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The Panacea of Annuity Depreciation

Abstract

This paper examines the validity of the argument that symmetry between capital-budgeting-decision making and post-performance evaluation can be achieved by the use of annuity depreciation. The examination was made by comparing the results for a given investment project under varying sets of rename or cash flows using the annuity and straight-line depreciation methods. The findings suggest that the attributes claimed by the proponents of the annuity scheme of depreciation do not stand the tests made.

It would be ideal to have the model used for capital-budgeting-decision making on the same wave length as the one used to appraise subsequent performance of those managing the assets acquired. But the usual practice is to base capital investment decisions on discounted cash flow, present value or models and to use accrual accounting data for post-performance evaluation purposes.

This type of inconsistencies often leads to dysfunctional managerial behavior. For example, a manager may hesitate or even may be opposed to make an investment that may be very well justified by present value or similar methods, but that he knows will generate an unsatisfactory performance record for some years by the accrual accounting techniques. This is especially true if the outflow of funds is subject to immediate write-off or to straight-line or accelerated-depreciation methods. An interested example that is often cited is the one related to leasing. A division manager may improve his or her performance record by leasing assets instead of buying them. But from the whole company's standpoint, it might be less costly to buy the assets.

Even if the investment is made, the corresponding manager might be dysfunctionally inclined to cut other costs (as product advertising, preventive maintenance, process improvement, and the like) to offset the short-run negative income effects of a particular depreciation method. The result might be greater short run profits at the expense of long run profitability.

Proposed Solution

As a possible solution for this kind of inconsistencies between capital investment decision-making and accrual accounting models, the annuity method of accounting for the depreciation charge is proposed in the accounting literature. Some writings even imply that this is not only the right prescription for this malady, but that this is the cure itself. For instance,the following type of suggestion is common.

There is something inherently strange about the view that it is right to include fixed assets in a balance sheet at their depreciated value, but wrong to include the fixed assets at that depreciated value in a computation of capital. The only reason for holding such a view is the irrational behavior of the rate of return on investment when fixed assets are taken at book value rather than at cost. The proper *remedy* is to be found in the use of a compound *interest method of depreciation*, not in the abandonment of book value as a basis for valuing investment. If depreciation were handled in a theoretically *correct manner* i.e., by the *compound interest method*) the decline in the book value of depreciating assets would not of itself disturb the *stability* of the rate of return on investment. (Emphasis is added).

Professor's Anthony *solution* to this dilema is equivalent to that suggested in the above quote. He suggests (1) to use a depreciation method that matches the implicit recovery of the investment, and (2) to make a charge for the use of capital as an element of cost. The annuity depreciation method, according to him, is the indicated one to accomplish the proposed solution.[1]

The purpose of this paper is to examine, by experimentation, whether or not the annuity depreciation method adheres to the attributes claimed by its proponents, and under which circumstances it might be a proper tool.

Objective

As it claimed, the striking feature of the annuity depreciation method is that it produces a constant rate of return while others, like the straight-line depreciation method, generate an increasing or erratic rate of return. It is correct that if certain very specific conditions are met, the

annuity depreciation method, will yield a constant rate of return on investment. But to accomplish this objective the actual revenues associated with a particular asset must represent a certain cash flow; any capital charge rate must be constant.

Basic Examples

The following example illustrates a set of conditions under which the method will work. This example is based on the assumptions that an asset is acquired for $37,910, a capital charge of 10 percent is made every year (based on the beginning of year balance of the asset), that there is a certain and constant stream of forecasted revenues, $10,000, related to this specific asset, that the revenue stream has the same duration as the useful life of the asset, and that the depreciation charge is calculated following the annuity or compound interest method. The decision criterion in this case is the required rate of return, 10 percent. Since the present value of the revenue stream, discounted at 10 per cent, is equal to the cost of the asset, the investment is expected to yield this rate.

