Depreciation, Inflation and Investment Incentives: The Effects of the Tax Acts of 1981 and 1982

Mack Ott

THREE years after its enactment, controversy still surrounds the Economic Recovery Tax Act of 1981 (ERTA) and its successor, the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA). On the one hand, the Reagan administration claims that the 1981 tax reductions substantially increased U.S. business investment and contributed to the strong recovery from the 1981–82 recession[1]. On the other hand, some commentators argue that the tax reductions have failed to increase business investment.[2] Moreover, other critics of ERTA argue that, although investment has increased, it has done so in an unbalanced fashion: too few resources are going into plant, while too many are going into producers' durable equipment.[3] Omitted almost entirely from the debate over the effectiveness of the tax reductions has been the independent impact of the recent disinflation. That is, to what extent would investment have been increased simply by the decline of the inflation rate and how does such an influence come about?

This article develops the foundation for assessing these issues. First, the economics of depreciation deductions is discussed. Second, depreciation accounting is reviewed. Third, the legislatively enacted effects of ERTA and TEFRA are set forth. Following this, the relation of U.S. capital investment to distortions in depreciation and inflation during the last three decades are reviewed. In each of these steps, the particular impact of a declining inflation rate is examined to weigh its relative importance in changing the investment incentives due to depreciation deductions from taxable income.

THE ECONOMICS OF DEPRECIATION DEDUCTIONS

In the course of any business activity, equipment and plant gradually are consumed: equipment wears out from use or becomes obsolete and must be replaced; structures deteriorate, ultimately requiring renovation or demolition and reconstruction. Consequently, depreciation is a normal expense of business activity and, like other normal expenses — wages and salaries, insurance premiums, utilities and material costs — is deducted from gross revenues to determine taxable income.[4]

Two Types of Depreciation: Physical Deterioration and Economic Obsolescence

An inherent difference between depreciation and other deductible business expenses, however, is that depreciation can be determined only implicitly; other

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[1]*Economic Report of the President* (1984), p. 34.

[2]For example, see Editorial, *Washington Post*, April 22, 1984.

[3]Greenhouse (1984).

[4]From the institution of the federal income tax with the sixteenth amendment to the Constitution in 1913, depreciation has been an allowable deduction in computing taxable income. Under the Revenue Act of 1913, taxpayers were allowed to deduct "a reasonable allowance for the exhaustion, wear and tear of property arising out of its use or employment in the business." Internal Revenue Service (Vol. 1971-2), C.B. 504.

expenses can be substantiated explicitly by such positive documentation as invoices.

Two distinct types of economic value loss are covered by depreciation: First, there is the obvious deterioration due to use which lessens the remaining value in producers' durable equipment and structures. The rate of such deterioration is difficult to establish objectively because wear and tear on a given type of equipment or structure may occur at different rates in different applications. Second, there is the economic value that is lost when either an improved machine is developed — that is, better quality of output, faster rate of output or more frugal in its input use for a given output rate — or a change in the relative prices of an input (such as energy) occurs that requires a change in production techniques and equipment design. Although the economic loss due to obsolescence is obviously difficult to predict, it has been a tenet of business income tax procedures resulting in the acceleration of depreciation since well before the explicit adoption of accelerated depreciation accounting systems in 1954.[5]

To establish an explicit basis for depreciation expenses, then, the taxing authority could either allow each firm to estimate its own current depreciation expenses or provide guidelines in the form of somewhat arbitrary schedules of allowable percentage deductions. For the first 20 years of the federal income tax, individuals were given the freedom to determine their own depreciation allowances subject to IRS review. The U.S. tax code now primarily takes the second approach.[6]

Elements of Depreciation

There are three elements of depreciation expensing implied by the foregoing discussion, only two of which are explicit in the depreciation schedules: First, there is the length of time, the asset's *tax life*, over which the asset, for tax purposes, is assumed to deteriorate.[7] Second, there is the pattern of deductions; this component determines the *acceleration* of the depreciation schedule, which varies from equal deductions in each period — no acceleration — to proportionally large initial-period deductions, which decline according to specified accounting patterns over the asset's tax life. Third, there is the problem of how to treat *scrap* or salvage value. Given the differences in deterioration that exist in different applications, this problem would exist even if tax life and useful life were equal.

In general, tax lives are shorter than the durability implied by the rate of physical deterioration so that scrap value — more particularly, after-tax scrap value — is a problem for all capital users. Moreover, the longer the physical life of an asset, the more uncertain its scrap value; technological advance, changes in relative prices of inputs or evolution in use patterns may make the market value at disposal much less than the value implied by its remaining physical life given its original purchase price. For example, a 30-year-old industrial building may be physically sound but of little value because of a change in regional industrial use, demographic changes or a shift in transportation methods.

Therefore, both the shortening of tax lifetimes and the acceleration of depreciation deductions can be economically rationalized as approximating the actual wear and obsolescence patterns of assets. Moreover, as discussed in the next section, acceleration may offset an asset's rising replacement cost due to inflation, though the more pragmatic rationalization usually advanced is that acceleration or shortened tax lives provide inducements to investment.[8] In any case,

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[5]See Internal Revenue Service, p. 505.

[6]For example, the original IRS Bulletin F of 1920, which set forth depreciation guidelines, clearly allowed the freedom to choose (and imposed the burden to substantiate) depreciation deductions both for deterioration and obsolescence:

> The Bureau does not prescribe rates to be used in computing depreciation and obsolescence, as it would be impractical to determine rates which would be equally applicable to all property of a general class or character. For this reason, no table of rates is published. The rate applicable and the adjustment of any case must depend upon the actual conditions existing in that particular case. (Internal Revenue Service, p. 505, note 13.)

From 1934 onward, however, this procedure was tightened in large part due to the declining prices of replacement capital. In response to criticism (and proposed legislative action), the Treasury switched to a procedure requiring substantial documentation to support the operational as opposed to the procedural validity of depreciation deductions. *Ibid*, p. 505.

[7]At least since 1956 (and perhaps as early as 1942), the Internal Revenue Code's provisions for depreciation have been moving from a physical concept of asset life to a useful life, where the latter is intended to accord with business practice rather than a potential period of use. *Ibid*., p. 506. In general, the useful life would be shorter than physical life due to obsolescence, optimizing of salvage value and the benefits of replacing the asset when its net economic value of output, while still positive, declines below that of a replacement asset.

[8]For example, President Kennedy argued that the shortening of tax lives by 30–40 percent in 1962 (by an administrative not a legislative procedure) was justified in spite of the large revenue loss because of the investment impact:

> Business spokesmen who have long urged this step estimate that the stimulus to new investment will be far greater — perhaps as much as four times greater — than the $1.5 billion [revenue loss] made available. In any event, it is clear that at least an equal amount will go into new income producing investment and eventually return to the Government in tax revenues most, if not all, of the initial costs. *Ibid*., p. 507.

Depreciation Accounting Methods

Straight line — Annual deduction of 1/N of original value of asset, where N is tax life of asset.

Declining balance — Annual deduction of a specified (α) multiple of 1/N of remaining (i.e., undepreciated asset value). Most common forms are 150 percent, 175 percent, and 200 percent declining balance. Since this formulation of the depreciation deduction takes a fraction of the declining balance each period, its deductions would never accumulate to the total value of the asset. Hence, the tax code allows a switch over to straight line at any time; the maximizing switchover point (N*) is

$$N^* = 1 + [N(\frac{\alpha - 1}{\alpha})];$$

when N* is not an integer, the switchover occurs at the next year. Thus, the optimal switchover for a 15-year asset under 200 percent declining balance is year 8, for 175 percent declining balance it is year 7, and for 150 percent declining balance it is year 5.

