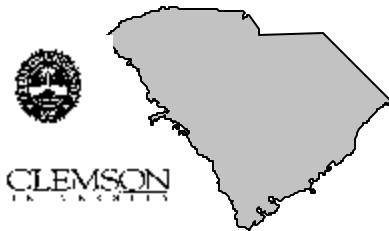# WORKING PAPER

AN ANALYSIS OF ALTERNATIVE
NET PRESENT VALUE CAPITAL
INVESTMENT DECISION MODELS

DEPARTMENT OF AGRICULTURAL AND APPLIED ECONOMICS
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AN ANALYSIS OF ALTERNATIVE
NET PRESENT VALUE CAPITAL
INVESTMENT DECISION MODELS

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CAPITAL INVESTMENT DECISION MODELS

Introduction

The scene is the class for Agricultural Economics (AE) 4123, Farm Management, and the lecture topic is the evaluation of an investment project via net present value (NPV) analysis. Professor RTA calls attention to a handout, reproduced here as Figure 1.

Professor RTA:

Now, let's see how we implement the NPV analysis. The calculated NPV is the change in wealth of the firm, and thus of the firm's owners, if the firm undertakes the project. The first term on the right side of the NPV equation, INV_0, is the cash outlay needed to undertake the project.

Alert 4123 Student:

I'm confused. This isn't the way we are learning to calculate NPV in Professor RTE's AE 4978, Agricultural Financial Management. This handout from his class has different definitions of the terms in the NPV equation. Will I get the same value for NPV if I use your method as I would if I use Professor RTE's method?

Professor RTA, after studying Professor RTE's handout, reproduced here as Figure 2:

Okay. Professor RTE is using the Returns-to-Equity (RTE) method. Chances are that you won't get the same value of NPV from the two methods. Actually, the RTE method is

mentioned in today's reading assignment (leafing through *Farm Management* by Boehlje and

Eidman [4]). Look at their footnote on page 323. Don't say that I said so, but Professor

RTE's approach is wrong! Besides this reading assignment, consult any financial management

text, and you will see that it uses my method. Time is up for today. We will continue this

discussion at our next class meeting.

The scene shifts to Professor RTE's office ten minutes later.

Alert Student:

Professor RTA in AE 4123 just told us that the way you teach us to calculate NPV is

wrong. Here's the handout from his class. Who's right?

Professor RTE (after studying Figure 1):

Well, Professor RTA is using the Returns-to-Assets (RTA) method. Why didn't you show

him your text for AE 4978 (reaching for *Financial Management in Agriculture* by Barry

et al. [1])? The authors are financial management experts in the agricultural economics

profession, and they use the RTE method. You can tell Professor RTA that there is nothing

sacrosanct about the RTA method. In fact, the RTE method is superior in many cases,

especially for farm firms!

We know this story to be true (except for some use of poetic license): Professors RTA and

RTE are in our Department. Similar situations likely have occurred at other universities. Most

would agree that agricultural economics and agribusiness majors should have a basic competency in

the use of NPV analysis. However, as this paper illustrates, instructors and texts in agricultural

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economics do not agree on the appropriate way to conduct and teach the analysis. These conflicting views surely raise questions in our students' minds regarding the validity of NPV analysis.

This experience motivated us to ask whether undergraduate students in agricultural economics are unique in being exposed to, and possibly confused by, alternative methods for conducting an NPV analysis. To answer this question, we conducted a survey of texts from agricultural economics and from a number of other subject matter areas that cover NPV analysis. Our objective in this paper is to report the results of that survey. Our aim is not to show that one method should be preferred to the other, but rather to discuss how the two methods are treated in textbooks.

We have found that the disagreement between RTA and RTE proponents is not confined to agricultural economics. Depending on the course they are taking and the accompanying text, students are likely to learn that there is a "right" way to calculate NPVs, either by the RTA method or the RTE method. In most cases, only one of the two methods is discussed and illustrated with numerical examples. Less common are texts that compare the two methods, discuss their underlying assumptions, or show how the NPVs from the two methods can be reconciled.

The paper is organized as follows. The first section of the main body of the paper provides a comparative overview of the RTA and RTE methods; the second section discusses our textbook survey; the final section offers our conclusions. Appendix A contains a brief history of the theoretical development of discounted cash flow (DCF) concepts. Appendix B contains additional

details (elaboration) on defining components of NPV models. Finally, Appendix C is a listing of some supplemental references.

Comparison of the RTA and RTE Methods

As shown in Figures 1 and 2, the RTA and RTE methods start with an apparent common formula for the NPV of a potential investment that provides multi-year cash flows. Both methods agree on some essential points, namely:

a) the NPV model is appropriate for evaluating a project that is of "average-risk,"

b) incremental direct and indirect after-tax cash flows from the project should be included and sunk costs excluded,

c) resources used in the project should be valued at their opportunity costs,

d) the cash flows should be discounted to obtain their present value,

e) the discount rate should measure the marginal cost of capital, and

f) the NPVs should measure the change in the present value of the firm (and the wealth of the firm's owners) if the investment project is undertaken.

