Australian Journal of Agricultural Economics, Vol. 23, No. 1 (April 1979), pp. 37-47.

A COMPARISON OF DEPRECIATION METHODS UNDER CURRENT COST ACCOUNTING

L. E. DAVEY*

Agricultural Economics Research Unit, Lincoln College

In New Zealand the Richardson Report has recommended to government the adoption of a form of inflation accounting known as Current Cost Accounting (CCA). This paper reports research carried out to determine which of the traditional historical cost depreciation methods used in farm accounting might be most appropriate when adapted to a current cost basis. The current cost depreciation methods are compared on the basis of their ability to predict accurately actual replacement values for a survey sample of farm tractors and headers. The resultant measures of depreciation are compared with those currently allowable under New Zealand taxation laws, and the proposition that investment allowances on purchases of new machinery offset the inadequacies of historical cost depreciation is discussed.

Introduction

The high levels of inflation experienced in many countries in recent years have led to fairly widespread concern about the adequacy of accounts prepared on an historical cost basis. Criticisms of historical cost accounting are the inaccurate representation of profit in the Revenue Statement and the inaccurate fixed asset and proprietorship values in the Balance Sheet.

In matching revenue and expenses in a Revenue Statement when input prices are rising, the historical cost method fails to make an adequate charge against revenue for the current cost of assets consumed during the period. All profit is allocated to the period of sale and no separation is made of operating profits and gains made from holding assets in times of rising prices.

In Balance Sheets prepared on an historical cost basis, long-term assets and stocks of goods may be entered at values well below current prices.

Current Cost Accounting (CCA) is one of a number of inflation accounting methods which has been proposed as an alternative to overcome some of the problems associated with Historical Cost Accounting. In this paper research is outlined which was carried out to determine which of the traditional historical cost depreciation methods, when adapted to a current cost basis, most accurately predicts actual replacement values for a survey sample of farm tractors and headers. As a first step, an optimal depreciation rate was determined for each depreciation method. The various methods were then compared at their optimal rates.

In order to assess the implications of adoption of current cost depreciation, the measures of depreciation resulting, at the optimal depreciation rates, are compared with those allowable under present

* This study was carried out while the author was working with the Agricultural Economics Research Unit at Lincoln College. He is currently employed as an Agricultural Economist with the Tasmanian Department of Agriculture.

New Zealand taxation laws. In addition, the proposition that investment allowances on purchases of new machinery offset the inadequacy of historical cost depreciation is discussed.

Background

The problems associated with Historical Cost Accounting and the proposed solutions (inflation accounting methods) have been the subject of numerous reports and publications (e.g. the Sandilands Report in the U.K., the Australian Exposure Draft and the Mathews Report in Australia and the New Zealand Exposure Draft). In New Zealand, the Committee of Inquiry into Inflation Accounting (Richardson 1976) has recommended the adoption of a form of inflation accounting known as Current Cost Accounting (CCA).

Essential features of the recommended method are:

(a) the measurement of assets in the balance sheet at current cost to the enterprise;
(b) the calculation of the operating profit of the enterprise based on charging the current costs of resources consumed or used in earning the revenue;
(c) the presentation of the profit attributable to owners which includes the portion of the movement in the capital maintenance reserve financed from borrowings.

This present paper is concerned primarily with the valuation of assets in the Balance Sheet and the calculation of depreciation in current cost terms. The Richardson Report outlines alternative valuation procedures which might be used in a current cost method of accounting, and concludes that 'current replacement cost is the most appropriate basis of valuation in the great majority of cases because of its emphasis on maintaining the operating capacity of the continuing enterprise' (Richardson 1976, p. 91). Current replacement cost is defined as 'the lowest amount that would have to be paid in the normal course of business to obtain an asset of equivalent operating or productive capacity' (Richardson 1976, p. 90). The Report does note, however, that in some circumstances current replacement cost can overstate the value of an asset to the enterprise and makes provision for such items to be entered at net realisable value. A range of official indices is recommended as the appropriate method, in most cases, for revaluation of assets in the Balance Sheet.