TABLE 1
FORECASTED RESULTS FOR CONSTANT REVENUE PATTERN

Year	Asset Bal.. Beg. of Yr	Revenues	Capital Charge	Depr'n. Charge	Rate of Return
1	$37,910	$10,000	$3,791	$6,209	10%
2	31,701	10,000	3,170	6,830	10%
3	24,871	10,000	2,487	7,513	10%
4	17,358	10,000	1,736	8,264	10%
5	9,094*	10,000	909	9,901	10%

**There is still a $3 balance due to rounding.*

In table 1, the rate of return was determined by dividing the hypothetical net income (Revenues minus Depreciation Charge) by the beginning-of-year balance of the asset. Because of the assumptions made,the rate of return obtained in this example is equal to the capital

charge rate, 10 percent, and the net income is equal to the amount of the corresponding annual capital charge. Thus, the post-performance record is identical to the decision criterion, i.e., 10 percent.

This is the usual type of example given in the accounting literature to highlight the virtues of the annuity or compound interest scheme as the correct depreciation method for performance measurement of capital investments.

Methodology

To examine the validity of the argument that the use of annuity depreciation yields a post-performance record similar to the expectations of the capital investment proposal, a series of comparative experiments was developed. The basic changing element of the comparisons made was the cash flow stream, beginning with a constant set, described above, and the use of your different increasing, and decreasing bell-shaped flows for four different patterns. In each of the cases analyzed the original investment cost remains constant and is equal to the present value of the assumed revenue or cash flows, discounted at a 10 percent rate of return.

EXPERIMENT 1

TABLE 2
COMPARATIVE RESULTS FOR INCREASING REVENUE PATTERN

Year	Asset Bal. Beg. of Yr.	Revenues	Capital Charge	Depr'n Charge	Income (Loss)	*Rate of Ret'n* Ann'ty Depr'n	S-line Depr'n
1	$37,910	$ 3,966	$3,791	$6,209	($2,243)	-5.9%	-9.5%
2	31,701	5,000	3,170	6,830	(1,830)	-5.8%	-8.5%
3	24,871	10,000	2,487	7,513	2,487	10.0%	10.6%
4	17,358	15,000	1,736	8,264	6,736	38.8%	48.9%
5	9,094*	20,000	909	9,091	10,909	120.0%	136.6%

*There is still a $3 balance due to rounding.

As Table 2 shows, the rate of return based on the annuity method of depreciation depicts an increasing pattern similar to the revenue flows assumed. The rate of return based on the straight-line depreciation

method also describes an increasing pattern, but of a more dramatic nature. Table 3 contains the basic data for the straight-line depreciation method. Although the second rate is more erratic than the first, the questions that arise are: How more useful is the first method vis-a-vis the second for the purpose of depicting a performance record? How more consistent are the data generated by one method or the other with the data used to make the decision to buy the asset based on the promise to yield a 10 percent rate on the investment? The data generated by the first method are as useless as that of the second for the purpose indicated. The results would have been even more erratic if the present value of the actual flows discounted at 10 percent were greater or smaller than the asset cost. These might run very wild and the assymetry asset would be compounded in the usual situation of entities with groups of assets acquired at different dates, with different useful lives and fluctuating actual revenue streams, a situation which despicts the different revenue flows from those projected when the investment decisions were made. To test this point, however, the case of a single asset with different revenue patterns is enough.

TABLE 3
DATA FOR STRAIGHT-LINE-DEPRECIATION METHOD
(INCREASING REVENUE PATTERN)

Year	Asset Bal. Beg. of Yr.	Revenues	S-Line Depr'n	Income (Loss)
1	$37,910	$ 3,966	$7,582	($3,616)
2	30,328	5,000	7,582	(2,582)
3	22,746	10,000	7,582	2,418
4	15,164	15,000	7,582	7,418
5	7,582	20,000	7,582	12,418

EXPERIMENT 2

The same conclusions can be made by observing the results included in Table 4. In it the revenue flow pattern was changed to a decreasing one. The rate of return based on the annuity-depreciation method was determined following the same procedure followed in the two

previous cases. A rate of return based on the straight-line depreciation method was also included. Table 5 summarizes the basic figures used to determine the latter rate of return.