To illustrate the changeover to straight line, consider a 10-year asset with an original purchase price of $1,000. The deductions under 150 percent declining balance would be as shown in the table.

Note that if the straight-line deduction were used in the fourth year, it would be smaller than the 150 percent declining balance deduction — (1/7)($614.12) = $87.73 vs. $92.12; conversely, if the 150 percent declining balance deduction were taken in year 5, it would be smaller than the straight-line — (1.5)(1/10)($522.00) = $78.30 vs. $87.00.

Sum of the years' digits — Annual deduction is a declining fraction of the asset's value; this fraction is the ratio of the number of years remaining in the asset's tax life at the beginning of the tax year to the sum of the years (1 + 2 + 3 + ... + N) in the asset's tax life. For assets with a tax life of six years or more, SYD was the most accelerated depreciation schedule allowed in the tax code prior to the enactment of ERTA in 1981.

Annual Deductions for Depreciation for a $1,000, 10-Year Asset under Various Depreciation Methods

Year	SL	150 DB	200 DB	SYD
1	$ 100.00	$ 150.00	$ 200.00	$ 181.81
2	100.00	127.50	160.00	163.63
3	100.00	108.38	128.00	145.45
4	100.00	92.12	102.40	127.27
5	100.00	87.00	81.92	109.09
6	100.00	87.00	65.54	90.91
7	100.00	87.00	65.54	72.73
8	100.00	87.00	65.54	54.54
9	100.00	87.00	65.54	36.36
10	100.00	87.00	65.54	18.18
Total	$1,000.00	$1,000.00	$1,000.00	$1,000.00

NOTE: Columns may not add to total due to rounding.

the concomitant gain at disposition of the fully depreciated asset, scrap value, is treated as ordinary income to the taxpayer.[9]

DEPRECIATION ACCOUNTING

The 1954 tax code explicitly authorized a variety of accelerated depreciation accounting methods: sum of the years' digits and variations on declining balance methods.[10] These methods are described in the accompanying insert. Assuming that tax life and useful life are equal, the impact of accelerated depreciation accounting is to return the invested capital to the firm earlier in the asset's life than under straight-line depreciation, thereby reducing the impact of inflation. As a result of the higher depreciation deductions, the taxable proportion of the asset's income is reduced.

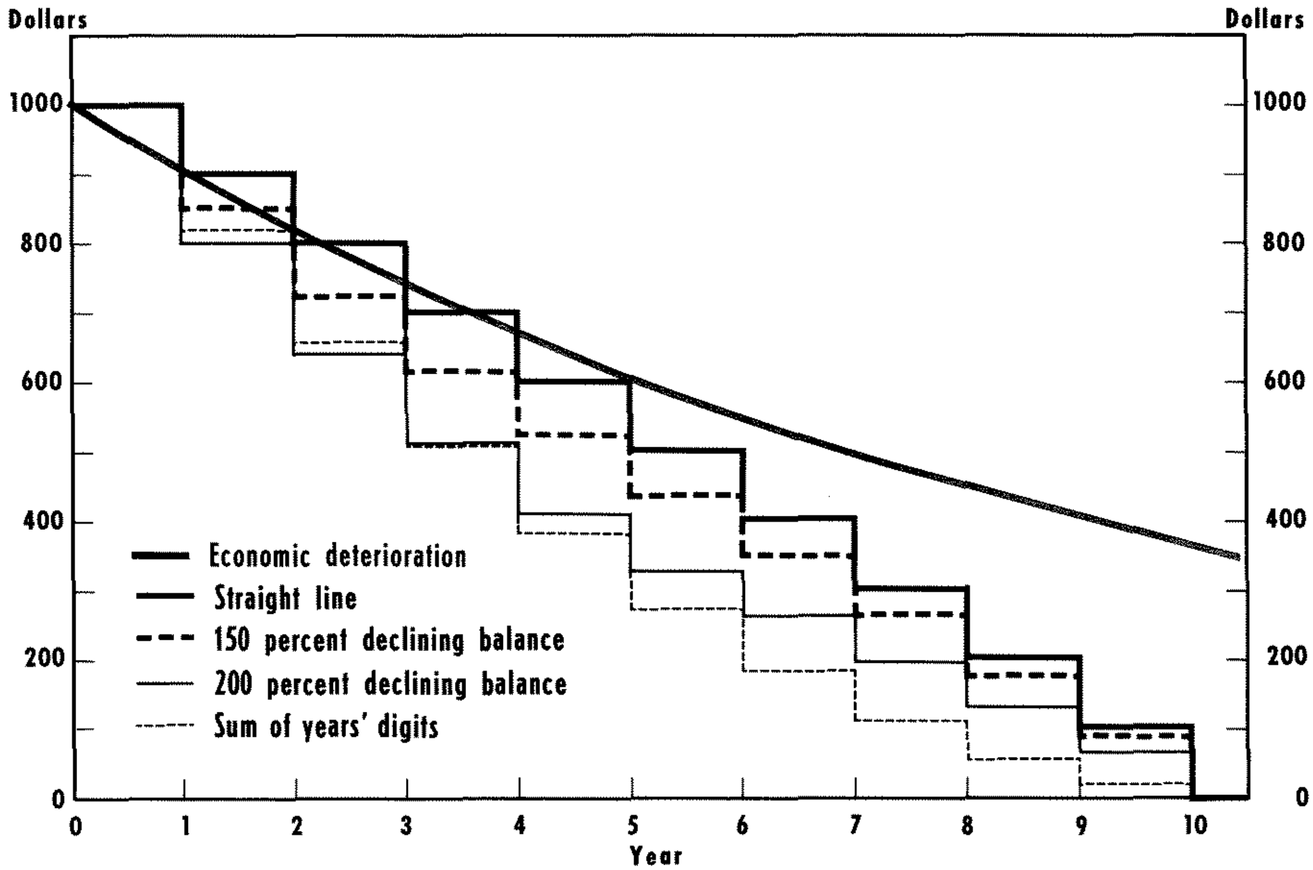
[9] *Economic Recovery Tax Act of 1981*, p. 188.

[10] As early as 1946, there was recognition that declining balance depreciation could bring accounting practice closer to the deterioration and obsolescence rates implicit in business organization; however, in contrast to the 1954 tax code which allowed the taxpayer to use declining balance methods, the 1946 IRS ruling imposed the burden of proof on the taxpayer:

> The declining balance method of computing depreciation would be approved for federal tax purposes, provided it accorded with the method of accounting regularly employed in the books of the taxpayer *and resulted in reasonable depreciation allowances and proper reflection of net income for the taxable year or years involved.* [Emphasis added], Internal Revenue Service, p. 505, note 14.

