ECONOMIC IMPACTS OF THE TAX REFORM ACT OF 1986: SHORT-RUN AND LONG-RUN PERSPECTIVES

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PREFACE

This paper was written by Frederick Ribe while he was employed at the Congressional Budget Office. It was undertaken as technical background work in connection with ongoing studies of the Tax Reform Act of 1986.

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Edward Gramlich
Acting Director

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SUMMARY

What effect will the Tax Reform Act of 1986 have on the United States' economy? Will it slow the economic expansion or help it along? Will it raise interest rates? What will be the long-run economic benefits of the act, and how important are they likely to be? This study provides detailed analysis of these questions.

SHORT-TERM IMPACTS OF THE TAX REFORM ACT

The paper's estimates of the effects of tax reform over the period 1986-1988 are computed using three small short-run econometric models developed by the author. These models measure the effects of changes in tax provisions on demand in each important sector of the economy. Because these are simultaneous models, the results show not only the direct effects of tax reform on each sector, but also interactions among sectors, and multiplier effects.

The three models differ only in their treatment of business fixed investment: because there is still a great deal of controversy over the correct way to model that sector, this study used three separate approaches imputing varying degrees of sensitivity with respect to tax provisions for business investment. The results from the three models are shown in Summary Tables 1-3.

The most important short-run results are that:

- There is a risk that business fixed investment could be reduced sharply, though temporarily, by the business provisions of the Tax Reform Act. According to one investment model used in this study, the cutback in investment could reach a peak of about 1½ percent of GNP during mid-1987, but the reduction would fade steadily after that.

- Uncertainty over the behavior of business investment suggests that tax reform could have a range of possible effects on the strength of the economic expansion. According to the estimates in this study, the effect during 1986 and 1987 is likely to be (or have been) at least slightly negative, with the estimates of the effect on the 1987 growth rate of real GNP ranging between -0.05 percentage point and -1.0 percentage point. The negative effects should have worn off by late 1988, however, so that by the end of that year the estimates of the effects on the growth rate of real GNP range from 0.0 percentage point to +0.3 percentage point.

- Housing investment is likely to be reduced over the entire forecast period, with the reduction amounting to as much as 0.5 percent of GNP during 1988. The reduction is likely to be concentrated among multiple-family structures, which are especially hard hit by the Tax Reform Act's scaling back of tax benefits to tax shelterers and other business investors in structures. Investment in single-family housing is likely to be affected positively, if at all.

- Sales of consumer durable goods such as automobiles are likely to be affected positively, in the same way as single-family housing. While the reduction in marginal tax rates and the withdrawal of deductions for sales taxes and some consumer interest obligations will all make purchasing these goods more expensive, this negative effect will be more than offset by the positive impact of the increases in after-tax income that are promised to households as a group by the tax reform.

- Interest rates are likely to be reduced very slightly--perhaps a tenth of a percentage point--by the effects of the tax reform act in the near term. The range of estimated changes in market rates attributable to the act is from zero to -0.2 percentage point in 1987, and is effectively zero in 1988.

LONG-TERM EFFECTS OF THE TAX REFORM ACT

Apart from its impact during the first few years after enactment, the Tax Reform Act can be expected to have effects that are felt only after several years at least. Although there are several aspects to the long- run economic improvements promised by the act, among the most important is its effect in making the tax code more "neutral" with respect to different types of capital--that is, subjecting different types to effective tax rates that are more nearly equal than under the previous law. This implies that the capital stock should be more productive than before.

This study develops estimates of the output gain from greater tax neutrality using a neoclassical growth model that recognizes five different types of productive capital and the associated effective tax rates. The estimates suggest an output gain from improved neutrality of about 0.1 percent of the economy's present potential output. While this figure appears small, it is consistent with those in other studies. Even at that, the estimate may be overstated because it takes no account of an important nonneutrality that is preserved by the Tax Reform Act: the relatively low effective tax rate on the large stock of owner-occupied housing.

The estimates in the paper were made with an open-economy growth model that takes account of the possibility that some financial capital will stop flowing into--or actually begin flowing out of--the United States in response to changes in taxation and consequent changes in U. S. interest rates. Though the model suggests a net capital outflow in response to the tax reform, this has only a very slight effect on gross domestic product (GDP)--about 0.01 percent of present GNP. The effect on gross national product (GNP) is even smaller.

SUMMARY TABLE 1. ESTIMATED OVERALL ECONOMIC IMPACTS OF TAX REFORM USING ACCELERATOR INVESTMENT EQUATIONS (In percent of baseline real GNP unless otherwise noted)

Quarter	GNP	Int [a]	Cons	Cars	OCD	Hous	PDE	NRST	Imp
1986:1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987:1	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	0.0	0.0
1987:2	0.0	0.0	0.1	0.0	0.0	-0.2	0.0	0.0	0.0
1987:3	-0.1	0.0	0.1	0.0	0.0	-0.3	0.0	0.0	0.0
1987:4	-0.2	0.0	0.1	0.0	0.0	-0.4	0.0	0.0	0.0
1988:1	0.2	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:2	0.3	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:3	0.3	0.1	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:4	0.3	0.1	0.4	0.1	0.1	-0.3	0.1	0.0	0.0

SOURCE: Author's estimates described in text.

a. Percentage points.

Details may not add to totals because of rounding.

"GNP" is gross national product.
"Int" is the interest rate (91-day Treasury bill rate).
"Cons" is spending for nondurable consumption.
"Cars" is consumer spending for automobiles and parts.
"OCD" is consumer spending for durable goods other than autos and parts.
"Hous" is residential investment.
"PDE" is investment in producers' durable equipment.
"NRST" is investment in nonresidential structures.
"Imp" is imports of goods and services.

SUMMARY TABLE 2. ESTIMATED OVERALL ECONOMIC IMPACTS OF TAX REFORM USING PUTTY-CLAY INVESTMENT EQUATIONS (In percent of baseline real GNP unless otherwise noted)

Quarter	GNP	Int [a]	Cons	Cars	OCD	Hous	PDE	NRST	Imp
1986:1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987:1	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	0.0	0.0
1987:2	0.0	0.0	0.1	0.0	0.0	-0.2	0.0	0.0	0.0
1987:3	-0.1	0.0	0.1	0.0	0.0	-0.3	0.0	0.0	0.0
1987:4	-0.2	0.0	0.1	0.0	0.0	-0.4	0.0	0.0	0.0
1988:1	0.2	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:2	0.2	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:3	0.2	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:4	0.2	0.0	0.4	0.1	0.1	-0.3	0.1	0.0	0.0

SOURCE: Author's estimates described in text.

a. Percentage points.

Details may not add to totals because of rounding.

"GNP" is gross national product.
"Int" is the interest rate (91-day Treasury bill rate).
"Cons" is spending for nondurable consumption.
"Cars" is consumer spending for automobiles and parts.
"OCD" is consumer spending for durable goods other than autos and parts.
"Hous" is residential investment.
"PDE" is investment in producers' durable equipment.
"NRST" is investment in nonresidential structures.
"Imp" is imports of goods and services.

SUMMARY TABLE 3. ESTIMATED OVERALL ECONOMIC IMPACTS OF TAX REFORM USING PUTTY-PUTTY INVESTMENT EQUATIONS (In percent of baseline real GNP unless otherwise noted)

Quarter	GNP	Int [a]	Cons	Cars	OCD	Hous	PDE	NRST	Imp
1986:1	-0.2	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
1986:2	-0.6	-0.1	0.0	0.0	0.0	0.0	-0.6	0.0	0.0
1986:3	-0.8	-0.2	0.0	0.0	0.0	0.0	-0.9	0.0	0.0
1986:4	-0.9	-0.2	0.0	0.0	0.0	0.1	-1.1	0.0	-0.1
1987:1	-0.8	-0.2	0.1	0.0	0.0	0.0	-1.2	0.1	-0.1
1987:2	-0.9	-0.2	0.2	0.0	0.0	-0.1	-1.3	0.1	-0.1
1987:3	-1.1	-0.2	0.2	0.0	0.0	-0.2	-1.2	0.0	-0.1
1987:4	-1.0	-0.2	0.2	0.0	0.0	-0.3	-1.1	0.0	-0.1
1988:1	-0.5	-0.1	0.4	0.1	0.1	-0.3	-1.0	0.0	-0.1
1988:2	-0.3	-0.1	0.4	0.1	0.1	-0.3	-0.8	0.0	-0.1
1988:3	-0.2	0.0	0.4	0.1	0.1	-0.3	-0.6	0.0	-0.1
1988:4	0.0	0.0	0.4	0.1	0.1	-0.3	-0.4	0.0	-0.1

SOURCE: Author's estimates described in text.

a. Percentage points.

Details may not add to totals because of rounding.

"GNP" is gross national product.
"Int" is the interest rate (91-day Treasury bill rate).
"Cons" is spending for nondurable consumption.
"Cars" is consumer spending for automobiles and parts.
"OCD" is consumer spending for durable goods other than autos and parts.
"Hous" is residential investment.
"PDE" is investment in producers' durable equipment.
"NRST" is investment in nonresidential structures.
"Imp" is imports of goods and services.

SECTION I

INTRODUCTION

Popular discussion both before and since passage of the Tax Reform Act of 1986 has revealed a great deal of uncertainty over its likely economic effects. Predictions of the near-term impact turn mainly on differing views of the act's effects on fixed investment: some analysts expect a severe downturn in investment leading to a noticeable overall economic slowdown, while others foresee little effect. In the longer term, tax reform is expected to improve economic efficiency, but little information is available on the magnitudes of the potential improvement in output or of the other economic changes that maybe in prospect.

This paper presents model results regarding both the short-run and long-run effects of the Tax Reform Act. The short-run analysis adopts the Keynesian approach that is used in most other formal short-run studies of the effects of the act and is implicit in virtually all public discussion of this subject. 1/ The analysis in this study improves on others, however, in that it uses carefully chosen models to determine the impact of the tax change on demand in each important sector of the economy. In dealing with business investment, in particular, the paper uses three alternative models representing various schools of thought on the behavior of spending in this sector. What results is an estimate of the range of GNP effects that is implied by these alternative investment equations (in combination with the other sectoral equations).

The long-run discussion provides an analytic treatment of how the tax change should ultimately affect the economy, including in particular the increase in output that should result from the improvements in tax neutrality. Neoclassical growth models are then used to develop estimates of the long-run effects on output, interest rates, and the external trade balance. The quantitative analysis treats the U.S. as a large open economy, and thus represents the behavior of the rest of the world explicitly.

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1. Examples of formal studies of the short-run impact of the Tax Reform Act that use essentially the same procedures employed here are Chase Econometrics, "U.S. Macroeconomic Forecasts and Analysis," September 1986; and University of Michigan Research Seminar in Quantitative Economics, "The U.S. Economic Outlook for 1986-1987: October Forecast Update," October 9, 1986.

Major Features of Tax Reform

The Tax Reform Act of 1986 is a comprehensive change in the nation's income-tax laws that reduces income taxes for most individuals, shifting much of this burden to corporations. Those features of the act that play a central role in the analysis in this paper will be summarized here. 2/

The act provides reductions for individual taxpayers in both the number and the level of the tax rates that apply to income after all deductions and exemptions have been taken. The number of rates is reduced from 15 to 5, and their level is reduced effective January 1, 1987. The top rate, for example, falls from 50 percent before 1987 to 38.5 percent in that year. In 1988, the rates are reduced and simplified again, with the number falling effectively to three, the highest of which is 33 percent. At the same time, however, individual taxpayers face the reduction or elimination of many deductions, such as those for consumer interest and state and local sales taxes. The deductibility of contributions to Individual Retirement Accounts is limited to lower-income individuals and those without access to employer-provided pension plans. The exclusion of 60 percent of long-term capital gains from taxable income under prior law is repealed. There is a stronger alternative minimum tax, and limits are placed on the extent to which "passive" losses (tax losses taken principally by limited partners in real-estate or other ventures) can be offset against income other than that from similar sources. Many of the changes in the definition of taxable income became effective on January 1, 1987.

A parallel set of changes affects corporations and businesses generally, although the overall result is to increase the tax burden on business income. Prominent among these features are the repeal of the investment tax credit, and an overall lengthening of useful lives for depreciation of fixed investments. Less accelerated methods of depreciation were prescribed for structures. Except for the repeal of the investment tax credit, which was effective at the beginning of 1986, these changes generally take effect at the beginning of 1987. The tax rates that apply to taxable corporate profits are also reduced effective July 1, 1987, with the top rate falling from 46 to 34 percent.

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2. For a more detailed account, see U.S. House of Representatives Report 99-841, *Tax Reform Act of 1986: Conference Report to accompany H.R. 3838* (U.S. Government Printing Office, September 18, 1986).

SECTION II

SHORT-RUN ECONOMIC IMPACTS OF THE TAX REFORM ACT OF 1986

The analysis in this section follows standard textbook principles of short-run macroeconomic analysis. Indeed, the model in this section is methodologically quite similar to most large-scale short-run macroeconometric models. The most important defining assumption used in this short-run analysis is that the aggregate capital stock is constant. The rationale for this assumption is that cumulative net investment flows over the typical short-run horizon of one to five years are typically too small in relation to the existing stock of capital to represent significant changes in it. For much the same reason, components of the stock of physical capital and most financial stocks--for example, the stocks of interest-bearing government debt and of claims on other countries--are assumed fixed over the short run as well. 3/ While not a necessary corollary of the assumption of unchanged capital stocks, it is usually assumed in short-run analyses that relative prices are unchanged as well.

Organization of the Section

The first part of this section is a discussion of the likely direct short-run impacts of the Tax Reform Act on business investment, residential investment, spending on consumer durables, nondurable consumption, net exports, interest rates, labor supply, and prices. Econometric equations are

3. One consequence of the assumption of fixity of all categories of physical capital that is important in the analysis is this one: when an increase in the taxation of the income from capital occurs (as it does in the case of the Tax Reform Act), the assumption of short- run capital fixity means that the tax falls on savers in the short run. For this reason, flows of dividends are assumed in the analysis below to be reduced by the full amount of the increase in corporate tax liabilities that is caused by the Tax Reform Act. However, the short-run analysis recognizes that the supply of capital to corporations will respond to the tax change in the long run in such a way as to pass at least some of the tax increase forward in the form of higher capital costs, and that investment will begin responding to this development in the short run. Thus the short-run analysis models investment flows on the basis of long-run measures of the cost of capital while at the same time making the seemingly inconsistent assumption that savers bear the full tax increase in the short run.

developed for modeling the effects on each spending category and on interest rates. These direct effects are calculated using these equations and presented at the end of this section in tabular form.