TABLE 4
COMPARATIVE RESULTS FOR DECREASING REVENUE PATTERN

Year	Asset Bal. Beg. of Yr.	Revenues	Capital Charge	Depr'n Charge	Income (Loss)	*Rate of Ret'n* Ann'ty Depr'n	S-line Depr'n
1	$37,910	$16,000	$3,791	$6,209	$9,791	25.8%	22.2%
2	31,701	15,000	3,170	6,830	8,170	25.8%	24.5%
3	24,871	8,000	2,487	7,513	487	2.0%	1.8%
4	17,358	5,000	1,736	8,264	(3,264)	-18.8%	-17.0%
5	9,094*	2,500	909	9,091	(6,591)	-72.5%	-55.9%

*There is still a $3 balance due to rounding.

TABLE 5
DATA FOR STRAIGHT-LINE-DEPRECIATION METHOD
(DECREASING REVENUE PATTERN)

Year	Asset Bal. Beg. of Yr.	Revenues	S-Line Depr'n	Income (Loss)
1	$37,910	$16,000	$7,582	$8,418
2	30,328	15,000	7,582	7,418
3	22,746	8,000	7,582	418
4	15,164	5,000	7,582	(2,582)
5	7,582	2,500	7,582	(5,082)

EXPERIMENT 3

The rates of return included in Table 6, as well as the results of Table 7, are based on the additional assumption that the revenue flows first increase and then decrease describing more or less a bell-shaped curve. The rate of return figures based on the annuity-depreciation method describe the same pattern very closely while those based on the straight-line-depreciation method are more of an eschewed nature.

TABLE 6
COMPARATIVE RESULTS FOR BELL-SHAPED REVENUE PATTERN

Year	Asset Bal. Beg. of Yr.	Revenues	Capital Charge	Depr'n Charge	Income (Loss)	*Rate of Ret'n* Ann'ty Depr'n	S-line Depr'n
1	$37,910	$ 3,125	$3,791	$6,209	($3,084)	-8.1%	-11.8%
2	31,701	12,000	3,170	6,830	5,170	16.2%	14.6%
3	24,871	20,000	2,487	7,513	12,487	50.0%	54.6%
4	17,358	12,000	1,736	8,264	3,736	21.5%	29.1%
5	9,094*	3,125	909	9,091	(5,966)	-65.0%	-58.8%

*There is still a $3 balance due to rounding.

TABLE 7
DATA FOR STRAIGHT-LINE-DEPRECIATION METHOD
(BELL-SHAPED REVENUE PATTERN)

Year	Asset Bal. Beg. of Yr.	Revenues	S-Line Depr'n	Income (Loss)
1	$37,910	$ 3,125	$7,582	($4,457)
2	30,328	12,000	7,582	4,418
3	22,746	20,000	7,582	12,418
4	15,164	12,000	7,582	4,418
5	7,582	3,125	7,582	(4,457)

EXPERIMENT 4

The revenue flow pattern assumed in obtaining the rates of return of Table 8 is a decreasing one,but at a very slow pace. In this case the two rates of return (the one based on the annuity method and the one based on the straight-line method) are equal. The conclusion is that in this type of case one method may be as good as the other if the revenue flow pattern assumed is experienced in practice. Thus, the comparison that is often made of these two methods to highlight the virtues of the first one as opposed to the other may not be more than an academic exercise. In sum, the truth is that any method might be as good as any other depending on the pattern of the actual revenue stream.

TABLE 8
COMPARATIVE RESULTS FOR SLOW-DECREASING REVENUE PATTERN

Year	Asset Bal. Beg. of Yr.	Revenues	Capital Charge	Depr'n Charge	Income (Loss)	*Rate of Ret'n* Ann'ty Depr'n	S-line Depr'n
1	$37,910	$11,373	$3,791	$7,582	$3,791	10.0%	10.0%
2	30,328	10,615	3,033	7,582	3,033	10.0%	10.0%
3	22,746	9,857	2,275	7,582	2,275	10.0%	10.0%
4	15,164	9,098	1,516	7,582	1,516	10.0%	10.0%
5	7,582	8,340	758	7,582	758	10.0%	10.0%

Note: The Income (Loss) figures are identical for both depreciation methods.

Other Aproaches

The implications of the above-indicated conclusion seem to have been the triggering element which moved Barnea and Bierman to adopt a revised definition of depreciation. They define a period's depreciation expense of an asset as the decrease in the value of the asset during the period.[4] This definition offers nothing new, for that is a generally accepted concept of depreciation in theory. But what might be considered new is their approach to measure the depreciation charge. For their method, the depreciation charge is taken as the difference between the annual revenue related to a specific asset and capital charge as previously defined. In such a case the method will always yield a constant rate of return no matter what the pattern of revenues is. But one must be able to identify the specific revenues of specific asset in order to make the corresponding relationship. Very few cases in the real business world satisfy this very restrictive requirement. There may be some situations in which it might be partially satisfied, like rental properties and individual revenue-producing assets. But this type of cases seems to be more the exception than the rule. Ferrara et al. suggest the use of the cash flow method as one possible approach for performance evaluation purposes. The application of their method is in essence similar to Anthony's suggestion.[5]

A speculative kind of conclusion that comes to mind is that probably the usual reasons adduced for not accepting of the annuity-depreciation method in practice are not the only, and may not be the true, ones. The accounting literature indicates that this method is not used because it produces an increasing charge over the life of the asset and that, intuitively, managers do not see the justification for an increasing charge for depreciation if cash flows remain constant or decline. It is added that the implicit principal recovery pattern is more difficult to compute and explain if projected cash flows differ markedly through the years.[6] It is our contention that the method has not been accepted not only for these reasons, but because its findings in practice do not correspond with the theoretical assumptions of the model and because, in practice, cash flow forecasting under conditions of uncertainty is the crux of the capital budgeting problem.[7]

Summary and Conclusions

It has been argued throughout this paper that the present value or annuity method of accounting for the depreciation charge is not necessarily the solution or the remedy as claimed by some proponents for offsetting the inconsistencies that exist between cash flow models for decision making and accrual or financial accounting methods for performance evaluation purposes. It has been shown that the straight-line method, as a comparative example, can be as good or bad as the annuity method for these purposes depending on the revenue flow pattern associated with a particular investment. Possibly any other depreciation method might do as well or bad in this respect. This suggests that there is much to be learned by management accountants to bring harmony between financial accounting techniques and managerial needs in order to enhance managerial goal congruence.

The suggested solution does not stand the test of a single asset with uneven flow patterns, much less the test of multiple investments with different useful lives and varying streams, which represent a common combination of capital investment elements for ordinary business entities. The suggested solution considers the scheme of annuity depreciation though, in the case of a single investment with a certain revenue flow and a life equal to the one used when the purchasing decision was made.

The suggestion made by Barnea and Bierman to redefine the depreciation charge of any period as the difference of the actual revenue and capital charge may be of little usefulness because of the usual difficulty, or impossibility, to identify specific revenues with specific assets in most situations in practice. It can be of some value in those cases in which it is practical and feasible to establish such relationship.

The annuity depreciation method is not accepted in practice, not necessarily for the reasons adduced in the accounting literature, but because its virtues do not stand up to the expectations of its most vigorous proponents. In brief, the method is not the panacea suggested in some writings.

Finally, the conflict alluded in this paper could be better approached, as suggested by Ferrara et al., by evaluating and rewarding specific persons in terms of their actual achievements vs. their own expected performance, and not on the basis of the minimum performance applicable to all personnel and projects.

Notes

1. William L. Ferrara et al., *Managerial Cost Accounting: Planning and Control*, p.606.
2. David Solomons, *Divisional Performance: Measurement and Control*, p.135.
3. Robert N. Anthony, et al., *Management Control Systems*, pp. 281-82.
4. Amir Barnea and Harold Bierman, Jr., "Cash Flow Valuation and Depreciation" *Accounting and Business Research*, pp. 193-96.
5. Ferrara, pp. 608-10.
6. Eldon S. Hendriksen, *Accounting Theory*, pp. 378-79; and Maurice Moonitz and Louis H. Jordan, "Accounting: an analysis of its problems," pp. 392-93.
7. Luis A. Berríos Burgos, "*The Association Between Payback and Internal Rate of Return in Product-Life-Cycle Models.*" p. 142.
8. Ferrara, p. 608.

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