THE INFLUENCE OF RESIDUAL VALUES IN CAPITAL EXPENDITURE DECISIONS

By

JAMES IO ALCOCK

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Oklahoma State University

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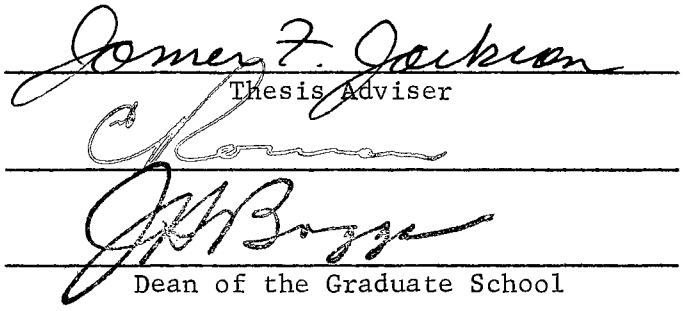

Thesis Adviser

Dean of the Graduate School

PREFACE

This report is intended to supply information on the subject of capital expenditures. Specifically, the information provided deals with residual values and their influence on investment decisions. Although some previous knowledge concerning capital expenditures is assumed, the report is aimed at the uninitiated. In other words, residual values and their influences are investigated and discussed in detail.

I would like to acknowledge Dr. James F. Jackson, the chairman of my report committee. His untiring assistance and useful advice were very valuable to me when preparing and finishing the report. I would also like to acknowledge my fellow graduate students whose support and advice aided my writing. Mrs. Sally Phelps and Miss Linda Hoefer receive special mention for their typing and editing.

Obviously, however, any mistakes or erroneous conclusions occurring in the report can be attributed to me.

TABLE OF CONTENTS

Chapter — Page

I. INTRODUCTION 1

II. RECOVERY OF CAPITAL 4

- Sources 4
- Economic Significance 6
- Factors Influencing Significance 9
- Background 11
- Omission 11
- Viewpoint of Bierman and Smidt 14
  - Leasing 18
  - Salvage Value 20
- Summary 21

III. INFLUENCE OF RESIDUAL VALUES 22

- Economic Life 22
- Rate of Return 26
- Depreciation 29
- Taxes 33

IV. SPECIAL ASPECTS OF RESIDUAL VALUES 35

- Determination of Residual Values 35
- Residual Value of Present Equipment 37
- Residual Value and Leasing 39

V. CONCLUSION 41

SELECTED BIBLIOGRAPHY 43

LIST OF TABLES

Table		Page
I.	Negative Residual Value	8
II.	Omission of Material Residual Value	13
III.	Relative vs. Absolute Cash Flows	16
IV.	Determination of Economic Life	26
V.	Residual Value and Rate of Return	27
VI.	Increase in Economic Life and Rate of Return	28
VII.	Discount Rate and Residual Value	29

LIST OF ILLUSTRATIONS

Figure		Page
1.	Economic Depreciation	25

CHAPTER I

INTRODUCTION

Capital expenditure analysis is a topic that has been very widely discussed during the last fifteen years. Since Joel Dean[1] and George Terborgh[2] discussed their respective methods of analyzing investments, the literature has been overwhelmed with articles dealing with this subject. The literature has dealt with practically every facet of an investment decision. Payoff period, present value method, discounted rate of return, economic life, and leasing provide only a sample of what has been emphasized by many of the authors. Almost every discussion and analysis, however, relates to the main problem in investment analysis. This paramount problem involves determination of the profitability of the investment. This paper provides useful information which can be used to further an analyst's ability to project an investment's profitability.

Specifically, the problem investigated in this paper concerns the influence of residual or terminal values in the analysis of investment alternatives. Before proceeding to the scope of the paper, however, explicit definitions are needed. These definitions will provide a basis for the discussion that follows.

Residual value--Residual value represents any and all cash flows

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[1] Joel Dean, Capital Budgeting (New York, 1951).

[2] George Terborgh, Dynamic Equipment Policy (New York, 1949).

resulting from the termination of the economic life of the asset. These cash flows may be real flows of cash or they may represent the opportunity costs of relegating the asset to a status other than its original one. For the purposes of this paper, terminal and disposable values are synonymous with residual value.

Economic life--Economic life refers to the useful life of the asset. The useful life represents that period between the acquisition of the asset and the time at which the benefits received from the asset in its originally intended use terminate.

Salvage--Salvage value will be used as a type of residual value. It refers to the cash flows occurring when the asset is disposed of in a manner that will lead to some continued use of the asset. In this case the asset continues to perform a service as useful equipment.

Scrap--Scrap value is another form of residual value. In this case the residual value is received from dismantling the asset and disposing of its various parts.

Discount Rate--Discount rate represents the rate at which the cash flows involved in the investment are discounted in order to reduce the flows to present value. The discount rates appropriate for this paper are the cost of capital and the lending rate. The cost of capital is a weighted average of the cost of debt and the cost of equity.[3] The lending rate involves the expected rate of return on equity investments outside of the firm. These investments appear to the entrepeneur to involve

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[3]The writer realizes that controversy does exist concerning the "appropriate" cost of capital. The scope of this paper does not include this dispute. For simplicity's sake, the average cost of capital will be used rather than the marginal cost of capital.

a degree of riskness similar to those contemplated within the firm.[4]

Other definitions will obviously be needed in the text of the paper. The previous definitions, however, provide a starting point for the discussion. Each of the defined terms plays an important role in the investigation of the influence of residual values in investment decisions. Many terms in this paper have not been defined. These terms, ever present in the literature concerning capital expenditures, should be quite familiar.

In determining the profitability of an investment, all the cash flows relating to the investment must be analyzed. One of these cash flows is residual value. In certain instances residual values may have important effects on the profitability of an investment. The purpose of this report is to investigate these effects.

Thus, the economic significance of residual values in investment decisions is thoroughly investigated and analyzed.

The paper evolves in three parts. The second chapter deals with the recovery of capital. This chapter deals with the economic significance of residual values; then it discusses the methods different authorities have used in handling residual values. This chapter provides the background for the paper. The third chapter pertains to the influence of residual values on certain facets of investment decisions. The fourth chapter handles various special aspects of residual values.

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[4]Harry Roberts, "Current Problems in the Economics of Capital Budgeting," Journal of Business, XXX (January, 1957), pp. 11-17.

CHAPTER II

RECOVERY OF CAPITAL

In order to properly evaluate capital expenditure proposals, the cash inflows and outflows relating to the investment must be investigated. When these cash flows are discounted to their present value by the proper discount rate, the profitability of the investment may be determined. Residual values result in one of these cash flows.