Chart 1

Remaining Depreciable Value Compared with Remaining Economic Value



This raises the present value of the asset's anticipated after-tax income stream relative to its price. Consequently, increasing depreciation deductions should induce a higher rate of investment, all other things the same.[11]

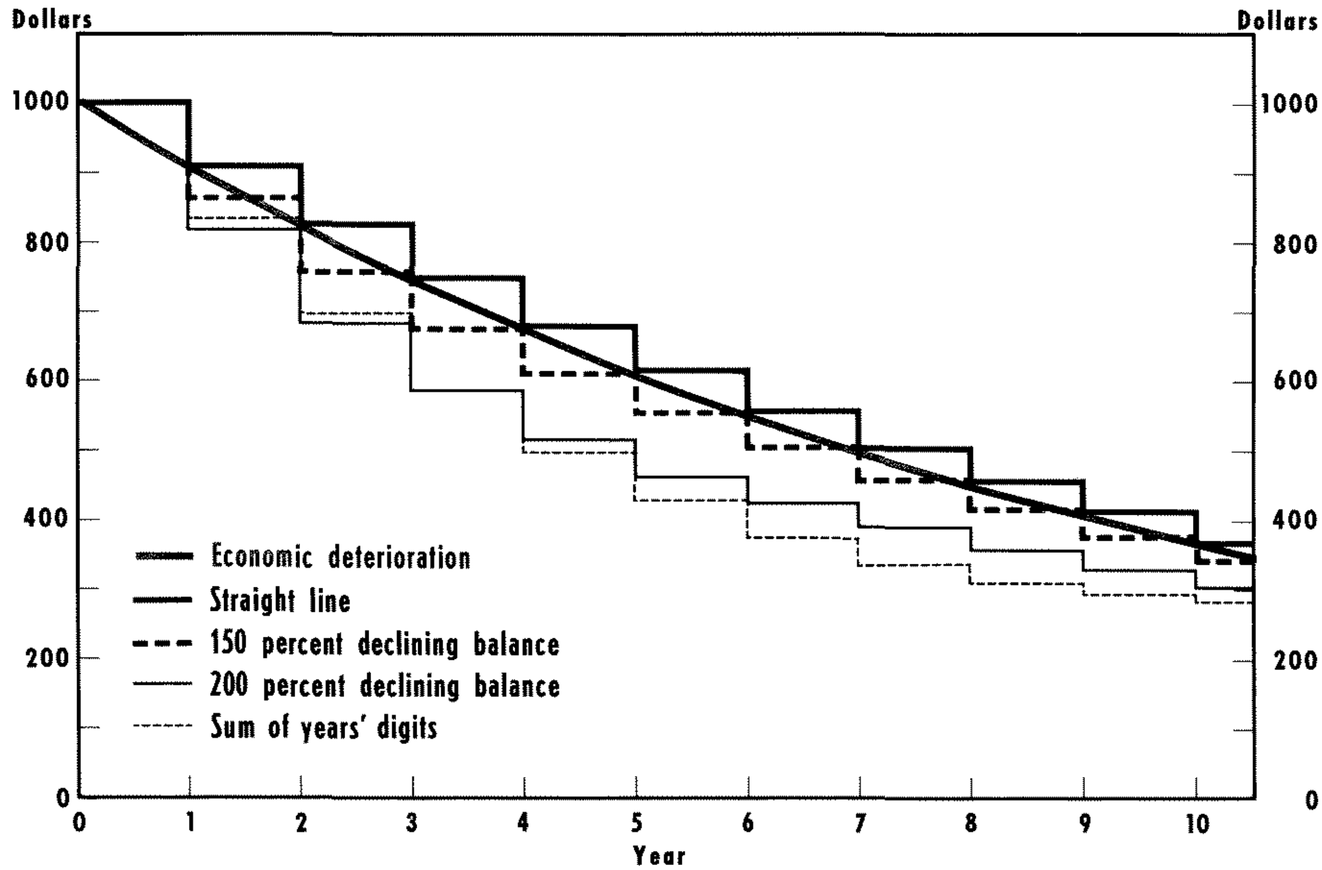
Graphically, this early return of capital can be seen in chart 1 where the remaining undepreciated value of an asset with a 10-year tax life is displayed. The undepreciated or remaining value is shown for four depreciation accounting methods: straight line (SL), 150 percent declining balance (150 DB), 200 percent declining balance (200 DB) and sum of the years' digits (SYD). As a benchmark, the remaining economic value — the asset's initial value less cumulated deterioration — is also plotted; economically, the asset is assumed to deteriorate at an exponential 10 percent rate — that is, in inverse proportion to its original useful life. Note that the depreciation schedules all provide for an earlier return of capital than warranted by physical deterioration alone. This occurs for two reasons: First, since the physical deterioration is a fraction of the declining balance, it will never consume the asset; there will always exist a positive scrap value.[12] In con-

[11]The theoretical foundations for this exist in a variety of sources: Hall and Jorgenson (1967) is the classic reference and Nelson (1976) provides a clear exposition of the issues most germane to this article. Auerbach (1983) surveys the literature on corporate finance as it relates to taxation and the cost of capital. Kopke (1981) addresses the choices confronting tax policymakers regarding the most effective form of tax reductions to stimulate investment.

[12]If an asset's economic deterioration is proportional — e.g., geometric or exponential — it will always have a scrap or salvage value at the end of any finite period. For example, if the asset's output deteriorates at a rate δ, $0 < \delta < 1$, and has a tax life $N = 1/\delta$, then the

Chart 2

The Impact of Inflation on Remaining Economic Value



trast, depreciation schedules are designed to exhaust the asset's value over its tax life. Second, the accelerated schedules take a larger portion of depreciation earlier than does the asset's decay rate.

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scrap value per dollar of initial value (S) will be about 3/8:

$$S = 1 - \int_0^N \delta_e^{-\delta t} dt$$

$$= 1 - (-e^{-\delta t}|_0^N), \delta = 1/N$$

$$= e^{-\delta N} = e^{-1}$$

$$= .368.$$

This inverse relation of depreciation and tax life holds for a variety of assets under the ADR system — for example, autos ($\delta = .333$, $N = 3$), railroad equipment ($\delta = .066$, $N = 15$) and metal working equipment ($\delta = .1225$, $N = 7.8$). Gravelle (1982), table 1, p. 8. Even when $\delta > 1/N$, however, there will be a positive scrap value. For example, aircraft ($\delta = .1818$, $N = 9.2$) and office, computing and accounting equipment ($\delta = .2729$, N-7.0) have δs about twice the reciprocal of their respective Ns for which S would be about 1/8: $S = e^{-\delta N} = e^{-2} = .135$.

Despite the apparent excess of depreciation over economic decay depicted in chart 1, accelerated depreciation accounting is insufficient to provide for replacement if the rate of inflation is high enough. Chart 1 implicitly assumes a zero inflation rate in that economic decay is displayed relative to a historical purchase price.

Chart 2, drawn with the remaining value adjusted for an inflation rate of 9 percent, illustrates the impact of inflation on the relation of economic and accounting measures of depreciation. This has the effect of pivoting each of the accounting depreciation profiles counter-clockwise around the zero-time intercept due to the rising nominal price of the replacement asset relative to its historical nominal purchase price. At a 9 percent inflation rate, the $1,000 purchase price of the asset will rise to $2,367 over its 10-year tax life. Consequently, at any point in the asset's 10-year tax life, a smaller portion of the real replacement cost (the economic remaining value) is recovered with a high inflation rate (chart 2) than with a zero inflation rate (chart 1).[13]

INFLATION DISTORTIONS IN DEPRECIATION SCHEDULES AND THE CHANGES DUE TO ERTA AND TEFRA

To evaluate the combined effects of accelerated depreciation, inflation, scrap value and shortened tax lifetimes, we first examine the depreciation schedules applied to assets under the assumption that tax lives and economically useful lives are equal. In this examination, presented in table 1, the relative adequacy of depreciation deductions is assessed for assets of 3-, 5-, 10-, 15- and 30-year durabilities. The table also incorporates one final complication — the investment tax credit.