One of the objectives inherent in the current cost approach is to measure the cost of maintaining the operating capability of the enterprise. 'The purpose of providing depreciation in current cost accounting is to match the current cost of fixed assets used up in earning revenue with that revenue and to state such assets net of accumulated depreciation at current cost.' (Richardson 1976, p. 113.) This approach differs from what might be called pure 'replacement cost accounting' which is aimed at recovering sufficient funds to finance the future replacement of the asset consumed. Richardson concurs with others such as Graham (1959) and Kirkman (1974, p. 66) that availability of sufficient funds for replacement is a question of funds management rather than accounting for depreciation.

Depreciation Methods

In general, there have been two basic approaches in the development of the concept of depreciation. The accounting approach to depreciation has traditionally been one of cost allocation. In the economic approach, on the other hand, cost is considered to be irrelevant. Under this latter approach, depreciation is the difference in capital value at the beginning and end of the period under consideration. Thus the process is one of valuation rather than of allocation. Because of the considerable problems in measurement of capital value (discounted future net earnings), there is general adherence in practice to the accounting concept of cost allocation.

The most commonly used depreciation methods whereby the historical cost of an asset has been allocated over its 'life' are the following (or variations of these):

(a) Straight Line Method (SL);
(b) Sum of the Years Digits (SOYD);
(c) Diminishing Value (DV).

A number of studies have been carried out to determine which of the traditional methods is the 'best' in terms of maximising the net present value of future after-tax cash flows (e.g. Buck and Hill 1977 and Davidson and Drake 1961). A more limited number of studies have been made to determine which is the best method in terms of accurately calculating book values and measuring 'true' depreciation. Of these attempts most (e.g. Cramer 1958 and Mathieson 1963) have involved a study of the decline in second-hand values. All support the contention that depreciation is best expressed by an exponential form. Mathieson (1963, p. 456) concludes that:

> 'An approach based on standard depreciation curves calculated from second-hand values goes a long way toward reconciling the accountant and the economist. Such an approach gives a degree of uniformity and ensures that annual valuation figures bear some relation to reality.'

Despite the widely recognised view that market values do decline in an exponential fashion, the New Zealand Society of Accountants in their Statement of Standard Accounting Practice state that 'In the absence of special circumstances, the most suitable method for general application is the straight line method . . .' (NZSA 1975).

Methodology and Data

For the purposes of this study the basic historical cost depreciation methods were adapted to a current cost basis by the inclusion of an index of inflation in farm machinery replacement costs.[1] The current cost depreciation methods were then compared on their ability accurately to predict actual replacement costs (as assessed by machinery dealers) for a sample of farm tractors and headers.

[1] Source: (1) New Zealand Department of Statistics, Farming Capital Expenditure Indices, *Monthly Abstract of Statistics*, August 1976.
(2) Johnson, R. W. M., Ministry of Agriculture and Fisheries, pers. comm. (1976).

Data on make, cost, age, years owned and hours run had been collected for individual tractors and headers on approximately 150 farms in a survey of New Zealand wheatgrowers (Moffitt and Davey 1977). These data were presented to various machinery agents (depending on the type and make of machine involved) who then provided an assessment of replacement value. The data on cost, age and years owned were used in the current cost depreciation formulae to calculate book values and depreciation.

Determining depreciation by the use of standard depreciation formulae while at the same time ensuring that book values bear some relation to reality is an attempt to reconcile the accounting and economic viewpoints. The use of standard depreciation formulae and indexed historical costs means that the results may be useful for accounting purposes. However, since depreciation is calculated by effectively valuing assets first and then computing the depreciation, the approach conforms more closely to economic theory.

For each of the current cost depreciation methods tested, and for each depreciation rate, the sum of squares of errors (SSE) between calculated book values and the actual (assessed) replacement values was determined. The rate resulting in minimum SSE for a given method was defined as the *optimal rate* and that method with the lowest SSE at its optimal rate was defined as the *best method.* Optimal rates and best methods were determined for (a) 230 tractors, and (b) 97 headers for which survey data were available.

Having determined optimal depreciation rates for each method, a number of tests were then carried out to indicate goodness-of-fit between the calculated book values and the actual replacement values.