Sources of Residual Value

Termination of the economic life of an asset may result in the recovery of capital through cash flows. These residual cash flows may have several different sources. The residual value may produce cash or an opportunity cost value; it may even represent intangible value.[1] In any case residual values represent cash flows which must be considered in evaluating capital expenditures.

The most common residual value occurs through salvage. As the definition stated in the introduction, salvage value results in the equipment receiving some continued use; this use may be external or internal. The value occurs from the resale price or from the opportunity cost value resulting from using the equipment in a manner other than was originally intended. While the resale price value should be obvious, the opportu-

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[1] Gordon Shillinglaw, "Residual Values in Investment Analysis," Journal of Business, XXVIII (October, 1955), p. 276.

nity cost value concept needs to be explained. A simple example would be that of a small power plant that was originally intended to furnish power in an industrial complex. If the small plant were replaced an opportunity cost value could occur. This value would occur if the small power plant served as an auxilliary to its replacement. The value received from using the old plant in this auxilliary fashion represents an opportunity cost value.

Another well-known residual value results from scrapping the asset. However, the value recieved from scrap may be of less importance. This is due to the fact that the cash outflow from dismantling and removing the asset may offset the proceeds from the sale of the scrap. In fact, a negative residual value could occur. This would happen if the cash outflows caused by dismantling and removing the asset exceeded the cash inflow from scrap. Just as in salvage, the scrap value may represent an opportunity cost residual value.

Besides salvage and scrap, residual value may result from several other sources. The commitment of working capital during the life of the investment leads to another form of residual cash flows. Recovery of this form of residual values takes place when the termination of the economic life of the asset reduces the level of operations which releases working capital. The commitment of funds to working capital results from an increase in operating cash balances, accounts receivable, or inventories caused by the acquisition and utilization of the equipment. Once the use of the equipment ceases, the need for working capital decreases and cash inflows occur. This situation often exists when the new equipment increases output or produces a new product.[2]

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[2]Robert Anthony, Management Accounting (Illinois, 1964), p. 629.

Opportunity cost value may be relevant in this situation as well as in salvage and scrap. If the equipment requires extensive use of employees or other company resources, an opportunity cost would exist when the resources were released.

A final source of residual value may be derived from the tax situation. The termination of the economic life of an asset may involve the write-off of undepreciated tax book value. This results in a capital loss. A capital loss of this type can produce tax credits that are just as relevant to the investment's cash flow as are the direct proceeds from salvage or scrap.[3]

Economic Significance

The economic significance of residual values is determined by their relative importance in the investment. This relevance depends on the manner in which the residual values affect the cash flows involved in the last period of the investment. If residual values are relatively large, they can materially affect an investment's worth. An obvious example is a non-wasting asset such as commercial land. Land seldom loses value and often appreciates considerably. The residual values of wasting assets may also be material. An ordinary pickup truck provides a good example of a wasting asset with material residual value. An average pickup truck maintains 20-25 percent of its original value even after five year's use.[4]

On the other hand, however, the residual values of an investment

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[3] Shillinglaw, p. 276.

[4] NADA Official Used Car Guide (October, 1964), p. T-16.

project may be relatively small; thus, they would have only limited affect on the cash flows. Specialized equipment often falls into this category. If the equipment were built to certain specifications (i.e., tailor-made) and did not require extra working capital, its residual values would probably be small when considered as a percent of the original cost. In such a case the residual cash flows realized would be relatively unimportant, and there would be no practical gain from measuring them. The previous example of the pickup truck can also be useful here. If the truck were used 20-25 years instead of five, its residual value would be rather insignificant in evaluating the investment's worth.

Residual values need not always have positive or neutral effects on cash flow. Negative effects are also possible. Negative residual values would occur when the cash outflows resulting from termination of the economic life of the asset exceeded the cash inflows. As was stated earlier, negative values could take place any time removal costs associated with the asset exceeded the scrap value and working capital commitment. This situation, however, probably is not common. Negative residual values could possibly exist in another form--a working capital commitment caused by the termination of a project. Just as an investment could increase the need for working capital, an efficiency investment could decrease the requirement for working capital.[5] If the acquisition and utilization of an asset decreased working capital, termination of the asset's life would require more working capital. Consequently, cash outflow would increase in the last period and a negative residual value could occur. Table I

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[5]Harold Bierman and Seymour Smidt, The Capital Budgeting Decision (New York, 1961), p. 115.

illustrates a situation of this type.

TABLE I

NEGATIVE RESIDUAL VALUE

Year	Cash Inflows	Cash Outflows	(10%) Present Value of Cash Flow
0		50,000	(50,000)
0-1	18,000		16,200
1-2	18,000		14,860
2-3	18,000		13,500
3-4	18,000		12,290
4-5	18,000		11,160
5-6		18,000	(10,200)
		Net Present Value =	$ 7,790

In this illustration an accounting computer can be purchased for $50,000. This computer will release four bookkeepers earning a total of $18,000 per year. The economic life of the asset is five years and assume no salvage or net scrap values. Also, assume a 10 percent discount rate. As the table illustrates, utilization of the computer reduces the payroll by $18,000 per year. Termination of the economic life, however, requires the reinstatement of the four bookkeepers. Thus, negative residual values occur and the present value of the investment is reduced by $10,200. This negative residual value resulted from an increase in the commitment of working capital at the end of the economic life of the asset. The economic significance of negative residual values may be limited in a series of investments in which the working capital requirement is continually lower. For disjunctive investments, however, negative residual values may be as pertinent as positive values.

Factors Influencing Significance

The influence of residual values on the profitability of an investment depends on materiality; this materiality is dependent upon certain characteristics of the investment. One of these influential factors has already been mentioned. This factor is the classification of the cash outlay for the investment. Cash outlay can be classified as (1) an expense of the period, (2) a wasting asset, or (3) a nonwasting asset.[6] Obviously, a cash outlay that is an expense of the period would have no residual value. Residual value can occur, however, in the other two classifications, wasting and non-wasting. A perfectly non-wasting asset would have complete residual value in the form of salvage while a perfectly wasting asset would have no residual value. For practical purposes, most industrial assets fall between the two extremes. Although the position of the asset on the wasting-nonwasting scale through the economic life may be dependent on other factors, the original materiality of salvage value depends on this wasting-nonwasting characteristic of the asset.

Another characteristic of assets greatly influencing the materiality of residual values is their economic life. As the economic life of assets increase, the materiality of the residual values decrease.[7] There are two reasons for this relationship. First and obviously, as the age of the asset increases, salvage value decreases due to natural obsolescence and deterioration; the greater the age, the less is the salvage

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[6] Ibid., p. 102.