Since 1962, the investment tax credit (ITC) has been, in effect, a second form of accelerated capital return in the tax code. In principle, because it is a return of capital at the end of the asset's initial tax year, ITC augments the depreciation deduction; adjusting for its being a credit rather than a deduction can be accomplished by dividing by the tax rate.[14]

Each entry in table 1 is the sum of the real present discounted value of the tax-deduction equivalent of the investment tax credit plus the depreciation deductions plus the after-tax anticipated proceeds from the sale of the asset (scrap value) in ratio to the present discounted value of the replacement cost of the asset. A real after-tax interest rate of 3 percent was used in the computations.[15] The entries are computed over a range of inflation rates typical of those experienced during the last three decades. The higher the inflation rate, the lower the real value of the depreciation deductions since the deductions are based on a fixed nominal value — the historical purchase price of the asset. In contrast, the denominator is unaffected by inflation since it is cast in real terms to measure the declining value in production of the asset. Note that these are actual, not expected, inflation rates. It is the actual inflation rate that determines whether depreciation deductions will be adequate to provide for the replacement asset; however, as this implies, the higher the expected inflation rate over the asset's life, the lower the value of the asset.

These ratios determine whether there is adequate provision in the tax code for the anticipated net cost of asset replacement (net of scrap value). The fund is exactly adequate if the ratio equals 1.0. Ratios less than 1.0 indicate that the fund is inadequate, and implicit subsidies are present in ratios that exceed 1.0. The ratios are computed for a variety of depreciation schedules, both straight-line and accelerated. The Accelerated Cost Recovery System (ACRS) mandated by ERTA and modified by TEFRA also is included in the table; ACRS-ERTA is based on the 150 DB method. ACRS-TEFRA is ACRS-ERTA with the reduction in depreciation base — 50 percent of the investment tax credit — mandated by TEFRA.[16]

The table suggests that, even at an inflation rate as high as 9 percent, the present value of depreciation deductions is sufficient to provide for replacement of assets with tax lives up to 10 years under any of the schedules; with two exceptions, this also holds for 15-year assets. While the ratios are lower under current law (TEFRA) than under prior law, they remain adequate for replacement funding. In marked contrast, for the most durable assets — those with 30-year lifetimes which are, generally, structures and other plant — the deductions are inadequate even at an inflation rate as low as 3 percent. While the more accelerated depreciation schedules, 200 DB and SYD, appear to overcome this shortfall, structures and plant were restricted, before ERTA, to using 150 DB. Consequently, for investment in plant, depreciation deductions were woefully inadequate to provide for replacement at the inflation rates experienced in the United States over the

[13]The inflation effect is symmetric: rising prices lower the value of depreciation deductions and falling prices raise it. Consequently, it is not surprising that in 1934, during a period of sustained deflation, legislation was introduced in Congress to *lower* depreciation allowances. Internal Revenue Service, p. 505, note 10.

[14]For the first two years after its introduction, the depreciable base of an asset was reduced by the credit; from 1964 to 1982, no such reduction was required. In 1982, the enactment of TEFRA has restored a reduction in the depreciation base — by 50 percent of the credit. ITC is currently 10 percent of the asset's price in the case of equipment with a tax life of five years or more and 6 percent for shorter-lived equipment; structures, generally, are not eligible for ITC, although some equipment associated with structures and certain low-income housing does qualify. *Tax Equity and Fiscal Responsibility Act of 1982*, pp. 41–43.

[15]This is the commonly used rate in the literature, going back to Hall and Jorgenson (1967) and continuing through Kopke (1981). Gravelle (1982) uses 5.5 percent following Hendershott and Hu (1981); all of the ratios reported in this article were also recomputed with a 5.5 percent real rate, and neither the qualitative nor quantitative results using 5.5 percent were appreciably different.

[16]More accelerated versions of ACRS were mandated by ERTA for 1985 (175 percent declining balance) and for 1986 and beyond (200 percent declining balance); however, these later changes were repealed by TEFRA. See *Tax Equity and Fiscal Responsibility Act of 1982*, pp. 40–43.

Table 1

Ratio of Present Value of Depreciation Deductions to Replacement Cost with Scrap Value

Tax Life (years)	π (%)	Prior Tax Law: SL	150 DB	200 DB	SYD	ACRS: ERTA	TEFRA
3	0	1.323	1.330	1.339	1.333	1.319	1.289
3	3	1.262	1.276	1.293	1.280	1.255	1.227
3	6	1.204	1.224	1.249	1.231	1.194	1.168
3	9	1.151	1.176	1.207	1.184	1.138	1.114
5	0	1.424	1.433	1.445	1.444	1.420	1.370
5	3	1.333	1.351	1.373	1.370	1.327	1.281
5	6	1.251	1.276	1.306	1.301	1.242	1.200
5	9	1.176	1.207	1.245	1.238	1.165	1.127
10	0	1.453	1.468	1.489	1.499	1.460	1.408
10	3	1.300	1.327	1.363	1.378	1.311	1.266
10	6	1.173	1.208	1.255	1.274	1.187	1.148
10	9	1.067	1.109	1.163	1.183	1.083	1.049
15	0	1.483	1.505	1.535	1.556	1.497	1.445
15	3	1.274	1.309	1.359	1.390	1.296	1.253
15	6	1.114	1.159	1.220	1.255	1.142	1.106
15	9	0.991	1.042	1.110	1.144	1.021	0.991
30	0	1.223	1.265	1.325	1.379	N/A	N/A
30	3	0.889	0.949	1.033	1.096	N/A	N/A
30	6	0.688	0.755	0.846	0.904	N/A	N/A
30	9	0.561	0.630	0.719	0.767	N/A	N/A

NOTE: Each entry in the table is computed as

$$\frac{(ITC/\tau)e^{-(r+\pi)} + (1-\theta ITC)\sum_{t=1}^{N} D(t)e^{-(r+\pi)t} + (1-\tau)e^{-(r+\delta)N}}{\frac{\delta}{r+\delta} + e^{-(r+\delta)N}\left(1-\frac{\delta}{r+\delta}\right)}$$

where ITC = Fraction of asset's purchase price received as investment tax credit, 6 percent for three-year assets and 10 percent for longer-lived assets, except structures for which it is zero; in the table, 30-year assets are assumed to be structures

τ = Corporate tax rate, .46

θ = .5 for ACRS-TEFRA; for other schedules, $\theta = 0$

D(t) = Depreciation deduction under the specified schedule in year t

π = inflation rate

r = Real after-tax discount rate, assumed to be 3 percent

N = Tax life of asset; assumed equal to useful life in table 1

δ = Real economic rate of deterioration, assumed to be 1/N

15 years preceding ERTA. As we shall see below, one of ERTA's clearest impacts has been to rectify this shortfall for structures.

