However, differences are pronounced at relatively large sizes of sheep farms. It is perhaps not surprising that the LRAC curve HRT in Figure 1 for high rainfall properties based on synthetic New England properties falls continuously since any diseconomies experienced on large properties were not incorporated in Tuck's [39] analysis. This contrasts with the diseconomies suggested by curves HRB, WSB, and PB sketched through points representing averages of cross-sectional B.A.E. data [4]. Of course, such data cannot be relied upon to yield a curve comparable with that derived by synthetic methods. Amongst other possibilities, it may be that large farms in the wool industry are generally endowed with low-quality land resources and disadvantageous locational aspects. On the other hand, since the size-stratified B.A.E. samples contain only a few large farms, less confidence can be had in the higher-output regions of the derived cost curves.

The most divergent curve in Figure 1 is PA which was derived by fitting a Cobb-Douglas cost function to individual farm data. This function (reported below) is based on a fixed scale coefficient and the influence of the majority of farms being relatively small (with declining costs) is reflected in a curve that is everywhere diminishing. The Cobb-Douglas statistical cost curve relates to a subset of firms (described in [1]) included in the sample for which the stratum average costs are indicated by curve PB.

In considering the height (and to a lesser extent the shape) of the cross-sectional cost curves it should be noted that only data for one year underly the respective curves. At least in the pastoral zone, output from individual farms varies substantially from year to year and this variability measured, say, by the variance of wool production or total revenue increases fairly systematically with farm size [1]. The statistical cost function depicted by curve PA involved an attempt to correct for such variability by including a capacity variable, $CAP$ = 1966-67 wool production of each farm expressed as a percentage of its average production from 1952-3 to 1966-7, and setting this to 100 per cent. The log-linear least squares equation estimated for the cross section of 37 farms was

$$TC = 42{\cdot}85\ TR^{\cdot 6736(\cdot 054)}\ e^{-\cdot 00393(\cdot 0018)CAP}, \quad \bar{R}^2 = 0{\cdot}84,$$

where $TC$ denotes predicted total cost in dollars, $TR$ denotes total revenue in dollars, $e$ is the base of Naperian logarithms and numbers in parentheses are respective standard errors.

Several attempts have been made to fit Cobb-Douglas production functions to cross-sectional data from sheep farms but as noted in the discussion of Table 1, these studies are of limited value in assessing economics of size. However, the broad picture that emerges for sheep farms from Table 1 is that returns to scale are more or less constant for the high rainfall zone and the wheat-sheep zone but may be increasing (over the range of observation) for the pastoral zone.

*The Wheat Industry*

Wheat farms have been the subject of two explicit studies of cost-size relationships. Statistical cost analysis has been used by Powell to analyse farms included in three successive B.A.E. surveys (1954-55 to 1956-57,