[7] This relationship deals with that practical range of assets that fall between nonwasting and completely wasting.

value. Second and more important in investment analysis is the fact that as the periods containing cash flows accumulate, the present value of the last period's cash flow decreases. With a different assumption, the first example will illustrate this point. If the economic life of the computer were 20 years instead of five, the negative residual value would be reduced to $2,600. This figure is relatively insignificant when compared to the five-year residual value figure of $10,200 and an investment of $50,000.[8]

A final characteristic of an investment influencing the materiality of residual values in an analysis concerns the discount rate. As the discount rate increases, the materiality of residual values decrease. With high discount rates the present value of residual cash flow is obviously less than the value at low discount rates. In the previous computer example, assume a 25 percent discount rate rather than the 10 percent rate. The residual cash flows would then be reduced from $10,200 to $5,750. Thus the materiality of the residual value decreased significantly. This property may be unimportant when the net present value method of investment analysis is used; this is based on the idea that the cost of capital or lending rate, whichever is used, is usually relatively low. In investment analysis using the rate of return method, however, the discounting rate is usually much higher and may reduce the present value of the residual cash flows substantially.[9] Therefore, the materiality of

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[8]This example may seem impractical as few $50,000 investments result in cash flows as large as $18,000 in the 20th year. It does explain the point however.

[9]This would assume a profitable investment of 15-25 percent. See Shillinglaw, pp. 279-280, for an example of the lack of economic significance of residual values in an investment with a high rate of return.

residual values is often more important in a net present value analysis than in a rate of return analysis.

In summary, the economic significance of residual values is relevant and dependent upon materiality of the cash flows in the last period. The nature of the asset, its economic life, and the discount rate involved in the analysis determine materiality. Again it should be emphasized that if materiality does not exist, no practical gain results from computing residual values.

Background

In the next chapter the materiality of residual values will be discussed and specific effects demonstrated. The discussion will center around residual value's influence on the economic life of the investment, the rate of return and cash flows, depreciation method, and tax considerations. Before proceeding to that discussion, however, a survey of the literature might be helpful. This survey will be aimed at demonstrating various methods by which residual cash flows are handled. From these methods a basic position will be taken and used as background for the analysis in the third chapter.

Omission

Residual values often receive inadequate attention in investment analysis. Furthermore, this attention is usually limited to a brief discussion of salvage or possibly scrap value. Both the practitioner and theoretician participate in this mistake. The continual use of the payback method of analysis demonstrates the practitioner's mission of termi-

nal value.[10] Payback analysis focuses on the number of years required for an investment to pay for itself. Among other fallacies the payback method completely ignores terminal values. To substantiate the theoretician's omission of residual values, one just has to examine the literature concerning capital expenditures. Frequently, residual values are evaded through statements concerning their immateriality.

The factors leading to this neglect have been well summarized by Shillinglaw. Residual values are often omitted because:

> (1) the economic life is frequently so long and the ultimate dollar realization so far away that these future values have very little effect on present investment decisions;
> (2) the probable residual value is so low that it can safely be ignored;
> (3) the available data do not provide an adequate basis for forecasting;
> (4) the future is so uncertain that changing times may wipe out whatever values now seem probable.[11]

Besides these factors, another reason seems eminent in investigating the practitioner's neglect. The practitioner will often ignore residual values because he does not realize that working capital commitment, opportunity cost values, and tax credits may be just as tangible as salvage or scrap values. Thus, he ignores the cash flows associated with these seemingly "intangible" values.

The first two reasons given for the failure to acknowledge residual values may be proper. These two reasons both deal with materiality which was discussed earlier as the basis for the economic significance of resi-

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[10] This has gone down since the general acceptance of the discounting methods. Still, however, its use hovers around 25 percent. See Donald Istvan, "The Economic Evaluation of Capital Expenditures," Journal of Business, XXXIV (January, 1961), p. 50.

[11] Shillinglaw, p. 275.

dual cash flows. These reasons, however, are insufficient causes for complete omission of residual values. Even if the values are immaterial, they should be considered and investigated or the analysis may lead to mistaken conclusions. Table II illustrates the effect of omitting a material residual value.

TABLE II

OMISSION OF MATERIAL RESIDUAL VALUE

Year	Net Cash Flow	Present Value at 10%
0	(12,000)	(12,000)
1	3,000	2,700
2	3,000	2,480
3	3,000	2,250
4	3,000	2,050
5	3,000	1,860
		(660)

This $12,000 investment would be rejected if this analysis were complete. If, however, a $2500 residual value discounted to present value were recognized the investment would have a net present value of nearly $1000. Thus, the omission of residual values can unwisely restrict (or permit in the case of negative values) capital expenditures.

Reasons three and four are often used in connection with any analysis that requires the approximation of future values. Obviously, complete data are never available; nor is the future completely predictable. Still, however, approximations fulfill an important role in capital expenditure analysis. Operating costs, economic life, and investment revenues represent a sample of the approximations necessary in investment analysis. Forecasting these elements, just as the forecasting of residual values,

provides the information needed for effective investment analysis. If uncertainty and lack of data were allowed to dominate the analysis, proper capital expenditure investigation would cease. Effective implementation by practitioners of systems in which uncertainty and lack of data exist demonstrates that approximations are beneficial. The last reason obviously should be dismissed as the lack of knowledge.

Thus, it has been shown that the omission of residual values is inappropriate and can effect investment analysis adversely. The proper method of handling residual values provides the basis for the discussion that follows.

Viewpoint of Bierman and Smidt

Bierman and Smidt in their book The Capital Budgeting Decision present an exhaustive examination of capital expenditure analysis. This examination includes a thorough discussion on residual value influences.

Bierman and Smidt center their discussion around two types of residual values. Salvage value is considered one end-of-life capital source. All other residual sources of capital are encompassed under terminal value. Specifically, these other sources include working capital and tax credits. Opportunity cost values and scrap values receive no attention while negative values are only implicitly recognized.

The significant discussion of salvage value in Bierman and Smidt focuses on the distinction between relative and absolute cash flows occurring from salvage value. Relative cash flows refer to net flows while absolute flows represent total cash flows. The difference between these two terms revolves around cash flows resulting from the salvage value of present equipment and the salvage value of the proposed equipment.

Relative flows represent those cash flows from purchasing the new equipment minus the cash flows which would have occurred if the old equipment were retained.[12] If the analysis were in relative cash flows, the salvage value flows would be placed on a differential basis. In other words, the differences in the cash flows caused by the retirement of the present equipment and acquisition of the new equipment provide the pertinent cash flows. An example will clarify the discussion. Assume a piece of equipment is to be purchased for $1000. If the salvage value of the equipment to be replaced is $200, the relative cash flow in the first period is $800. The salvage value of the replaced equipment and cost of the new equipment are important only in the sense that they affect the relative cash flow in the first period.