The Uncertain Effect of Anticipated Salvage Value

For assets with tax lives under 15 years, the entries in table 1 suggest that the present value of depreciation deductions combined with the investment tax credit have been sufficient to provide for replacement. Yet, included in these entries is the after-tax portion of the asset's anticipated scrap or salvage value. That is, for example, the replacement of an electric typewriter is in part financed by the anticipated sale of the old, used typewriter. Yet, the inclusion of such anticipated scrap value in the investment decision entails significant risks: technological obsolescence, economic obsolescence due to changes in relative prices and (in the case of structures) locational obsolescence. The first of these is exemplified by the widespread use of word-processing machines, which has reduced the value of even the most sophisticated electric typewriters. The second can be appreciated by considering the effect of the mid-1970s' run-up in oil and gas prices on the value of standard-sized American used cars. The third is an obvious risk entailed in purchasing any commercial, industrial or residential structure. Moreover, each of these risks rises with the durability of the asset.[17]

Because scrap value is so uncertain, especially for longer-lived assets, it is informative to recompute the ratios in table 1 without scrap value. The results are shown in table 2. Without scrap value, the most accelerated depreciation schedules under prior law were adequate for replacement except for assets of 10- or 15-year tax lives at 9 percent inflation and 30-year assets at any inflation rate. Under current tax law (TEFRA), however, even three-year assets in the face of moderate inflation, say 6 percent, could not have their replacement financed through depreciation deductions alone.

Nonetheless, the shorter is the asset life, the smaller is the risk entailed in the anticipated scrap value; thus, a three-year asset (for example, an automobile or light truck according to the tax code) surely does have a more secure resale market than, say, an asset with a seven-year life (for example, accounting, computing or other office equipment). Consequently, the ratios presented in tables 1 and 2 should be interpreted as defining a range of uncertainty within which the specific values of particular assets can be considered in relation to their depreciation allowances and scrap values.

Shortened Tax Lives under ACRS and the Impact on Specific Asset Types

Although ERTA contains a bewildering array of features, the principal changes to prior tax law are lower personal income tax rates, changes to gift and estate tax rules, incentives for saving and the ACRS depreciation deduction schedules. In the context of depreciation, the primary impact of TEFRA was to repeal the more accelerated ACRS schedules, which would have become effective in 1985 and 1986, and to reduce the depreciable asset base by one-half of the ITC. ACRS under either ERTA or TEFRA, as tables 1 and 2 show, is not as accelerated for a given tax life as were some options available earlier — for example, 200 DB and SYD. The major impact of ERTA, however, was in shortening the tax life of assets, an impact not revealed by either of these tables.

Under ERTA, four ACRS schedules replaced the various options available to asset owners under prior law.[18] The older system was based on surveys conducted by the U.S. Treasury Department from which asset life distributions were computed. The system based on these distributions, called the Asset Depreciation Range system (ADR), was the basis for determining the tax life over which an asset could be depreciated using the various deduction formulas.[19]

The new system, ACRS, replaced more than 100 classes of asset lives with four: 3-year, 5-year, 10-year and 15-year. The 3-year class primarily contains automobiles, light trucks and research equipment. Most equipment is included in the 5-year class. The 10-year class primarily comprises specialized machinery of the public utility industry. All structures and some other utilities' capital are in the 15-year class.[20] Thus, the acceleration of the depreciation allowance under ERTA relative to prior tax law is not due to the formula applied.[21] Rather, the saving is primarily due to a pro-

[17]That is, suppose that there is a 1 percent likelihood that during any single year an innovation in technology will make an existing asset's value decline due to the improvements in newer machines. Then, the probability that an investment will *not* have its scrap value lowered is 97 percent for a three-year asset, 90 percent for a 10-year asset and 74 percent for a 30-year asset.

Further, consider the uncertainty associated with relative prices. Every manufacturing process makes use of a variety of inputs — labor, various raw materials and energy — so that the optimal design based on existing technology of a machine used in that process will depend on the relative prices of the inputs. Suppose that the likelihood during any single year of a significant change in relative input prices (sufficient to induce an alteration in capital design) is 1 percent and is independent of the likelihood of technological innovation. Then, the probability that an asset's salvage value will *not* be lowered by either event is 94 percent for a three-year asset, 82 percent for a 10-year asset and only 55 percent for a 30-year asset.

Finally, if we add a third source of obsolescence, the problem of neighborhood decline or a change in locational use patterns, also an independent likelihood of 1 percent, this final obsolescence risk which is peculiar to structures causes the 30-year asset probability of *no decline* in salvage value to plummet to 40 percent.

[18]See *Economic Recovery Tax Act of 1981*, pp. 6–7, 67–68, and 75–85.

[19]In particular, the 30th percentile of the survey responses was the minimum allowable tax life.

[20]Certain manufactured housing and tank cars also fall into the 10-year class. See *Economic Recovery Tax Act of 1981*, pp. 78–80.

[21]The schedules for equipment are based on 150 DB with a switch to straight line at the deduction optimizing point (see insert). There is a half-year convention in these schedules — the asset is assumed to be acquired at mid-year so the initial year's depreciation is one-half of the 150 DB schedule in the insert. The ACRS schedule for structures is 175 DB with a switch to straight line at year 8; the structures' schedules are specific to the month of asset acquisition. See *Economic Recovery Tax Act of 1981*, pp. 40–41.

Table 2

Ratio of Present Value of Depreciation Deductions to Replacement Cost without Scrap Value

Tax Life (years)	π (%)	Prior Tax Law SL	Prior Tax Law 150 DB	Prior Tax Law 200 DB	Prior Tax Law SYD	ACRS ERTA	ACRS TEFRA
3	0	1.131	1.138	1.147	1.141	1.127	1.097
3	3	1.069	1.084	1.101	1.088	1.063	1.035
3	6	1.012	1.032	1.057	1.039	1.002	0.976
3	9	0.959	0.984	1.015	0.992	0.946	0.922
5	0	1.236	1.246	1.258	1.256	1.233	1.182
5	3	1.145	1.163	1.185	1.182	1.139	1.093
5	6	1.063	1.088	1.119	1.114	1.054	1.012
5	9	0.989	1.020	1.057	1.050	0.978	0.939
10	0	1.276	1.292	1.312	1.322	1.283	1.231
10	3	1.123	1.150	1.186	1.201	1.134	1.090
10	6	0.996	1.031	1.078	1.097	1.010	0.972
10	9	0.890	0.932	0.987	1.006	0.906	0.872
15	0	1.317	1.338	1.369	1.390	1.331	1.278
15	3	1.108	1.143	1.193	1.224	1.130	1.087
15	6	0.948	0.993	1.054	1.089	0.976	0.940
15	9	0.825	0.876	0.943	0.978	0.855	0.825
30	0	1.088	1.129	1.190	1.243	N/A	N/A
30	3	0.754	0.814	0.898	0.961	N/A	N/A
30	6	0.553	0.620	0.711	0.768	N/A	N/A
30	9	0.426	0.494	0.584	0.632	N/A	N/A

NOTE: Entries in the table are computed as in table 1 except the present value of anticipated scrap value does not appear in the numerator:

$$\frac{ITC\,(1/\pi)\,e^{-(r+\pi)} + (1-\theta\,ITC)\sum_{t=1}^{N} D(t)\,e^{-(r+\pi)t}}{\frac{\delta}{r+\delta} + e^{-(r+\delta)N}\left(1-\frac{\delta}{r+\delta}\right)}$$

nounced shortening of the tax lives of each asset class. The mean reductions in asset tax lives from ADR to ACRS for equipment and for structures were, respectively, 44 percent and 49 percent.[22] The reductions in tax lifetimes varied widely. The tax life of the three-year class was shortened by only half a year from ADR to ACRS, but for longer-lived assets, the reductions included 22.5 years for commercial structures (15-year category), 4.7 years for aircraft (five-year category) and 5.5 years for railroad equipment (10-year category).

Thus, in evaluating the adequacy of depreciation deductions in providing for replacement of any specific asset, there are six elements to be considered: the depreciation schedule, the anticipated inflation rate, the asset's tax life, its investment tax credit, economic life and scrap value. The effects of these elements are revealed in the ratios of depreciation to replacement cost for specific assets in table 3.

Column a of table 3 lists the specific asset types analyzed; the nine assets were selected to cover a variety of economic depreciation rates, durability and ACRS tax lives, which are reported in columns b, c and d, respectively, for each asset. Column e lists the inflation rate assumed in each ratio, the range of rates being the same as in tables 1 and 2. In the next three columns, the ratio of the present values of depreciation, ITC and after-tax salvage value to economic depreciation and scrap value are reported; the ratios are computed under prior tax law in column f, under ERTA in column g and under TEFRA in column h. Columns i and j display the ratio of the entries in columns g and h to column f; if the ratio is greater (less) than 1.0, then the tax treatment under ERTA or

[22]Computed from ADR data by producers' equipment and structures classes in table 1 of Gravelle (1982).

Table 3

Comparison of Present Values of Depreciation Tax Deductions with ITC and Scrap Value to Replacement Cost for Selected Assets

		Tax Life (years)[2]			Ratios of Present Value of Depreciation Deduction to Replacement Cost[3]			Ratios of Present Value of Deductions	
Asset Type (a)	Economic Depreciation Rate[1] (b)	ADR (c)	ACRS (d)	π (%) (e)	ADR[4] (f)	ACRS-ERTA (g)	ACRS-TEFRA (h)	ACRS-ERTA/ADR (i)	ACRS-TEFRA/ADR (j)
Automobiles, light trucks	.3333	3.0	3	0	1.339	1.319	1.289	0.985	0.963
				3	1.293	1.255	1.227	0.970	0.949
				6	1.249	1.195	1.168	0.956	0.935
				9	1.207	1.138	1.114	0.943	0.923
Office, computing and accounting equipment	.2729	7.0	5	0	1.305	1.301	1.251	0.997	0.959
				3	1.215	1.207	1.162	0.994	0.956
				6	1.135	1.123	1.081	0.990	0.953
				9	1.062	1.047	1.008	0.985	0.949
Aircraft	.1818	9.2	5	0	1.389	1.365	1.314	0.983	0.946
				3	1.276	1.268	1.221	0.994	0.957
				6	1.178	1.181	1.137	1.003	0.966
				9	1.091	1.101	1.062	1.009	0.973
Mining and oilfield machinery	.1650	9.2	5	0	1.415	1.391	1.339	0.983	0.946
				3	1.301	1.293	1.245	0.994	0.957
				6	1.202	1.205	1.161	1.003	0.966
				9	1.114	1.125	1.085	1.009	0.973
Communications equipment	.1179	11.5	5	0	1.511	1.464	1.409	0.969	0.933
				3	1.371	1.362	1.312	0.993	0.957
				6	1.251	1.269	1.224	1.014	0.978
				9	1.150	1.186	1.144	1.031	0.995
Ships and boats	.0750	16.0	5	0	1.501	1.594	1.534	1.062	1.022
				3	1.331	1.483	1.428	1.114	1.073
				6	1.193	1.382	1.333	1.158	1.117
				9	1.082	1.291	1.246	1.194	1.152
Railroad equipment	.0660	15.0	10	0	1.559	1.570	1.514	1.007	0.971
				3	1.393	1.407	1.359	1.010	0.975
				6	1.258	1.272	1.230	1.011	0.978
				9	1.147	1.158	1.131	1.010	0.978
Industrial structures[5]	.0330	36.0	15	0	1.192	1.495		1.254	
				3	0.853	1.239		1.452	
				6	0.660	1.045		1.584	
				9	0.540	0.895		1.657	
Commercial structures[5]	.0230	37.0	15	0	1.361	1.713		1.259	
				3	0.981	1.427		1.456	
				6	0.766	1.210		1.580	
				9	0.634	1.042		1.644	

[1]See Gravelle (1982), table 1.
[2]Actual tax lives for equipment under ACRS are .5 years less than shown due to an assumption, implicit in the schedules, of acquisition at mid-year; for structures, the ACRS schedules explicitly allow for actual month of acquisition.
[3]Entries are as in table 1 except ADR uses ADR tax life and ACRS uses ACRS tax life for numerator of ratios; denominator for both ADR and ACRS use ADR tax life as proxy for useful life.
[4]For structures, the depreciation schedule utilized is 150 DB with a switch to SL after 12 years (for industrial structures) or 13 years (for commercial structures). For autos, 200 DB was used (200 DB is more accelerated than SYD for assets with tax lives less than 6 years); all other assets used SYD.
[5]Note that TEFRA did not change the ERTA tax schedules for structures.

TEFRA has increased (decreased) the value of depreciation for that asset. Notice that for structures, columns g and h are combined as are columns i and j; this reflects the fact that investments in structures do not qualify for ITC, and, thus, the 50 percent of ITC reduction in the depreciable base mandated by TEFRA does not affect structures.

Scanning down the columns of ratios in columns f–j of table 3 provides an overall assessment of the impact on depreciation adequacy under ERTA and TEFRA relative to prior tax law. Column f reiterates the general message of table 1 for specific assets — namely that equipment, especially shorter-lived equipment such as automobiles, was more than adequately provided for under the prior tax law, while structures' depreciation deductions were inadequate at even low inflation rates. Columns g and h show that the new tax laws have reduced the benefits of fast depreciation for short-lived equipment, but sharply raised these benefits for structures at all inflation rates. For example, at a 6 percent inflation rate, the depreciation ratio for office, computing and accounting equipment declines from 1.135 under prior tax law to 1.081 under TEFRA, while for industrial structures it rises from 0.660 to 1.045. Finally, the entries in columns i and j affirm that longer-lived assets have had their depreciation ratios reduced less or increased more than shorter-lived assets. For example, comparing the ratios in column j at a 6 percent inflation rate, communications equipment has 0.978 of its prior tax law depreciation ratio under TEFRA, while the shorter-lived asset aircraft has 0.966 and the longer-lived asset commercial structures has 1.580.

In summary, the ratios in column h reveal that the shift to ACRS has provided inducements to purchase new capital equipment that rise with the durability of the equipment. Moreover, relative to prior law (column j), the additional incentives are especially strong for nonresidential structures, particularly at low inflation rates. Compared with prior tax law, ACRS diminishes the deleterious effects of inflation on the value of depreciation deductions for long-lived assets and reduces the attractiveness of investments in equipment relative to structures. For example, the present value of the depreciation deductions plus scrap for industrial structures under ACRS is greater than the present value of the replacement cost at inflation rates up to 6 percent; moreover, the deductions are increased massively relative to prior tax law at all inflation rates.[23] In particular, the ratios for industrial structures in column h exceed those for automobiles and aircraft at low inflation rates where, as column f shows, the ranking was the reverse under prior law.

