

NBER WORKING PAPER SERIES

INVESTMENT INCENTIVES  
AND THE DISCOUNTING OF  
DEPRECIATION ALLOWANCES

Lawrence H. Summers

Working Paper No. 1941

NATIONAL BUREAU OF ECONOMIC RESEARCH  
1050 Massachusetts Avenue  
Cambridge, MA 02138  
June 1986

The research reported here is part of the NBER's research program in Taxation and projects in Government Budgets and Taxation and Capital Formation. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

Investment Incentives and the Discounting of Depreciation Allowances

ABSTRACT

This paper examines the discounting of depreciation allowances both theoretically and empirically. Economic theory suggests that depreciation tax shields should be discounted at the after tax riskless rates. However, a survey of 200 major corporations indicates that they employ much higher discount rates to depreciation allowances. Typical discount rates are in the 15 percent range. This finding suggests that "frontloaded" incentives like the ITC provide maximal stimulus to corporate investment.

Lawrence Summers  
Department of Economics  
Harvard University  
Cambridge, MA 02138

The importance of depreciation and investment tax credit provisions in determining the level and composition of investment is widely recognized. Economists have long understood that the present value of depreciation tax shields along with the investment tax credit determines the effective purchase price of new capital goods, which in turn determines the cost of capital. Measures of the cost of capital are widely used in evaluating the likely effect of proposed tax reforms on the total level of investment and in assessing the distortions across capital goods caused by tax rules.

The cost of capital depends on the present value of depreciation allowances permitted by the tax system. This raises the question of what discount rate should be used in calculating this present value and determining the cost of capital. The choice of a discount rate is of considerable importance in assessing investment incentives. For example, the much discussed adverse effect of inflation in conjunction with historic cost depreciation on investment results from the increased discount rate that must be applied to future nominal depreciation allowances. At a zero discount rate all depreciation schedules which permitted assets to be fully depreciated would be equivalent. It is only because of discounting that depreciation schedules affect investment decisions, and their effects depend critically on the assumed discount rate.

Tax reform proposals often change the extent to which depreciation tax benefits are "backloaded". For example, the proposal of Auerbach and Jorgenson (1981) would have given firms all of their depreciation benefits in the year that investments were made. On the other hand, the recent proposal

of the President (1985) stretches out the tax benefits associated with investment outlays by indexing depreciation allowances and abolishing the investment tax credit. A comparison of either of these proposals with current law will depend critically on the discount rate applied to future tax benefits in computing the cost of capital.

Despite its importance, the choice of an appropriate discount rate for depreciation allowances has received relatively little attention from tax analysts. This paper examines both theoretically and empirically the discounting of depreciation allowances and its implications for tax policy. I conclude that economic theory suggests that a very low and possibly negative real discount rate is appropriate for calculating the present value of future tax benefits. But empirical evidence from a survey of 200 major corporations suggests that most companies in fact use very high real discount rates for prospective depreciation allowances. This conflict makes the analysis of alternative tax policies difficult. It surely suggests that there is little basis for confidence in tax policy assessments based on specific assumed discount rates which are constant across companies.

The paper is organized as follows. Section 1 argues that given the risk characteristic of depreciation tax shields, a very low or negative real discount rate should be applied. Section 2 reports survey results on the actual capital budgeting practice of firms and discusses possible reasons for the apparent conflict between the recommendation of theory and firms' reported behavior. Section 3 concludes the paper by discussing the implications of the analysis for the assessment of alternative tax policies.

I. HOW SHOULD DEPRECIATION ALLOWANCES BE DISCOUNTED?

This paper begins by reviewing the theory of capital budgetting and its application to the discounting of depreciation allowances. The theory has clear implications. Because prospective depreciation allowances are very nearly riskless, they are more valuable than other prospective sources of cash flow. The appropriate discount rate for safe cash flows like the stream of future depreciation deductions is lower than the rates applied to risky physical investments. An argument is made that the appropriate discount rate for depreciation deductions is the same rate applied to the after-tax coupon payments on a safe bond. The present value of depreciation deductions so computed can then be used in assessing potential investment projects. At current levels of inflation and interest rates, it appears that only a negligible real interest rate is appropriate for assessing alternative tax policies.