On the other hand, absolute cash flow analysis focuses on these individual cash flows. The salvage value of the replaced equipment represents a cash inflow in the first period and the cost of the new equipment represents a cash outflow. Thus, in the example there is a $1000 cash outflow and a $200 cash inflow in the first period.

The real importance in this difference is that relative and absolute cash flows emerge in situations in which the replaced equipment is being retired earlier than necessary. In this case, two salvage values of the retired equipment become important. One is the present salvage that increases cash inflow of this period and the other is the salvage of the old equipment that would have been obtained had it remained in use until normal retirement.[13] Relative and absolute cash flows now come into play

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[12] Bierman and Smidt, p. 99.

[13] Ibid., p. 98.

in deciding between the alternatives of replacing now or waiting until normal retirement. Using the previous example, assume the old equipment with present salvage of $200 has two years left before normal retirement; at which time it will have a $100 salvage value. Also, assume the new equipment has a five-year life with a $200 salvage value. Table III illustrates this situation and the differences in relative and absolute cash flow.

TABLE III

RELATIVE VS. ABSOLUTE CASH FLOWS

	Year		
	0	2	5
Absolute flows of:			
Retaining Old		100	
Purchasing New	(1000) - 200		200
Relative flows of:			
Replacement	800	100	200

Terminal value is used by Bierman and Smidt to describe all other types of end-of-life capital sources. As far as working capital is concerned, Bierman and Smidt handle it in the same manner as was described earlier in this paper. If the new equipment requires a working capital commitment, retirement of the asset results in a cash inflow in the final period. One important point, however, is made in their discussion.

> It should not be thought that ignoring the working capital investment and the recovery of working capital will balance each other out. The factor that must be considered is the required return on the working capital during the period of use.[14]

This paragraph provides a direct retort to those who do not accept the

[14]Ibid., p. 115.

importance of the working capital commitment and recovery.

Bierman and Smidt's final investigation into residual values is concerned with salvage value and taxes. The discussion shows that salvage values may be inexpedient in lieu of certain situations. The factors that cause such situations are high discount rates, high tax rate, long-lived assets, and accelerated depreciation.[15] Their example will illustrate this situation.

> Assume all the necessary factors: 10 percent cost of capital, 20-year economic life, 50 percent tax rate, and accelerated depreciation of five years. Salvage value is $100.
>
> The present value of the salvage 20 years hence is $14.86. If there were no salvage, however, taxes would be reduced $50 (.50 x $100) or $10 per depreciation year. Over five years this would lead to a present value annuity of $39.91.
>
> Thus, the $100 of depreciable assets may be worth more than the $100 of terminal value.[16]

The importance of this situation, however, has diminished greatly since passage of the new tax law. For depreciation purposes, the new law permits omission of salvage value of up to 10 percent of the investment.[17] Consequently, salvage value and tax credits on depreciation are not mutually exclusive as long as salvage value falls to 10 percent or below.

The last item to be discussed in connection with Bierman and Smidt concerns the discount rate. Throughout their discussion, Bierman and Smidt assume equivalence of the borrowing and lending rate. This assumption arises from another assumption which assumes a market in which a

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[15] Ibid., p. 115.

[16] Ibid., p. 116.

[17] Sidney Davidson and David R. Drake, "Capital Budgeting and the Best Tax Depreciation Method," Journal of Business (July, 1964), p. 258.

company may borrow or lend as much as it wishes at the going rate of interest. Thus, the discount rate equals the borrowing rate equals the lending rate. Determination of the appropriate discount rate is beyond the scope of the paper.[18] For background purposes, however, two different situations utilizing different discount rates will be presented.

Leasing

Richard Vancil thoroughly discusses residual values under financial leasing.[19] His discussion focuses on those leases in which there is no fixed obligation concerning salvage value. The lessee is not obligated to purchase the leased equipment at the end of the lease. Obviously, if economic life equals the lease life, the equipment has no further value to the lessee and salvage cost is immaterial. On the other hand, however, if the economic life is greater than lease life, the lessee may be interested in retaining the asset at some cost greater than scrap. This cost greater than scrap can be considered to be the residual value of the equipment to the lessee. It can be considered an imputed cost because a cash outflow is necessary to acquire the asset.

Residual cash flows of this type are handled just as any other residual flows. They represent a cash flow in the last period; they are discounted to their present value and added to the other cash flows. A problem exists, however, when trying to determine the appropriate discount rate. Should the rate used be the same as the rate used for discounting

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[18]For discussion of the various rates see Ezra Solomon, The Theory of Financial Management (New York, 1963), Bierman and Smidt, Chapter 12, and Roberts, pp. 198-200.

[19]Richard Vancil, Leasing of Industrial Equipment (New York, 1963), Chapter 6.

the other cash flows associated with the lease? Vancil says no; he argues that an investment opportunity rate, analogous to the lending rate, should be the discounting factor.[20] Although the percent difference in the lending rate and other rate may be small, the monetary difference can become quite large if the lease is long term or involves considerably large residual value. For example, at a certain point in time, a company's cost of capital is 10 percent and their lending rate is 13 percent. If an asset with a $5000 residual cash flow and a 10-year lease life were leased, there would be a $500 difference in the present values figured using the two discount rates.

Vancil suggests use of the firm's lending rate which is based on an opportunity cost concept. Usage of the lending rate evolves from recognition of the fact that purchase of the leased asset is not mandatory. At the end of the lease the lessee must make a new decision concerning the acquisition of the used equipment based on its residual market value.[21] Since the capital could be invested in other alternatives, there is an opportunity cost associated with purchasing the used equipment. This opportunity cost represents the rate of return from these other alternatives. If capital is invested in the used equipment, the rate of return received from the other alternatives is foregone. Consequently, Vancil believes that the negative residual values (i.e., the imputed cost) associated with leasing should be discounted at the lending rate of the company.

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[20] Ibid., p. 156. This statement assumes that the cost of capital or some lower rate (borrowing rate) is used in discounting the other cash flows.

[21] Ibid., p. 156.

Salvage Value

Contrast the preceeding situation with a purchase investment and its salvage value. Again, the salvage value is treated as a cash inflow in the final period; it is also discounted to its present value and figured in the analysis. Just as before, however, the question arises as to what is the proper discounting rate used to reduce this lump sum to present value.

Salvage value represents the resale or reusable value of the asset at the termination of its economic life. It is the expected end-of-life return on the committed capital. The key words in the previous sentence are "committed capital." Once the investment is made, the capital is committed; and there will be no new investment decision concerning the salvage value. In a certain respect, the salvage value becomes mandatory. In contrast to the previous discussion on leasing, the "mandatory" salvage value removes the possibility of alternatives. Consequently, the lending rate would be inappropriate as the discount rate. The proper rate in this case would be the cost of capital. Discounting at the cost of capital would result in a present value based on the minimum return required for the ownership value not to be diluted.[22] For example, a salvage value of $1000 for an asset with a 10-year economic life could be discounted to present value by using a lending rate of 13 percent or a cost of capital of 10 percent. Since dilution of ownership is to be avoided, however, the cost of capital is used; and the present value is $385 rather than $290.