These calculations of the direct impacts on each sector take no account of indirect effects stemming from effects in other sectors. For example, investment in housing may be reduced by the increase in the user cost of residential investment resulting directly from the tax change, but it may be increased if the impacts in other sectors generate an increase in aggregate demand, in output, and hence in income for potential buyers of housing. Such indirect effects are not discussed in the sector-by-sector discussion in the first part of this section of the paper, primarily because they are too numerous and complicated to take into account completely. However, the indirect effects, together with other "multiplier" effects on demand in each sector, are calculated in the simulations of the full simultaneous econometric model made up of the collected sector-by-sector equations (together with a number of identities shown in the appendix). These full-model results are shown toward the end of the section in separate tables accompanying those showing the indirect effects.

DISCUSSION OF THE SHORT-RUN EFFECTS

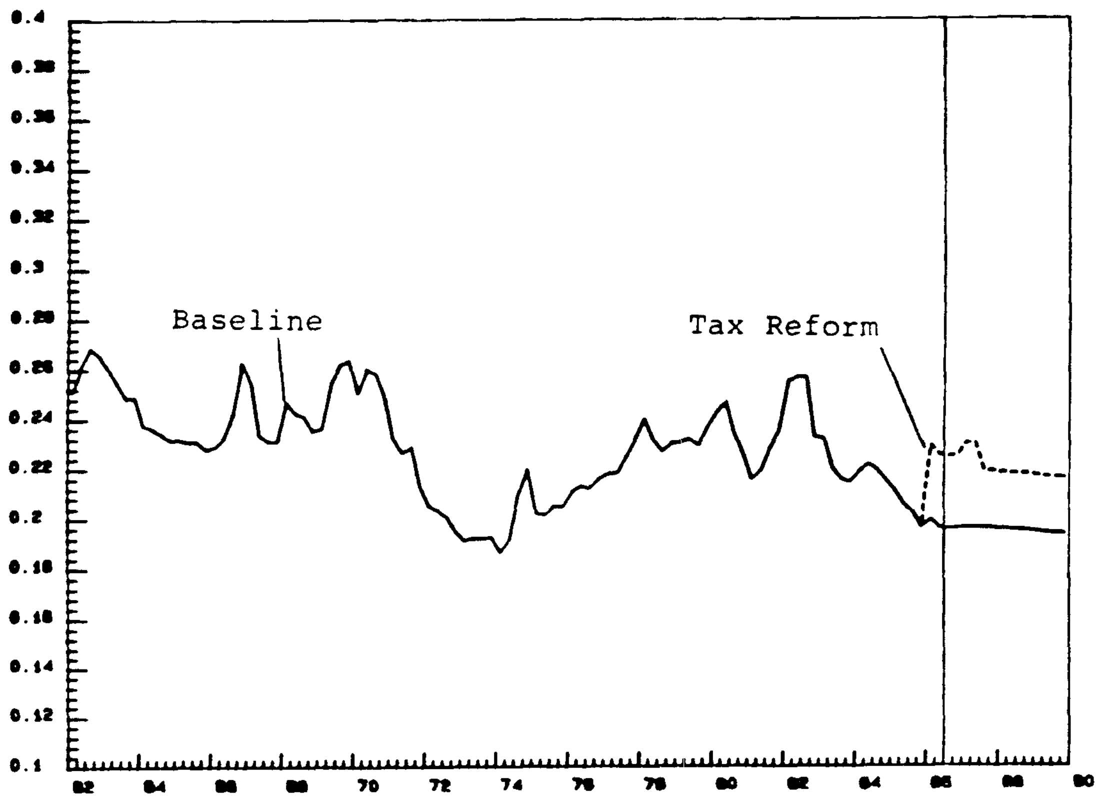
Effects on Business Fixed Investment

As this discussion has already mentioned, the Tax Reform Act entails a number of provisions that increase the effective tax rate on business capital. The increases in the effective marginal tax rate are reflected in significant increases in the user cost of capital. This is shown in Figures 1 and 2, which respectively show current estimates of the user costs for producers' durable equipment and for nonresidential structures since 1962, together with forecasts over the 1986-1989 period, with and without the changes implied by the act. 4/

4. These estimates were developed using the CBO user-cost model. This model incorporates a specification that differs only slightly from that originally put forward by Robert Hall and Dale W. Jorgenson, "Tax Policy and Investment Behavior," *American Economic Review* (June 1967), pp. 391-414. User costs are computed separately for each of the 21 categories of equipment and 10 categories of nonresidential structures in the National Income and Product Accounts, and then aggregated using weights reflecting relative stocks. The model uses estimates of economic depreciation rates from Charles R. Hulten and Frank C. Wyckoff, "The Measurement of Economic Depreciation," in C.R. Hulten, ed., *Depreciation, Inflation, and the Taxation of Income from Capital* (Washington, D.C.: Urban Institute, 1981). The measure of the real cost of capital is similar to that in the

Figure 1.

User Cost for Producers' Durable Equipment



SOURCE: Congressional Budget Office.

As Figure 1 shows, the increase in the cost measure caused by tax reform is especially sharp for producers' durable equipment, owing to the repeal of the investment tax credit effective retroactively to the beginning of 1986. The cost rises slightly more in early 1987 when depreciation deductions for equipment are scaled back, and then falls somewhat in mid-1987 when the statutory marginal corporate tax rate is reduced from 46 percent to 34 percent. The reduction in the tax rate reduces the user cost because of its strong effect in increasing the expected after-tax return to capital. This effect is sharp enough in these cases to dominate another that works in the opposite direction--the effect of the rate cut in reducing the value of the deductions for depreciation and interest.

The user cost for nonresidential structures owned by corporations, shown in Figure 2, rises very slightly in early 1986 with the repeal of the investment tax credit. The increase is not sharp because most structures were already ineligible for the credit. A sharper increase in the cost comes in early 1987 when depreciation deductions for structures are scaled back. The user cost falls nearly to its baseline level with the reduction in the statutory tax rate in mid-1987. 5/

The timing of the user-cost reductions entailed by the fall in the statutory tax rate is open to question. The figures shown here put the reduction at the same time that the reduction is made effective, in mid-1987, but much of its effect may have been felt earlier. This is because the user-cost-reducing effect comes about through increases in the expected after-tax return to investment, which may have increased as soon as such a rate cut became a matter of probability, perhaps in early 1986.

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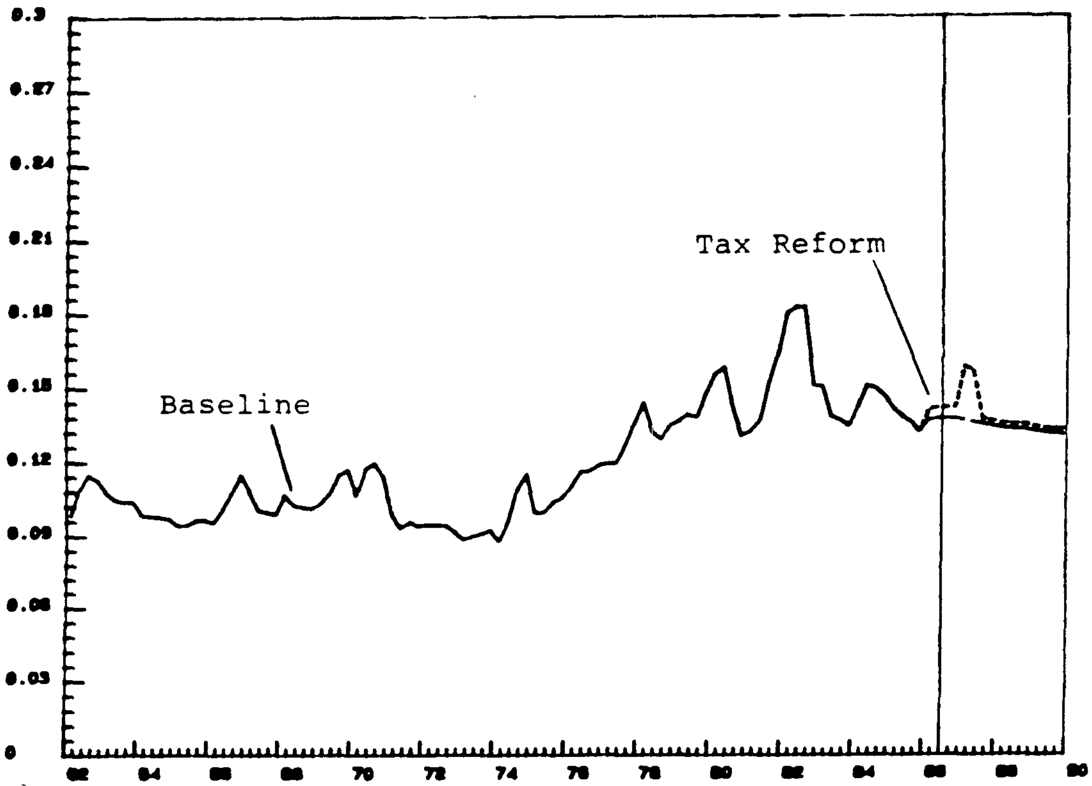
4. Continued
MPS econometric model, in that it is based on a weighted average of the real after-tax interest rate and the yield on equity, represented as twice the dividend/price ratio. (For further explanation, see Flint Brayton and Eileen Mauskopf, *The MPS Model of the United States Economy* (Washington, D.C.: Board of Governors of the Federal Reserve System, 1985). Inflationary expectations are computed using a backward-looking mechanism applied to the GNP deflator. Streams of depreciation deductions are computed using algorithms for computing optimal deductions exactly, and are discounted using an after-tax nominal interest rate. For more information, see Congressional Budget Office, "The User Cost of Capital: An Update" (internal memorandum, October 20, 1986).

5. The behavior of the user cost for residential structures owned by corporations is quite similar to that of the measure for nonresidential structures shown in Figure 2.

Figure 2.

User Cost for Nonresidential Structures



SOURCE: Congressional Budget Office.

How Will These Tax Changes Affect Investment? The short-run effects of such tax changes on business investment have for 20 years been the subject of one of the more intense controversies in economics. Various competing theories of investment have been developed, some of which impute a role to tax factors and some of which do not.

Three such models are considered here. The first is the "simple accelerator" model (hereafter referred to as the "accelerator") associated mainly with Robert Eisner, an approach that imputes no direct investment effect to changes in user costs. The second model is the neoclassical "putty-putty" model of Dale Jorgenson. 6/ This approach assumes that the changes in relative factor costs that are implied by user-cost changes, ceteris paribus, give rise to adjustments in the labor intensity with which all capital, both new and old, is used. This implies relatively sharp investment impacts from user-cost changes. The third model considered is the"putty-clay" approach developed by Bischoff, in which it is assumed that changes in factor intensity can only be made in carrying out new investment. 7/ This view implies that changes in investment in response to changes in user costs are relatively gradual.

The specifications of all of these models are based on the assumption that the desired capital stock is related to (a distributed lag on) some observable variable(s), which, following Hall, will here be called "X". 8/ This implies that net investment is related to (a distributed lag on) the change in X, and that gross investment--the usual left-hand-side variable--is this distributed lag plus one or more lagged capital stock terms to measure depreciation.

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6. Dale W. Jorgenson, "Capital Theory and Investment Behavior," *American Economic Review*, vol 53 (May 1963), pp. 247-259.

7. Charles Bischoff, "Hypothesis Testing and the Demand for Capital Goods," *Review of Economics and Statistics*, vol 51 (August 1969), pp. 354-368, and later work.

8. The discussion that follows draws heavily on Robert Hall, "Investment, Interest Rates, and the Effects of Stabilization Policies," *Brookings Papers on Economic Activity*, 1977:1, pp. 61-121. The econometric work that is reported in this subsection was carried out by my CBO colleague Matthew Salomon, who also provided valuable discussion. As Hall points out, the distributed lag by which X is related to the desired capital stock reflects formation of expectations of permanentlevels of X. As a consequence, estimated lag coefficients like those reported below are potentially subject to the well-known criticism associated with Robert Lucas to the effect that estimates reflecting expectation formation may be unreliable if economic agents use rational expectations. See Robert E. Lucas, "Econometric Policy Evaluation: A Critique," *Journal of Monetary Economics*, Supplement, vol. 2 (1976). No attempt to deal with this issue is made in this subsection or elsewhere in the paper.

In the accelerator model a constant desired capital/output ratio is assumed, so X is simply output. Thus the right-hand side of the estimated investment equation consists of the lagged capital stock and a distributed lag on changes in output. The equations in the first lines of Tables 1a and 1b are examples.

The putty-putty model is derived assuming a Cobb-Douglas production function, which implies directly that the desired capital stock is a linear function of the ratio of output to the user cost. 9/ Hence, this ratio constitutes X in the putty-putty model. Moreover, no asymmetries in the potential investment effects of output and the user cost are recognized, so empirical putty-putty equations, like those in the second lines of Tables 1a and 1b, often consist simply of one or more lagged capital stock terms to pickup depreciation, plus a distributed lag on the change in the output/user cost ratio. The putty-putty model implies a relatively fast response of investment to a change in either output or the user cost, and necessarily imputes the same response pattern to a change in either variable.

The putty-clay approach also assumes that the output/user cost ratio indexes capital demand. In this case, however, the assumption of ex-post fixity in the capital/labor ratio embodied in installed capital implies that output and the user cost must be treated asymmetrically in the investment equation. Changes in output alone imply a need simply to add to (or subtract from) the existing capital stock, maintaining the current capital/labor ratio--something that can be done relatively quickly. Changes in the user cost, on the other hand, imply a need to alter the factor proportions embodied in the existing capital stock. This process can take a relatively long time under putty-clay assumptions, since the capital/labor ratio embodied in the existing capital stock can only be changed as this stock depreciates and is replaced. Empirical putty-clay equations therefore require more than one distributed lag in order to treat output and the user cost asymmetrically. For example, the specifications in the third lines of Tables 1a and 1b are of the form

$$\begin{aligned} I = A + \; & B_i[(Y_t/c_t) - (Y_{t-1}/c_{t-1})(1-d)] \\ + \; & G_i[(Y_t/c_{t-1}) - (Y_{t-1}/c_{t-2})(1-d)] \end{aligned}$$

where A and the B_i and G_i are estimated parameters and d is an economic depreciation rate estimated a priori. Unlike the putty-putty equation, this specification yields separate estimates of the effect of a change in output, Y, and of a change in the user cost, c.