In theory (and in practice as demonstrated below), firms decide whether or not to undertake investments by computing the present value of the net cash flows they generate, using a discount rate corresponding to their cost of funds.<sup>1</sup> In a frictionless world of certainty, this process is completely straightforward. There is only one available rate of return and firms invest to the point where the marginal project earns just this rate of return. Or put more precisely, the net present value of the marginal project evaluated at the required rate of return is zero.

Once the possibility that a project is risky is recognized the problem of capital budgetting becomes much more difficult. The theoretically appropriate procedure is to find the certainty equivalent of each period's

cash flow and then to discount the certainty equivalents at the return paid by riskless assets. In reality it is difficult to assess certainty equivalents because the certainty equivalent of the cash flow payable in a given period generally depends on the distribution of cash flows in preceding and subsequent periods. Hence the normal procedure is to use a "risk adjusted discount rate" appropriate to the project under consideration. This rate in general will depend on the covariance of its returns with aggregate returns in the economy. In the special case where a given project's returns will mirror the returns of the entire firm, it is often suggested that the appropriate discount rate be inferred from the firm's stock market beta.

A fundamental principle in finance is that of superposition. The valuation of a stream of cash flows is the same regardless of how it is broken up into components. This insight makes it clear how depreciation allowances should be treated at least to a first approximation. Consider an arbitrary investment project. The project will after an initial outlay generate a stream of uncertain future operating profits which will then be taxed. It will also generate a stream of future depreciation deductions which can be subtracted from the firm's income to reduce its tax liabilities. These two streams can be valued separately for analytic purposes. The valuation of the profit stream is difficult absent a satisfactory way to gauge its riskiness. But the valuation of future depreciation tax shields is much easier since they are close to being riskless.<sup>2</sup> They therefore should be evaluated by discounting at a riskless rate. Since depreciation tax shields represent after tax cash flows, they should be discounted at an after tax rate of

return. Their present value can then be added to the present value of the profit stream evaluated at an appropriate risk adjusted discount rate to evaluate the total return on an asset.

The same conclusion may be reached using an arbitrage argument as in Ruback (1985). Consider a set of prospective depreciation deductions which a firm is entitled to utilize. Imagine that the firm instead possesses a portfolio of treasury bills designed so that the after tax coupon payments in each period equal exactly the value of the tax deductions. It should be obvious that the firm has an equally valuable asset in either case. It follows that the appropriate discount rate for valuing depreciation deductions is the same as that for the treasury bill portfolio -- the after tax nominal interest rate on safe assets. Note that the after-tax nominal interest rate is likely to be much lower than the appropriate discount rate for a project's operating cash flows.

At present nominal interest rates on safe assets are less than ten percent. With a forty six percent corporate tax rate, it follows that the appropriate discount rate for future depreciation allowances is no more than a five percent nominal rate. This means a real rate very close to zero, contrary to the four percent real rate assumed in many calculations of the effects of tax incentives.

The assumption that prospective depreciation deductions represent a riskless asset has been maintained so far. In fact future depreciation deductions are subject to some risks. Depreciation deductions will be useless for firms that make losses and become nontaxable and are unable to make use of carryback and carryforward provisions. The results of Auerbach and Poterba

(1986) suggest that this is not an important factor for most large firms. There is also the possibility of changes in tax rules. Since depreciation deductions represent a hedge against changes in tax rates, this source of uncertainty may drive the appropriate discount rate down rather than up. Finally there is always the possibility that the depreciation rules will be changed with respect to assets already in place. This has never occurred in the United States. On balance, it seems fair to conclude that depreciation tax shields represent an essentially riskless asset.