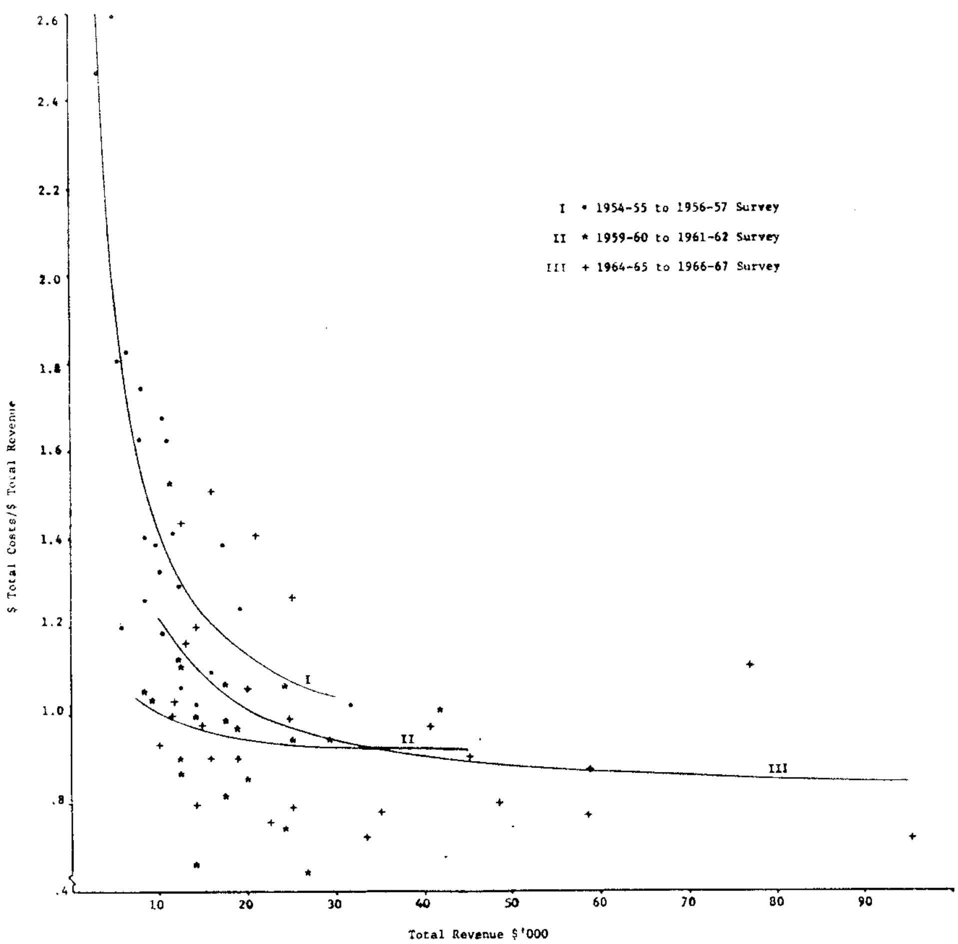



FIGURE 2—Cost-output observations and estimated average cost curves for wheat farms located in central N.S.W.