9. Expressing both capital, k, and output, y, in per-worker-hour terms, the Cobb-Douglas function is $y = k^a$, and the marginal product of capital is $mp = ak^{a-1} = ay/k$. Setting this equal to the user cost, c, and rearranging implies $k = ay/c$.

The estimates typically imply a much slower response to changes in the user cost than to changes in output, or to output or the user cost in the putty-putty estimates in Table 1.

Choosing Among Investment Models. Neither empirical nor theoretical reasoning yields a clear choice among these three investment models. Attempts to estimate neoclassical models are plagued by problems in measuring the user cost and by simultaneous-equations problems that are likely to bias their coefficients toward zero. Tests based on explanatory and/or predictive power typically favor the accelerator model. Among the equation estimates shown in Table 1, for example, the accelerator formulation explained both equipment and structures investment better than any other model, as Table 2 shows. 10/ Among the others, the putty-clay model ranked second in explaining equipment investment. All of the models did a poor job of predicting investment in nonresidential structures when no autocorrelation correction was used. When an autocorrelation correction was used, the relative ranking of the putty-putty and putty-clay models was reversed relative to the case of equipment investment.

Many economists nevertheless prefer the neoclassical approach to the accelerator on theoretical grounds. This is because varying factor proportions are clearly possible in the long run, and even casual inspection suggests that shifts in relative prices induce some cost-reducing changes in factor intensity. The effects of these long-run developments should be evident in short-run behavior as well.

There seems, however, to be no clear consensus in favor either of putty-putty or putty-clay as a short-run approach. This reflects, in part, the difficulty in judging the degree of ex-post substitutability that is afforded by such institutional possibilities as combining varying numbers of shifts of labor with a given amount of capital. 11/ In view of these ambiguities, this study uses the estimates in Table 1 of all three models as alternative measures of the investment impact of the Tax Reform Act.

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10. Earlier studies that arrived at similar conclusions were Peter K. Clark, "Investment in the 1970's: Theory, Peformance, and Prediction," *Brookings Papers on Economic Activity*, 1979:1, pp. 73-124; and Richard W. Kopcke, "The Behavior of Investment Spending During the Recession and Recovery," *New England Economic Review*(November-December 1977), pp. 5-41.

11. For a detailed discussion of these issues, see Robert Hall, op. cit., and the accompanying comments by Franco Modigliani,

TABLE I-A. ESTIMATED EQUATIONS FOR INVESTMENT IN PRODUCERS' DURABLE EQUIPMENT

Accelerator

$$\text{Ipde} = \underset{(5.054)}{-4.885} + \underset{(11.534)}{2.637^{*}[Y - Y_{t-1}]} + \underset{(41.921)}{0.162\,\text{Kpde}_{t-1}}$$

R-bar2: .948 Durbin-Watson: 2.310
Sample period: 1953:1--1985:4
Estimated first-order autocorrelation coefficient:
* Variable is entered as 18-quarter distributed lag, fit to a third-degree polynomial with far endpoint constraint. Reported coefficient and t-statistic are for the sum of lag coefficients.

Putty-Clay

$$\text{Ipde} = \underset{(8.861)^{**}}{-391.995^{**}}[(Y/\text{cpde})-(1-\text{dpde})(Y_{t-1}/\text{cpde}_{t-1})] + \underset{(9.931)^{**}}{409.941^{**}}[(Y_{t-1}/\text{cpde}_{t-1})-(1-\text{dpde})(Y\text{-}2/\text{cpde}_{t-1})]$$

R-bar2: .922 Durbin-Watson: 2.005
Sample period: 1961:3--1985:4
Estimated first-order autocorrelation coefficient: 0.848
** Variable is entered as 27-quarter distributed lag, fit to a third-degree polynomial with far endpoint constraint. Reported coefficient and t-statistic are for the sum of lag coefficients.

Putty-Putty

$$\text{Ipde} = \underset{(0.546)}{1.010} + \underset{(7.782)}{.156\,\text{Kpde}_{t-1}} + \underset{(0.325)^{*}}{3.030^{*}}\,[(Y/\text{cpde}) - (Yt\text{-}1/\text{cpde}_{t-1})]$$

R-bar2: .549 Durbin-Watson: 1.764
Sample period: 1960:2--1985:4
Estimated first-order autocorrelation coefficient: 0.932
* Variable is entered as 23-quarter distributed lag, fit to a third-degree polynomial with far endpoint constraint. Reported coefficient and t-statistic are for the sum of lag coefficients.

Definitions:

Ipde: investment in producers' durable equipment (MPS). [a]
Kpde: net stock of producers' durable equipment (MPS).
Y: Gross corporate product (MPS).
cpde: Real user cost of capital for producers' durable equipment (cents per dollar) (MPS).
dpde: Real depreciation rate (estimated in putty-putty equation as 0.156).

NOTE: All variables are in billions of 1982 dollars unless otherwise specified. Numbers in parentheses below coefficient values are t-statistics.

a. MPS indictates MIT-Penn-Social Science Research Council model databank.

TABLE I-B. ESTIMATED EQUATIONS FOR INVESTMENT IN NONRESIDENTIAL STRUCTURES

Accelerator

$$\text{Inrst} = \underset{(1.076)}{-1.046} + \underset{(6.762)}{0.075}\, \text{Knrst}_{t-1} + \underset{(6.287)}{2.989^{*}} [Y - Y_{t-1}]$$

R-bar2: .517 Durbin-Watson: 1.687
Sample period: 1955:3--1985:4.
Estimated first-order autocorrelation coefficient:
* Variable is entered as 28-quarter distributed lag, fit to a third-degree polynomial with far endpoint constraint. Reported coefficient and t-statistic are for the sum of lag coefficients.

Putty-Clay

$$\text{Inrst} = \underset{(0.553)^{**}}{-12.331^{**}}[(Y/\text{cnrst})-(1-\text{dnrst})(Y_{t-1}/\text{cnrst}_{t-1})]$$
$$+ \underset{(1.145)^{**}}{25.305^{**}}[(Y_{t-1}/\text{cnrst}_{t-1})-(1-\text{dnrst})(Y_{t-2}/\text{cnrst}_{t-1})]$$

R-bar2: .246 Durbin-Watson: 1.027
Sample period: 1965:4--1985:4
Estimated first-order autocorrelation coefficient: 0.923
** Variable is entered as 28-quarter distributed lag, fit to a third-degree polynomial with far endpoint constraint. Reported coefficient and t-statistic are for the sum of lag coefficients.

Putty-Putty

$$\text{Inrst} = \underset{(0.191)}{-0.448} + \underset{(2.860)}{0.093}\, \text{Knrst}_{t-1} + \underset{(2.546)^{*}}{8.248^{*}} [(Y/\text{cnrst}) - (Y_{t-1}/\text{cnrst}_{t-1})]$$

R-bar2: .306 Durbin-Watson: 1.315
Sample period: 1965:3--1985:4
Estimated first-order autocorrelation coefficient: 0.936
* Variable is entered as 27-quarter distributed lag, fit to a third-degree polynomial with far endpoint constraint. Reported coefficient and t-statistic are for the sum of lag coefficients.

Definitions:

Inrst: Investment in nonresidential structures (MPS). [a]
Knrst: Net stock of nonresidential structures (MPS).
Y: Gross corporate product (MPS).
Cnrst: Real user cost of capital for nonresidential structures (cents per dollar) (MPS).
Dnrst: Real depreciation rate for nonresidential structures (estimated in putty-putty equation as 0.093).

NOTE: All variables are in billions of 1982 dollars unless otherwise specified. Numbers in parentheses below coefficient values are t-statistics.

a. MPS indicates MIT-Penn-Social Science Research Council model databank.

Effects on Residential Investment

The Tax Reform Act contains a number of provisions that may affect residential investment. For individuals with owner-occupied homes, these include the reduction in statutory individual income tax rates, which decrease the tax-reducing effect of deductions for mortgage interest and property taxes. These provisions cause increases in the estimated user costs for owner-occupied homes, as shown in Figure 3. For other investors in housing, including many tax-shelterers, these provisions include the reductions in both individual and corporate statutory tax rates, the significant scaling back of depreciation allowances, the increases in tax rates on capital gains, and the limitations on deductibility of "passive losses" by limited partners in enterprises such as real-estate ventures.

The literature suggests more conclusively that increases in user costs, in and of themselves, may work to reduce residential investment more than

TABLE 2. GOODNESS-OF-FIT OF ALTERNATIVE INVESTMENT EQUATIONS (Standard error of estimate as percentage of mean of dependent variable)

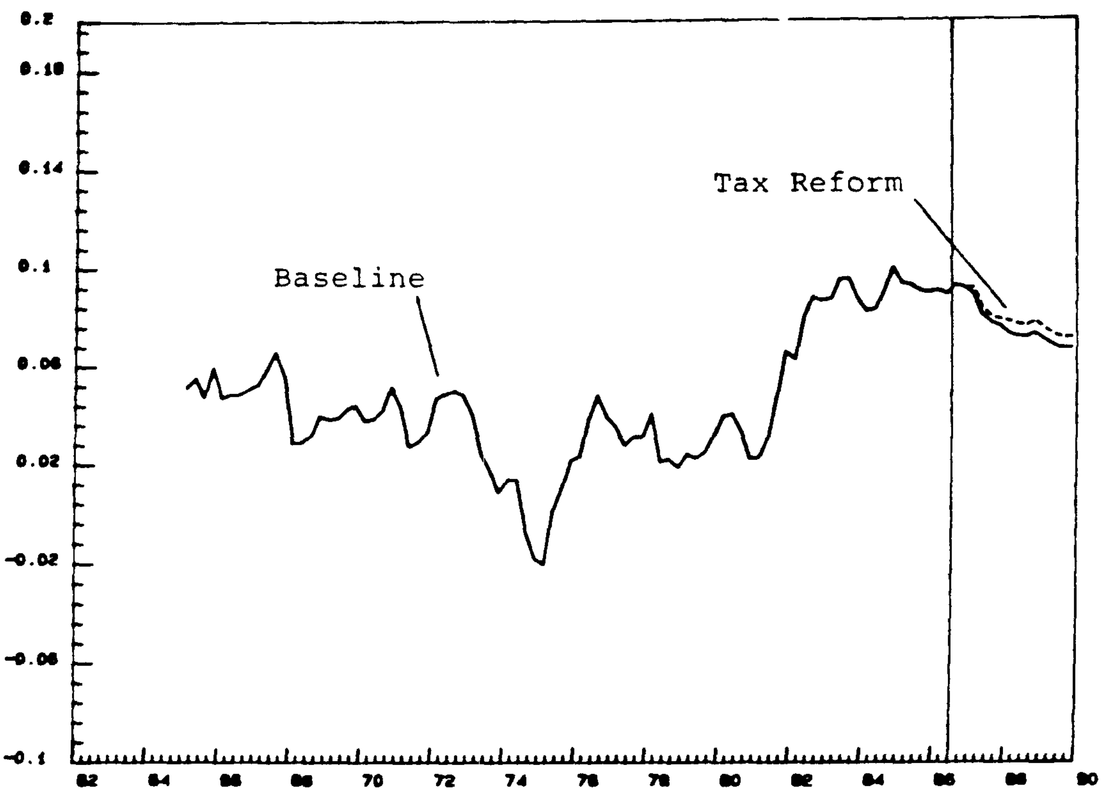
	Unadjusted for Serial Correlation	Adjusted
Accelerator		
Equipment	3.93	2.46
Structures a/	7.18	2.31
Putty-Putty		
Equipment	8.81	3.04
Structures a/	9.00	3.09
Putty-Clay		
Equipment	5.39	2.59
Structures a/	13.53	3.32

Note: Equation estimates are those shown in Table 1.

a. Dependent variable in "structures" regressions was nonresidential structures; in the accelerator case it included utility structures, while in the neoclassical equations it excluded them.

Figure 3.

User Cost for Owner-Occupied Single-Family Homes



SOURCE: Congressional Budget Office.

is the case with nonresidential investment. (As will be suggested below, however, the effects of the Tax Reform Act are likely to be concentrated in multiple-family housing rather than in single-family construction.) A few previous studies have approached the demand for housing services or housing starts using user costs explicitly in an unrestricted form with considerable success. 12/ Moreover, among the many other empirical housing studies there is virtually unexceptioned success in relating demand to the mortgage rate, with broadly similar quantitative results. 13/ While the mortgage rate is not the same as the user cost, the two are highly correlated. In studies of business fixed investment, by contrast, there has apparently been little success in relating demand either to interest rates or to user costs in unrestricted specifications.

If there is a depressing effect on housing from this increase in user costs, it is likely to be concentrated on multiple-family rather than single-family housing. Most studies on this subject emphasize that single-family housing starts depend on the user cost for owner-occupied single-family houses relative to that for rental housing. The rental price of rental housing, in turn, is proxied by that on multifamily housing. Calculations using an equation developed by Esaki and Wachtenheim suggest that single-family starts may rise slightly in response to the Tax Reform Act because the act increases the user cost of multifamily structures more sharply than that of single-family houses. 14/

Even if changes in user costs do have the partial effect of reducing residential investment, the Tax Reform Act may also have the partial effect of working to increase housing investment by increasing the disposable incomes of households. This study takes account of both the user-cost and the income effects by using the residential-investment equation from the MPS econometric model, which incorporates both effects,

12. See, for example, Patric H. Hendershott, "Real User Costs and the Demand for Single-family Housing," *Brookings Papers on Economic Activity*, 1980:2, pp. 401-452.

13. A survey is provided in James Kearl, Kenneth Rosen, and Craig Swan, "Relationships Between the Mortgage Instruments, the Demand for Housing, and Mortgage Credit: A Review of Empirical Studies," in *New Mortgage Designs for an Inflationary Environment* (Boston: Federal Reserve Bank of Boston, 1975).