The arguments made so far indicate that firms should separately discount at different rates expected operating profits and depreciation deductions. It might be thought that firms could use a common discount rate for all the components of cash flow on a given project that reflected their average degree of riskiness in some way. But this is not correct because there is no way to know how much weight to give each component of cash flow until its value is determined which in turn requires the choice of a discount rate. Even if an appropriate rate could be found, it would vary across projects depending on the value of prospective depreciation deductions. Moreover, a weighted average rate is unlikely to be varied when tax rules changes and alter the share of a project's value represented by depreciation tax shields.

Before turning to an examination of tax policies, the next section reports evidence on firms' actual capital budgeting practices. They do not in general conform to those recommended in this section.



## II. HOW ARE DEPRECIATION DEDUCTIONS DISCOUNTED?

In order to learn how depreciation deductions are discounted by actual major corporations in making their investment decisions, a brief questionnaire was sent to the chief financial officers of the top 200 corporations in the Fortune 500. A copy of the questionnaire and covering letter are provided as an appendix to this paper. Usable replies were received from 95 corporations. No effort was made to raise the response rate by following up on the initial mailing but there is little reason to suspect systematic differences in capital budgeting procedures between responding and nonresponding firms. The questionnaire was designed to find out whether capital budgeting procedures embodied the principles suggested in the preceding section and to find out what discount rates firms actually apply to depreciation deductions.

The survey results are reported in Table 1. As the table indicates, the vast majority of corporate respondents stated that they had capital budgeting procedures and that these procedures were of "considerable" but not "overriding" importance in corporate investment decisions. Only 7 percent of the companies responding indicated that they discounted different components of cash flow on a given project at different rates, and even several of these companies did not distinguish operating profits and depreciation allowances. Many of the responding companies indicated that they dealt with risk issues by discounting projects emanating from different divisions or locations at different rates, but that they discounted all the cash flows from a given project at the same rate. It is clear that the practice of separately discounting safe and unsafe components of a project's return as suggested by

TABLE 1

## SURVEY RESULTS ON THE DISCOUNTING OF DEPRECIATION ALLOWANCES

---

I.	Capital budgeting procedure is of:		
	overriding importance		6%
	considerable importance		91%
	little importance		3%

---

II.	Cash flow components discounted	Yes	6%
	at different rates:	No	94%

---

III.	Discount rate applied to depreciation	< 12%	13%
	allowances:	13-15%	48%
		16-18%	16%
		19-21%	13%
		22%+	10%

---

theory is a rarity in American industry.

The lower part of the table indicates the distribution of the rates used by companies to discount depreciation allowances. In most cases the figure refers to the common nominal discount rate applied to all cash flows. The reported discount rates for depreciation allowances were surprisingly high with a median of 15 percent and a mean of seventeen percent -- far in excess of the after tax nominal interest rate. Given that depreciation tax shields have very similar risk characteristics across firms, it is also noteworthy that the rate at which they are discounted varies widely. The discount rates reported by firms varied from 8 to 30 percent. This variability is almost certainly the result of firms applying a common discount rate to all cash flows.

It is not easy to account for the level and variability of depreciation discount rates. One possibility is that managers do not understand the financial theory outlined in the preceding section or find it too complex to implement. Another possibility is that shareowners represent the locus of irrationality. If they apply a common discount rate to all components of cash flow, value-maximizing managers will do so as well. It is also conceivable that some of the variations in discount rates across firms result from different conceptual definitions of the required rate of return.

Before turning in the next section to the implications of these results for tax policy, there is an important methodological question to be addressed.<sup>3</sup> Economists continue to assume that consumers maximize utility even though it is clear that they never actually solve explicit optimization problems and indeed would reject the idea that they are maximizing anything.

Firms rarely admit to knowing their marginal costs yet economists frequently assume they equate price to marginal cost. The reason is the power of "as if" modeling. There is a great deal of evidence that firms and consumers behave "as if" they were maximizing profits or utility functions, even if they do not do so consciously. Can a similar point be made with respect to evidence that firms use inappropriate discount rates in making investment decisions?