In order to assess the implications of adoption of current cost depreciation as suggested by the methods tested (at their optimal rates), the average depreciation calculated by these methods for the 1976/77 year was compared to that allowable under present New Zealand taxation laws (viz. historical cost basis; 25 per cent DV depreciation in the first year and 20 per cent thereafter). In addition to the depreciation allowance, a 40 per cent investment allowance is currently allowed on purchases of new machinery. The significance of this item was also determined for the survey sample of tractors and headers for the 1976/77 year.

The actual methods and formulae used for determining book values and depreciation are presented below, where:

A = age (years);
k = years owned;
L = estimated life (years);
R = diminishing value depreciation rate (%);
I_0 = replacement cost inflation index at time of purchasing (new or second hand);
I_k = replacement cost inflation index at end of year k;
V_0 = initial cost (\$);
V_k = book value at end of year k (\$);
X_k = current cost depreciation in year k (\$).

Because some machines had been purchased second hand, the Straight Line (SL) and Sum of the Years Digits (SOYD) methods required the use of an effective or remaining life figure (E) dating from the time of purchase[2]; $E = [L - (A - k)]$

(1) Straight Line, no salvage value (SL, 0)

$$X_k = (V_0 \, . \, I_k/I_0)(1/E) \qquad (A \leqslant L)$$
$$X_k = 0 \qquad (A > L)$$
$$V_k = (V_0 \, . \, I_k/I_0)(1 - k/E) \qquad (A \leqslant L)$$
$$V_k = 0 \qquad (A > L)$$

(2) Straight Line, 10 per cent salvage value (SL, 10)

$$X_k = (0{\cdot}90)(V_0 \, . \, I_k/I_0)(1/E) \qquad (A \leqslant L)$$
$$X_k = 0 \qquad (A > L)$$
$$V_k = (V_0 \, . \, I_k/I_0)(1 - 0{\cdot}90)(k/E) \qquad (A \leqslant L)$$
$$V_k = 0{\cdot}10(V_0 \, . \, I_k/I_0) \qquad (A > L)$$

This formulation of straight line depreciation with salvage permits the book value (V_k) to increase with inflation in replacement costs after depreciation has ceased (i.e. when $A > L$).

(3) Sum of the Years Digits (SOYD)

$$X_k = V_0 \, . \, I_k/I_0 \; [2(E + 1 - k)/(E(E + 1))] \qquad (A \leqslant L)$$
$$X_k = 0 \qquad (A > L)$$
$$V_k = V_0 \, . \, I_k/I_0[(E(E + 1) - 2kE + (k - 1))/(E(E + 1))] \qquad (A \leqslant L)$$
$$V_k = 0 \qquad (A > L)$$

Whereas the SL method maintains depreciation as a constant fraction of cost (replacement cost new) over time, SOYD depreciation decreases in an arithmetic process.

(4) Diminishing Value (DV)

$$X_k = V_0 \, . \, I_k/I_0 \quad (1 - R/100)^{(k-1)} \, . \, (R/100)$$
$$V_k = V_0 \, . \, I_k/I_0 \quad (1 - R/100)^k$$

In practice a number of variations of historical cost DV depreciation exist, but in all cases depreciation is determined as a constant percentage of the depreciated asset value at the beginning of the accounting period. For the current cost DV formula above (4), depreciation in a given period is a constant percentage of the depreciated asset value at the beginning of the period, adjusted for inflation over the period. Of the four methods outlined, DV permits the most rapid depreciation in early years relative to later years.

Best Depreciation Method

The results of this study indicate the superiority of the DV method (Table 1). The comparison of current cost depreciation methods in terms of accurately estimating actual (assessed) values is presented in terms of the 'proportion of variation explained'. This figure is calculated as for R^2 in regression analysis (e.g. Wonnacott and Wonnacott

[2] When age (A) = years owned (k), effective life (E) = actual life (L).

1970, p. 120). Because of the use of postulated depreciation allowances, however, the estimated values (book values) were not determined by normal regression analysis.

The recorded optimal depreciation rates were higher for tractors than headers, indicating more rapid physical and/or economic depreciation. In that depreciation is due at least partly to economic factors, the optimal depreciation rates would need to be reviewed periodically if they were to be adopted for general use.