14. Howard Esaki and Judy Wachtenheim, "Explaining the Recent Level of Single-Family Housing Starts," *Federal Reserve Bank of New York Quarterly Review* (Winter 1984-85), pp. 31-38.

and which deals with both single- and multiple-family housing. 15/ The current version is:

$$\begin{aligned} QEH &= 0.440 - 6.531 \log [(KH1 + KH5)/N]_{t-1} - 0.054\, RMEFF \\ &+ 7.531 \log [0.125(\mathrm{sum}_{i=0 \text{ to } 7}\, CON_{t-i})]/N \\ &- 0.047^{**} [(0.75 \log cho) + (0.25 \log chr)] \\ &- 0.043 [U - U_{t-1}] - 0.156^{**}\, DCR. \end{aligned}$$

**Variable is entered as a 4-quarter distributed lag, fit to a second-degree polynomial with near and far endpoint constraints. Reported coefficient is the sum of the lag coefficients.

Definitions:

QEH: Log of real per capita nonsubsidized housing expenditure.
KH1: Stock of one to four-family houses.
KH5: Stock of multifamily (five or more) houses.
N: Population (millions).
RMEFF: Effective nominal mortgage rate, MPS model definition.
CON: Consumption, MPS model definition.
cho: User cost for owner-occupied houses (cents per dollar).
chr: User cost for rental housing (assumed in simulations to be the user cost for nonresidential structures owned by corporations shown in Figure 2 above; measured in cents per dollar).
U: Civilian unemployment rate (percent).
DCR: Credit-rationing dummy.

This equation implies that investment is negatively related to a weighted average of the user costs for single- and multiple-family structures, as well as to the nominal mortgage rate. The long-run elasticity of expenditure with respect to the mortgage rate, which is reached after four quarters, is approximately 1.3. The equation also holds residential investment to be positively related to nondurable consumption, which in turn is related to disposable income. These properties appear to accord well with consensus views. 16/

15. For a discussion of this and other equations of the MPS model, see Flint Brayton, and Eileen Mauskopf, The MPS Model of the United States Economy, (Washington, D.C.: Board of Governors of the Federal Reserve System, 1985).

16. See Kearl, Rosen, and Swan, op. cit.

Consumer Durables

The implications of the tax legislation for spending on consumer durables are similar to those for housing: the tax change acts to reduce spending by increasing the user cost, but it may also act to stimulate spending by increasing the after-tax incomes of consumers. The increase in the user cost comes about because the act first reduces, and ultimately eliminates, the tax deductibility of interest on consumer loans, and because it eliminates the deductibility of state and local sales tax on such purchases. An estimate of the increase in the user cost for consumer-owned automobiles is shown in Figure 4. 17/

This study developed estimates of the overall effect of the legislation on durables spending using modified forms of equations developed by Mishkin. 18/ In the versions that are used here, which are shown below, these equations take account of the conflicting effects of the bill by relating durables spending to a user cost and to expected permanent and transitory disposable personal income. 19/

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17. This study has not attempted to measure the user-cost effect of the fact that interest on consumer credit remains deductible if secured by real estate. As a result, the increase in the average user cost portrayed in the figure is somewhat overstated.

    In the longer term, the user cost could also be changed by differences in the cost of production of consumer durable goods that are brought about by the tax reform. Such changes are, however, assumed not to occur within the short-run perspective to which the present analysis is confined.

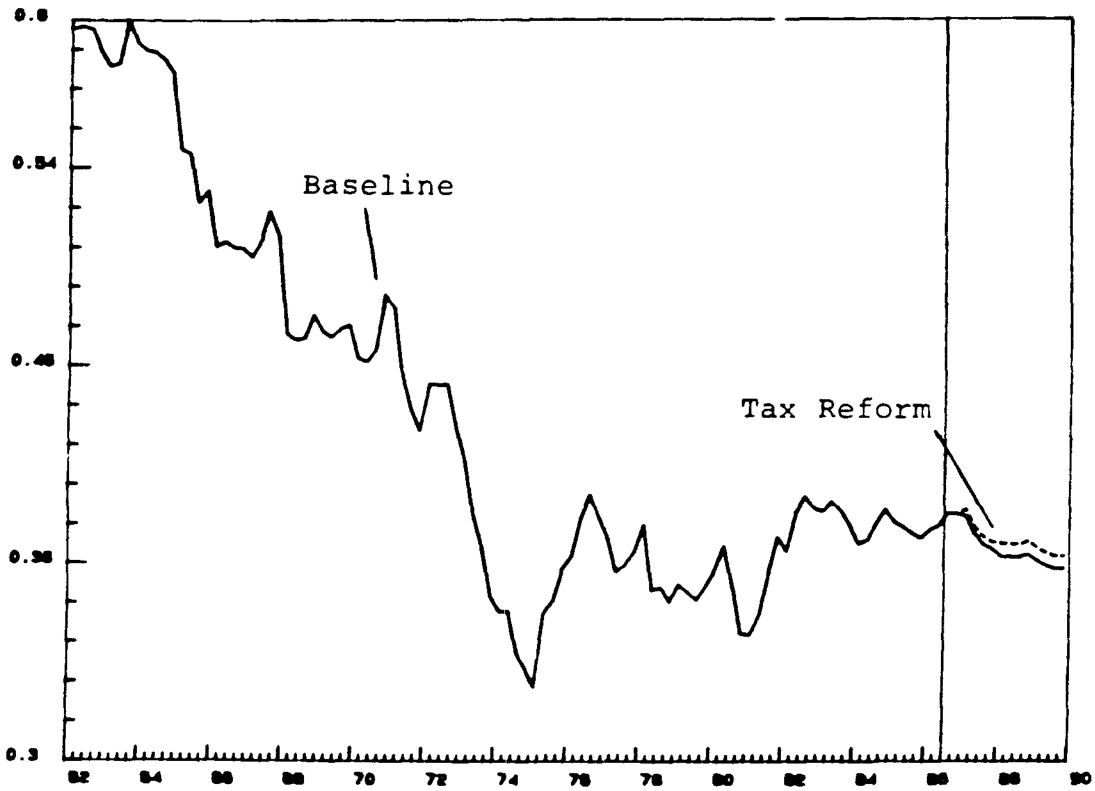
18. Frederic Mishkin, "Illiquidity, Consumer Durable Expenditure, and Monetary Policy," *American Economic Review* (September 1976), pp. 642-654.

19. Instrumented values of DBT, ASF, (YP x cc), and (YP x co) were used in the regressions (making the estimates shown two-stage least squares estimates). The instruments were current and lagged values of the discount rate (Federal Reserve Bank of New York), nonborrowed reserves, federal purchases, exports, the population 16 and over (all of which are in the MPS model databank), and the estimated marginal tax rate.

    Values of permanent and transitory disposable real per-capita personal income were derived as follows: real per capita personal income (MPS) was fitted to a third-order autoregressive process. Before-tax permanent and transitory real per-capita personal income were then taken to be given, respectively, by the fitted values and the residuals of this equation. These were converted to disposable values by multiplying them both by 1 minus the estimated average tax rate. This tax rate, then, is taken to be deterministic and subject to static expectations. The average tax rate is given by federal individual income tax liabilities plus state and local individual income tax liabilities (both MPS) divided by adjusted gross income (MPS). The marginal tax rate is taken to be 1.5 times the average tax rate.

Figure 4.

User Cost for Consumer Automobiles



SOURCE: Congressional Budget Office.

New Automobiles and Parts

$$EC/N = \underset{(4.85)}{-0.456} + \underset{(3.67)}{0.140\, YT} + \underset{(6.13)}{0.114\, YP} - \underset{(0.77)}{0.015\, (YP \times cc)}$$

$$\underset{(3.68)}{-0.307\, CSTOCK_{t-1}} - \underset{(2.52)}{0.027\, DBT} + \underset{(5.81)}{0.014\, ASF}$$

R-bar2: .689 Durbin-Watson: 0.992
Sample period: 1965:1--1985:3

Other Consumer Durables

$$EO/N = \underset{(9.04)}{-0.871} + \underset{(3.55)}{0.147\, YT} + \underset{(12.88)}{0.148\, YP} - \underset{(4.43)}{0.101\, (YP \times co)}$$

$$\underset{(1.28)}{-0.042\, OSTOCK_{t-1}} + \underset{(3.48)}{0.084\, DBT} + \underset{(1.78)}{0.006\, ASF}$$

R-bar2: .981 Durbin-Watson: 0.598
Sample period: 1965:1-1985:3

Definitions:

EC: Consumer durable spending on new autos (MPS).
EO: Consumer durable spending on goods excluding new autos (MPS).
N: Population (MPS).
YT: Transitory disposable personal income (see footnote 19).
YP: Permanent disposable personal income (see footnote 19).
cc: User cost for consumer automobiles (dollars per dollar; incorporates nominal rather than real interest rate).
co: User cost for consumer durables other than automobiles (dollars per dollar; incorporates nominal rather than real interest rate).
CSTOCK: Stock of consumer autos (MPS).
OSTOCK: Stock of consumer durables other than autos (MPS).
DBT: Gross real per capita financial liabilities of household sector (FF).
ASF: Real gross per capita financial assets of household sector (FF).

Nondurable Consumption

The tax legislation may affect nondurable consumption in a variety of ways. Several features of it affect the after-tax return to capital and may therefore affect the saving rate. Apart from the effects of changes in effective marginal tax rates, the significant reduction in the average individual income tax rate will increase disposable incomes for many and thus may increase both their spending and their saving. There is an offset to this effect in the short run, however, in that the increase in corporate tax liabilities implied by the act causes a reduction in income and wealth for individual stockholders.

Overall Effective Marginal Tax Rates. A complication in judging how saving may be affected by changes in the after-tax rate of return comes about because the change in the after-tax return itself is ambiguous: the legislation reduces marginal individual income tax rates, but it increases the corporate tax rate. As a result, most estimates suggest that the Tax Reform Act increases the overall effective marginal tax rate on income accruing to individuals from investments in corporate assets.

Regardless of the answer to the question of how much the after-tax rate of return is changed by the tax law, the econometric literature is ambiguous as to whether any such change will have an effect on saving. Most recent studies of the consumption function have failed to find significant after-tax interest-rate effects on saving, although some dissent from this view. 20/

Capital-Gains Tax Changes. Even though the increase in capital-gains tax rates under the act is most directly an individual income tax provision, it could reduce corporate saving. Under the old tax law, some corporations had an incentive to retain earnings (taxed at the shareholder level at the relatively low capital-gains rate) rather than pay dividends (taxed at a higher rate). Corporate finance theory implies that only those firms whose equity was undervalued in the market had an incentive to pay dividends. 21/ The undervaluation of their stock implied a reduced return to the stockholder from retentions, before and after taxes. In equilibrium, this after-tax return equalled the reduced after-tax return from dividend payouts entailed by their higher tax rate. The new law nearly equalizes the tax rates on capital gains and other forms of income. This should mean that more corporations should be indifferent between paying out dividends and retaining earnings than was true before, so more should pay dividends.

Thus there might be a reduction in corporate saving after the tax change. This would reduce total saving unless shareholders offset the reduction with an increase in their own saving. Stockholders might increase their saving if they see through the corporate veil and realize how corporate financial policy affects the value of their own assets. If stockholders are

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20. Prominent among the dissenting empirical studies is Lawrence Summers, "Tax Policy, the Rate of Return, and Savings," National Bureau of Economic Research Working Paper 995 (September 1982).

21. Alan J. Auerbach, "Share Valuation and Corporate Equity Policy," *Journal of Public Economics* (1979), pp. 291-305.

not that sophisticated, however, the change in business saving could reduce overall saving. 22/

Disposable Income Effects. While the factors just described seem likely to have some effect on consumption and saving, the dominant effect is likely to be that related to the changes in permanent disposable income implied for households by the act. The changes in individual and corporation income tax revenues that are relevant to this question are shown in Table 3. 23/

As the table shows, individuals receive a direct tax cut concentrated in fiscal 1988 and 1989, while corporations face a tax increase of roughly equal cumulative magnitude (over five years) distributed uniformly over the years shown. According to the general lifecycle/permanent income model of consumption, permanent income and consumption should be increased by the permanent component of the individual income tax cut, while consumption should be reduced by the corporate tax increase through its effects on financial wealth. The net effect on consumption depends on relative propensities to spend out of the different components of wealth that are affected by the tax change. 24/

In order to estimate these effects, this study uses the nondurable consumption equation of the MPS econometric model--a life-cycle equation. This formulation incorporates separate distributed lags on four income flows--after-tax labor income, transfers, after-tax taxable property income,

22. Tax reform affects the after-tax return to saving in another way because the act curtails access to individual retirement accounts (IRAs). A recent paper by Venti and Wise adduces empirical evidence based on cross-sectional survey data from 1982 and 1983 implying that such reductions in the limit on IRA contributions might reduce saving. Steven F. Venti, and David A. Wise, "Tax-Deferred Accounts, Constrained Choice, and Estimation of Individual Saving," *Review of Economic Studies* (August 1986), pp. 579-601.

23. Many state and local governments that "piggyback"--that is, use the federal income tax bases under their own income taxes--have said that they plan to keep their tax rates unchanged and thus to collect more revenue after the federal tax base is broadened. This could at least partially offset the changes in permanent household income that are implied by the change in federal tax liabilities. It is assumed in this study, however, either that state and local tax rates will be reduced to give the piggybacking windfall back to taxpayers, or that state and local government spending will rise in roughly equal proportion. Accordingly, the estimates of the tax effect on consumption (and hence on aggregate demand) that are shown below ignore the piggybacking effect.

24. As this discussion suggests, the neoricardian proposition that tax changes have zero consumption impacts is obviated by this analysis to the extent that the tax reform act is really revenue neutral. The anticipated offsetting tax change that finances any single tax change is already accounted for within this analysis. For an exposition of the neoricardian view, see Robert Barro, "Are Government Bonds Net Wealth?", *Journal of Political Economy* (1974).

and nontaxable property income. The values of three components of the stock of household wealth enter as well: household stock, other financial wealth, and real household assets. The average tax rates that are involved in converting taxable income flows to after-tax terms enter separately with their own distributed lags (not shown in the equation listing below). Like the lags on the income flows, these lag distributions model the formation of expectations regarding the permanent values of the corresponding variables. The estimated equation is:

$$\begin{aligned} CON/N = {} & (1\text{-}T) \times 0.418^{**}YL/N + 1.053^{*}YTR/N + \\ & (1\text{-}T) \times 0.489^{***}YPR1/N + 0.489^{***}\ YPR2/N + \\ & 0.049^{**}VST/N + 0.148^{****}VCNF/N + 0.082\ VCNR/N - \\ & 0.043\ JOIL \end{aligned}$$

This equation is not estimated for this study, but rather is taken directly from the MPS econometric model.