The Combined Effects of Tax Changes and Disinflation in the 1980s

To focus only on the changes in the depreciation schedules and their effects on various assets at any specific inflation rate understates the investment incentives provided by the changes in the 1980s. The reduction in the observed inflation rate and, presumably, the anticipated inflation rates over the investment term provide another strong impetus. For example, the rate of inflation measured by the implicit GNP deflator has been falling over the past four years — from an average rate of over 9 percent during 1978–81 to between 3 and 4 percent during 1982–84. Consequently, the most pertinent assessment of the impact on investment incentives afforded by this substantial decline in the inflation rate is to compare (using the data in table 3) the ratio of depreciation to replacement cost under pre-ERTA schedules at 9 percent inflation with the ratios for 6 percent inflation under TEFRA. These inflation rates approximate the expected inflation rates, based on survey data, which prevailed in late 1980 and late 1984, respectively.[24] When this comparison is made for communications equipment, the ratio rises from 1.150 to 1.224 instead of declining. In the case of automobiles, this enhanced comparison shows a slight decline — from 1.207 to 1.168 — while in the case of industrial structures it reveals a near doubling — from 0.540 to 1.045.

THE HISTORICAL RELATION BETWEEN DISTORTIONS IN DEPRECIATION DEDUCTIONS AND INVESTMENT

As shown above, there are two sources of distortion in depreciation deductions: On the one hand, they may provide more expense deduction than required for the eventual replacement of the used-up asset. This can result either from a shortening of the tax life below the span of its economic usefulness, or from an acceleration of the deductions. On the other hand, they may be inadequate to provide for the purchase of the replacement asset given a rise in its nominal price due to inflation. That is, since the deductions are based on the purchase price — its historical cost — inflation will progressively make the depreciation allowance inadequate for the purchase of the replacement.

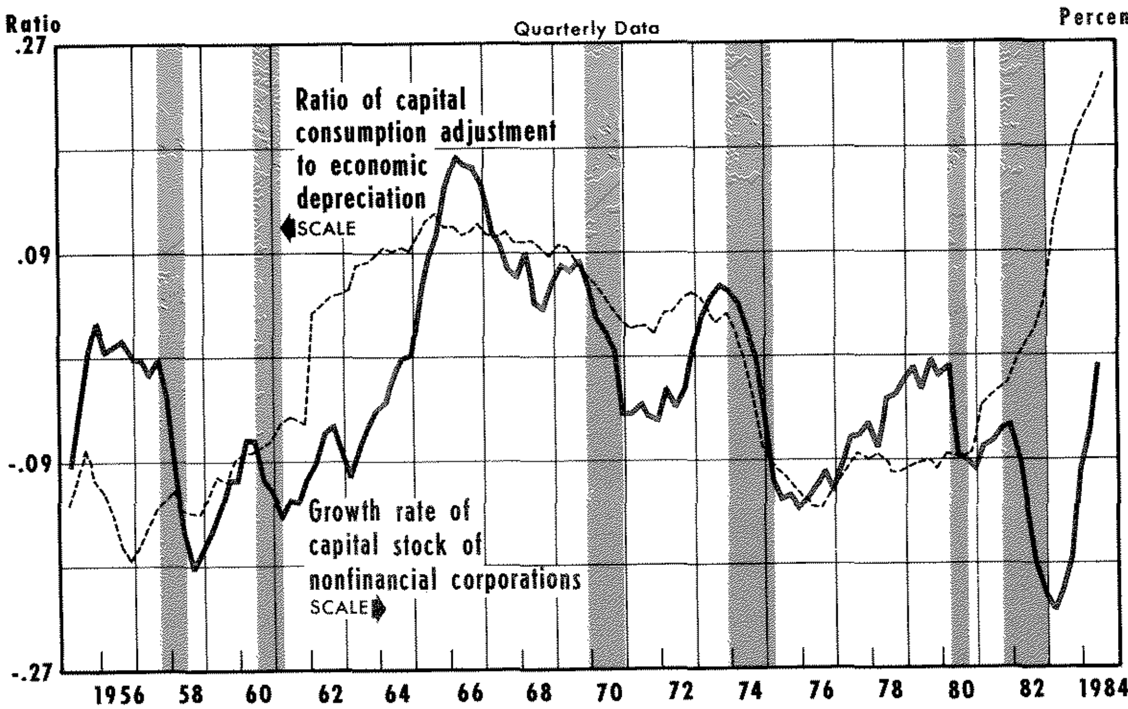
As shown in tables 1 and 2, these two distortions work in opposition. For example, in table 1 consider

[23]In part, this higher present value of depreciation deductions is offset by the lack of investment tax credit on investment in nonresidential structures. Moreover, the tax act of 1984 has lengthened the depreciation term for structures from 15 to 18 years, which will slightly reduce the impetus. See *Tax Reform Act of 1984*, p. 178.

[24]The short-term (one-year period) expected inflation rate in June 1980 was 10.22 percent and 5.47 percent in June 1984; these estimates are from a semi-annual survey of economists conducted by Joseph Livingston of *The Philadelphia Inquirer*, as revised by Carlson (1977). The long-term (10-year period) expected inflation rate in October 1980 was 8.82 percent and had fallen to 5.79 percent in October 1984; these estimates are from a decision-makers poll conducted by Richard B. Hoey of Drexel Burnham Lambert, Incorporated.

Chart 3

Depreciation Distortion and the Growth Rate of the Corporate Capital Stock



Sources: Board of Governors of the Federal Reserve System and U.S. Department of Commerce
Shaded areas represent periods of business recessions.

the effect of increasing acceleration on the ratio of depreciation to replacement cost for a 10-year asset at a 6 percent inflation rate: as the depreciation schedule is accelerated from SL to 150 DB to 200 DB, the ratio rises from 1.173 to 1.208 to 1.255, an increase of nearly 7 percent. Conversely, consider the impact of rising inflation on the 10-year asset's ratio under 200 DB: as inflation rises from 3 percent to 9 percent, the ratio falls from 1.362 to 1.163, a decrease of over 17 percent. Consequently, the rate of investment should vary positively with the net distortion of depreciation — that is, the difference between these two opposing distortions.