Table 2 provides further evidence of the goodness-of-fit between the calculated book values and the actual (assessed) replacement values. Each of the four methods gave average book values which closely approximated the average assessed replacement values. The t-statistic for paired observations indicated no significant difference ($p = 0 \cdot 05$) between average book value and average assessed value except for the Straight Line, zero salvage value (SL, 0) method for tractors. The variance in book values, however, tended to be greater than the variance of assessed values. The DV method for tractors was the only case where the F-statistic indicated no significant difference between the two values ($p = 0 \cdot 05$).

Although each of the four methods tested gave results (at the optimal depreciation rates) in which average book values closely approximated average assessed values, they all resulted in an overestimate of the frequency of higher and lower values and an underestimate of the number of middle values—hence the significant differences recorded for the Chi-squared test.[3] It would appear that each of the methods used resulted in an under-depreciation of new and over-depreciation of older machines. In this regard the DV method was more accurate than other methods. However, the results indicate that a depreciation method with higher depreciation in the early years than that permitted by DV

TABLE 1

Optimal Depreciation Rates

Current cost depreciation method	Optimal depreciation rate	Proportion of variation explained
Tractors		
SL, 0	8 year life	0·70
SL, 10	7 year life	0·76
SOYD	13 year life	0·81
DV	17% p.a.	0·85
Headers		
SL, 0	12 year life	0·70
SL, 10	11 year life	0·72
SOYD	18 year life	0·80
DV	14% p.a.	0·87

[3] This would also appear to explain the larger variance recorded for book values than for actual (assessed) values.

TABLE 2

Comparison of Book Values and Assessed Values at Optimal Depreciation Rates

	Current cost depreciation method			
	SL, 0	SL, 10	SOYD	DV
Tractors				
Optimal depreciation rate	8 year life	7 year life	13 year life	17% p.a.
Average book value	4 600	4 371	4 879	5 058
Average assessed value	4 964	4 964	4 964	4 964
Significance of t-statistic[a] (paired observations)	**	NS	NS	NS
Standard deviation book values	5 210	4 975	4 915	4 542
Standard deviation assessed values	4 110	4 110	4 110	4 110
Significance of F-statistic[a]	**	**	**	NS
Significance of χ^2 statistic[a]	**	**	**	**
Headers				
Optimal depreciation rate	12 year life	11 year life	18 year life	14% p.a.
Average book value	10 198	10 613	10 508	10 463
Average assessed value	10 807	10 807	10 807	10 807
Significance of t-statistic[a] (paired observations)	NS	NS	NS	NS
Standard deviation book values	14 022	13 854	12 862	11 543
Standard deviation assessed values	10 047	10 047	10 047	10 047
Significance of F-statistic[a]	**	**	**	**
Significance of χ^2 statistic[a]	**	**	**	**

[a]NS—No significant difference at 5% level.
**—Significant difference at 5% level.

(and a slower fall-off) might give an even better fit between book values and assessed values.

Sensitivity analysis was carried out to determine the effect on average book value, and on the proportion of variation explained, of a change in the DV depreciation rate away from the optimum (Table 3).

Depreciation and Investment Allowances

The depreciation determined by the current cost depreciation methods (at their optimal depreciation rates) was compared with the historical cost depreciation allowable under present New Zealand taxation laws and with current investment allowances on purchases of new machinery.

Under the four current cost depreciation methods tested (at optimal rates), the average depreciation allowance for the 230 survey tractors for the 1976/77 year would have been approximately $1000 (Table 4). For the 97 survey headers, the average depreciation allowance would have been around $1700. Under the historical cost depreciation allowed

TABLE 3

Sensitivity of the Current Cost Diminishing Value Depreciation Method to Changes in Depreciation Rate

Deprecia-tion rate (% p.a.)	Tractors		Headers	
	Average book value (as a % of average assessed value)	Proportion of variation explained	Average book value (as a % of average assessed value)	Proportion of variation explained
5	159	0·25	151	0·35
10	131	0·69	117	0·79
11	126	0·74	112	0·83
12	121	0·78	106	0·84
13	117	0·80	101	0·86
14	113	0·83	97	0·87
15	109	0·84	92	0·87
16	105	0·85	88	0·86
17	102	0·85	84	0·84
18	99	0·85	81	0·83
19	95	0·85	77	0·82
20	92	0·84	74	0·79
25	78	0·76	60	0·66

under New Zealand taxation laws (25 per cent DV depreciation first year, and 20 per cent thereafter), the average depreciation calculated for the tractors was $764 and for the headers $1094. Hence current allowances for tractors average about 75 per cent of that suggested by the current cost methods and for headers, around 65 per cent. The difference is due to the fact that the tractors sampled were, on average, newer than the headers and hence the historical cost basis more closely approached the current cost basis.