*Variable is entered as a 5-quarter distributed lag, fit to a second-degree polynomial with far endpoint constraint. Reported coefficient is the sum of the lag coefficients.
**Variable is entered as a 6-quarter distributed lag, fit to a second-degree polynomial with far endpoint constraint. Reported coefficient is the sum of the lag coefficients.
***Variable is entered as a 6-quarter distributed lag, fit to a second-degree polynomial with near and far endpoint constraints. Reported coefficient is the sum of the lag coefficients.
****Variable is entered as a 12-quarter distributed lag, fit to a second-degree polynomial with near and far endpoint constraints. Reported coefficient is the sum of the lag coefficients.

Definitions:

CON: Nondurable consumption.
N: Population.
YL: Labor income.
YTR: Transfer income.
YPR1: Taxable property income.
YPR2: Nontaxable property income.
VST: Value of common stock (nominal).
VCNF: Financial assets in household net worth.
VCNR: Real assets in household net worth.
JOIL: Oil shock dummy.
T: Estimated average federal and state and local individual income tax rate.

The marginal (and average) propensities to consume out of permanent incomes suggested by the equation are between 40 and 50 percent except for transfers, where the propensity exceeds unity. These marginal propensities (other than that for transfers) are strikingly low relative to earlier estimates. The propensities to consume out of wealth are between 5 and 15 percent.

In modeling the consumption impacts of the Tax Reform Act, the individual income tax rate was reduced year by year by the amount implied by the figures in the first column of Table 3, and the flow of taxable property income was reduced by the full amount of the corporate tax increase in the second column. Correspondingly, the value of stock holdings was reduced by this same figure after it was capitalized using the MPS capitalization equation. The assumptions regarding the timing of changes in income expectations are discussed further below.

Interest-Rate Impacts

Many analysts expect the Tax Reform Act to affect interest rates. One common view is based on the premise that rates are closely related in equilibrium to the after-tax return to capital. According to this view, rates should fall after implementation of tax reform, given that the act increases the effective marginal tax rate on capital income. This is a likely long-run effect of the tax change, and as such it is discussed in some detail in the next section of this paper.

TABLE 3. CHANGES IN REVENUES FROM INDIVIDUAL AND CORPORATION INCOME TAXES IMPLIED BY THE TAX REFORM ACT (In fiscal years and in billions of dollars).

Year	Individual	Corporation
1987	-14.0	25.2
1988	-41.0	23.9
1989	-37.9	22.5
1990	-15.6	23.4
1991	-13.5	25.2
Five-year Total	-122.0	120.2

SOURCE: Joint Committee on Taxation.

In the short run, by contrast, the strongest effect on interest rates is likely to come through increases or decreases in the demand for money that are consequent upon the overall changes in the demand for goods and services that are caused by the tax change. In order to estimate interest-rate impacts coming about through this channel, this study assumes that the Federal Reserve will hold the path of the monetary aggregate M2 fixed during the 1986-1988 period over which the tax bill is implemented, in accordance with stated Federal Reserve policy. 25/ Accordingly, estimates of the interest-rate impacts in the calculations below were made using the following estimated equation for the demand for M2:

$$\log(M/N) = -0.526 + 1.053^{*} \log(GNP/N) - 0.032^{*} OPP$$

R-bar2: .997 Durbin-Watson: 0.508
Sample period: 1977:1--1985:4

*Variable is entered as a 5-quarter distributed lag, fitted to a second-degree Shiller lag. Reported coefficient is the sum of the lag coefficients.

Definitions:

M: M2 (MPS).
N: Population (MPS)
GNP: Nominal GNP (MPS)
OPP: Estimated opportunity cost of holding M2, defined as the 91-day Treasury-bill rate minus a weighted average of yields available on components of M2.

This equation relates M2 demand to GNP with a long-run income elasticity of approximately one, and to an estimate of the average opportunity cost of holding M2 in terms of forgone interest income, which enters with a negative coefficient. 26/ The change in the short-term market interest rate needed to maintain equality between the supply and demand for money is calculated using this equation and the identity defining the opportunity-cost variable.

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25. Statement by Paul A. Volcker, Chairman, Board of Governors of the Federal Reserve System, before the Committee on Banking, Housing, and Urban Affairs, United States Senate, July 23, 1986.

26, The equation was estimated by two-stage least squares: the contemporaneous observation on OPP was instrumented by a constant, the (Federal Reserve Bank of New York) discount rate, nonborrowed reserves, and four lagged values of OPP, and four lagged values of per capita GNP.

Net Exports

The Tax Reform Act might affect U.S. real net exports. Net exports could be reduced if the tax change increased the prices of U.S. goods without an offsetting adjustment in the exchange rate. A significant change in U.S. prices seems unlikely, however, as the discussion below suggests. Another effect on net exports could come about if the tax change stimulated a flow of capital between this country and the rest of the world that affected the exchange rate and with it the relative dollar prices of foreign and domestic commodities.

The strongest short-run impact on net exports seems likely, however, to be indirect, working through the changes in the demand for imports that are implied by the overall impact of the tax change on aggregate demand. In order to estimate the effect, this study borrows an import equation from the Fair model of the U.S. economy. 27/ This equation expresses real imports of goods and services as a function of GNP, interest rates, and the average price levels for domestic and imported goods. The equation is

$$\begin{aligned}(IM/N) = \; & \underset{(4.13)}{-0.0930} + \underset{(16.24)}{0.761}\,(IM_{t-1}/N_{t-1}) + \underset{(4.57)}{0.0444}(Y/N) - \underset{(2.70)}{0.0820}\,PIM_{t-1} \\ & + \underset{(4.88)}{0.201}\,PX_{t-1} - \underset{(3.30)}{0.00523}\,RMA + \ldots\end{aligned}$$

R2: .9909 Durbin-Watson: 1.79
Sample period: 1954:1--1985:4

Definitions:

IM: Imports of goods and services.
N: Population.
Y: Domestic demand.
PIM: Price deflator for imports.
PX: Price deflator for domestic demand.
RMA: After-tax mortgage rate.
...: The equation as estimated also included several dummy variables to account for dock strikes in the United States.

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27. Ray C. Fair, *Specification, Estimation, and Analysis of Macroeconometric Models* (Harvard University Press, 1984).

Possible Labor-Supply Responses

Recent economic research has suggested that the reduced marginal individual income tax rates may significantly increase the desire to work among secondary earners. 28/ This opens the possibility that the Tax Reform Act may stimulate an increase in labor supply and consequently perhaps in GNP.

Such an outcome seems unlikely, however. One reason is that the act does away with the second-earner deduction (marriage penalty relief) that existed previously, which has the effect of increasing marginal tax rates on secondary workers. In any case, it appears that reductions in marginal rates entailed by the Tax Reform Act will be quite small for most taxpayers. There will be large apparent reductions in marginal rates for high-income taxpayers, but these account for a relatively small percentage of the total. The average reductions in marginal tax rates for wage earners (that is, reductions weighted by the percentages of taxpaying wage earners who are affected) are quite small: 2.3 percentage points in 1987 and 3.2 in 1988. 29/

Possible Price Responses

The analysis in this section assumes that the paths of all prices are unaffected by the implementation of the Tax Reform Act. All the demand responses in the modeling exercise below are assumed to give rise to equivalent changes in real output rather than to changes in the price level--an assumption based on the relatively high amount of excess capacity in the economy presently and the relatively small GNP effects of the tax legislation.

Similarly, the various effects of the tax change on the cost of production and consequently on the price level are assumed to offset each other and result in no net effect. On the one hand, the reduction in individual income tax rates might reduce wage demands in collective-bargaining sessions, either directly or through a possible increase in labor supply among secondary workers. On the other hand, an increase in the effective tax rate on capital income might cause corporations to raise the prices of their products in order to try to pass the increase in their costs along to consumers.

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28. Jerry Hausman, "Labor Supply," in Joseph A. Pechman and Henry Aaron, eds., *How Taxes Affect Economic Behavior* (Brookings Institution, 1984).

29. "Preliminary Analyses of Tax Reform Provisions," Congressional Budget Office internal memorandum, September 15, 1986.

Transition Rules

The analysis in this section does not take adequate account of the effects of the "transition rules" involved in the Tax Reform Act. The act contains many special rules providing exceptions for particular industries and areas to the broad terms it sets out. These are too numerous and complicated to be included in the analysis here, but they could significantly increase the overall stimulus from the act by reducing negative impacts on business investment.

THE ECONOMETRIC MODEL

Estimates of the economic effects of the Tax Reform Act are made by treating the eight behavioral equations described above (together with a number of identities that are shown in the appendix) as a small simultaneous econometric model. The model was used to compute changes in GNP and its components, as well as in the interest rate, during the 1986-1988 period. In the tables below, these are expressed as percentages of "baseline" GNP--GNP as forecasted by CBO in the fall of 1986.

These equations were used instead of an established econometric model for several reasons. One is that these equations were developed taking tax factors more carefully into account than is typically true with larger models. Another reason was that each of the three alternative investment models that were used in forecasting could easily be embedded in the simple model constructed here, while with larger econometric models this would have been more difficult. Many analysts, in any case, mistrust results from large models because they fear that their simulation results are affected by the complexity that necessarily accompanies increases in model size.

There are, of course, drawbacks from using a relatively small model such as the one employed in this section. The most obvious one is that important aspects of the response of the economy to tax reform may be left out.

The Timing of Tax Effects. The repeal of the investment tax credit is assumed to have begun to have its effect on January 1, 1986, in spite of the fact that it was not enacted until late October of that year. This assumption reflects the fact that all versions of tax reform since the House bill passed in late 1985 entailed well-publicized provisions to repeal the investment tax credit effective on January 1, 1986, retroactively if necessary.

Individual income tax rates are cut by the act in two stages: one on January 1, 1987, and the other a year later. Another change in disposable personal income is implied by increases in corporation income tax liabilities that are caused by the act. These changes are assumed to take effect when the underlying tax changes become effective: on January 1, 1986, January 1, 1987, and July 1, 1987.

It is possible that expectations about permanent disposable income changed in response to the tax cut as early as the beginning of 1986 (or perhaps even earlier), when passage of the (widely-publicized) tax bill became highly probable. If this happened, the effects of the act on consumption might have been felt at the same time. In this study, however, it is assumed that expected disposable income changed at the same time that the underlying changes in individual or corporate tax rates were implemented. This assumption is made because most of those receiving tax cuts are relatively low-income households that might not be so sophisticated as to formulate forecasts of disposable income months in advance. In any case, the tax cut for consumers as a whole implied by the act is small enough that the analysis is not effected substantially by changes in assumptions about timing.

Economic Impacts

Tables 4-9 below show estimated impacts of the tax legislation on business investment, housing, consumption, output, and interest rates using three alternative models of business investment. Separate figures are given in Tables 4, 6, and 8 for the direct or "static" effects of the tax change--those that leave interactions among sectors and multiplier effects out of account and in Tables 5, 7, and 9 for the overall effects. Tables 4 and 5 show the direct and overall impacts of the tax change using the accelerator formulation for business investment. Tables 6 and 7 show results from the modified Bischoff putty-clay formulation, and tables 8 and 9 show results from the Hall-Jorgenson putty-putty approach.

The impact on business investment depends heavily on the investment submodel that is chosen. In the accelerator results, the Tax Reform Act has no direct effect; and even in the putty-clay results it is barely perceptible (but concentrated in producers' durable equipment). Even the indirect effects in these models are quite small, but they are positive and growing in magnitude by late 1988 when the calculations end. In the putty-putty figures in Tables 8 and 9, by contrast, the act has a strong negative impact, again concentrated in equipment investment. The depressing effect on investment reaches a peak in early 1987 and diminishes steadily after that.

As all the tables show, the tax cut for individuals has a noticeable effect in stimulating consumption spending for both durable and nondurable goods, especially after the beginning of 1988. There is net stimulus to spending on consumer durables in spite of the fact that the user cost for consumer durables increases with the reductions in individual income tax rates that take effect then: the stimulus from increased disposable income more than offsets the restraining effect of increased user costs. The bill has a depressing effect on residential investment that begins to be felt at the beginning of 1987 when the scaled-back depreciation allowances for commercial housing and reduced individual and corporate income tax rates take effect.

The sharp reduction in GNP in the putty-putty results induces a decline in imports (which decline because they depend on domestic demand, which depends on GNP). This is the only case in all the solutions in which imports are affected noticeably by tax reform.

Overall Effects. The GNP impacts of all these changes taken together are relatively slight except in the putty-putty-based model. In the accelerator and putty-clay models, there is little discernible GNP impact in 1986. In 1987, the negative effects on housing are sufficient to make the overall GNP impact slightly negative. Only in 1988 does a noticeable positive impact on GNP emerge as growth in durable and nondurable consumption finally begins to exceed negative effects in other sectors and lead to a noticeable rise in GNP. This GNP increase is growing in magnitude as the calculations end in the last quarter of 1988.

In the putty-putty-based model, the story is somewhat more pessimistic. The shortfall in business investment caused by the act is so strong in this model as to bring about a significant reduction in GNP relative to the baseline during 1986, 1987, and early 1988. The shortfall peaks at just over 1 percent of baseline GNP in the third quarter of 1987. The reduction in investment dies out rapidly late in 1988, however. This should make it possible for the sustained increases in durable and nondurable consumption to increase GNP after the forecast period; in fact the overall GNP effect is growing and just turning positive at the end of 1988.

Interest Rates and Monetary Policy. Interest rates are affected only slightly in the accelerator- and putty-clay-based models: they are bid upward by about a tenth of a percentage point late in 1988 by the positive GNP impacts that emerge then. In the putty-putty-based model, by contrast, rates are pulled downward by the GNP reductions by as much as two-tenths of a percentage point during 1987.

The figures above were calculated assuming that Federal Reserve policy is to keep the path of M2 at its previously announced targets after implementation of the Tax Reform Act. If the central bank were instead assumed to allow M2 to grow more strongly, interest rates in this model would rise less or would fall, GNP would grow more, and business investment and housing would fall less or would expand more strongly. The impact of lower interest rates would be concentrated in housing and in business investment in structures rather than in equipment, because the user cost of structures is more sensitive to changes in the interest rate.