However, the RTA and RTE methods differ in several respects in defining the terms in the NPV formula. Definitions differ because the two methods account for debt financing in different ways; the RTA method implicitly through the discount rate, and the RTE method explicitly through the cash flows.

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Among proponents of both the RTA and RTE methods, there is near unanimity about the definition of the total cash outlay from debt (L_0) and equity (E_0) sources needed to acquire the investment assets, I_0. The RTA and RTE methods differ, however, in how INV_0 is defined relative to I_0. The RTA method defines INV_0 as I_0, whereas the RTE method defines INV_0 as total cash acquisition cost less the net proceeds of the loan used to finance the project ($INV_0 = I_0 - L_0 = E_0$).

The RTA method defines CF_t as the after-tax net operating cash flows generated by the project in period t so that debt service payments in period t are excluded. The RTE method requires a specific debt repayment schedule in order to compute the value of the net equity flows. Note that adding the after-tax debt flows, $rL_t(1 - T) + (L_t - L_{t-1})$, to the net equity flows of the RTE definition of CF_t gives the RTA definition of CF_t.

The cost of equity capital is agreed to be the appropriate discount rate for the RTE method. Among authors discussing the RTA method, most specify i as the Weighted Average Cost of Capital (WACC), and this view is reflected in Figure 1. The proportion of debt financing, w, is determined by the firm's target debt-to-value ratio, or the optimal w when using the WACC framework. The firm's value is usually specified as the firm's capitalization: long-term debt plus the value of the owners' equity.

Students are advised that assets already under the control of the firm should be assigned market values or book values (acquisition costs less accumulated depreciation) in calculating w when the firm's current balance sheet reflects its target debt-to-value ratio. But there are differing views regarding the debt capacity of the proposed project, and as a consequence, the appropriate

amount of initial debt financing of the project under the WACC approach. These differing views

arise because there are two ways to value the proposed project: (a) its "market value" equal to the

incremental discounted cash flows of the project, I_0 + NPV, or (b) its "book value" equal to the

total cash acquisition costs needed to acquire the investment assets, I_0 [8]. The "market value"

view recognizes the debt supported by the proposed project's NPV, and determines the debt

financing ratio for the proposed project required to maintain the target debt-to-value ratio

according to w* = w(I_0 + NPV)/I_0. Note that w* is greater than the target debt-to-value ratio for

positive NPV projects and can be greater than unity. The "book value" approach ignores the new

debt capacity provided by the project's NPV, and uses w as the debt financing ratio for the

proposed project. The "book" and "market" values will be equal for a project with an NPV equal

to zero.

More details on how best to define components of NPV models are presented in Appendix

B.

A Survey of Textbooks

Table 1 lists selected undergraduate textbooks that we reviewed. These texts are classified

according to the subject matter area is which they most likely would be used, and in a column of

notes we indicate the NPV analysis method(s) covered by the author(s). We exclude texts dealing

with natural resource economics and public sector economics in which capital budgeting techniques

are used to evaluate public investments. Readers who desire to learn more about how discounted

cash flow (DCF) and thus NPV models have evolved over the past 200 or so years are advised to read Appendix A of this paper.

We draw several inferences from our survey. First, there are at least seven academic subject matter areas in which students encounter NPV analysis. Within some subject matter areas, students are exposed to the analysis in more than one course. For example, in agricultural economics NPV analysis is covered in undergraduate farm management, agribusiness management, and agricultural financial management courses, among others. Finance majors are likely to encounter NPV analysis in corporate finance, financial management, and asset management courses.

Second, Fiske [8] says that the RTE method is confined for the most part to the agricultural economics literature. Our survey shows otherwise. Students taking a course in real estate investment are likely to be exposed to the RTE method. Indeed, Okoruwa et al. [17] indicate that the RTE method predominates in the real estate discipline. Depending on the adopted textbook, students taking courses in financial management or engineering economics may also encounter the RTE method. Although Brigham and Gapenski [5, pp. 836-39] advocate the RTA method for most analyses, they recommend the RTE method for analyzing mergers. But Van Horne [20, p. 165] says the RTA method, not the RTE method, should be used in merger analysis.

Third, several texts discuss both methods, but usually one of the methods is touted as being superior to the other. For example, Barry et al. [1, p. 286] say "(e)ither approach may be used… (W)e use the returns-to-equity approach because it is consistent with the smaller-scale, non-

corporate structure of most farm businesses." Among RTA proponents, Moyer et al. [15, p. 348] are typical in arguing that "(o)ften the purchase of a particular asset is tied closely to the creation of some debt obligation, such as … a bank loan. Nevertheless, it is considered incorrect to deduct the interest charges associated with a particular project from the estimated cash flows… The decision about how a firm should be financed should be financed can – and should – be made independently of the decision to accept or reject one or more projects."