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[22] Gordon Shillinglaw, Cost Accounting (Illinois, 1961), p. 534.

Summary

Residual values in certain cases can have significant influences in capital expenditure analysis. If significant residual values are ignored, investments are unduly restricted or permitted. Determination of significance depends on the materiality of the cash flows resulting from the residual values. In general, it can be stated that materiality of residual values is the function of three asset characteristics. Wasting-non-wasting characteristic of the asset, economic life, and discount rate comprise the vital factors. If the wasting characteristic, economic life, and discount rate are all high, materiality of residual values is minimal. On the other hand, if these factors are all low, residual values will be material. The bulk of investment assets obviously fall between the two extremes and should be individually analyzed.

These residual values influence the profitability of an investment through the cash flows they cause in the final period. The significant, positive or negative residual values, represent material cash inflows or outflows in the form of salvage or scrap values, working capital recovery or commitment, or tax credits. The flows may be real or represent opportunity cost values. In any case, the cash flows are discounted to their present value using the cost of capital or lending rate. The present value of the residualvalues is then incorporated into the analysis.

CHAPTER III

INFLUENCE OF RESIDUAL VALUES

Generally, it has been shown that material residual values are economically significant. This economic significance arises from the influence of residual values on cash flows. Specifically, however, residual values influence four elements of investment. The elements influenced are economic life of the asset, rate of return, depreciation and taxes. Material residual values are important in capital expenditures analysis because of their influence on these elements.

Economic Life

As was stated in the introduction, economic life represents the period during which benefits are received from the project in its originally intended use. When this life terminates, residual values occur. Ordinarily, economic life could be thought of in terms of the usefulness of the asset. When this usefulness ceases due to physical deterioration the economic life of the asset terminates. Assuming a profit motive, however, results in economic life not being strictly technological. Economic life becomes dependent on both technological and economic factors.

The presence of technological and economic factors results in three definitions of economic life. Anthony describes these as:

> (1) physical life which represents the number of years the machine will perform the technical job for which it was purchased. It is of little use in investment

decisions.

(2) technological life which refers to that period of time that elapses before a new machine is produced that will be more effective than the present machine. It is this life that, for most companies, corresponds to economic life.

(3) product market life, which refers to termination of the originally intended use of the asset because the company ceases to market the product made by the asset. Also, product-market life terminates if the company goes out of business.[1]

Assuming a profit motive, theoretically the shortest of these three is the appropriate economic life. Due to the tremendous expansion of industrial production, the technological life usually represents the shortest period. Product-market life may be shorter in some circumstances. These circumstances, however, may be unimportant because companies with frequent product changes usually do not restrict assets to the production of specific products. For example, Ford probably did not restrict new equipment to merely the production of the Edsel. Equipment is usually purchased for general purposes; it can be adapted for the production of several different products.[2] Physical life is greater due to the slowness of physical deterioration that characterizes modern industry. Also, with respect to residual values, physical life becomes less important. Upon physical deterioration, residual value usually occurs through scrap. As was stated earlier, scrap value is often slight due to removal costs. Therefore, technological life usually remains as the pertinent life.

Each economic life defined above depends on economic as well as technological factors. These economic factors can be summed by the phrase

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[1] Anthony, p. 626.

[2] The author realizes that new processes may be incorporated for specific products, in which case residual values would occur through opportunity cost values and working capital.

"generated earnings." Once these generated earnings cease, economic life terminates. Generated earnings, in turn, relies on differential operating and maintenance costs (i.e., the variable costs associated with the asset), cash flows generated by the equipment, and residual values. As long as generated earnings are greater than zero, the asset should be retained. Once the generated earnings are less than or equal to zero, economic life terminates. The following formula represents this relationship:

$$E = CI - (Co + Cm) - i(Rt) + (Ri)$$

E = generated earnings

CI = cash inflow resulting from the asset

Co, Cm = differential operating and maintenance costs (i.e., the extra costs resulting from utilization of this asset)

Rt = residual value of asset in period t

i = discount rate

Ri = loss in the residual value resulting from one more period's use

The residual value influence or economic life represents an opportunity cost value and economic depreciation. The opportunity cost value refers to the loss of interest on the residual funds that would be released if economic life terminated. Economic depreciation (not to be confused with accounting book depreciation) represents the loss of residual value (usually market salvage value) from retaining the asset for another period.[3] Another more formal discussion of economic life and its relationship with residual value is found in Lutz and Lutz.

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[3] William Haynes, Managerial Economics (Illinois, 1963), p.531. Economic depreciation is referred to as capital wastage by Dean, p. 93.

> A machine is kept in use until its quasi rent (total gross revenue from using the machine in the period minus all operating costs) only just covers the interest on the scrap value at that date plus the depreciation of the scrap value if the latter is supposed to decline with the aging of the machine.[4]

Thus, it can be seen that residual values influence economic life just as economic life influences the materiality of the residual values. Figure 1 and Table IV demonstrate the described relationship. Figure 1 shows the loss in residual value of a truck encountered through each year's use. This loss of value must be considered when analyzing economic life. Residual value of the truck times discount rate and the loss in residual value from Figure 1 are transferred to Table IV and used in the determination of the economic life of the new truck; assuming a 10 percent interest rate, the table shows that the truck should be used for three years and discarded in the fourth.

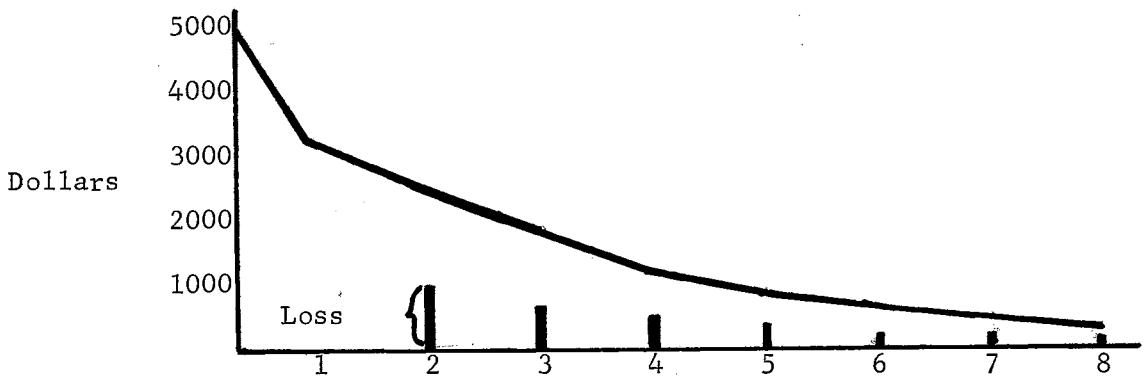

Fig. 1.* Economic Depreciation

*Source: Joel Dean, Capital Budgeting Decision (New York, 1951), p. 101.