TABLE 4. ESTIMATED DIRECT SPENDING IMPACTS OF TAX REFORM USING ACCELERATOR INVESTMENT EQUATIONS (In percent of baseline real GNP unless otherwise noted)

Quarter	GNP	Int [a]	Cons	Cars	OCD	Hous	PDE	NRST	Imp
1986:1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987:1	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	0.0	0.0
1987:2	0.0	0.0	0.1	0.0	0.0	-0.2	0.0	0.0	0.0
1987:3	-0.1	0.0	0.1	0.0	0.0	-0.4	0.0	0.0	0.0
1987:4	-0.2	0.0	0.1	0.0	0.0	-0.4	0.0	0.0	0.0
1988:1	0.1	0.0	0.4	0.1	0.1	-0.5	0.0	0.0	0.0
1988:2	0.1	0.0	0.4	0.1	0.1	-0.5	0.0	0.0	0.0
1988:3	0.1	0.0	0.4	0.1	0.1	-0.5	0.0	0.0	0.0
1988:4	0.1	0.0	0.4	0.1	0 1	-0.5	0.0	0.0	0.0

a. Percentage points.

Details may not add to totals because of rounding.

"GNP" is gross national product.
"Int" is the interest rate (91-day Treasury bill rate).
"Cons" is spending for nondurable consumption.
"Cars" is consumer spending for automobiles and parts.
"OCD" is consumer spending for durable goods other than autos and parts.
"Hous" is residential investment.
"PDE" is investment in producers' durable equipment.
"NRST" is investment in nonresidential structures.
"Imp" is imports of goods and services.

TABLE 5. ESTIMATED OVERALL ECONOMIC IMPACTS OF TAX REFORM USING ACCELERATOR INVESTMENT EQUATIONS (In percent of baseline real GNP unless otherwise noted)

Quarter	GNP	Int [a]	Cons	Cars	OCD	Hous	PDE	NRST	Imp
1986:1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987:1	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	0.0	0.0
1987:2	0.0	0.0	0.1	0.0	0.0	-0.2	0.0	0.0	0.0
1987:3	-0.1	0.0	0.1	0.0	0.0	-0.3	0.0	0.0	0.0
1987:4	-0.2	0.0	0.1	0.0	0.0	-0.4	0.0	0.0	0.0
1988:1	0.2	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:2	0.3	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:3	0.3	0.1	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:4	0.3	0.1	0.4	0.1	0.1	-0.4	0.1	0.0	0.0

a. Percentage points.

Details may not add to totals because of rounding.

"GNP" is gross national product.
"Int" is the interest rate (91-day Treasury bill rate).
"Cons" is spending for nondurable consumption.
"Cars" is consumer spending for automobiles and parts.
"OCD" is consumer spending for durable goods other than autos and parts.
"Hous" is residential investment.
"PDE" is investment in producers' durable equipment.
"NRST" is investment in nonresidential structures.
"Imp" is imports of goods and services.

TABLE 6. ESTIMATED DIRECT ECONOMIC IMPACTS OF TAX REFORM USING PUTTY-CLAY INVESTMENT EQUATIONS (In percent of baseline real GNP unless otherwise noted)

Quarter	GNP	Int [a]	Cons	Cars	OCD	Hous	PDE	NRST	Imp
1986:1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987:1	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	0.0	0.0
1987:2	0.0	0.0	0.1	0.0	0.0	-0.2	0.0	0.0	0.0
1987:3	-0.2	0.0	0.1	0.0	0.0	-0.4	0.0	0.0	0.0
1987:4	-0.2	0.0	0.1	0.0	0.0	-0.4	0.0	0.0	0.0
1988:1	0.1	0.0	0.4	0.1	0.1	-0.5	0.0	0.0	0.0
1988:2	0.1	0.0	0.4	0.1	0.1	-0.5	0.0	0.0	0.0
1988:3	0.1	0.0	0.4	0.1	0.1	-0.5	0.0	0.0	0.0
1988:4	0.1	0.0	0.4	0.1	0.1	-0.5	0.0	0.0	0.0

a. Percentage points.

Details may not add to totals because of rounding.

"GNP" is gross national product.
"Int" is the interest rate (91-day Treasury bill rate).
"Cons" is spending for nondurable consumption.
"Cars" is consumer spending for automobiles and parts.
"OCD" is consumer spending for durable goods other than autos and parts.
"Hous" is residential investment.
"PDE" is investment in producers' durable equipment.
"NRST" is investment in nonresidential structures.
"Imp" is imports of goods and services.

TABLE 7. ESTIMATED OVERALL ECONOMIC IMPACTS OF TAX REFORM USING PUTTY-CLAY INVESTMENT EQUATIONS (In percent of baseline real GNP unless otherwise noted)

Quarter	GNP	Int [a]	Cons	Cars	OCD	Hous	PDE	NRST	Imp
1986:1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986:4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987:1	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	0.0	0.0
1987:2	0.0	0.0	0.1	0.0	0.0	-0.2	0.0	0.0	0.0
1987:3	-0.1	0.0	0.1	0.0	0.0	-0.3	0.0	0.0	0.0
1988:1	0.2	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:2	0.2	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:3	0.2	0.0	0.4	0.1	0.1	-0.4	0.0	0.0	0.0
1988:4	0.2	0.0	0.4	0.1	0.1	-0.3	0.1	0.0	0.0

a. Percentage points.

Details may not add to totals because of rounding.

"GNP" is gross national product.
"Int" is the interest rate (91-day Treasury bill rate).
"Cons" is spending for nondurable consumption.
"Cars" is consumer spending for automobiles and parts.
"OCD" is consumer spending for durable goods other than autos and parts.
"Hous" is residential investment.
"PDE" is investment in producers' durable equipment.
"NRST" is investment in nonresidential structures.
"Imp" is imports of goods and services.

TABLE 8. ESTIMATED DIRECT ECONOMIC IMPACTS OF TAX REFORM USING PUTTY-PUTTY INVESTMENT EQUATIONS (In percent of baseline real GNP unless otherwise noted)

Quarter	GNP	Int a/	Cons	Cars	OCD	Hous	PDE	NRST	Imp
1986:1	-0.2	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
1986:2	-0.6	0.0	0.0	0.0	0.0	0.0	-0.6	0.0	0.0
1986:3	-0.9	0.0	0.0	0.0	0.0	0.0	-0.9	0.0	0.0
1986:4	-1.0	0.0	0.0	0.0	0.0	0.0	-1.1	0.0	0.0
1987:1	-0.9	0.0	0.1	0.0	0.0	-0.1	-1.2	0.0	0.0
1987:2	-1.1	0.0	0.1	0.0	0.0	-0.2	-1.3	0.0	0.0
1987:3	-1.2	0.0	0.1	0.0	0.0	-0.3	-1.2	0.0	0.0
1987:4	-1.2	0.0	0.1	0.0	0.0	-0.4	-1.1	0.0	0.0
1988:1	-0.7	0.0	0.4	0.1	0.1	-0.4	-1.0	0.0	0.0
1988:2	-0.5	0.0	0.4	0.1	0.1	-0.5	-0.8	0.0	0.0
1988:3	-0.4	0.0	0.4	0.1	0.1	-0.5	-0.6	0.0	0.0
1988:4	-0.2	0.0	0.4	0.1	0.1	-0.5	-0.4	0.0	0.0

a. Percentage points.

Details may not add to totals because of rounding.

"GNP" is gross national product.
"Int" is the interest rate (91-day Treasury bill rate).
"Cons" is spending for nondurable consumption.
"Cars" is consumer spending for automobiles and parts.
"OCD" is consumer spending for durable goods other than autos and parts.
"Hous" is residential investment.
"PDE" is investment in producers' durable equipment.
"NRST" is investment in nonresidential structures.
"Imp" is imports of goods and services.

TABLE 9. ESTIMATED OVERALL ECONOMIC IMPACTS OF TAX REFORM USING PUTTY-PUTTY INVESTMENT EQUATIONS (In percent of baseline real GNP unless otherwise noted)

Quarter	GNP	Int [a]	Cons	Cars	OCD	Hous	PDE	NRST	Imp
1986:1	-0.2	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
1986:2	-0.6	-0.1	0.0	0.0	0.0	0.0	-0.6	0.0	0.0
1986:3	-0.8	-0.2	0.0	0.0	0.0	0.1	-0.9	0.0	-0.1
1986:4	-0.9	-0.2	0.0	0.0	0.0	0.1	-1.1	0.0	-0.1
1987:1	-0.8	-0.2	0.1	0.0	0.0	0.0	-1.2	0.1	-0.1
1987:2	-0.9	-0.2	0.2	0.0	0.0	-0.1	-1.3	0.1	-0.1
1987:3	-1.1	-0.2	0.2	0.0	0.0	-0.2	-1.1	0.0	-0.1
1987:4	-1.0	-0.2	0.2	0.0	0.0	-0.3	-1.1	0.0	-0.1
1988:1	-0.5	-0.1	0.4	0.1	0.1	-0.3	-1.0	0.0	-0.1
1988:2	-0.3	-0.1	0.4	0.1	0.1	-0.3	-0.8	0.0	-0.1
1988:3	-0.2	0.0	0.4	0.1	0.1	-0.3	-0.6	0.0	-0.1
1988:4	0.0	0.0	0.4	0.1	0.1	-0.3	-0.4	0.0	-0.1

a. Percentage points.

Details may not add to totals because of rounding.

"GNP" is gross national product.
"Int" is the interest rate (91-day Treasury bill rate).
"Cons" is spending for nondurable consumption.
"Cars" is consumer spending for automobiles and parts.
"OCD" is consumer spending for durable goods other than autos and parts.
"Hous" is residential investment.
"PDE" is investment in producers' durable equipment.
"NRST" is investment in nonresidential structures.
"Imp" is imports of goods and services.

SECTION III

LONG-RUN ECONOMIC IMPACTS OF THE TAX REFORM ACT

This section describes some of the ultimate economic effects of the Tax Reform Act and develops estimates of their magnitudes. In particular, the discussion focuses on the promise of the legislation to improve domestic output as a result of better allocation of investment among assets, by increasing the evenness or "neutrality" with which different types of capital are taxed. Greater neutrality, and the associated increases in output, are among the most prominent reasons why many consider that act a significant improvement in tax policy.

This study takes a relatively simple approach to estimating the output gains from tax neutrality--using estimates of the change in effective tax rates on six different types of productive physical capital to see how much of a gain in potential output can be realized from the consequent near-equalization of the productivities of these types of capital. This is done in the context of a neoclassical growth model. It should be borne in mind, however, that other ways in which the Tax Reform Act contributes to neutrality--such as its more nearly equal treatment of different financing instruments, or its effects in redistributing the capital stock among sectors and industries--are left out of this analysis. Some of these have been dealt with in other papers. 30/ Also, the paper takes no account of the fact that the act preserves the relatively low tax rate on owner-occupied housing--an important nonneutrality. For this reason, the figures below may overstate the output gains from reform.

Although they stem from a relatively simple model, and are therefore preliminary, the estimates developed in this paper suggest that the output improvements from improved tax neutrality may be small--perhaps one-tenth to two-tenths of 1 percent of present potential output. At the same time, the results suggest that there could be a reduction in U.S. interest rates on the order of one-tenth of a percentage point.

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30. In particular, see Harvey Galper, Robert Lucke, and Eric Toder, "The Economic Effects of the Tax Reform Act of 1986: Simulations with a General Equilibrium Model," paper presented to the Brookings Tax Conference, October 30-31, 1986.

Among the consequences of a possible reduction in interest rates is that it might reduce the net inflow of capital from other countries. This would have the effect of reducing domestic capital and production in the U.S. relative to what it otherwise would have been while effecting an offsetting increase in net claims on production abroad. This shift might have the effect of reducing the growth of worker productivity and wages, which depend in part on the amount of domestic capital.

THE SIMPLE (LONG-RUN) ECONOMICS OF TAX REFORM

How will the economy be affected in the long run by the changes in taxation implied by the Tax Reform Act? This section uses simple graphs to describe several effects. Attention focuses on the impacts of changes in effective marginal tax rates on income from capital. The act also changes marginal tax rates on labor income but, as the discussion above pointed out, the effects of these changes seem likely to be relatively small.

Effects of an Increase in Overall Capital Income Taxation

The Tax Reform Act causes an increase in the overall effective marginal tax rate on the income from capital, and it makes the effective marginal rates on different types of capital, such as equipment and structures, more nearly equal. This is shown in estimates of effective marginal rates before and after implementation of the law, such as those in Table 10.

Interest-Rate and Capital-Allocation Effects

Simple analysis suggests that an increase in the overall effective marginal rate of capital income taxation such as that implied by the Tax Reform Act is likely to lead to a reduction in real interest rates. This is illustrated in Figure 5. The curve marked D is the demand curve for capital (which is the before-tax marginal product function, net of depreciation) graphed as a function of the capital/labor ratio. The supply of capital from saving is shown as the curve marked S, assumed to be an increasing function of the interest rate. The intersection of curves S and D determines the quantity of capital put in place, K_0, and the interest rate, r_0.

The effects of imposition of capital income taxation can be represented as a downward shift in the demand for capital, to curve D1 (the after-tax net marginal product of capital). The proportional distance between corresponding net marginal product curves before and after tax reflects the magnitude of the effective tax rate. This shift causes, as a partial effect, a reduction in the interest rate to r_1, and in the capital stock to K_1. The rate reduction will be larger and the capital stock reduction smaller, the more insensitive is saving to the interest rate.

More Than One Type of Capital

The analysis becomes more complex when there is more than one type of capital--for example, equipment and structures--and, correspondingly, more than one effective tax rate. This case is presented in Figure 6, which shows the determination of the interest rate and the allocation of capital in a world in which there are two types of capital. In this discussion it will be assumed for simplicity that the supply of saving is insensitive to the interest rate. The fixed total stock of capital, which is represented by the distance of the saving-supply curve from the vertical axis in Figure 5, is instead represented as the width of the graph in Figure 6.