In a case like the discounting of depreciation allowances, the usual arguments for "as if" reasoning do not seem compelling. Evolutionary pressures against firms who do not optimize are likely to be weak. And the linkages between what managers say they are doing and what they actually do seem reasonably straightforward. Capital budgeting is a tool developed to help managers make more rational investment decisions than their unaided intuitions would permit. When it yields the "wrong" answer it seems excessively Panglossian to assert that managers are unconsciously doing what is right anyway. The next section therefore focuses on the implications of these survey results for tax reform.

### III. TAX POLICY IMPLICATIONS

This section treats two aspects of the relationship between the discounting of depreciation allowances and tax policy. First, I illustrate the sensitivity of judgments about the effects of alternative tax policies on incentives to the discount rate applied to future depreciation allowances. Second, I argue that the high and variable depreciation discount rates used by firms may themselves create important distortions, which the tax structure may

either mitigate or exacerbate.

Table 2 presents estimates of the sum of the present value of depreciation allowances and the deduction value of the investment tax credit under current tax law, the President's proposal of May 1985 and the House of Representatives' 1985 tax bill using alternative discount rates for depreciation. The possibility of churning assets discussed by Gordon, Hines and Summers (1986) is ignored.

Calculations indicate that the effects of alternative tax rules are quite sensitive to the assumed discount rate for depreciation allowances. At the theoretically appropriate zero real discount rate only the House bill is less generous than a policy of immediate expensing of investment outlays. Current law provides a substantial subsidy to the purchase of new equipment because of the availability of the investment tax credit. On the other hand, with a 10 percent real discount rate applied to depreciation allowance as the survey results suggest all three tax laws provide benefits significantly less generous than expensing. Especially for long lived equipment in asset class IV, both the Treasury bill and the House proposal would lead to a substantial increase in the effective purchase price. It is interesting to notice that while the President's proposal is more generous at a zero discount rate, it appears less generous at a 10 percent discount rate.

The choice of a discount rate is especially important in evaluating the incentives provided for long lived structures investments. At a zero discount rate the President's proposal provides far more incentives to structures investment than does current law. On the other hand, at a 10 percent rate current law is much more generous than the President's proposal. In both

TABLE 2

EFFECTS OF ALTERNATIVE DISCOUNT RATES ON THE PRESENT VALUE OF DEPRECIATION DEDUCTIONS UNDER ALTERNATIVE PROPOSALS<sup>a</sup>

ACRS Asset Class	I	II	III	IV	V	VI
d = 0						
Current Law	1.06	1.08	1.08	1.08	.939	.736
President's proposal	1.0	1.0	1.0	1.0	1.0	1.0
House Bill	.951	.916	.916	.916	.79	.67
d = 1						
Current Law	.972	.938	.938	.938	.709	.487
President's proposal	.891	.862	.820	.759	.694	.351
House Bill	.874	.802	.799	.792	.566	.430

<sup>a</sup>The present value of depreciation includes the value of the investment tax credit. A value of 1.0 corresponds to expensing. All calculations assume a 5 percent inflation rate. The discount rate is denoted by d.

cases the House bill is intermediate between current law and the President's proposal.

The fact that firms use very high discount rates in evaluating projects suggests that the investment tax credit is likely to be a very potent tax incentive per dollar of government revenue foregone. The government will presumably want to trade off tax revenue at present and in the future using its borrowing rate. If firms discount future tax benefits a rate higher than the government borrowing rate, tax incentives can be enhanced with no increase in the government's permanent cost by restructuring tax incentives to move the benefits forward, without changing the present value of the revenue foregone. The investment tax credit is frontloaded in this way. Still greater frontloading of tax incentives is possible through accelerating depreciation allowances, since this policy keeps the sum of the deductions that can be taken on an investment constant while increasing their present value. On the other hand, indexation of depreciation allowances tends to increase the duration of tax benefits.