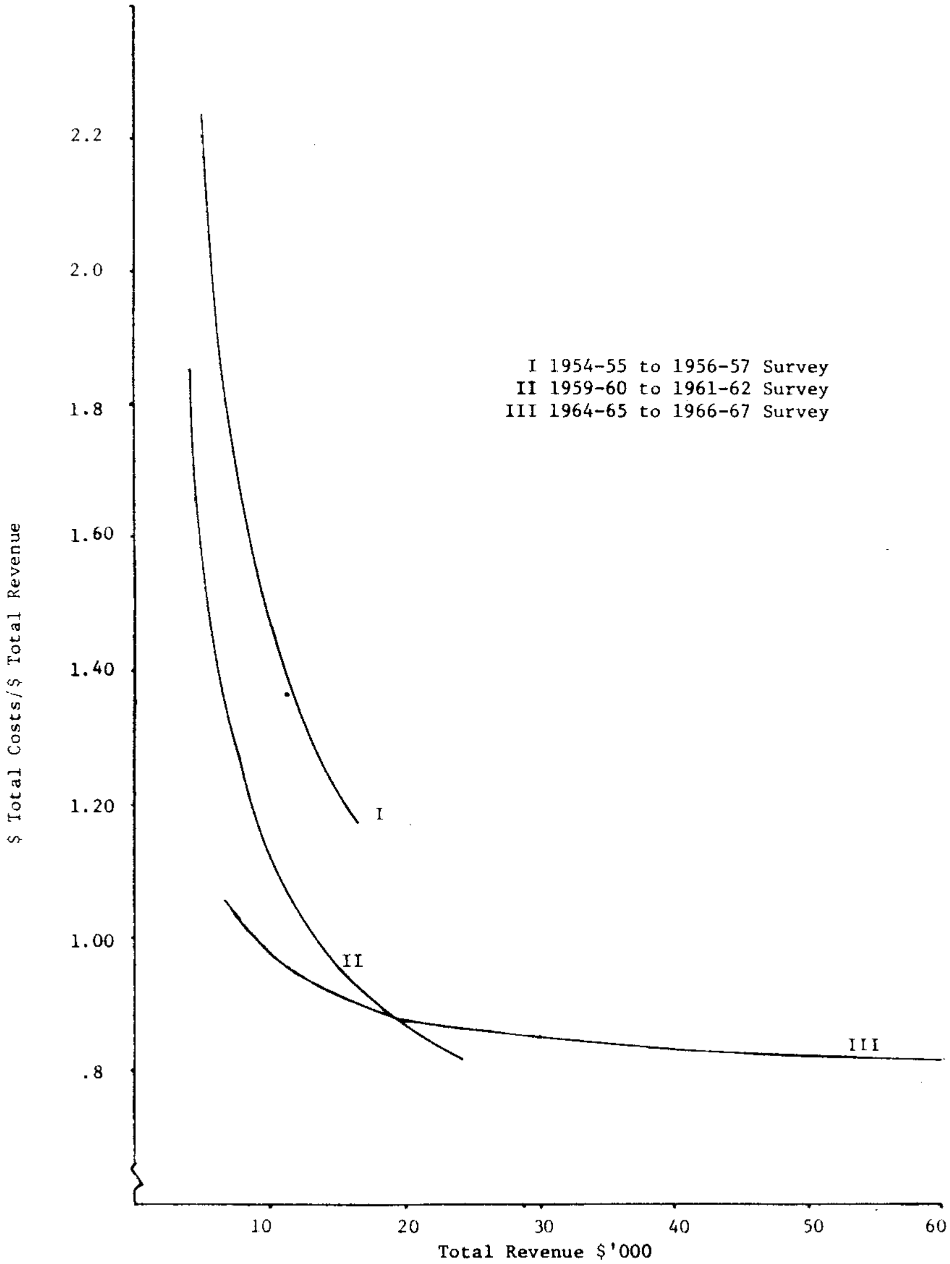



FIGURE 3—Estimated average cost curves for wheat farms located in southern N.S.W.

1959-60 to 1961-62 and 1964-65 to 1966-67),[3] and some farms served by farm consultants whose records were processed by the Agricultural Business Research Institute (A.B.R.I.), Armidale.[4] The geographical areas covered were the central slopes of N.S.W., the southern slopes and

[3] We are grateful to the Director of the Bureau of Agricultural Economics for making available these unidentified data and those used in deriving the statistical cost function reported above.

[4] Unpublished material.

Riverina of N.S.W., and the Mallee and Wimmera of Victoria. Only the results from the N.S.W. groups of farms included in the B.A.E. surveys are presented here to illustrate the general nature of the findings.

The data are averages of the three years included in each B.A.E. survey expressed in constant prices (average from 1964-65 to 1966-67). A different sample of farms was selected for each survey. Figures 2 and 3 show estimated AC curves for farms on the central and the southern slopes of N.S.W. respectively.[5] Figure 2 also shows the cost-output observations for each farm distinguished by survey.

The findings indicate apparent economies of size up to an output level of $30,000 gross revenue. Figures 2 and 3 illustrate this clearly in the case of the AC curve labelled III (1966-67 survey). The AC curves estimated for earlier surveys also indicate the existence of substantial economies of size. However, the restricted range of observations makes it difficult to determine output levels at which most of the economies are realized. The evidence also indicates differences in costs between regions. The curves labelled III in Figures 2 and 3 reveal a (mean) difference of $0·09 per $ of revenue at a gross revenue of $30,000. Similar differences exist between other regions that were examined using both B.A.E. and A.B.R.I. data.

The cost-output observations in Figure 2 illustrate wide cost disparities at specified output levels but it is not clear how the disparities vary with size due to the scarcity of observations for large farms. It is also noticeable that over time the observations are tending downwards and to the right so that a greater proportion of farms is in the output range represented by the horizontal portion of the AC curves. There is a smaller number of small farms with high costs so that the estimated AC curves are tending to become more horizontal through time. These tendencies suggest that farms were increasing in size and so realizing the apparent economies.

The estimated AC curves depicted in Figures 2 and 3 show significant downward displacement of the curves especially over the period 1957 to 1962. With both output and costs (inputs) measured in constant prices, this suggests that technological change has increased efficiency, but other factors, such as differences in the sample of farms between surveys, and varying seasonal conditions (e.g. central N.S.W. was affected by drought in the 1965-66 season), could be important. However, it is unlikely that the contribution of each of these factors could be separately identified.

A consideration of all sources of increased efficiency may be gauged by comparing the estimated AC for the average-sized farm in each survey. Thus, for central N.S.W., AC fell from $1.37 in 1957 to $0.95 and $0.94 in 1962 and 1967 respectively. For southern N.S.W., the fall was from $1.55 to $1.04 and $0.86.[6] In each case, these reductions

[5] Each cost curve was estimated as a linear total cost function, and plotted as an AC curve. This method and function gave consistently acceptable results which can be compared directly.

[6] The AC per $ of revenue used here are real values and will only reflect the then current money values for the two earlier B.A.E. surveys if output and input prices changed in the same proportion. The B.A.E. indexes indicate that approximately proportionate changes occurred between the 1962 and 1967 surveys.

indicate that many farms have realized the available size economies and utilized improved techniques. Farms that have reached the 1967 'average' levels seem to have realized most of the apparent benefits of technology and size and will probably find further efficiency gains more difficult. Small farms could possibly make large gains in efficiency if output could be increased.