TABLE 10. ESTIMATED EFFECTIVE TAX RATES AND ECONOMIC DEPRECIATION RATES ON DIFFERENT TYPES OF CORPORATE CAPITAL BEFORE AND AFTER IMPLEMENTATION OF THE TAX REFORM ACT (In percent)

	Effective Tax Rates		Depreciation
	Old Law	Tax Reform	Rates
Equipment	4.5	37.3	14.1
Structures	41.7	44.2	3.4
Public Utilities	32.7	43.8	3.0
Inventories	47.7	43.4	3.0 a/
Land	49.6	45.4	0.0

SOURCE: Yolanda Henderson, "Lessons from Federal Reform of Business Taxes," *New England Economic Review* (November/December 1986), p. 16.

a. Henderson uses a depreciation rate of 0.0 for inventories, in contrast to the value shown here. A higher value was assumed in this study to take account of the possibility that inventories are subject to obsolescence over time.

Figure 5.

Effects of Capital Income Tax in Closed Economy with One Asset

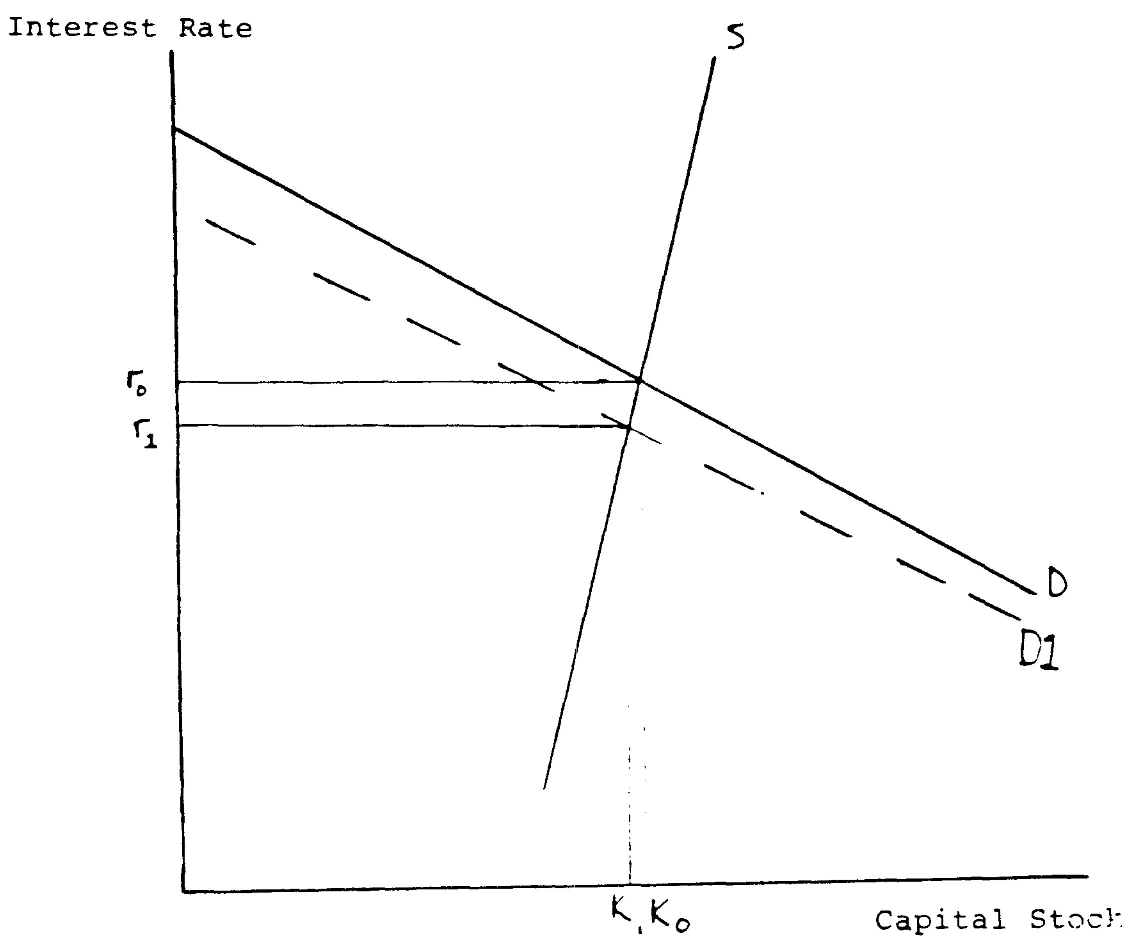
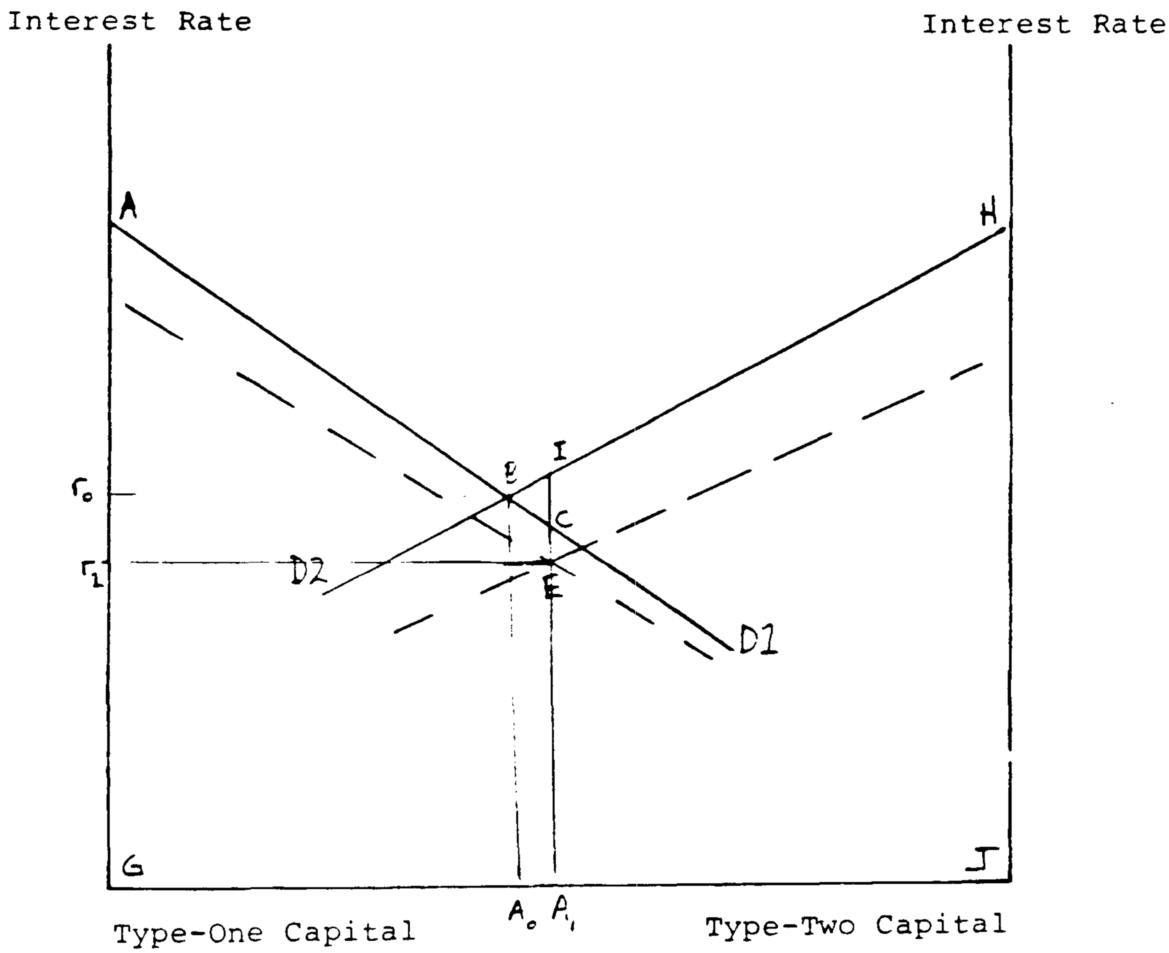


Figure 6.

Effects of Nonneutral Capital Income Taxes in Closed Economy with Two Assets



The demand curve for capital of type 1 is shown as the curve marked D1, with the quantity of that type of capital increasing from left to right. The demand for type-2 capital, the quantity of which increases from right to left, is shown by curve D2. The total available stock of saving must be invested in one or the other type of capital. If there are no taxes, this means that the allocation, A_0, occurs where the two demand curves intersect. The interest rate, r_0, is given by the ordinate of this intersection.

When there are taxes on the income from the two types of capital, they are reflected, as in Figure 5, by separate lines lying below the two capital-demand curves, representing the after-tax net marginal products of the two types of capital. The new interest rate r_1 and allocation of the capital stock, A_1, are determined by the intersection of the two lower after-tax marginal product curves--point E in the graph. As Figure 6 suggests, higher capital income-tax rates are likely to reduce the interest rate, just as in the one-asset case.

If saving contracts with lower interest rates, one can imagine the width of the whole graph in Figure 6 contracting after the tax change and the interest-rate decline that it brings about. The contraction, however, forces the two after-tax net marginal product curves to intersect at a higher level--that is, at a higher interest rate. In the case of an infinitely elastic saving function, the interest rate will be restored by this process to its initial level. An infinitely elastic supply of capital from abroad, in particular, is one of the defining conditions of a "small" open economy. Neither the supply of private domestic saving nor of capital from abroad is likely to be highly elastic in the U.S. case, however, so that the interest rate is likely to fall somewhat as a result of tax reform.

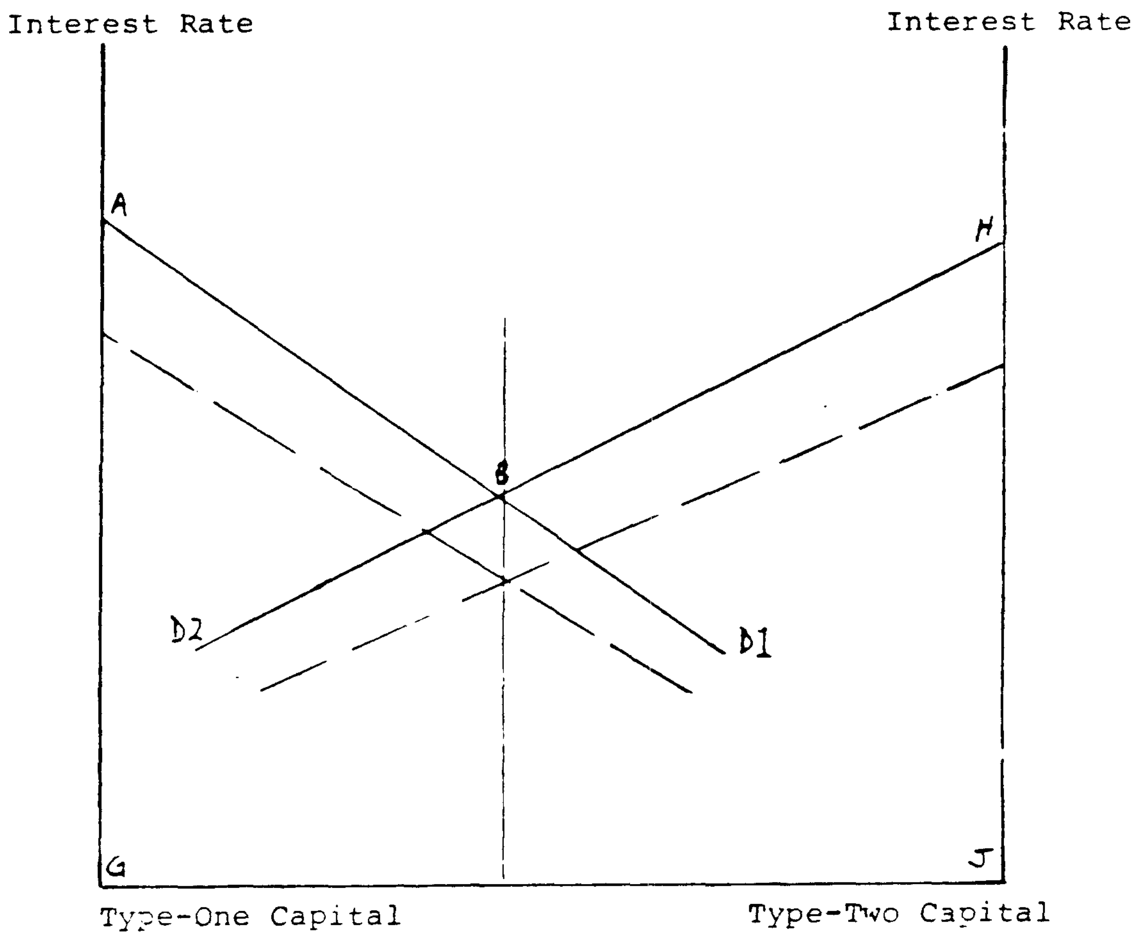
Efficiency Aspects

It is easy to demonstrate, using a graph like that in Figure 6, that a change in effective tax rates on different types of capital which makes these tax rates more equal leads to an increase in the total output produced by the two types of capital together--assuming that the tax change does not bring with it a change in the total amount of capital. This is shown by Figure 7 in comparison to Figure 6. Tax rates in the latter are quite unequal while in the former they are equal. Total output in the former case is the area ACIHJG while in the latter it is ABHJG. This is greater than ACIHJG by the area of the triangle BIC.

This demonstration is quite general, and it shows the virtues of a "neutral" tax code--that is, one that subjects different assets to equal effective tax rates. Equal effective rates mean that the two after-tax net

Figure 7.

Effects of Neutral Capital Income Taxes in Closed Economy with Two Assets



marginal product of capital curves intersect exactly below the intersection of the before-tax curves. This in turn results in an allocation of capital between the two types that equalizes net marginal products of capital before taxes--the point at which total before-tax production is maximized.

Open-Economy Aspects

Changes in the U.S. interest rate caused by the tax change may stimulate flows of saving into or out of the country. If the interest rate falls, capital may flow out. These possibilities are illustrated in Figure 8. Like Figure 5, Figure 8 assumes a single asset; as before, curve S is the supply of capital from domestic saving and curve D is the after-tax marginal product of capital located in the United States. The initial interest rate in the rest of the world is r_R. Curve R shows how the net supply of capital to the U.S. from the rest of the world responds to differentials between the U.S. interest rate and r_R; curve S+R is the horizontal sum of S and R. The intersection of S+R and D determines the U.S. interest rate, r_{US0} and domestic capital stock. Although the total domestic capital stock is K_0, only K_{US0} represents wealth to the United States.