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[4]Frederick Lutz and Vera Lutz, The Theory of Investment of the Firm (Princeton, 1951), p. 103.

TABLE IV

DETERMINATION OF ECONOMIC LIFE

Years	Net Revenue	Discount Rate i(Residual Value)	Loss in Residual Value	Generated Earnings
1	$1300	$330		$970
2	1300	240	900	160
3	900	180	600	120
4	600	130	500	(30)
5	400	100	300	
6	200	90	200	(90)
7	100	80	100	(80)
8	100	70	100	(70)

Rate of Return

Throughout this paper the influence of residual values has been discussed in terms of cash flows and their effect on the net present value of expenditures. Materiality has been emphasized as the key to this cash flow influence. Materiality, however, denotes relativity (i.e., the relativity of the residual cash flows to the cash flows occurring from investment). The net present value method does not emphasize relativeness; it emphasizes the positive or negative result of discounting the cash inflows and outflows. Therefore, a more meaningful concept of residual value influence and materiality may be gained from use of the rate of return method of analysis. The important parameters are still the wasting-nonwasting characteristic, economic life, and discount rate involved in analysis of the asset.

In Table II the omission of the residual values reduced the net present value of investment by over $1500. Although the materiality of the

residual value was obvious, the relative importance of it was unknown. Table V demonstrates this residual value relativity using the rate of return method.

TABLE V

RESIDUAL VALUE AND RATE OF RETURN

Year	Rate of Return 8 Percent (omission of residual value)	Correct Rate of Return 13 Percent
0	($12,000)	($12,000)
1	2,775	2,655
2	2,575	2,350
3	2,380	2,080
4	2,205	1,850
5	2,045	3,080
	+20	+15

Recognition of the $2500 residual cash inflow in the final year resulted in a 5 percent increase in the rate of return. It represents over 25 percent of the cash inflows. Obviously, the residual value is relative in this simplified example.

Just as before, however, a significant increase in the economic life of the investment will significantly reduce the relativity of the residual value. Table VI exemplifies this reduction in relativity for the previous example using a 15-year value of $2500 but a reduction in cash flows to $2000 per year. With the significant increase in economic life, the table shows that recognition of the residual values increases the rate of return by approximately 5 percent. In this case, the residual flow represents only 4.5 percent of the total cash flows and is relatively unimportant.

TABLE VI

INCREASE IN ECONOMIC LIFE AND RATE OF RETURN

Years	Rate of Return 14.3 Percent (omission of residual value)	Correct Rate of Return 14.8 Percent
0	($12,000)	($12,000)
1	1,745	1,740
2	1,530	1,520
3	1,335	1,320
4	1,175	1,160
5	1,030	1,000
6	895	880
7	790	760
8	695	660
9	600	580
10	520	490
11	465	430
12	395	375
13	345	325
14	300	280
15	250	550
	+80	+80

Similar results occur if the discount rate rises significantly. For example, Table VII illustrates the same example but with $4500 cash inflows. Assume the original five-year economic life and $2500 residual value. With the higher cash inflows, the rate of return jumps to 27 percent. Omission of the residual value lowered the rate of return by only 2 percent. In this example the residual value represents only 6 percent of the cash inflows and is relatively unimportant.

Residual values influence the rate of return in the same manner as they influence net present value. Instead of being discounted to their

present value by the minimum discount rate, the residual flows are discounted at the rate of return. Through use of the rate of return method, the relative importance as well as the materiality of residual values can be determined. When economic life is significantly long and/or the rate of return comparatively high, the relevance of residual values decreases.[5] Also, the relevance of residual values decreases as the wasting characteristic increases.

TABLE VII

DISCOUNT RATE AND RESIDUAL VALUE

Years	Rate Return 25 Percent (omission of residual value)	Correct Rate of Return 27 Percent
0	($12,000)	($12,000)
1	3,600	3,540
2	2,880	2,790
3	2,295	2,195
4	1,800	1,725
5	1,470	1,800
	+45	+50

Depreciation

Depreciation represents another element of an investment influenced by residual values. Depreciation refers to the conversion of fixed assets into expense by spreading the cost of the asset over its economic life.[6] The depreciation expense for a period depicts that part of the total cost

[5] "Significantly long" represents economic lives greater than 10 years. "Comparatively high" represents rates of return greater than 20 percent. See Shillinglaw, Journal of Business, p. 281.

[6] Anthony, p. 156.

contributable to use of the asset in that period. Residual values influence depreciation by altering the cost of the asset. If residual values are present, the cost of the asset decreases. This, in turn, decreases the depreciation expense per period. Since depreciation represents a tax deductible cost, taxes increase due to the presence of residual value. A simple example of straight line depreciation will illustrate this influence. A $10,000 asset with a five-year economic life has a $1000 residual value. Assume a 50 percent tax rate. The residual value reduces the cost of the asset to $9000, which in turn reduces depreciation from $2000 to $1800 per year. The lower depreciation expense increases taxes $100.

Since passage of the 1954 tax code, accelerated depreciation has received much more emphasis than the older, straight line method. Accelerated depreciation is aimed at increasing the depreciation expenses in the earlier years of the asset; by increasing immediate depreciation, the current or near-year taxes are reduced. Sum of the years-digits and double declining balance methods represent the most widely used accelerated methods. Although the optimum method of depreciation is beyond the scope of this paper, brief mention needs to be made of the influence of residual values in accelerated depreciation.[7]

In the sum of the years-digits method, the years of economic life are accumulated through an arithmetical progression (i.e., 1 + 2 + 3... + n = denominator). The depreciation expense per period represents a

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[7]Optimum depreciation refers to that method that will provide the greatest present value for the tax deduction stream. For discussion of accelerated depreciation and the optimum method, see Sidney Davidson and David F. Drake, "Capital Budgeting and the 'Best' Depreciation Method," Journal of Business, XXXIV (October, 1961), pp. 442-452.

fraction with the progression as the denominator. The numerator changes for each period. The numerator begins with n in the first and proceeds to n - 1, n - 2...1 for each succeeding year. For example, the depreciation fraction for the first year of an asset with a five-year life would be 5/15; the second year would be 4/15; and so on down to the fifth year with 1/15. Depreciation expense for a year is determined by multiplying that year's fraction by the depreciable cost of the asset. Residual value reduces this depreciable cost in the sum of the years-digits method.