It has been suggested that investment allowances may help to offset the deficiencies of historical cost accounting. In New Zealand there is a 40 per cent investment allowance on purchases of new farm machinery.

For the sample of tractors in this study, the average investment allowance was sufficient to increase the total taxation allowance (depreciation plus investment) above that suggested by the current cost methods of depreciation. However, because there were fewer new headers, average total taxation allowance for these was still below that indicated on a current cost basis.

These results indicate that, on average, the investment allowance may go a long way towards offsetting the deficiency of historical cost depreciaton. However, the distribution of allowances would appear to be highly inequitable. Owners of new tractors and headers in 1976/77 were allowed depreciation (plus investment allowance) at rates considerably higher than that suggested on a current cost basis, whereas

TABLE 4

Depreciation Allowances and Book Values

Depreciation method	Average depreciation allowance (1976/77)	Average book value (end of 1976/77 year)
Tractors:	$	$
Current cost[a]		
SL, 0	1 038	4 600
SL, 10	1 029	4 731
SOYD	1 093	4 879
DV	1 036	5 058
Historical cost[b]		
(i) DV (25% 1st year, 20% p.a. thereafter)	764	2 631
(ii) 40% investment allowance	533	
Total taxation allowance ((i) + (ii))	1 297	
Headers:		
Current cost[a]		
SL, 0	1 709	10 198
SL, 10	1 636	10 613
SOYD	1 774	10 508
DV	1 703	10 463
Historical cost[b]		
(i) DV (25% 1st year, 20% p.a. thereafter)	1 094	4 039
(ii) 40% investment allowance	380	
Total taxation allowance ((i) + (ii))	1 474	

[a] At optimal depreciation rate.
[b] Current New Zealand allowances for taxation purposes.

those who had not purchased new machinery were allowed considerably less. If all farmers purchased new machinery on the same regular basis, it could be argued that the benefits would be evened out over time. However, as noted by others, for example Barton and Harcourt (1959) and more recently Carman (1974) and Ross (1977), the operation of an investment allowance against taxable income favours those with higher incomes (higher marginal tax rates). This factor, combined with a greater available cash surplus, means that one group of farmers is more likely to buy new machinery. These farmers receive the benefits of the investment allowance and also base depreciation calculation on values closer to replacement cost.

If Current Cost Accounting is adopted in New Zealand it may be an appropriate time to review the need for current investment allowances on purchases of new machinery. In terms of allowing for machinery replacement, the current cost measure of depreciation appears to be more adequate overall and more equitable than the present depreciation plus investment allowance. If the annual current cost depreciation provision for an asset is invested at a rate equal to the rate of inflation, sufficient funds will be available at the end of the asset's life to cover the purchase price of a replacement. If the government wishes to encourage investment in farm machinery above replacement, an investment allowance of the taxation credit type outlined by Barton and Harcourt (1959) would be more equitable. Under this system, actual tax payable would be reduced by a fixed proportion of the cost of the investment and thus would be the same for all farmers regardless of marginal tax rates.

It should be noted, however, that an investment allowance of any type will tend to increase the economic depreciation of present machinery by favouring the purchase of new machinery. Since most farm machinery in New Zealand is imported, policies encouraging new machinery purchases should be viewed, on the one hand, in the light of their effect on import costs at a time of balance of payment difficulties and, on the other hand, in the light of their potential contribution to increased productivity.

Summary

Compared to Historical Cost Accounting, Current Cost Accounting is an attempt to provide a more accurate valuation of fixed assets in the Balance Sheet and to calculate depreciation in current cost terms.

If standardised depreciation formulae are to be used under CCA, and if the aims of accurately reflecting the amount of an asset consumed during an accounting period and providing an accurate valuation are to be fulfilled, it is essential that an appropriate method and rate (life) of depreciation be used.