Longworth and McLeland [20] made a detailed study of the wheat enterprise on about 50 farms in the Boolooroo Shire in northern N.S.W. for the years 1966-67 and 1967-68. The analysis entailed allocating farm costs to enterprises and fitting cost functions to the costs allocated to the wheat enterprise. Generally, data giving a precise allocation of all costs between enterprises are not available so arbitrary methods are employed. This makes single enterprise studies difficult and added care must be taken in interpreting the results. Size was measured in acres or bushels and most economies of size appear to have been realized at 1,000 acres (25-30,000 bushels). The authors observed a discontinuity in the apparent cost-output relationship at about 1,000 acres—the level at which large equipment could be used at full capacity. At larger outputs, significant reductions in costs are absent. Thus, the results of Longworth and McLeland support the results obtained elsewhere, although an area of 1,000 acres of wheat with some livestock would suggest a somewhat larger gross farm revenue than the $30,000 indicated above and by Mackey [21] as the size which realizes most of the economies of size.

The evidence relating to wheat production consistently points to economies of size up to farm gross revenues of approximately $30,000 or about 800-1,000 acres of wheat. In addition, none of the studies produced significant evidence of diseconomies of size although a suggestion of such a possibility was revealed by Longworth and McLeland [20]. However, in all the studies just reviewed, there are few observations on large farms. Thus the implications for large farms are very tentative.

### *The Dairy Industry*

Conclusive recent studies of economics of size in dairyfarming are not available. Evidence for a number of areas assembled by Mackey [21] highlights the greater efficiency of Victorian producers compared with producers in northern N.S.W. and Queensland. In Victoria there is evidence of size economies as most farms with over $15,000 gross revenue were breaking even or better, while below this level, the majority failed to break even.

In contrast to Victoria, the Queensland and northern N.S.W. data are dominated by small producers with less than $10,000 gross revenue. These farms tend to have high costs, particularly those with less than $5,000 revenue, and substantial economies of size are indicated up to about $10,000 of gross revenue. We suspect that this evidence is not truly representative of 'commercial' dairyfarming and care needs to be exercised in interpreting the indicated economies of size. Standen [35] investigated the dairy industry on the North Coast of N.S.W. He fitted

However, between the 1957 and 1962 surveys, output prices decreased by about 8 per cent while input prices rose by about 12 per cent. Thus, the 1957 money values for AC per $ of revenue would be about 80 per cent of the real values.

Cobb-Douglas cost functions to B.A.E. survey data and although the functions indicated significant economies of size, this result is subject to the limitations of fixed elasticity noted above for the Cobb-Douglas cost function. In any case, average costs exceeded average revenue over the entire range of farm sizes observed.

Standen's studies [34, 35] suggest that in the relatively inefficient areas, there has been a considerable reduction in the number of small dairy farms in the past decade. Thus it is unlikely that these areas would indicate the exaggerated apparent economies of size resulting from the large number of non-viable farms contained in the 1965 B.A.E. survey [3].

Other evidence relating to dairyfarming comes from the first ten Cobb-Douglas cross-sectional production functions summarized in Table 1. These studies suggest approximately constant or slightly increasing returns to scale. The lack of recent evidence relating to economics of size in dairyfarming makes definitive conclusions impossible. However, in the more efficient areas such as Victoria, there are significant economies of size at least to the extent revealed by Mackey [21].

### *The Beef Industry*

Evidence from the Australian beef industry is scarce and tentative. The Australian Beef Cattle Industry Survey [5] for 1962-63 to 1964-65 included data for various size strata for northern Australia only. In Queensland, average costs increased up to gross output levels of about \$40,000, or herds of 2,000-5,000 head and thereafter declined significantly. The Northern Territory costs showed a similar pattern, although not as consistently, while for the Kimberley region of Western Australia there was little change in costs between farms in the \$40,000 gross revenue class or larger classes. Care needs to be exercised in drawing conclusions from such evidence because of seasonal and management variations in beef production in the north. However, some economies of size are suggested. Elsewhere in Australia, beef cattle are carried on mixed farms making it difficult to study cost-size relationships for the beef enterprise itself.