The double declining balance method describes the other widely used accelerated method. The depreciation rate in this method is twice the rate used in the straight line method. This rate is applied against the balance of the total asset of the investment. Thus, for the previous straight line example, the first year's depreciation expense would be $4000; the second year's would be $2400, and the third year's $1440. The total depreciable cost of the asset, however, cannot exceed its net cost. Therefore, residual value must be accounted for in the latter years of the depreciable life. This can be done by switching from the double declining balance method to the straight line method in the latter years. In the above example, the depreciable cost is $9000. Accelerated depreciation has accounted for $7840 of this cost during the first three years. Straight line depreciation is now used in the last two years in order not to exceed depreciable cost and to avoid the uneven depreciation property of the double declining balance method.[8] The last two year's depreciation expense would be $580; thus, the total depreciation expense rises to

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[8]Davidson and Drake, p. 445. For determination of optimum switch over time, see the appendix to Davidson and Drake, p. 450.

$9000.

During the 1964 Congressional year a new section was added to the 1954 Internal Revenue Code. This section permits the taxpayer to disregard residual values for depreciable cost purposes as long as they do not exceed 10 percent of total cost.[9] This new law raises the depreciable cost of the previous example from $9000 to $10,000. If the residual value of the asset were $1500 instead $1000, the depreciable cost would be $9500 under the new tax law.

Before the new tax law, the presence of residual value (given economic life and the cost of capital) tended to favor the double declining balance method of depreciation. This was because total cost is used as the depreciation cost in the double declining balance method during the early years. Consequently, the early depreciation expenses were greater causing taxes to be less. Now, however, residual values of 10 percent or less can be ignored for tax purposes. With an economic life of greater than eight years and a cost of capital less than 50 percent, the sum of the years-digits receives the advantage.[10] This is the case if residual value is 10 percent or less because the present value of depreciation expenses is greater, thus reducing taxes. With a practical economic life and cost of capital, however, the difference in the two methods is often less than $10. Therefore, further discussion and examples are immaterial to this paper. For a detailed analysis of depreciation, see the articles footnoted. For purposes of this paper, the important thing

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[9]Sidney Davidson and David Drake, "The 'Best' Tax Depreciation Method," Journal of Business, XXXVII (July, 1964), p. 258.

[10]Davidson and Drake, "The 'Best' Tax Depreciation Method," p. 259.

to remember is that residual values decrease the depreciable cost which in turn increases taxes. Thus, in certain situations (such as described in Chapter II) cash outflows decrease if there is no residual value.

Taxes

Residual values influence taxes in two ways. Residual values can either alter the depreciation expense as was described in the previous section or they can result in a book value tax or credit. This book value tax or credit represents a capital gain or capital loss. The tax rate for a capital gain or loss depends on the manner in which the asset is replaced. If the asset is replaced by one similar in nature and function, the transaction is taxed at the regular rate of approximately 50 percent.[11] On the other hand, if the new asset is dissimilar the appropriate tax rate is 25 percent. In industrial analysis with continuous investment and replacement, the 50 percent tax rate seems more appropriate.

Residual values affect taxes whenever the economic life of the asset does not equal the depreciation life. Whenever one life is greater than the other, book value and residual value differ. If the asset is sold, the book value - residual value difference gives rise to a capital gain or loss. If residual value (i.e., resale value for tax purposes) is greater than book value, there is a capital gain. A capital loss occurs when book value is greater than residual value.

In the event of a capital gain, the book value is subtracted from the resale price, and the difference is subject to either a capital gains

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[11]Anthony, p. 628.

tax (25 percent) or income tax (50 percent). For example, if an asset has a $1000 resale value but was depreciated on a total cost recognizing only $500 resale value, the residual value would be reduced to either $875 or $750 depending on the tax rate. The residual value increased taxes because the projected economic life was shorter than the depreciable life. In other words, the asset had greater use than was realized; and the resale price was greater than the book value.

Economic life and use of an asset can be overestimated as well as underestimated. In this case, a capital loss occurs. In the event of a capital loss, resale value is less than book value and an undepreciated balance remains on the books. The write off of this undepreciated balance results in a tax credit. Using the previous example, assume the depreciable cost was based on a $1000 resale value but the actual resale value is only $500. Thus, there is a $500 undepreciated balance on the books. The write off of this $500 loss reduces taxes by either $125 or $250 depending on the rate.

CHAPTER IV

SPECIAL ASPECTS OF RESIDUAL VALUE

Determination of Residual Value

The preceding chapters have traced the economic significance and influence of residual values. These chapters were both based on a certain assumption; the assumption that residual values were given. Obviously, this is an unrealistic assumption. In fact, one of the main reasons cited for ignoring residual values is that they are too difficult to measure, or that appropriate data for their measurement is unavailable. If proper capital expenditure analysis is to occur, however, residual values must be determined. Just as the preceding chapters illustrated, residual values may exert a telling influence on the analysis. Therefore, even a best estimate of the value provides more information and leads to better analysis than ignoring the value. Even if the projected value does not have great precision, a substantial error is allowable because of the effect of time on present value.[1]

Salvage value estimates usually represent the most difficult residual value to measure. This difficulty arises because salvage value can occur through a resale value or through another use by the original owner. In general, salvage values should be based on historical information, and available knowledge concerning the future. Sources of this informa-

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[1]Shillinglaw, Journal of Business, p. 759.

tion, past and future, could be accounting records, appraisal companies, publications by authorities, and individual experience.[2] The job of the analyst is to assimilate this information, taking into account the standards of service and maintenance the equipment receives. Through this assimilation a range of values is determined. With this range of values two possibilities exist.

One possibility is to use the expected value. The expected value represents the complete range of values, each weighted with the probability of its occurrence. The expected value is determined by the summation of these weighted values. For example, an analyst has gathered the information, assimilated it, and determined a range of possible values; the values are $500, $700, $800, and $1200. Through past experience and some knowledge of the future the analyst assigns the probability of .20, .30, .45, and .05 respectively to each value. By weighting each value with its probability and totaling the results, the expected value of the salvage is $730.

Another possibility is for the analyst to make a purely subjective evaluation of what he considers the most likely salvage value of the asset. In this case the value given the salvage represents the value in the range that has the highest probability of occurrence.[3] Thus, in the previous example, $800 would be the value taken as the salvage value of the asset. Obviously, this method is less sophisticated than the expected value method. On the other hand, if the value or range is small or

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[2] An example of publications by authorities is the well known "Blue Book" for motor vehicles. Also, a similar publication concerns some industrial equipment.

[3] Vancil, p. 156.

the asset being analyzed is very familiar to the analyst, the most likely value method may be just as effective as the expected value method.