Fourth, only a handful of texts discuss the circumstances under which the NPVs from the RTE and RTA methods can be reconciled. Bierman and Smidt [3, pp. 118-30] argue that the NPVs of the RTA and RTE methods are equal only when the cost of debt is used as the discount rate. Park and Sharp-Bette [18, pp. 183-85] solve a numerical example using the RTE method and the WACC version of the RTA method. Their example has an NPV equal to zero, so they do not have to specify whether the firm's desired debt-to-value ratio is based on book or market values. Barry et al. [1, pp. 305-10] show that the NPVs from the RTE method and the WACC version of the RTA method can be reconciled by adjusting the WACC as the firm's debt-to-value ratio changes for an arbitrary debt repayment schedule. Brigham and Gapenski [5, pp. 279] note that the RTE and RTA (WACC version) methods "are equivalent provided that projected debt in any year equals a constant fraction of the present value of the future cash flows, a condition necessary to maintain the capital structure at the target level giving consideration to the fact that taking on the project increases the value of the equity." They do not show how debt repayments could be scheduled so that the optimal debt-to-value ratio could be obtained, but such a repayment schedule is easy to construct as shown by Linke and Kim [13].

Concluding Remarks

This article illustrates how/why students in agricultural economics courses are likely to be confused by textbooks and instructors as they explain incremental (individual-project) discounted cash flow (DCF), usually net present value (NPV), models and analyses. The crux of this confusion appears to lie in two distinctly different NPV definitions and formula calculations, commonly designated as the returns-to-assets (RTA) and returns-to- equity (RTE) methods.

The RTA method emphasizes the total investment outlay for the project, with periodic cash flows being defined and estimated as net operating income absent financing cash flows. Financing of the project investment outlay is not explicitly separated from continued financing of the firm's relevant set of assets; the appropriate discount rate for a leveraged firm, thus, is a composite of the firm's debt and appropriate risk-adjusted equity rates. The RTE method, in contrast, emphasizes the owner equity amount invested in the project, and periodic cash flows include net operating income less debt interest costs and loan principal reductions. Financing of the project, thus, is reduced to financing the equity portion; the relevant discount rate, for a leveraged or unleveraged firm, equals the appropriate equity rate for the project.

The two methods agree on a number of basic points (underlying premises), which we outline near the beginning of the article. And both methods employ a common formula. More precisely, the formula's terms usually are delineated to be identical in structure and appearance. This, by itself, could be the main root of much of the textbook, instructional, and thus student confusion. Further, to the extent that contemporary theory has been developed, neither method has

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a corner on logical completeness; each has its own theoretical shortcomings. This is contrary to what many advocates of each method claim; only a handful of texts discuss the circumstances under which the NPVs can be reconciled.

A compete treatment of the reconciliation of the RTA and RTE methods, however, is beyond the scope of this paper. Rather, we concentrated on investigating the nature and extent of the RTA-RTE academic treatment, through a survey of selected undergraduate textbooks in agricultural economics and in six other academic subject matter areas. We found that students are exposed to NPV analyses in all seven areas, and that they are likely to learn only about one of the two methods, that this method is uniquely correct (or at least preferred), and they seldom are even introduced to how the NPVs from the two methods can be reconciled. Professors' RTA and RTE, in our Department, are not alone in their dogmatism.

Table 1. Summary of Selected Textbook Treatments of Net Present Value Analysis, by Subject Matter Area

Subject Matter Area	Selected Textbook	Notes
Finance	Bierman and Smidt [3]	Recommends RTA, discusses RTE pitfalls (pp. 118-30)
	Brigham and Gapenski [5]	Recommends RTA, covers RTE in an appendix (pp.278-80)
	Moyer et al. [15]	Recommends RTA, is skeptical of deducting interest charges to calculate CFs (pp. 345-48))
	Van Horne [20]	Covers RTA only
Real Estate	Brueggeman and Fisher [6]	Recommends RTE for evaluating equity investment performance (pp. 323-27) and RTA for totally valuing property (pp. 438-46)
Accounting	Horngren et al. [9]	Covers RTA only
	Morse et al. [14]	Covers RTA only
Economics	Seo [19]	Covers RTA only
Industrial Engineering	Newnan and Johnson [16]	Covers RTA only
	Park and Sharp-Bette [18]	Covers both RTA and RTE, shows equivalence when NPV=0
Agricultural Economics	Boehlje and Eidman [4]	Recommends RTA, notes that RTE is "typically less accurate," (p. 323)
	Kay and Edwards [10]	Recommends RTA, indicates project financing should be omitted from the CFs (p. 289)
	Beierlein et al. [2]	Covers RTA only
	Barry et al. [1]	Recommends RTE "for smaller, non-corporate firms," (p. 286), discusses RTA as an alternative (pp. 285-86, 305-10)
	Lee et al. [12]	Covers RTA only
Forestry	Klemperer [11]	Covers RTA only
	Bullard and Straka [7]	Covers RTA only

Figure 1. Net Present Value Calculations, according to Professor RTA.

$$NPV = -INV_0 + \sum_{t=1}^{N} \frac{CF_t}{(1+i)^t} + \frac{TERM_N}{(1+i)^N}$$

where:

NPV	= net present value of the project,
INV_0	= initial total cash acquisition cost of the project,
	= I_0,
Cf_t	= net cash flow attributable to INV_0 occurring at the end of period t, t = 1, 2, …, N, for N periods (years)
	= $(R_t - C_t - D_t)(1-T) + D_t$,
R_t	= pretax cash operating revenues generated by the project in period t,
C_t	= pretax cash operating costs due to the project during period t,
D_t	= additional depreciation due to the project during period t,
T	= firm's marginal income tax rate,
$TERM_N$	= the after-tax terminal or salvage value of the project's assets at the end of end of period N, the planning horizon,
i	= pertinent cost of capital, which may be $(1-T)rw + k(1-w)$,
r	= interest rate paid on debt capital,
k	= required rate of return on the owner's equity invested in the project, and
w	= the optimal proportion of the firm's financing from debt, $0 \leq w \leq 1$.

Figure 2. Net Present Value Calculations, according to Professor RTE.

$$NPV = -INV_0 + \sum_{t=1}^{N} \frac{CF_t}{(1+i)^t} + \frac{TERM_N}{(1+i)^N}$$

where:

NPV	= net present value of the project,
INV_0	= owner's equity invested at time 0 in the project, in present dollars,
	= E_0,
Cf_t	= net cash flow attributable to INV_0 occurring at the end of period t, = 1, 2, …, N,
	= $(R_t - C_t - D_t - rL_t)(1-T) + D_t - (L_t - L_{t-1})$,
R_t	= pretax cash operating revenues generated by the project in period t,
C_t	= pretax cash operating costs due to the project during period t,
D_t	= additional depreciation due to the project during period t,
T	= firm's marginal income tax rate,
L_t	= project debt outstanding from time t to time t-1, and L_0 is the proceeds at time 0, the present, of new debt incurred in undertaking the project,
r	= interest rate paid on debt capital,
$TERM_N$	= after-tax terminal or salvage value of the project's assets at the end of period N, the planning horizon, and
i	= pertinent cost of capital which is the required rate of return on the owner's equity invested in the project,
	= k.

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[19]Seo, K. K. *Managerial Economics* (7th Edition). Homewood, IL: Irwin, 1991.

[20]Van Horne, J. C. *Financial Management and Policy* (10th Edition). Englewood Cliffs, NJ: Prentice-Hall, Inc., 1995.

* Some additional (supplemental) references are presented in Appendix C of this paper.

APPENDIX A
A BRIEF HISTORY OF THE THEORETICAL DEVELOPMENT
OF DISCOUNTED CASH FLOW (DCF) CONCEPTS

One of the first applications of discounted cash flow concepts (DCF) was by Stevin in 1582 when he proposed using interest tables for selecting loans. Historians Jones and Smith (1982) claimed that one of the earliest applications of DCF models to nonfinancial capital budgeting decisions was by Wellington, an American civil engineer. His 1887 book, *The Economic Theory of the Location of Railways*, dealt with the problem of whether or not a railway line should be constructed. He employed DCF models to solve the problem. In 1907, Irving Fisher, an American economist, referred to DCF models in his seminal book, *The Rate of Interest*. DCF models were also a part of Fisher's 1930 book, *The Theory of Interest*, a revised version of his earlier work.

In the same year (1930) that Fisher's landmark work was published, Grant, an engineering professor at Stanford University, published his classic textbook, *Principles of Engineering Economy*. In his book, Grant discussed the principles of present worth, the rate of return, and the equivalent annual cost methods for making capital budgeting decisions. These methods continue to underlie contemporary capital budgeting decisions. Articles by Boulding (1935) and Samuelson (1937) in the *Quarterly Journal of Economics* were pioneering pieces on the role of the internal rate of return and the net present value criteria in capital theory and investment analysis. However, widespread study and application of these methods did not begin until the 1950's.

Two important books provided the intellectual background for capital budgeting application of DCF models. One was Friederich and Vera Lutz's 1951 book entitled *The Theory of Investment of the Firm*. The second was Dean's 1951 book entitled *Capital Budgeting* which contributed much of the original work on capital budgeting. These works served as building blocks for subsequent theoretical and managerial developments in finance.

In 1955, Lorie and Savage pointed out the problem of multiple internal rates of return. Their article was followed by a host of other articles analyzing the relationship between the internal rate of return and the net present value approaches to capital budgeting. Especially noteworthy was Hirshleifer's 1958 article that clarified the theoretical base of present value and internal rate-of-return criteria.

Hirshleifer's 1970 book, *Investment, Interest, and Capital*, is still an industry standard. It extended Fisher's important work with the goal of presenting capital theory as a generalization of economic theory and extending it into the domain of time. The neglect of traditional economic concepts in DCF models often had led students to overlook the interdependence of profit-maximizing resource use with decisions to invest or disinvest in particular investment.

Later in the 1970's, analysis of DCF models by Johnson and Quance, consistent with Edwards (1959) came to be called investment/disinvestment analysis. This language calls attention to the fact that every investment has a corresponding disinvestment, and DCF models are designed to consider both decisions. Hirshleifer (1970) and Perrin (1972) identified the investment under consideration as the challenger and the investment considered for disinvestment as the defender.

This language is consistent with the focus of investment/disinvestment analysis and is also adopted in this research project.

By the early 1960's, capital investment decision models--DCF models and more simple models such as the Payback Method--gradually became the domain of scholars in finance and management departments in the academy. Bierman and Smidt of Cornell University were perhaps the first to devote an entire comprehensive text on capital budgeting, DCF methods of evaluating capital investment decisions. Their initial edition was published in 1960, and by 1993 their substantially revised 8th edition was more popular and widely used than any time in the past, by academicians and by practitioners in various industries. During the same most recent 30-year era, James C. Van Horne of Stanford University has focused on capital investment decisions, financing of these projects, and other key aspects of financial management policies developed and used by business firms. His seminal text was first published in 1968 and over the past 30 years, as DCF modeling, cost-of-capital and capital structure theory have evolved in the journal literature, we now have a substantially revised, much more thorough and larger 10th edition (1995).

Probably the most popular and widely used managerial finance text over the past 30 years was first published in 1968 by UCLA's J. Fred Weston, an icon in the finance profession. The current (1996) 11th edition of this text, authored by Weston, Besley and Brigham, is also a substantially expanded and revised version, which devotes almost 400 of its 800+ pages to capital budgeting, cost-of-capital and capital structure topics. There are now numerous other excellent texts; and, like the three cited in this paragraph, most of them capture the latest in DCF and other

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capital investment models. Hence, in conducting a thorough, contemporary literature review, one is

well advised to start with these texts and move to more specialized topics in the latest issues of the

leading academic journals, e.g. see Stewart C. Myers, "Still Searching for Optimal Capital

Structure," *Journal of Applied Corporate Finance 6* (Spring 1993): 4-14.

Agricultural economists have extensively applied capital budgeting models and methods to

farm and agribusiness management decision making. In so doing, they have liberally borrowed and

translated the theoretical developments from the finance and management academic worlds. As is

the case of the finance discipline, development of capital budgeting methods in the leading

contemporary textbooks on farm financial management serves as a barometer of what has recently

happened on the research front. For almost half a century (1935 to the mid 1980's) Professor

William F. Murray of Iowa State University was regarded by many as "Mr. Ag. Finance." His

classic text, *Agricultural Finance*, was first published in 1941; and over time, with new authors,

eight editions and numerous printings being added, capital investment topics have taken on more

and more prominence (see Lee, Boehlje, Nelson and Murray, 1988).

Professors Chet Baker and Peter Barry (at The University of Illinois), as heretofore noted,

are regarded by many as the leading agricultural financial management economists of the past 30-40

years. Their work on capital budgeting has been especially noteworthy. It has been published in an

number of research reports, journal articles, and eventually in the chapters on this subject in the text

entitled *Financial Management in Agriculture,* which is now in its fifth edition, 1995 (See Barry,

et al.). The publication in 1996 of a comprehensive text on *Present Value Models and*

Investment Analysis by Professors Lindon Robison (Michigan State University) and Peter Barry (University of Illinois) summarizes a great deal of research which has been conducted by them, a number of their colleagues and peers, and joins these summaries to the "state of the arts" by leading finance professionals.

Perhaps the most precise, useful treatment of agricultural capital investment applications written in text form since 1970, was conducted by Professors Casler, Anderson and Aplin of Cornell. The third and most recent edition of this book, *Capital Investment Analysis Using Discounted Cash Flows*, which was published in 1984, remains relatively widely used by researchers and extension specialists in the field of agricultural capital investments.

Finally, there are a number of texts and other publications in the general area of farm management, e.g. *Farm Management* by Boehlje and Eidman, 1984, which contribute to the understanding of capital investment modeling and analyses. All of this leads back to the objectives of the research in this paper, which deal with areas that have yet to be investigated in agricultural business, particularly by farmers.

Appendix A, Table 1. Historical Development of Discounted Cash Flow Methods: Abbreviated Outline of Pertinent Chronology

Concept and Development Dates (approximate)	Published Sources[a]	Comments
Interest on loans (1600-400 B.C.)	Holy Bible (Revised Standard Version) Deuteronomy, Chap. 23	Laws of the Hebrew Nation sanctioned the charging of interest on loans to traders from other nations, including Assyrians, Babylonians, Persians and Egyptians.
Classical and neoclassical economic theory of consumption, production and prices. Time value of money and interest rate theory (1836-1940)	Lutz and Lutz (1951) Liebhafsky (1968) and numerous others trace developments prior to Keynes.	Lutz and Lutz (1951) note that "real" or "time-preference" theories of interest commodity are attributed to an Austrian economist Böhm-Bawerk (1891), who had adapted it from earlier works by Nassau Senior and other English economists, dating from 1836. Liebhafsky (1968) notes that Wicksell, a Swedish economist, introduced the concept of a "market rate" and "natural rate" of interest in 1901, stating that the market rate does not equal the "real rate" if/when the supply of money is manipulated by those outside the banking system.
Real vs. nominal interest rates, compounding and inflation (1900-1940)	Notably, Fisher (1907 and 1930) Knight (1920s and 1930s)	Fisher's 1930 work is often cited as the foundation of the modern theory of interest. Knight linked interest and profit theory to risk and uncertainity. Articles in the 1930s by Boulding (1935) and by Samuelson (1937) delineated the concepts of internal rate of return and net present value.

Appendix A, Table 1. (continued)

Concept and Development Dates (approximate)	Published Sources[a]	Comments
"Liquidity Preference" and essentials of modern macroeconomic theories of the economy. (1936-present)	Keynes (1936) Hansen (1953)	Keynes started an intellectual revolution when he argued that interest is a payment for the use of money and defined "liquidity preference" as a preference for holding wealth as money rather than in the form of other assets (viz. of securities). The revolution, which is still going, led to "loanable funds theories" and the Hicks-Hansen analysis, where interest rates are related to income.
Capital budgeting models (1938-present)	Lutz and Lutz (1951) Dean (1951)	Dean's 1951 book is often credited with containing much of the original work on capital budgeting. Lutz and Lutz (1951, pp. 17-22) link the concepts of profits and "quasi rent" (Q), which equal to economic profits from risk taking, adjusted for periodic losses (gains) in capital values and income taxes. They also compare four criteria for determining the "profitability of an investment," including, in effect, the RTA and RTE methods of this paper.
Capital investment theory and project financing (1958-present)	Hirshleifer (1970)	As Robison and Barry (1996) note, Hirshleifer's book is still "an industry standard," as it extends Fisher's work (1907, 1930) by presenting capital theory as a generalization of 20th century economic theory. Hirshleifer (p. 46) clearly distinguishes investment decisions from financing (of projects) decisions.

Appendix A, Table 1. (continued)

Concept and Development Dates (approximate)	Published Sources[a]	Comments

Discounted cash flow (DCF) models (1938-present)	Brigham and Gapenski (1996) Robison and Barry (1996)	Unlike most other books, these authors present both the RTA and RTE methods. Brigham and Gapenski appear to prefer the traditional RTA approach with the cost of capital being the weighted cost of equity and debt capital. They refer to the RTE approach as the "equity residual method," and describe how/when it is equivalent to the RTA method (pp. 278-80).
Optimal cost of capital and capital structure theory (1958-present)	Block and Hirt (1994) Moyer, et al. (1995) Brigham and Gapenski (1996)	Modigliani and Miller (MM) were the first (1958) to rigorously address the question of how much return is required to compensate the firm's owners (investors) for the increased risk of more debt, i.e., what is the optimal amount of debt financing by the firm, thus what is the optimal capital structure. These questions are closely intertwined with choosing the most appropriate models (and methods) of capital investment decision making. MM's initial work concluded the firm's optimal value is independent of its capital structure; but when their stringent assumptions of perfect capital markets, zero taxes and zero bankruptcy and agency costs were relaxed this conclusion was altered. Now, the question of optimal capital structure is still being debated, so that many textbooks continue to employ traditional capital cost-leverage relationships (see, for example, Barry et al., (1995, pp. 156-160).

[a] This table is mostly limited to a listing of selected, more recently published sources.

APPENDIX B
AN EXPANDED DISCUSSION ON ISSUES
IN DEFINING COMPONENTS OF NPV MODELS

Defining the Initial Investment, INV_0

Among proponents of both the RTA and RTE methods, there is near unanimity about the definition of the total cash outlay needed to acquire the investment assets, I_0:   the new project cost inclusive of installation, shipping, and training costs incurred   in acquiring the asset and putting it into service.

+   any increase in net working capital required at time 0 as a result of adopting the project

-    the net proceeds from the sale or the trade-in allowance of existing assets when the investment project is a replacement for existing assets

±   any taxes arising from the purchase of new assets and/or sale of existing assets (Moyer et al., pp. 344-45, Barry et al., p. 287).

But this definition is sometimes violated. Without discussing their reasoning, Penson and Lins (p. 109) say that this total cash outlay should be gross of "the trade-in value of used machinery deducted from the purchase price at the time of the purchase."

The RTA and RTE methods differ in how INV_0 is defined relative to the total cash acquisition cost of the investment: the RTA method defines INV_0 as the total cash outlay from debt and equity sources, I_0; while the RTE method defines INV_0 as the equity portion of the total cash

acquisition outlay, or total cash acquisition cost less the net proceeds of the loan used to finance the

project.

Defining CF_t

The RTA method defines CF_t as the after-tax net operating cash flows (operating revenues

less operating expenses and the depreciation tax shield) generated by the project in period t so that

any payments for debt service (interest and principal payments) in period t are excluded in

calculation of the cash flows. Thus there appears to be unanimity in the definition of the RTA cash

flows as, based on the notation of Figure 1.

The RTE method requires a specific debt repayment schedule (interest and principal

payments each period) in order to compute the value of the net equity flows as, with the notation of

Figure 2. Note that adding the after-tax debt flows, $rL_t(1 - T) + (L_t - L_{t-1})$ to the net equity flows

of the RTA CF gives the after-tax net operating cash flows of the RTE CF.

Most authors are in agreement when describing the RTE method (e.g., Chambers et al., pp.

25-26 ; Park and Sharp-Bette, p. 183; Fiske, p. 49; Okoruwa et al., p. 194, Brigham and

Gapenski, p. 280). Penson and Lins (pp. 185-87, 195) advise that an adjustment should be made

to the interest payment to account for the "implicit cost of debt capital" when there is less than

prefect certainty regarding the project's cash flows." This adjustment would reduce the annual net

cash revenue "by an amount equal to the implicit cost of debt capital multiplied by the remaining

balance on the loan (p.186)." Barry et al. (pp. 416-17) also refer to this implicit cost of debt

capital, discuss ways that the premium could be estimated, and calculate a total cost of debt that

incorporates this premium. However, they do not offer any guidance concerning whether or how

the total cost of debt so calculated should be used in Figure 2. Note what Penson and Lins (p.

187) say:

> *"Another approach would be to use a weighted cost of debt and equity capital*
>
> *in the discount rate in net present value analysis. The weights assigned to the*
>
> *required of return on equity capital and the total cost of debt capital would*
>
> *depend on the relative use of these resources of funds in financing the farm*
>
> *operator's investment projects. Both approaches will produce equivalent*
>
> *results. If you have already accounted for the total cost of debt capital in the*
>
> *annual net cash flows, however, you must use the first approach to avoid*
>
> *double accounting of the cost of capital.*

Defining the Discount Rate, i

Notwithstanding what you might read or hear elsewhere, the cost of equity capital is agreed

to be the appropriate discount rate for the RTE method. In contrast, there is a lack of unanimity

among authors discussing the RTA method concerning the appropriate specification of the discount

rate representing the firm's marginal cost of capital. Most authors specify the discount rate as the

Weighted Average Cost of Capital (WACC), but a few indicate that management can choose

between the WACC and other rates. For example, Kay and Edwards (p. 289) advise that "(if)

money will be borrowed to finance the investment, the discount rate can be set equal to the cost of

borrowed capital," or r in our notation; while Beierlein et al.(p. 305) say that management can "use the interest rate attainable by 'investing' in lending institutions (deposits or securities) before taxes."

In general, most RTA proponents advocate the use of the WACC as the appropriate discount rate. This prevailing view is reflected in Figure 1 where the expression for the discount rate used in implementing the RTA method is, with T representing the firm's marginal income tax rate, r the interest rate paid by the firm on debt capital, k the required rate of return on the owner's equity, and w, the proportion of the financing done with debt.

Defining the Cost of Equity Capital, k

Regardless of whether they are discussing the RTE method or the WACC version of the RTA method, most authors agree that the cost of owners' capital, k, is difficult to measure.

Lee et al. (pp. 87-88)

C   *k should exceed the debt rate by a (subjective) risk premium*

C   *(past rates)what rate of return on equity (after taxes) has the business been earning*
        in recent years

C   *(opportunity costs) if sold business assets, repaid all debts, what rate of return would*
        be earned? answer involves estimating returns on nonfarm equity investments

Boehlje and Eidman (p. 322)

C   *best estimated as the opportunity cost of committing equity to this investment*
        compared to other investments

C *best specific measure is to look at after-tax rate of return being generated by the*

  equity capital currently being used by the firm. Gives specific directions for

  calculation based on income and balance sheet data.

Casler et al. (pp. 51-53)

C *opportunity cost of funds in the business*

C *return on funds that could be invested elsewhere in investment of comparable risk,*

C *adjustment for intrinsic reward from operating own business*

C *should be significantly higher than cost of borrowed capital*

C *should be viewed as differing from one business to another (owing to differences in*

  owners' characteristics)

Beierlein et al. (pp. 306 -307)

C *opportunity cost of placing funds elsewhere in comparable risk situations*

C *vary across firms (owing to differences in owners' and firms' characteristics)*

C *should be greater than cost of debt capital "based on the premise that there is a*

  higher risk cost of the owner's money sunk in the business. However, the owner may

  view the opportunity cost at less than the actual interest cost of money in some cases

  (p. 306)."

Barry et al. (pp. 289-90)

C   *best understood as an opportunity cost*

C   *risk-free rate for time preference + risk premium to reflect riskiness of cash flows +*
        inflation premium

C   *The required rate of return needed to compensate for foregone consumption (p. 418)*

C   *the higher the business and financial risks associated with the farm operation, the*
        higher the cost of equity capital, reflecting the premium needed to compensate for
        bearing the added risk (p. 418).

Penson and Lins

C   [*Barry et al. (p. 292-93) adjust the required return on equity to account for the*
        financial risk associated with leveraging! They maintain a constant discount rate for
        a given initial level of debt funding but "(t)he required return increases in response to
        the greater financial risk from leveraging (p. 292) " But see (p. 317) where they say
        "(to) this point we have assumed complete certainty in the projections of investment
        performance and cash flows."

There's a problem with this logic by Penson and Lins. If the discount rate changes with the
initial level of debt funding, why doesn't it change as the debt-to-value ratio changes in their
examples with arbitrary debt-repayment schemes. One needs to relate this to the standard graph
relating cost of capital to the leverage of the firm as on page 158 of Barry et al. One assumption
would be that the owner recognizes the changing leverage over the course of the project and sets
his cost of equity capital accordingly.

Defining the Cost of Debt Capital, r

Within the WACC framework, there are differences of opinion among authors regarding the specification of the debt rate, r. According to Brigham and Gapenski (p. 168), the interest rate on debt capital, r, should be the borrowing rate for long-term debt unless the firm uses a mixture of short-term and long-term debt in financing long-term investments, a practice that "is not common among well-managed firms." If such a mixture is used, the value of r would be calculated as a weighted average of the short-term and long-term debt rates, with the weights given by the proportions of short-term and long-term debt used in long-term financing (Brigham and Gapenski, p. 189). But Beierlein et al. (p. 306) calculate a weighted average of short- and long term-interest rates on debt for usage in a WACC framework without specifying whether short-term debt is used to finance long-term investments. Boehlje and Eidman (p. 322) specify r as the cost of debt funds without specifying whether the debt is short or long term.

Lee et al. (p. 86) say that "(t)he use of debt financing results in increased financial risk and reduced credit reserves. Thus an internal credit rationing premium should be added to the interest cost. The estimate of this will be somewhat subjective, depending upon the manager's risk-return preference function." This is similar to the implicit cost of debt capital used by Penson and Lins (pp. 185-87, 195) to adjust the cash flows within the RTE method.

Defining the Debt-to-Value Ratio, w

The proportion w is determined by the firm's target debt-to-value ratio within the WACC framework. The firm's value is usually specified as the firm's capitalization: long-term debt plus the value of the owners' equity, and thus excludes short-term debt (Brigham and Gapenski, p. 168, Moyer et al., pp. 468-471). Assuming that the firm's current balance sheet reflects its target debt-to-value ratio, w would be calculated as the capitalization ratio, according to Moyer et al., p. 469. But Boehlje and Eidman (pp. 322-23) say that w would be calculated as the debt-to-asset ratio: and thus, assume (implicitly) that either short-term debt is used in financing investment s or the firm has no current liabilities.

In discussing the value of the firm — the firm's net worth — there appears to universal agreement that assets already under the control of the firm should be assigned their market values (rather than their acquisition costs less accumulated depreciation) in calculating w when the firm's current balance sheet reflects its target debt-to-value ratio. But there are differing views regarding the debt capacity of a given proposed project; and as a consequence, this leads to differing views on the appropriate amount of initial debt financing of the project under the WACC approach. These differing views arise because there are two ways to value the proposed project: (a) its "market value" equal to the incremental discounted cash flows of the project, $I_0 + NPV$, and (b) its "book value" equal to the total cash acquisition costs needed to acquire the investment assets, I_0 (Fiske, p. 50). The "market value" view recognizes the debt supported by the proposed project's NPV and determines the debt financing ratio for the proposed project required to maintain the target debt-to-value ratio. Note that w is greater than the target debt-to-value ratio for positive NPV projects and can be greater than unity. The "book value" approach ignores the new debt

capacity provided by the project's NPV, and determines the debt financing ratio for the proposed project.

Fiske (p. 50) cites Beranek (1977) in saying that most writers agree that the "book value" view is appropriate for evalauting the debt capacity of the proposed investment. This is misleading. Brigham and Tapley (p. 49), Chambers et al. (p. 29), Haley and Schall pp. (353-54), to list a few, say that the project's financing mix should be based on the project's market value rather its book value. Brigham and Tapley (p. 50) explain that while corporate finance textbooks indicate that w should be used in evaluating the debt capacity of a new project, those textbooks assume (implicitly) that "(i)nvestors have correctly anticipated the total value that management expects to add through capital budgeting (the sum of all projects NPVs) during the budget period. If this condition holds, then positive NPV projects will already be reflected in the firm's stock price.…With this scenario, the overall capital structure will remain on target if new projects are financed at the firm's target capital structure, as most textbooks recommend." It is difficult to see how the owners of a firm without publicly traded equity (or their lenders) could reflect anticipated positive NPV projects in the owners' equity.

Furthermore, Beranek (1980) argues that in general the NPVs calculated for mutually exclusive projects by the WACC approach should not be used to rank those projects when w is used as the debt-financing ratio for the projects. He claims that in this circumstance the firm's owners must determine a debt redemption policy that maximizes the owners' equity.

APPENDIX C
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