The economic approach to measurement of depreciation is to determine the difference in capital value at the beginning and end of the period under consideration. If the values can be accurately assessed, it follows that the measurement of depreciation is accurate. In this study standard historical cost depreciation formulae were adapted to a current cost basis and tested at various depreciation rates to determine which method (and rate) resulted in the best estimate of actual replacement values for a survey sample of farm tractors and headers.

Book values and depreciation allowances derived from these formulae were then compared with figures calculated using historical cost methods allowable for taxation purposes in New Zealand. The proposition that investment allowances on purchases of new machinery offset the inadequacies of historical cost depreciation was also investigated.

The evidence presented supports the view that the diminishing value method is superior to both the sum of the years digits and straight line methods. At the most appropriate (optimal) depreciation rate, the diminishing value method resulted in book values which most closely approximated actual values. Average book values for all methods were approximately the same as the average actual values and hence these current cost methods provide a much more satisfactory basis for valuation of fixed assets in the Balance Sheet than the present historical cost methods. Using methods and rate of depreciation allowable for taxation purposes in New Zealand, average book values were around 53 per cent of average actual values for the survey tractors and 37 per cent of average actual values for the headers.

For the survey tractors, current cost depreciation for 1976/77 would have been around 40 per cent higher than that allowed under the present taxation laws. For the survey headers, current cost depreciation would have been approximately 55 per cent higher. The difference between tractors and headers was due to the fact that the tractors sampled were relatively newer and hence historical cost depreciation more closely resembled current cost depreciation.

The 40 per cent investment allowance on purchases of new farm machinery in New Zealand has been claimed to offset the deficiency of historical cost depreciation. While on average this appears to be the case, the distribution of allowances is inequitable. The operation of an investment allowance against taxable income favours those with higher incomes. In addition, this group tends to have higher cash surpluses available for machinery purchases. These two factors mean that farmers with higher incomes are more likly to buy new machinery and in so doing they benefit from the investment allowance and are able to base depreciation calculations on values closer to replacement value.

These equity factors should be considered along with accuracy of accounting statements in comparing the present historical cost system (plus investment allowances) with the proposed current cost system. Before machinery investment allowances are continued under a current cost system, a decision should be made as to whether additional machinery investment or merely maintenance of the present stock is required. If the latter is the case then current cost depreciation without investment allowances should be adequate. A decision to encourage additional machinery investment should be made only after consideration of the effect on import costs at a time of balance of payments difficulties, and of the potential contribution to increased productivity.

References

Barton, A. D. and Harcourt, G. C. (1959), 'Investment for primary producers', *Australian Journal of Agricultural Economics* 3 (2), 12-18.

Buck, J. R. and Hill, T. W. (1977), 'Generalized depreciation methods and after-tax project evaluation', *The Engineering Economist* 22 (2), 79-96.

Carman, H. F. (1974), 'Tax motivated agricultural investment', *The Accountants Journal* 52 (7), 274-77.

Cramer, J. S. (1958), 'The depreciation and mortality of motor cars', *Journal of Royal Statistical Society* (Series A), 121, 18-46.

Davidson, S. and Drake, D. F. (1961), 'Capital budgeting and the "best" tax depreciation method', *Journal of Business* 34 (4), 442-52.

Graham, W. J. (1959), 'Depreciation and capital replacement in an inflationary economy', *The Accounting Review* 34 (3), 367-75.

Kirkman, P. R. (1974), *Accounting under Inflationary Conditions*, Allen and Unwin, London.

Mathieson, M. C. (1963), 'The depreciation of farm machinery', *Journal of Agricultural Economics* 15 (3), 451-60.

Moffitt, R. G. and Davey, L. E. (1977), *National Wheatgrowers' Survey, No. 1, 1976-77*, Agricultural Economics Research Unit Research Report No. 84, Lincoln College.

Richardson, I. L. M. (1976), *Report of the Committee of Inquiry into Inflation Accounting*, University of Waikato, Hamilton.

Ross, B. J. (1977), 'Finance for farming', *Lincoln College Farmers' Conference 1977*, Lincoln College, Canterbury, 46-60.

NZSA (1975), *Depreciation of Fixed Assets*, Statement of Standard Accounting Practice No. 3, New Zealand Society of Accountants, Wellington.

Wonnacott, R. J. and Wonnacott, T. H. (1970), *Econometrics*, Wiley, New York.