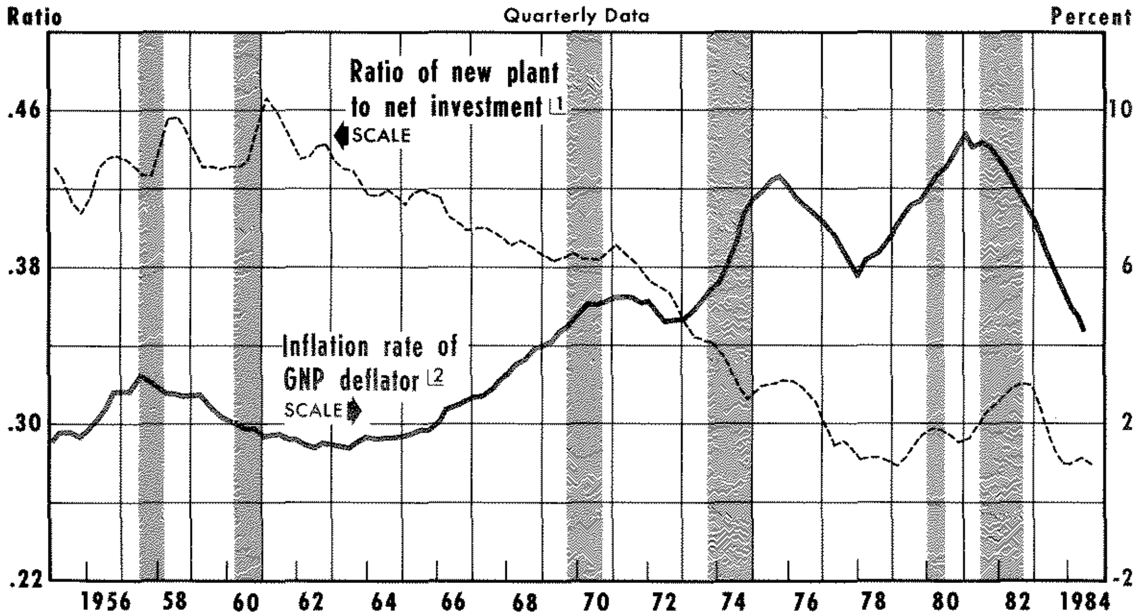
This association, in fact, can be seen in chart 3 which displays the growth rate of the capital stock and the ratio of the Capital Consumption Adjustment (CCA) to estimated economic depreciation for U.S. nonfinancial corporations beginning 1955. CCA, as estimated by the Commerce Department, is the difference between depreciation claimed by corporations on their tax returns and the estimated "economic depreciation" of their capital equipment; the Commerce Department defines economic depreciation as straight-line depreciation with an adjustment (an increase in the depreciable base) for inflation. By computing the ratio of CCA to economic depreciation, we obtain a proportional measure of depreciation distortion.

Chart 3 reveals important characteristics of the last 30 years' capital stock growth rates. First, the interval of highest capital stock growth over the period coincided with the interval during which the CCA ratio was highest — from late 1961 through early 1974.[25] From mid-1973 through early 1982, CCA was negative, hence its ratio was below zero, and capital growth was

[25]The simple correlation coefficient between the variables in chart 3 is .42, significant at the .0001 level. However, the association appears to have changed during the 1981–82 recession: from 1955–80, the correlation was .65, significant at .0001, but from 1981–84 it was −.08 and insignificant. Yet the sharp rise of CCA during the 1981–82 recession, due to disinflation and ERTA, is out of keeping with its behavior in the earlier recessions shown in chart 3. During the 1969–70 and 1973–74 recessions, CCA fell sharply and during the 1980 recession it was roughly constant. The other two recessions, 1957–58 and 1960–61, during which CCA rose moderately, had, like the current recovery, much sharper upturns in capital growth than the recoveries following the recessions with declining or unchanged CCA.

Chart 4

Investment in Structures and the Rate of Inflation



Sources: Board of Governors of the Federal Reserve System and U.S. Department of Commerce

[1] Two-quarter moving average.

[2] Twelve-quarter moving average.

Shaded areas represent periods of business recessions.

correspondingly slower. Second, capital stock growth appears to follow the growth rate of real output: it rises throughout expansions and plummets in recessions, ceteris paribus. Thus, the two pronounced non-recession declines in capital growth in chart 3 — 1955–56 and 1966–67 — each occurred in years when substantial slowdowns in the growth rate of real output occurred — year-over-year declines of 4.6 percent and 3.3 percent, respectively. Third, the sharpest rise in capital stock growth in any single year occurred in 1983 coincident with the largest rise in the proportion of CCA to economic depreciation.

A second qualitative indication of the effects of distortion in depreciation deductions is its impact on the relative share of investment devoted to structures. As is clear from tables 1 or 2, under prior tax law, investment in structures was penalized — in the sense of lowering the ratio of depreciation deductions to replacement cost — by sustained inflation relatively more than investment in shorter-lived assets. As a consequence, it is not surprising that periods of sustained high inflation are also periods in which investment in structures is relatively low.[26] Chart 4 depicts the proportion of total U.S. nonresidential investment in nonresidential structures and the rate of inflation since 1955. As expected, investment in plant has been proportionally lowest during periods of relatively high and sustained inflation. The enhanced incentives for investment in structures displayed in table 3 and the drop in the inflation rate suggest that the structures' share of investment should rise from its currently low proportion.

CONCLUSIONS

Elementary capital theory implies that lowering taxes on capital by increasing the acceleration of de-

[26]Nelson (1976), pp. 928–30, develops the simple analytics of this proposition, which are that the present values of shorter-lived projects rise relative to longer-lived ones, as implied by the data in tables 1, 2 and 3. The simple correlation between the variables in chart 4 during 1955–84 is −.89, significant at the .0001 level. Moreover, a regression of the plant share variable on the Livingston 6-month expected inflation rate yields a coefficient of −1.81, significant at the .0001 level.

preciation deductions or shortening the term over which depreciation is taken raises the value of capital and, other things the same, raises the rate of investment. The tax reductions in ERTA consisted primarily of a shortening of the tax lifetimes over which assets are depreciated; the changes in TEFRA, while repealing the more accelerated depreciation schedules that would have followed in 1985 and 1986, left intact the basic shortening of asset tax lives. This lowered the portion of net proceeds on which corporations would pay taxes and raised the value of capital.

Yet, the rise in investment occurring since the enactment of ERTA cannot be attributed solely to faster acceleration of deductions or shorter tax lives. In large part, the rise in CCA since 1980 has been due to the sharp decline in the inflation rate from about 9 percent to about 3 to 4 percent and the associated decline in inflation expectations. Previously, sustained shifts in the inflation rate also have been associated, inversely, with changes in the rate of capital stock growth. Part of the rapid rise in capital stock growth in 1983 may be due to the proximity and severity of the 1980 and 1981–82 recessions. In no other recovery, however, has capital growth risen as rapidly or as long as in the current expansion.

Since, in the case of most intermediate-lived capital equipment, the ACRS-TEFRA depreciation schedules are actually less accelerated than those allowed under prior tax law, ACRS could explain neither the recent rise in CCA nor in capital growth in chart 3. Yet, if the decline in inflation expectations continues to follow the decline in observed inflation, then the value of depreciation deductions will have been raised by 10 to 20 percent for most equipment and by more than 100 percent for structures.[27] Thus, the impacts of the 1981 and 1982 tax acts have been augmented by the substantial decline in the inflation rate since 1980 and, more important, the change in investors' expectations about what inflation rate policymakers will bring about in the future. Without question, the renewed vigor of corporate investment is due to both sources of effective tax reductions — ACRS and the lower rate of inflation.[28]

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[27]Specifically, the increases in the ratios of depreciation and scrap to replacement cost as inflation declines from 9 percent to 3 percent (from table 3, columns f and h) are: autos, 1.7 percent; office equipment, 9.4 percent; aircraft, 11.9 percent; mining and oil field equipment, 11.8 percent; communications equipment, 14.1 percent; ships and boats, 32.0 percent; railroad equipment, 18.5 percent; commercial structures, 125.1 percent; industrial structures, 129.4 percent.

[28]The *Economic Report of the President* (1984) is also clear on this apportioned credit:

> The tax climate for business investment has also been substantially improved in the past 3 years. During the 1970s the rising rate of inflation combined with the old depreciation rules to raise very substantially the tax rate on the income from investment in business plant and equipment. The 1981 changes in the tax rules governing depreciation, as modified in the Tax Equity and Fiscal Responsibility Act, and the sharp reduction in inflation reduced this effective tax rate substantially. (p. 34).