The fact that firms use widely varying and inappropriate discount rates for depreciation allowances suggests that patterns of investment may be very substantially distorted in ways not considered in standard analyses of the effects of tax incentives. Certainly the returns demanded on marginal projects vary by much more across firms than do conventional measures of the cost of capital.

The reasons for these patterns are a potential subject for future research. One possible clue is that corporations and individuals seem to apply very different discount rates to depreciation allowances. The frequency

with which individuals churn structures suggest that they apply a much lower (and more appropriate) discount rate than do corporations. This raises the possibility that agency issues may help to explain observed patterns of corporate capital budgeting. If so they may have an important bearing on the linkage between tax policies and investment decisions.



Footnotes

\*This paper was prepared for the NBER Conference on Capital Taxation in Palm Beach, Florida, February 14-15, 1986. Deborah Mankiw helped in the design and dissemination of the survey reported in this paper as well as providing valuable comments. Jim Hines, Jim Poterba, and Andrei Shleifer provided helpful comments.

1. For a general discussion of capital budgetting principles, see Brealey and Myers (1984).
2. The risk characteristics of depreciation tax shields are considered below.
3. I am grateful to Greg Mankiw for impressing on me the possible importance of this issue.

References

Auerbach, Alan and James Poterba, this volume, "Tax Loss Carryforwards and Corporate Tax Incentives."

Brealey, Richard and Stewart Myers, 1984, Principles of Corporate Finance.  
New York: McGraw Hill.

Gordon Roger, James Hines, and Lawrence Summers, this volume, "Notes on the Tax Treatment of Structures."

Jorgenson, Dale and Robert Hall, June 1967, "Tax Policy and Investment Behavior," American Economic Review.

Ruback, Richard S., 1986, "Calculating the Market Value of Riskless Cash Flows," Journal of Financial Economics, forthcoming.

The President's Tax Proposals to the Congress for Fairness, Growth and Simplicity, 1985.

APPENDIX

September 20, 1985

Dear \_\_\_\_\_:

As part of its ongoing program of research on the economics of capital formation, the National Bureau of Economic Research is studying the effects of proposed reforms in the investment tax credit and tax depreciation schedules. The effects of alternative proposals depend critically on how taxes are factored into companies' capital budgeting procedures. I am therefore attempting to systematically gather information on major corporations' capital budgeting techniques.

I would be very grateful if you could fill in the enclosed questionnaire regarding your company's capital budgeting procedure, and return it in the enclosed envelope. Information identifying individual companies will not be presented in any of our research reports. I will of course furnish you with the results of the study when it is completed.

Thank you for your consideration.

Sincerely,

Lawrence H. Summers  
Professor of Economics  
Harvard University

LHS/mh

Enclosure

Questionnaire

- 1) Does your company use a capital budgeting procedure based on evaluations of the discounted cash flows from proposed projects? \_\_\_\_\_yes \_\_\_\_\_no
  
- 2) If yes, would you say that the present value of the cash flows from proposed projects is of \_\_\_\_\_overriding importance  
\_\_\_\_\_considerable importance  
\_\_\_\_\_some consequence  
\_\_\_\_\_little consequence  
in determining whether they are undertaken?
  
- 3) What is the hurdle rate of return you apply to new projects? Specifically in your capital budgeting procedure, what discount rate do you apply to the after tax nominal cash generated by the typical project? \_\_\_\_\_  
(Alternatively, please provide the real discount rate which you use and the expected inflation rate which enters your calculations.)
  
- 4) In evaluating projects some companies discount different components of cash flow at different rates because of their different risk characteristics. For example, some companies discount prospective depreciation tax shields at a low rate because there is not much uncertainty associated with them. Does your company treat different components of cash flow differently?  
\_\_\_\_\_yes \_\_\_\_\_no.

5) If so, what discount rate do you apply to each of the following types of cash

flow: \_\_\_\_\_ operating profits

\_\_\_\_\_ scrap value

\_\_\_\_\_ depreciation tax benefits

\_\_\_\_\_ investment tax credits

\_\_\_\_\_ rental income

Comments: