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ON THE COST ALLOCATION METHOD OF DEPRECIABIE ASSETS

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Some eighteen years ago depreciation was asserted to be ".... probably the most discussed and most disputatious topic in all accounting."[1] This statement still holds true even at the present time. The problems in the depreciation accounting remain unsolved. Alternative depreciation methods are widely used without a theoretical justification. The AICPA's accounting research study project on "Accounting for Depreciable Assets" serves to indicate the continued interest and concern over this subject.

Over the years accountants seem to have agreed that the annual depreciation charges should be related in some way to the net economic benefit[2] resulting from using the depreciable assets.[3] The term "net economic benefit" (as defined in footnote 2) of a depreciable asset is conceptually clear but is practically difficult to determine. Of equal difficulty and probably more controversial is the method with which to relate the depreciation charges to the net economic benefit pattern. Three methods of cost allocation have been advanced with various justifications. The purpose of this paper is to evaluate each of these methods and to suggest the choice among them.

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1. Davidson, Sindney, "Depreciation, Income Taxes, and Growth," Accounting Research (July, 1957), p. 191.

2. Defined as the total revenues derived from the use of the asset less all costs and expenses, excluding depreciation, associated with the use of this asset.

3. One of the major deficiencies in this depreciation concept is that it assumes only the depreciable asset contributes to the profit; other factors such as raw material, labor, and management contribute nothing and the costs of these factors are subtracted from the total revenues to arrive at the net economic benefit of the depreciable asset.

ALLOCATION BASED ON A CONSTANT COST TO NET ECONOMIC BENEFIT RATIO

The first allocation method requires that the cost (less salvage value, if any) or other basis of asset be allocated among the time periods the asset is in use in proportion to the net economic benefit receive. In other words, a constant relationship between cost and net economic benefit is maintained for all periods.

Under this method, if the net economic benefit is relatively constant over the useful life of the asset, the straight-line method should be used. On the other hand, if an increasing (or decreasing) benefit pattern is expected, the appropriate depreciation method is the increasing (or decreasing) charge method.

Advantages

The argument for this method of cost allocation is that the depreciation procedure that purports to determine periodic income should match the efforts with the accomplishments. The cost of the asset represents the effort or sacrifice of a firm and the net economic benefit over the asset's useful life represents the accomplishment from that investment . The benefits are jointly produced by the cost. The productivity of each unit of cost should be the same for all periods. Therefore, each dollar of net economic benefit should be assigned an equal amount of cost.

The argument that each dollar of benefit should bear the same amount of cost regardless whether the asset is in first year's service or tenth year's service can be made more clear with the following example. Suppose a company leased two identical machines, one is new and the other is ten years old. Suppose further that the two machines are capable of performing the same quantity and quality of services and the repairs and maintenance are paid by the lessor. Under these conditions the two machines will produce the same amount of net economic benefit and command the same amount of rental.

Because this method matches the efforts with accomplishments, management performance is not distorted in each year. If the net economic benefit from using the asset is constant every year during its useful life, the net operating income from the asset will also be the same in each year. This would facilitate the intra- or inter-firm comparison of management performance.

Disadvantages

This method of allocation is often called conventional, probably connoting the meaning of "generally accepted" by those who use it and "outmoded" by those who advocate other methods. The main criticism of this method is that it ignores the cost of capital (the interest factor) and results in a widely varied rate of return on investment. The validity of a constant rate of return on investment will be examined in the later section. It will be shown that the assertion that this method produces a widely varied rate of return on investment is somewhat exaggerated and is based on a single asset situation.

Assume that a machine is acquired for $3,169 and is expected to have a useful life of four years with no salvage values at the end of this period. Assume further that this machine will generate a constant net revenue stream of $1,000 each year and that the reported income is withdrawn and an amount equal to the accumulated depreciation is invested in securities at an average rate of return of 10%. The "ture yield"[4] of the investment in this machine is 10%. The computed rate of return on investment varies from 6.5% to 14.0% as shown in Table 1.

Several observations can be made from this example. First, it is based on a single asset investment. Second, the net economic benefit of this investment does not decline. Third, an amount equal to the accumulated depreciation is invested in securities to earn 10% interest.

While it is true under the conditions stated above the rate of return on investment varies widely each year, a single asset investment in a firm must be very rare in reality. We may find another extreme situation that will produce a constant rate of return on investment under this allocation method.

Assume a firm has been operating for years. The firm owns four machines with even-age distribution, that is, one machine is new, another machine is one year old, and so forth. At the end of each year the oldest machine is retired and replaced by an identical new one. Other assumptions are the same as preceding example. The rate of return on investment for the four years is shown in Table 2 and the computa-

[4] Defined as the discount rate at which the present value of the net economic benefit will be equal to the cost. See Solomon, Ezra, "Return on Investment: The Relation of Book Yield to True Yield," in Ijiri, Yuji, Jaedicke. R., and Nielsen, O., eds., Research in Accounting Measurement (American Accounting Association, 1966), p. 233.

Table 1

Rate of Return on Investment - Single Asset
Constant Net Economic Benefit, Straight - Line Depreciation

	Year			
	1	2	3	4
Total capital invested at beginning of year	$3,169	$3,169	$3,169	$3,169
Book value of machine at beginning of year	3,169	2,377	1,585	793
Investment in securities at beginning of year	-0-	792	1,584	2,376
Operating revenues less operating expenses other than depreciation (net economic benefit)	$1,000	$1,000	$1,000	$1,000
Depreciation	792	792	792	793
Net operating income	$ 208	$ 208	$ 208	$ 207
Interest on securities	-0-	79	158	238
Total income	$ 208	$ 287	$ 366	$ 445
Rate of return on total investment	6.5%	9.1%	11.5%	14.0%

tion of depreciation and total investment is shown in Table 3.

From Table 2 it is easily seen that the rate of return on investment is constant every year. In a situation like this, if the firm did not replace the retired machine, instead, invested the funds in securities (in this example $3,169), the net economic benefit and net operating income in the second year will decline by $1,000 and $ 208 respectively. In other words, if the firm desires to maintain the same level of operating income, it has to invest an amount equal to the depreciation charges in a new machine. There would be no extra funds available for investment in securities to earn interest.

As might easily be pointed out, both single asset and an even-age distribution assets are extreme cases. The realistic asset structure must fall somewhere in between these two extremes. Professor Meij has stated that:

> If we look at the whole complex of capital goods of a business and not at a single machine or machine-group we will always find a diversity of life-time of those goods. That means, that in existing firms and in particular in large companies there will always be a tendency to an even-age distribution.[5]

It may then be concluded that the fluctuation of rate of return on investment under this allocation method is not as wide as is criticized from the entire company's point of view.

ALLOCATION BASED ON THE DISCOUNTED PRESENT VALUE OF THE NET ECONOMIC BENEFIT AT THE DATE OF ACQUISITION

The second allocation method suggests that depreciation in each year should be based on the net economic benefit received in that year discounted back to the date of acquisition. The discount rate is the rate at which the present value of future net economic benefits is equal to the purchase cost. Continuing the previous example, Table 4 shows the annual depreciation and net operating income over the asset's useful life under this allocation method.

In Table 4, the fourth column represents the discounted value of the net economic benefit in each year. For example, the first year's net economic benefit is discounted for one period, the second year's benefit is discounted for two periods, and so forth. Under this allocation method, when net economic benefit is constant, the depreciation decreases and net operating income increases every year.

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[5] Meij, L., ed., Depreciation and Replacement Policy (Chicago, Ill.: Quadrangle Books, Inc., 1961), p. 11.

Table 2

Rate of Return on Investment -- Even-Age Distribution
Constant Net Economic Benefit; Straight-Line Depreciation

	Year			
	1	2	3	4
Total capital invested at beginning of year	$7,924	$7,924	$7,924	$7,924
Book value of machines at beginning of year	7,924	7,924	7,924	7,924
Operating revenues less operating expenses other than depreciation (net economic benefit)	$4,000	$4,000	$4,000	$4,000
Depreciation	3,169	3,169	3,169	3,169
Net operating income	$ 831	$ 831	$ 831	$ 831
Interest on securities	-0-	-0-	-0-	-0-
Total income	$ 831	$ 831	$ 831	$ 831
Rate of return on investment	10.5%	10.5%	10.5%	10.5%

Table 3

Computation of Depreciation and Total Investment

	Total	Machine				
		1	2	3	4	5
Book value of machines	$7,924	$ 793	$1,585	$2,377	$3,169	
Depreciation	3,169	793	792	792	792	
Net book value before replacement	$4,755	$ -0-	$ 793	$1,585	$2,377	
Replacement	3,169					$3,169
Total investment at end of year	$7,924	$ -0-	$ 793	$1,585	$2,377	$3,169

Table 4

Depreciation Based on the Discounted Cost
of Net Economic Benefit
Constant Benefit, 10% Rate of Return

1	2	3	4	5
Year	Book Value at Beginning of Year	Net Economic Benefit	Discounted Value of the Year's Economic Benefit (Depreciation)	Net Operating Income
1	$3,169	$1,000	$909	$ 91
2	2,260	1,000	826	174
3	1,434	1,000	751	249
4	683	1,000	683	317
Total		$4,000	$3,169	$831

Dixon has advanced the following arguments for this allocation method:

(1) An asset is an embodiment of services to be rendered through time.
(2) Implicit in the purchase price of an asset is the cost of all services to be rendered.
(3) The rational purchaser places a higher valuation on the services immediately to be rendered than he does on those which will be rendered in the more remote future.
(4) If the cost of the asset is viewed as the renumeration of the present values of the bundle of services, then as the earlier layers of service are consumed they have higher price tags, and higher cost depreciation, than do the later services.[6]

While it is true that a remote revenue has less present value than an immediate revenue, this allocation method ignores the fact that when the services are used in each year, they have the same values. When one uses two machines to perform the same services, the value of the services is the same regardless when the machines were purchased. In a direct rebuttal to Dixon's argument, Lorig posed this question: "..... is there not an increase in the value of the services (reflected in the cost of carrying the investment in future services) as their time for use approaches which would offset the discount?"[7] He suggested that:

6. Dixon, Robert L., "Decreasing Charge Depreciation - A Search for Logic," The Accounting Review (October, 1960), p. 592.

7. Lorig, Arthur N., "On the Logic of Decreasing Charge Depreciation," The Accounting Review (January, 1962), p. 56.

> To the informed businessman, ... the cost of future services would be not only their purchase cost but also the interest cost of capital tied up in his investment in those services, and other possible carrying (waiting) costs such as insurance and taxes. .... If the discount rate accurately reflects the carrying costs, then the present value of each year's services plus the carrying costs applicable to those services will total the same as for each of the other years.[8]

Hendriksen also criticized this method as quite weak from a theoretical point of view. His criticism runs as follows:

> First, it represents a very rigid application of the cost rule -- each unit of service value is charged to expense in the amount of its original discounted cost. ..... Second, it applies a very rigid form of realization rule. The difference between the original cost and the value of the service is assumed to be realized only when the asset is used or when its product is sold. Third, depreciation is assumed to represent the expiration of the original cost of each year's contribution, rather than the net revenue contribution less the earnings associated with a declining investment.[9]

While there is merit in Hendriksen's first point, his second and third points are related to the time-adjusted allocation method which will be examined in the following section.

In summary, this allocation method results in an increasing net operating income and rate of return on investment every year which seems to be unreasonable from the point of view of measuring management performance.

THE TIME-ADJUSTED ALLOCATION METHOD

A third allocation method is that the depreciation charge each year is the difference between the discounted present values of all future net economic benefits at the beginning and end of the year. In other words, depreciation is measured by the decline in the present values of the asset during the year. This is usually called the time-adjusted, scientific, or compound interest depreciation method. Table 5 serves to illustrate this allocation method.

In Table 5, the figures in column 5 represent the depreciation in each year and are arrived at by subtracting the net income (column 3) from the net economic benefit (column 4). These figures also represent the decline in the present values in each

8. Ibid., pp. 56-57.

9. Hendriksen, Eldon S., Accounting Theory, Revised ed. (Homewood, Ill.: Richard D. Irwin, Inc., 1970), p. 414.

Table 5

Depreciation Based on the Time-Adjusted Method
Constant Benefit, 10% Rate of Return

1	2	3	4	5
Year	Investment-Book Value at Beginning of Year	Net Income 10% of Column 2	Net Economic Benefit	Depreciation (Decline in Present Value)
1	$3,169	$317	$1,000	$683
2	2,486	249	1,000	751
3	1,735	174	1,000	826
4	909	91	1,000	909
Total		$831	$4,000	$3,169

year. For example, at the beginning of the first year, there are four years benefits to be received and the present value (discounted at 10%) is $3,169. At the end of the first year, there are only three years benefits to be received and the present value is $2,486. The difference is $683 which is the depreciation for the first year.

Arguments For and Against the Time-Adjusted Allocation Method

The argument for this allocation method is that each year the investment should earn a constant rate of return on investment (usually defined as the book value at beginning of year) and that the book value of the asset should reflect the discounted present value of future net economic benefit of that asset. Since the investment earns 10% of return over its projected life and the first year's investment is $ 3,169, the income in the first year must be $317. The difference between this net income and the net economic benefit is then the depreciation for the year. Thus income is first determined and depreciation is the residual.

Proponents[10] of this allocation method claim that the net income and return on

10. Among them areBierman, Harold, Jr., "Depreciable Assets - Timing of Expense Recognition," The Accounting Review (October, 1961), pp. 613-618; Reynolds, Isaac N., "Selecting the Proper Depreciation Method," The Accounting Review (April, 1961), pp. 240-243; Johnson, Orace, "Two General Concepts of Depreciation," The Journal of Accounting Research (Spring, 1968), pp. 29-37; and Solomon, Ezra, op. cit., pp. 232-244.

investment are not distorted under this method. The literature is replete with the argument for the importance of the rate of return on investment in evaluating management performance and in making sound investment decisions by investors.

However, the rate of return on investment alone does not always given correct measurement of management performance and facilitate investment decisions. Consider the following example. Company A and company B each had $1,000,000 in net assets and each earned $200,000 in the first year. The ROIs of both companies were 20%. In the second year, company B issued new bonds at a 10% cost to obtain $1,000,000 which were invested to earn a 15% rate of return. The net incomes (before interest costs) in the second year were $200,000 for company A and $350,000 for company B. The ROIs in the second year were 20% for company A and 17.5% for company B.

If the rate of return on investment is used as a sole criterion (or is primarily relied upon) for judging mangagement's performance, it may be concluded that the management of company B performed less well than the management of company A in the second year. However, in terms of the profits to the stockholders, company B's stockholders fared better than company A's stockholders in the second year. The stockholders of company B would be willing to give extra rewards to their managers even though the ROI has declined. Here we can see the limitation of the ROI in measuring management performance and in making investment decisions.

It may be argued that if the net income after interest expense and the stockholders' equity are used to compute the ROI, company B would have higher ROI (25%) than company A. However, the ROI so computed actually measures both the management's investing and financing performance. While both investing and financing performance are important, depreciation should not be linked to the financing activities.

Commenting on the use of ROI as a criterion to determine whether management attempted to smooth income, Zeff states that this criterion has questionable utility for the following two reasons:

One, a rate of return on net assets is rarely found in corporation annual reports, suggesting that managers apparently do not intend to convey a notion of the success of operations in terms of that criterion. Two, financial analysts utilize a relationship between income and market value per share, not book value per share.[11]

[11] Zeff, Stephen A., "Discussion Comments," in Ijiri, Y., Jaedicke, R., and Nielsen, O., eds. Research in Accounting Measurement (American Accounting Association, 1966). p. 250.

Another disadvantage of the time-adjusted method is that when the net economic benefit is less than the associated earnings in any year, the depreciation will be negative. As noted previously, the depreciation under this method is a residual arrived at by subtracting the net income (computed by multiplying the rate of return to the beginning investment) from the net economic benefit. If the net economic benefit in any one year is less than the computed net income, the depreciation would be negative which is indeed hard to comprehend.

When the time-adjusted method is used, the magnitude of the rate of return on investment and the length of the useful life of the asset will affect the depreciation pattern. Suppose company A and company B both invest in the same type of machine with an expected useful life of ten years. The cost of the machine is $5,000. Company A estimates the net economic benefit pattern of this machine to be $1,250 in the first year and decreases $75 each year thereafter. The rate of return on this investment is 15%. Company B also estimates the same pattern as company A but the the dollar amount is only three-fourths of that of company A. The rate of return on investment for company B is 7.13%. The depreciation schedules for both companies using the time-adjusted method are shown in Table 6.

Note in Table 6 the benefit patterns are the same for both companies, but the depreciation patterns are quite different. For company A the straight-line method would be perfectly fit. But for company B some form of decreasing charge method is required. The difference in the depreciation pattern would be widened as the difference in the rate of return gets bigger or the useful life lengthens.

It is not uncommon for two companies buying identical machines to expect different rates of return on investment. This may happen because one company has better management, better organization, or better investment combination that increase the efficiency of the machine. If the difference in rate of return is real, use of different depreciation methods may be justified. But there is great possibility that the difference may be due to the management's personality such as conservatism or optimism, and the ability and facillity of the management to predict the future outcomes.

In summary, the most distinguishing feature of the time-adjusted allocation method is that a constant rate of return is obtained. To this point Vatter states that:

It does produce a constant return for each year of the investment term, but at the cost of an unrealistic pattern of depreciation or amortization - increasing charges

for the use of assets as they become older.

When depreciation is a factor in the measurement of income, one does not really measure that depreciation by treating it as the amount which remains when "income" has been deducted from cash receipts.[12]

THE TWO INTEREST METHODS COMPARED

The allocation based on the discounted present value of the net economic benefit at the date of acquisition and the time-adjusted method both take interest factor into consideration, but the resultant depreciation charges are completely different. The difference lies in the treatment of imputed interest revenue and cost. Harold Bierman, Jr., has made a refinement in the exposition of the imputed costs and revenues as shown in Table 7.

Note that in Table 7, column 2 represents the present value of net economic benefit discounted back to the date of acquisition. These figures are considered to be independent investments (or inventories) which will be consumed during the four year period according to the sequence indicated. Under the discounted present value at the acquistition date method, the imputed interest on each investment is recognized only when the investment (inventory) is consumed. Thus the first investment is consumed in the first year and earns $91 interest. The second investment is consumed in the second year and earns $174 interest, and so forth. On the other hand, the time-adjusted method recognizes the imputed interest on all investments, whether realized or not. Thus in the first year the interest earned on all investments is $317 (see column 3). In the second year, there are only three investments left and the interest revenue is $249 (see column 5).

While the time-adjusted method is commonly used in the lending institutions, the application of this method (i.e., the recognition of the unrealized interest) to the investment in depreciable assets requires further consideration. There are differences between the investment in assets and the lending of money. First, the interest on a loan is based on the passage of time whereas the profit from the investment of assets is dependent on the usage of the assets. The Accounting Principles Board has

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12. Vatter, William J., "Income Models, Book Yield, and Rate of Return," The Accounting Review (October, 1966), p. 696.

Table 6

Depreciation and Net Operating Income Using Time-Adjusted Method

Year	Company A				Company B			
	Book Value	Net Operating Income (15 %)	Net Economic Benefit	Depre-ciation	Book Value	Net Operating Income (7.13%)	Net Economic Benefit	Depre-ciation
1	$5,000	$ 750	$1,250	$ 500	$5,000	$ 356	$ 938	$ 582
2	4,500	675	1,175	500	4,418	315	880	565
3	4,000	600	1,100	500	3,853	275	825	550
4	3,500	525	1,025	500	3,303	236	769	533
5	3,000	450	950	500	2,770	197	712	515
6	2,500	375	875	500	2,255	161	656	495
7	2,000	300	800	500	1,760	125	600	475
8	1,500	225	725	500	1,285	92	544	452
9	1,000	150	650	500	833	59	488	429
10	500	75	575	500	404	27*	431	404
		$4,125	$9,125	$5,000		$1,843	$6,843	$5,000

*Adjusted for rounding error.

Table 7

Computation of Imputed Interest Costs and Revenues*

1	2	3	4	5	6	7	8	9	10
Period	Basic Investment	Interest Year 1 (2 x 10%)	Investment Plus Interest (2+3)	Interest Year 2 (4 x 10%)	Investment Plus Interest (4+5)	Interest Year 3 (6 x 10%)	Investment Plus Interest (6+7)	Interest Year 4 (8 x 10%)	Interest Cost (3+5+7+9)
1	$909	$91							$ 91
2	826	83	$909	$91					$174
3	751	75	826	83	$909	$91			249
4	683	68	751	75	826	83	$909	$91	317
Interest	Revenue	$317		$249		$174		$91	$831

*Adapted from Harold Bierman, Jr., Financial Accounting Theory, 1965, p. 123.

stated that "earnings arise from the use of facilities, not from their acquisition."[13] Second, the risks and rewards of ownership of assets are different from the credit risk in a loan. This difference is the primary criterion for the lessor to select the financing or operating method in accounting for the leased properties and revenues.[14] If the risks and rewards of ownership are passed to the lessee, the lease should be accounted for on the financing method. On the other hand, if the lessor retains the risks and rewards of ownership, the leasing activities should be accounted for on the operating method.

MEASURING MANAGEMENT PERFORMANCE - THE KEY TO THE SELECTION

Aside from the controversy over whether unrealized interest on investment should be recognized, perhaps a more basic question is whether the interest factor should be taken into consideration at all. While it is true that in making the investment decision management has to consider the rate of return on investment, once the investment is committed, what the management purchases is an asset item with physical substance and certain service capacities. The management performance should be evaluated based on how it effectively uses the physical asset. When the services rendered by an asset are the same in each year, the values and costs of the services must also be the same regardless the asset's condition.

Under the time-adjusted method, a decreasing income from using the asset would result as shown in column 3, Table 5. Suppose a plant manager is charged with using this machine and all net economic benefit is transferred to the headquarters every year. It would be highly difficult to understand why the manager used the same machine with the same capacity and efficiency and generating the same amount of revenues yet the operating income decreases every year. Suppose manager A uses this machine in the first year and manager B uses this machine in the fourth year, all physical and operating conditions are the same, but the former reports a $317 income

13. American Institute of Certified Public Accountants, Accounting Principles Board, "Accounting for the Investment Credit," Accounting Principles Board Opinion No. 2 (1962).

14. American Institute of Certified Public Accountants, Accounting Principles Board, "Accounting for Leases in Financial Statements of Lessor," Accounting Principles Board Opinion No. 7 (1966)

and the latter only $91. Is this a good measure of management performance?

It may be argued that a fund equal to the annual depreciation may be invested by the top management to earn revenues. In order to compensate for this revenue in the later years the depreciation in the early years should be reduced by the amount of expected revenues from the new investment. However, as previously pointed out, from the entire company's point of view, an amount equal to the annual depreciation may be required to replace the retired assets in order to maintain the same level of operating income. There would be no funds available for new investment that could increase the overall income. Even though the asset needs no replacement and a fund equal to the depreciation could be used for new investment, the management performance on the new investment should be evaluated separately.

One important point which is often overlooked in evaluating management performance is that, once the investment is committed, management is not to be rewarded or penalized for maintaining what is originally expected. The management is evaluated against a performance standard, which may be the last year's performance or a target performance. If the operating conditions are the same as that of last year or as expected, management is rewarded only for outperforming the standard. With this basis we can see how a misleading conclusion may be reached if management is evaluated based on the ROI and operating income as computed under the time-adjusted method.

Suppose company A and company B each purchased a machine costing $ 3,169 which is expected to generate a net revenue stream of $1,000 each year over the four-year period. The expected depreciation and operating income are shown in Table 5. Suppose further that during the first year company A's management outperformed the standard and generated a net revenue of $1,200. This could happen because of better pricing or promotional strategy, better production scheduling, improved labor relations and morale, etc. Suppose that the same is true for company B in the fourth year. The expected and actual operating income and ROI for the two companies are shown in Table 8.

Note in Table 8 that the net economic benefits were both increased from $1,000 to $1,200, which represent the same efforts and accomplishments of the two companies' management. However, company B's ROI increased from 10% to 32.01% whereas company A's ROI only increased 6.31%. In terms of net operating income, company A's increase from $317 to $517 (a 63% increase) certainly is less impressive

than company B's increase from $91 to $291 (a 220% increase). Should company B's management be rewarded more than company A's?

It should be pointed out that the ability of management to increase net economic benefit is totally unrelated to how much capital is tied in the asset. As long as the physical and operating conditions are the same, management is in the same position regardless whether the asset has $3,169 or $909 book value. The arguments against the time-adjusted method in the section apply equally well to the allocation method based on the discounted present value at the date of acquisition.

Table 8

The Net Operating Income and ROI Under the Time-Adjusted Depreciation Method

	Company A (First Year)		Company B (Fourth Year)	
	Expected	Actual	Expected	Actual
Net economic benefit	$1,000	$1,200	$1,000	$1,200
Depreciation	683	683	909	909
Net operating income	$ 317	$ 517	$ 91	$ 291
Book value at beginning of year	$3,169	$3,169	$ 909	$ 909
ROI	10%	16.31%	10%	32.01%

If the allocation method based on a constant cost to net economic benefit ratio is used, the net operating income from using the asset would be the same every year if the net economic benefit is constant. The reported actual net operating income in the above example would be $408 (actual net economic benefit $1,200 - depreciation $792) as compared to the expected net operating income of $208 for both companies. The percentage increase of net operating income is the same for both companies, which is a better indicator of the relative management efficiency between the two companies.

In summary, from the standpoint of measuring the management performance, the allocation based on a constant cost to benefit ratio method appears to be the best of all allocation methods.

Table 9

Depreciation and Net Operating Income Under Different Economic Benefit Patterns and Allocation Methods 10% Rate of Return

Constant Cost to Benefit Ratio

Year	Straight-Line			Sum-of-Year's-Digits		
	Economic Benefit	Depre-ciation	Operating Income	Economic Benefit	Depre-ciation	Operating Income
1	$1,000	$792	$208	$1,526	$1,267	$259
2	1,000	792	208	1,146	951	195
3	1,000	792	208	764	634	130
4	1,000	793	207	382	317	65
Total	$4,000	$3,169	$831	$3,818	$3,169	$649

Discounted Present Value at Acquisition Date

Year	Straight-Line			Sun-of-Year's-Digits		
	Economic Benefit	Depre-ciation	Operating Income	Economic Benefit	Depre-ciation	Operating Income
1	$ 871	$792	$ 79	$1,394	$1,267	$127
2	958	792	166	1,151	951	200
3	1,054	792	262	844	634	210
4	1,161	793	368	464	317	147
Total	$4,044	$3,169	$875	$3,853	$3,169	$684

Time-Adjusted Method

Year	Straight-Line			Sun-of-Year's-Digits		
	Economic Benefit	Depre-ciation	Operating Income	Economic Benefit	Depre-ciation	Operating Income
1	$1,109	$792	$317	$1,584	$1,267	$317
2	1,030	792	238	1,141	951	190
3	951	792	159	729	634	95
4	872	793	79	349	317	32
Total	$3,962	$3,169	$793	$3,803	$3,169	$634

THE RELATIONSHIP BETWEEN THE ALLOCATION METHOD AND THE DEPRECIATION METHOD

The three cost allocation methods discussed above could result in any one of the depreciation methods commonly used in the business firms depending on the net economic benefit pattern of the asset. Table 9 illustrates this situation. A machine costing $3,169 is purchased. The machine is expected to generate a rate of return of 10% over the projected four-year useful life. Depending on the net economic benefit and the allocation method used, the straight-line or sum-of-the-year's-digits method is appropriate.

The use of alternative depreciation methods has long been criticized for causing the financial statements incomparable. Comparability of financial statements requires that the same accounting principle or method be used under the same economic conditions. In depreciation accounting, two companies with different net economic benefit patterns may use the same depreciation method because different allocation methods are applied (e.g., see the straight-line depreciation under the constant cost to benefit ratio method and the time-adjusted method in Table 9). The financial statements of the two companies would not be comparable. On the other hand, if different depreciation methods are applied to the same net economic benefit pattern, the resulting financial statements would also be not comparable.

At the present time, it is not known which one of the three allocation methods is followed by business firms. George Terborgh has argued vigorously from both the theoretical and empirical grounds that the capital value (time-adjusted method) of machinery and equipment declines, on the average, about one half during the first one-third of their economic lives and two-thirds during the first one half of useful lives.[15] This decline pattern corresponds roughly to the accelerated depreciation charges. If this were true, the implication would be that under the time-adjusted method one of the accelerated depreciation methods should be used. However, according to a survey conducted by the writer, 77% of the 134 responding firms indicated a relatively constant net economic benefit pattern. This leaves the possibility that both the constant cost to benefit ratio and the time-adjusted methods are

15. Terborgh, George, Realistic Depreciation Policy (Chicago, Ill.: Machinery and Allied Products Institute, 1954), chapters 4 abd 5.

used in the straight-line depreciation firms.

In summary, comparability of financial statements requires, in the depreciation accounting, that (1) the net economic benefit pattern of the depreciable assets be determined, and (2) only one cost allocation method be used. The use of different depreciation methods does not necessarily impaire the comparability.

SUMMARY

The purpose of this paper was to evaluate the cost allocation methods of depreciable assets and to suggest the choice among them. Three cost allocation methods have been evaluated. The constant cost to benefit ratio method matches the efforts with the accomplishments, management performance on using the asset is not distorted. The major disadvantege of this allocation method is that it results in an increasing rate of return on investment over the asset's life. However,it was shown that the fluctuation was not as wide as was criticized. Besides that, the usefulness of a constant ROI is subject to severe limitations.

The discounted present value of the net economic benefit back to the date of acquisition method ignores the fact that when the services of the asset are used, they have the same value regardless when the asset was purchased. This method also results in an incresasing net operating income and rate of return on investment which appears to be unreasonable from the standpoint of measuring management performance.

The most distinguishing feature of the time-adjusted method is that it results in a constant rate of return on investment over the asset's useful life. However, it was shown that the evaluation of management performance and the investment decision could be misled if the ROI is primarily relied upon. This method distorts the net operating income from using the asset and may result in a negative depreciation.

In summary the constant cost to net economic benefit ratio method appears to be the most appropriate cost allocation method.

The relationship between the depreciation methods and the cost allocation methods was also examined. It was determined that the comparability of financial statements requires that only one cost allocation method, not depreciation method, be used. The depreciation method should be determined by applying the cost allocation method to the net economic benefit pattern of the asset.

BIBLIOGRAPHY

American Institute of Certified Public Accountants, Accounting Principles Board, "Accounting for the Investment Credit," Accounting Principles Board Opinion No. 2 (1962)

————. "Accounting for Leases in Financial Statement of Lessors," Accounting Principles Board Opinion No.7 (1966).

Bierman, Harold, Jr., "Depreciable Assets - Timing of Expense Recognition," The Accounting Review (October, 1961), pp. 613-618.

Davidson, Sindey, "Depreciation, Income Taxes and Growth," Accounting Research (July, 1957), pp. 185-204.

Dixon, Robert L., "Decreasing Charge Depreciation - A Search for Logic," The Accounting Review (October, 1960), pp. 590-597.

Hendriksen, Eldon S., Accounting Theroy, revised ed. (Richard D. Irwin, 1970).

Johnson, Orace, "Two General Concepts of Depreciation," The Journal of Accoun-Research (Spring, 1968), pp.29-37.

Lorig, Arthur N., "On the Logic of Decreasing Charge Depreciation," The Accounting Review (January, 1962), pp. 56-58.

Meij, L., ed., Depreciation and Replacement Policy (Quadrangle Books, 1961).

Reynolds, Isaac N., "Selecting the Proper Depreciation Method," The Accounting Review (April, 1961), pp. 240-243.

Solomon, Ezra. "Return on Investment: The Relation of Book Yield to True Yield," in Ijiri, Y., Jaedicke, R., and Nielsen, O., eds., Research in Accounting Measurement (American Accounting Association, 1966), pp. 232-244.

Terborgh, George, Realistic Depreciation Policy (Machinery and Allied Products Institute, 1954).

Vatter, William J., "Income Models, Book Yield, and Rate of Return," The Accounting Review (Octorbe, 1966), pp. 681-698.

Zeff, Stephen A., "Discussion Comments," in Ijiri, Y. et al. eds. Research in Accounting Measurement (American Accounting Association, 1966), pp. 249-254.