Estimation of residual values resulting from tax credits and working capital usually present no problem to the analyst. As long as the analyst knows the write off rates and the tax rate applicable, the tax credits or payments can be projected. The main problems occur in determining capital gains and losses. These depend on the salvage value which may be difficult to measure. Working capital commitments may present problems concerning opportunity costs. Opportunity cost problems may exist because the analyst is unable to differentiate between the capital tied up because of the asset and capital needed regardless of the asset. Also, inventory can be a problem if the inventory occasions end-of-life losses.[4] If these losses are recognized, they can be minimized by gradual liquidation of the inventories as the economic life of the asset terminates. In general, these problems do not occur or, if they do, they represent only a small part of the residual values and are relatively immaterial.

Residual Value of Present Equipment

Residual value of present equipment was discussed in Chapter II of this paper under Bierman and Smidt. The discussion centered around relative and absolute cash flows resulting from early and normal retirement of the present equipment. With this discussion in mind, several points need to be stressed.

First, residual value of present equipment occurs in the same manner

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[4]Shillinglaw, Journal of Business, p. 282.

as residual value of the proposed equipment. The acquisition of the proposed equipment releases the present equipment, and residual values result. Just as in other residual values, these values can result from salvage or scrap, working capital commitment or recovery, and tax credits. These values are often more important than the residual value of the proposed equipment because they are not subject to time influences. In other words, the residual values from the present equipment are usually received at the beginning of the economic life of the proposed investment. Therefore, they are not subject to reduction to present value through discounting. Even if the residual values are delayed into the earlier years, their present value may be higher than that of the new equipment because of the higher present values during early years. For example, a $1000 investment with $300 residual value in the fifth year immediately results in a $250 residual value from the present equipment. If the discount rate were 10 percent, the $250 from the present residual value would be more than the $186 present value of the new equipment. Even if the present equipment's residual value was received two years hence, the $186 new equipment value is still less than the $206 received from the present equipment.

Residual values of present equipment may be handled in two ways. One way is to simply reduce the proposed investment outflow by the residual amount. The cash outflow in the first period represents the additional or new funds required for the new asset. Subtracting the residual value from the investment requirement, however, implies that:

1. If the proposed machine is not purchased, the present machine will continue to be used and its residual value will decrease to zero through its continued use; and

2. if the proposed machine is purchased, residual value will occur immediately.[5]

If these assumptions are not valid, the residual values must be handled as cash inflows during the period for which they arise. These cash inflows would, of course, be reduced to their present value and included in the analysis.

Residual Values and Leasing

In Chapter II the residual values resulting from leased equipment were discussed in connection with the discount rate. This discussion was based on the assumption that the business wished to purchase an asset at the end of its economic life. Residual value was taken as the cash outflow required to purchase the asset.

Residual values in leasing can, however, result in cash inflows as well as cash outflows. First, if the leased asset is purchased at the end of the lease life, residual value inflows may occur when the economic life of the purchased asset terminates. In other words, residual outflows of the lease occur when the asset is purchased from the lessor; and residual inflows occur when the purchased asset's useful life ends. Since the asset has been purchased by the lessee, he receives the residual values from the asset.

Residual value inflow can also occur upon termination of the lease life. Even if the asset were not owned, utilization of it may still have required a working capital commitment. Thus, when the lease life of the asset ends, and the asset or a similar one is not purchased, there is a

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[5]Anthony, p. 628.

cash inflow resulting from the release of the working capital commitment. Obviously, negative flows could also be possible. This would occur when termination of the lease life required a working capital commitment.[6]

A final point to be made in residual values and leasing concerns the cost of the lease. Since the title to the equipment remains in the hands of the lessor, the lessee foregoes the cash inflow (salvage value) that would result from disposing of the used equipment.[7] Therefore, an extra cost is attached to the lease because the lessee does not receive this cash inflow. In order to properly analyze the lease and compare it with other means of financing, the foregone salvage value should be discounted to its present value and added to the other costs of the lease.[8]

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[6]See Chapter II, pp. 2-8.

[7]Richard Vancil, "Lease or Borrow-Steps in Negotiation," Harvard Business Review, XXXIX (November-December, 1961), p. 138.

[8]Ibid., p. 139.

CHAPTER V

CONCLUSION

Capital expenditure analysis focuses on the determination of the profitability of the investment. Cash inflows and outflows are determined, discounted to their present value, and compared. In this manner the net present value, or rate of return for an investment, is ascertained. In order for these methods to be accurate, all cash flows must be recognized and included in the analysis. Residual values represent some of the cash flows in an investment.

Residual value sources include salvage value, scrap value, working capital commitments or recovery, or tax credits. They may be positive or negative. Regardless of their state, however, residual values, just like all other flows, must be discounted to their present value. Their discounted present value represents a cash inflow in the final period. If residual values are ignored, the cash inflows in the final period are incorrect, and the analysis may lead to an erroneous decision.

The actual influence of the residual values on the profitability of the investment depends on materiality. If the residual values are relatively large, they may have a significant influence on the investments profitability. If they are small and immaterial, little is gained from including the residual flows. Therefore, the materiality of the residual values must be determined. In general, materiality depends on three things:

1. The wasting-nonwasting characteristic of the asset.

2. The economic life of the asset.

3. The discount rate utilized in the analysis.

When the wasting characteristic, economic life, or discount rate is significantly high, residual values are often immaterial. When they are low, the values may be quite important. In most cases the assets fall between high and low and must be individually analyzed.

Besides generally influencing the profitability of the investment, residual values also exert specific influence on the economic life, the rate of return, the depreciation method, and taxes. In determining the continued use and the economic life of an asset, the foregone interest possible on the residual value and the economic depreciation of the asset must be considered. Residual values influence the rate of return in the same manner as they affected the net present value. Also, residual values play an important role in both of the well known accelerated depreciation methods.

Residual values may be determined through a most probable estimate method or through the more sophisticated expected value technique. Regardless of the technique, the values should be based on historical information and future trends. Even a best guess is more appropriate and will lead to better decisions than when the values are ignored. By ignoring the residual values, analysts may be overly conservative or unduly permissive.

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VITA

James Io Alcock

Candidate for the Degree of

Master of Business Administration

Report: THE INFLUENCE OF RESIDUAL VALUES IN CAPITAL EXPENDITURE DECISIONS

Major Field: Business Administration

Biographical:

Personal Data: Born in Tulsa, Oklahoma, March 31, 1943, the son of Charles W. and L. Helen Alcock.

Education: Attended grade school in Dallas, Texas, and Jackson, Mississippi; graduated from Thomas Edison High School, Tulsa, Oklahoma, in 1960; received the Bachelor of Arts degree from the Oklahoma State University, with a major in economics, in May, 1964; completed requirements for Master of Business Administration degree in August, 1965.

Professional experience: Graduate assistant in College of Business, Oklahoma State University, during the 1964-65 school terms.