### *Some Other Industries*

*Fruit:* The evidence here is drawn from Mackey's [21] scatter diagrams. These relate to dried vine fruits (Sunraysia district), wine grapes (Murrumbidgee Irrigation Area, N.S.W., and South Australia), canning fruit (Goulburn Valley, Victoria), and apple production (southern Tasmania). In all cases, except wine grape production in the Murrumbidgee Irrigation area, the evidence of economies of size is weak and confounded by a substantial range of costs for small producers and little evidence from large farms. The observed cost-output relationships could be a poor guide to the relationships under 'modern' technology because industries which have not been expanding and are characterized by assets with a long life, include few farms using 'modern' technology. Synthetic firm analysis may be needed to establish 'modern' cost-output relationships. In these industries, which face declining export prospects, structural change (i.e. increased size of farms) is unlikely to increase efficiency to enable them to be more competitive in export markets. This contrasts with the evidence for most other industries. Thus, the export fruit industries must pin their hopes on technological developments which can often be introduced only when trees and vines are replaced.

*Cotton:* The irrigated cotton farming cost-output relationship appears to follow the general pattern with significant economies up to about 200 acres in south-western N.S.W. [27]. However, studies of the economics of size in cotton growing in other areas of Australia where larger farms are involved and where most production takes place are needed to clarify the situation in the Australian cotton industry.

*Eggs:* Egg producers have recently been surveyed by the B.A.E. [6]. The data suggest significant economies of size up to output levels of about $100,000 of gross revenue or about 14,000 layers. Thereafter, the AC curve seems to be horizontal and below average revenue. Again, the few large farms included in the sample raises some doubts about the nature of economics of size at high output levels.

## *Conclusions*

This overview of evidence on economics of size generally conforms with the findings in the U.S.A. mentioned earlier. Two general groups of industries for which information is available can be identified. In the first, which includes the sheep, wheat, dairy, cotton and egg industries, the evidence suggests that significant economies of size exist for small to medium sized farms and, thereafter, AC curves are nearly horizontal. In the second group, which includes the beef industry and most of the fruit industries, there is no clear evidence of significant economies of size.

The policy implications of these findings depend on (a) whether economies of size exist and (b) on whether the horizontal portion of the AC curve is above or below average revenue (AR). The case of 'economies of size present and AC $<$ AR' obviously suggests significant gains in efficiency and farm income from policies directed at increasing the size of farms. The implications of 'economies of size and AC $>$ AR' is less clear. Increased size will make these farms more efficient, but technological and managerial developments are required for them to break even. With 'no economies of size and AC $<$ AR' increasing farm size will increase net farm income without raising efficiency—a policy that may be favoured on welfare grounds. However, with 'no economies of size and AC $>$ AR' such a policy could not be favoured and the continued existence of the industry would need to be considered in the light of market prospects or new technologies which might favour the industry. Given these situations, and the observed differences in the economics of size between industries, there is a case for advocating a selective policy with respect to increasing farm size rather than an 'across the board' policy.

The results indicating the existence or otherwise of economies of size, at least for small farms, are credible but the results in relation to the height of the AC curves are less certain. A substantial element of imputed costs is included in total cost, the most important being interest on capital, including land. Thus, the valuation of capital, particularly land, directly influences the cost levels. An observed AC $>$ AR may not reflect inefficiency, but merely lags in the adjustment of the land market to lower industry returns, or (less likely) land prices reflecting profitable non-agricultural uses. Therefore, the vertical positions of the AC curves must be regarded with some scepticism.

Policy measures to increase farm size would not be necessary if farms are already increasing in size and realizing the potential economies that exist. This seems to have occurred over the 1956-1966 period in the wheat industry. However, in 1969, delivery quotas were introduced reducing wheat production and limiting the extent to which available economies of size could be realized.

Our overview of evidence suggests areas where research on economics of size might be concentrated most effectively. In most industries, the wide range of costs on small farms is well documented but inadequately understood. Research should endeavour to establish whether small farms are high cost because of the nature of economies of size (doubtful, because of the simultaneous existence of low-cost small farms), the use of inferior technologies (a possible explanation), the type of cost accounting procedures employed (a possible explanation) or some combination of all these factors (the most likely explanation). For sheep, wheat, dairy, cotton and egg farms there is a dearth of information on the efficiency of large farms. If reconstruction policy is intended to follow efficiency lines, then much more information on the efficiency of farms of various sizes is needed. For large farms, it may be possible to assemble and analyse sufficient data from large farms operating in these industries, but this work will probably need to be supplemented by synthetic firm analysis. For other industries, attention needs to be focused on all farm sizes. The beef industry and intensive livestock industries including broiler and pig production would all warrant examination to establish the nature of the economics of size [22]. In the horticultural industries where efficiency seems low and economies are apparently absent, large intensive production units could be investigated to establish whether such units can produce efficiently.

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