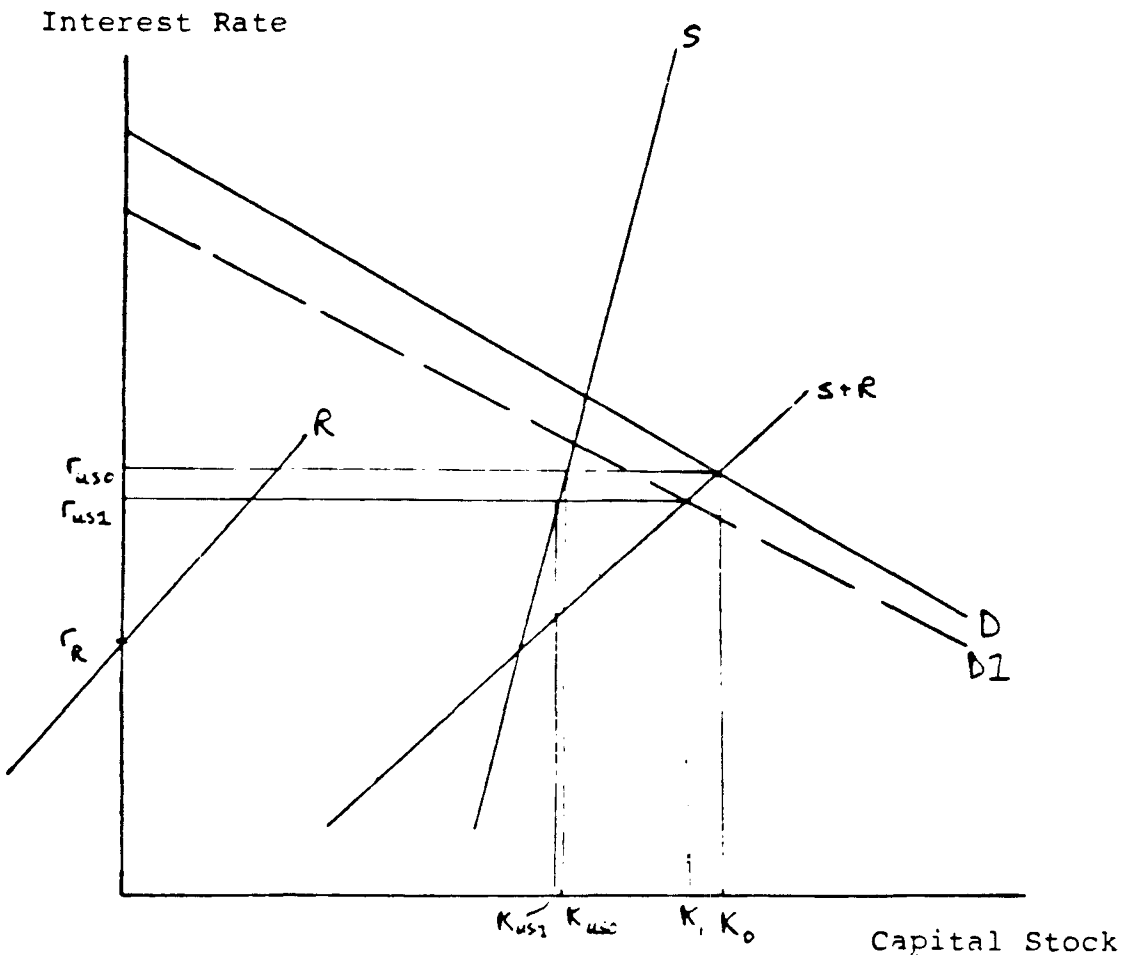
For the case shown, the U.S. interest rate is assumed to lie above the world rate. In conventional "small-economy" models the external supply of capital is assumed to be infinitely elastic with respect to the interest-rate differential for assets of a given degree of risk. In such cases, both R and S+R would be flat, pegging the U.S. interest rate at the world level. Because the country under study is assumed in those models to be small, moreover, this interest-rate level would be invariant to tax changes and other developments in that country. Since the United States is not a small economy, this case is not assumed here.

An increase in capital income taxation in the United States shifts curve D downward to D1. With the elasticities assumed in the figure, this reduces the U.S. interest rate to r_{US1}, reduces U.S. wealth slightly to K_{US1}, and reduces total domestic capital to K_1 by inducing a capital outflow. As the graph suggests, the presence of a relatively interest-elastic supply of saving from the rest of the world means that the decline in the interest rate is likely to be smaller than it is in a closed economy.

One effect of the capital outflow is to reduce domestic product--the output of all capital located in the United States. The decline in U.S. national product--the output of all U.S.-owned capital, or in this case U.S. wealth--is much less, however. This difference mirrors the fact pointed out

Figure 8.

Effects of Capital Income Tax in Large Open Economy with One Asset



above that domestic capital is likely to change more sharply than domestic wealth in response to a development like a domestic tax change. 31/ However, any change in efficiency from more neutral capital income taxation increases both domestic and national product.

Since the United States is large relative to the rest of the world, the capital outflow is potentially big enough to reduce the world interest rate. Part of the process of convergence to a new steady-state economy is a decline in the world rate, helping to reestablish an equilibrium differential. This is not shown in the figure, but it is accounted for in the calculations below by modeling the demand for capital and the determination of interest rates in the rest of the world explicitly.

One reason why the decline in domestic product associated with the net capital outflow may be important is that the underlying reduction in domestic capital may have effects on domestic labor productivity. While the evidence is not conclusive, several studies have suggested that the growth of labor productivity and real wages may depend on the growth of the capital/labor ratio. Both could suffer if an outflow of capital occurs. 32/

HOW BIG ARE THESE EFFECTS?

In order to estimate the magnitude of these effects one needs a long-run economic model. It is customary to use large-scale computable general equilibrium models for this purpose. Fullerton and Henderson, in particular, have provided model results on various economic implications of fundamental tax reform. 33/

31. For a more complete discussion of the effects of saving and investment incentives in an open economy, see Edward M. Gramlich, "Saving, Investment, and the Tax Reform Act of 1986," *Proceedings of the 1986 Annual Meetings of the National Tax Association*, forthcoming, and Joel Slemrod, "International Capital Mobility and the Theory of Capital Income Taxation," paper presented to the Brookings Tax Conference, October 31, 1986.

32. For a detailed discussion of the recent literature on the determinants of productivity growth, see Congressional Budget Office, *The Economic and Budget Outlook: Fiscal Years 1988-1992* (January 1987), pp. 71-108.

33. Don Fullerton, and Yolanda Kondrzycki Henderson, "A Disaggregated Equilibrium Model of the Tax Distortions Among Assets, Sectors, and Industries," National Bureau of Economic Research Working Paper 1905 (April 1986); and Don Fullerton and Yolanda Kondrzycki Henderson, "The Impact of Fundamental Tax Reform on the Allocation of Resources," *American Enterprise Institute Occasional Papers*, Working Paper 8 (April 1986).

This paper takes an alternative approach to long-run modeling--the neoclassical growth model. The chief difference between growth models and the typical general-equilibrium model is that while the former are less sophisticated, they are also more tractable. This makes it easier, for example, to model the reactions of the world economy to developments in this country--an important part of the analysis, as the above discussion has shown. This section presents results from both a closed-economy growth model and a large-open-economy formulation. 34/

The Closed-Economy Approach

This model consists of a production function that relates per-effective-worker gross output to the per-effective-worker stocks of five types of capital; a saving function; a relatively detailed representation of the financial portfolio in which saving can be invested; and equations for the real and nominal interest rates and the price level. The production function is a Cobb-Douglas form that incorporates at least a moderate degree of sensitivity of the stock of each type of capital to changes in its net rate of return.

Saving is added to financial wealth, which is stored in three assets: government-issued (high-powered) money, productive capital, and interest-bearing government debt. Interest-bearing debt and claims to capital are assumed to be perfect substitutes; their after-tax yield is the interest rate in this model. This interest rate is related to the marginal productivities of the different types of capital by their user cost equations.

Federal policy variables exogenous to the model are the primary government budget deficit, the effective tax rates on the income from different types of capital, and the growth rate of the money supply. The growth rate of the labor force and the rate of technical progress are fixed by assumption. The sum of the labor force growth rate and the rate of technical progress is the growth rate of the effective labor force.

This formulation roughly represents the long-run model underlying the putty-putty and putty-clay variants of the short-run model used in the last section. Here, as in the last section, a stylized life-cycle consumption function in which possible interest-elasticity is suppressed, and a Cobb-Douglas production technology, are assumed. The emphasis in this section is

34. The models used here are modified versions of that described in Frederick Ribe, and William Beeman, "The Monetary-Fiscal Mix and Long-Run Growth in an Open Economy," *American Economic Review* (May 1986), pp. 209-212. Somewhat similar approaches can be found in Jeffrey, Sachs, "Energy and Growth under Flexible Exchange Rates: A Simulation Study," in J.S. Bhandari and B.H. Putnam, eds., *Economic Interdependence and Flexible Exchange Rates* (Cambridge: MIT Press, 1984), pp. 191-220, and David Lipton, and Jeffrey Sachs, "Accumulation and Growth in a Two-Country Model," *Journal of International Economics*, vol. 15, pp. 135-159.

entirely different, however, in that it is placed on changes in stocks of capital and the output that they yield. These are long-run issues by definition, and hence were absent in the short-run discussion above.

The Formal Closed-Economy Model

All dollar-denominated variables are expressed here in real terms per unit of technical-progress-augmented labor, unless otherwise noted. The production function is

$$(1) \qquad y_t = b\, k1_t^{\,a1} k2_t^{\,a2} k3_t^{\,a3} k4_t^{\,a4} k5_t^{\,a5},$$

where y_t is output and $k1_t ... k5_t$ are the stocks of capital of kinds 1 through 5 in period t. The ai and b are parameters.

Claims to the five types of capital are perfect substitutes for each other and for interest-bearing government debt, d_t. Together they are referred to as "securities," s_t:

$$(2) \qquad k1_t + k2_t + k3_t + k4_t + k5_t + d_t = s_t.$$

It is assumed that the marginal product of each type of capital, gross of taxes, is equal to its gross user cost, which reflects the level of taxation:

$$(3)\text{-}(7) \qquad MPk_{it} = (r_t + dep_i)H_{it}, \ \ i = 1,2...5.$$

Here, r_t is the real interest rate, dep_i is the economic depreciation rate of capital of type i, and H_i is the factor by which the user cost for type-i capital is related to the sum of the real interest rate and the economic depreciation rate. A common user-cost expression, only slightly modified from that first put forward by Hall and Jorgenson, 35/ is

$$(8) \qquad uc = (r + dep)\, q\, (1\text{-}k\text{-}uz\text{-}un).$$

Here, q is the relative price of the asset in question, k is the effective investment tax credit rate, u is the statutory marginal tax rate on capital income, z is the present value of depreciation deductions, and n is the present value of interest deductions. Thus,

$$H = q(1\text{-}k\text{-}uz\text{-}un).$$

35. Hall and Jorgenson, op. cit.

The H_i are positively related by simple formulas to the effective tax rates (net of depreciation) on income from capital of different types as estimated by Henderson:

(9) $t_{eff} = [uc-(r+dep)]/(uc-dep).$

Substituting (8) for c in (9) shows that t_{eff} can be expressed as

(10) $t_{eff} = (r+dep)(H-1)/[rH+dep(H-1)].$

Using (10), the relationship between t_{eff} and H can easily be shown to be unambiguously positive.

Financial wealth is given by last period's wealth plus interest earnings plus new saving:

(11) $w_t = w_{t-1}\,[(1+r_t)/(1 + G_t)] + y_t - c_t,$

where G_t is the nominal growth rate (the sum of the rate of technical progress and the growth rates of the labor force and the price level), and c_t is consumption.

Consumption is given by a stylized function of human and financial wealth:

(12) $c_t = m_1\,y_t + m_2\,w_{t-1}.$

Human wealth is assumed to be proportional to the labor share of national income, which in turn is proportional, given the constant-share Cobb-Douglas production function, to output itself. The parameter m_1 reflects both the (constant) labor share of output and the (constant) propensity to consume out of human wealth.

Wealth is held in a portfolio consisting of outside money, m_t, and securities, s_t, as defined above. The allocation of wealth among these assets is given by:

(13) $m_t/w_t = o_{11} + o_{12}\,i_t$

(14) $s_t/w_t = o_{21} + o_{22}\,i_t,$

where, following straightforward Brainard-Tobin principles, $o_{11} + o_{21} = 1$, $o_{12} + o_{22} = 0$. i_t is the nominal interest rate, whose determination is described below. 36/ In the simulations, (13) is rearranged by first substituting in the definition for m_t in terms of the aggregate nominal money stock M_t, the augmented labor force N_t, and the price level, p_t:

(15) $m_t = M_t/p_t N_t$.

Once this is done, (13) is solved for the price level:

(13) $p_t = M_t /(o_{11} + o_{12} i_t) w_t N_t$.

The nominal interest rate is derived in two different ways in alternative versions of the model. One uses adaptive expectations of inflation:

(16a) $i_t = r_t + (p_t/p_{t-1})-1$,

and the other uses perfect foresight regarding inflation, involving Fair's iterative three-stage method of solving rational-expectations models: 37/

(16b) $i_t = r_t + (p_{t+1}/p_t)-1$.

It turned out that the properties of the solutions with these two methods did not differ noticeably, so the simpler version (16a) is used in deriving the results used in this study.

The evolution of the stock of interest-bearing government debt is given by the familiar difference equation:

(17) $d_t = d_{t-1} [(1+i_t)/(1+G_t)] + pd_t + m_t - m_{t-1}/(1+G_t)$

where pd_t is the primary budget deficit.

The 14 equations (1)-(7),(11)-(17) determine the 14 endogenous variables (without time subscripts) y, k1, k2, k3, k4, k5, r, c, w, p, s, m, i, and d. The policy variables M, pd, H1, H2, H3, H4, and H5 are exogenous, as is the technical-progress-augmented labor force, N.

36. William Brainard and James Tobin are known for having pointed out these and other restrictions on individual equations in portfolio-allocation models. Such restrictions ensure that the equations are mutually consistent and that, taken together, they allocate precisely 100 percent of financial wealth among different assets. See "Pitfalls in Financial Model Building," *American Economic Review*, vol. 58 (May 1968).

37. Fair, op. cit.

The Open-Economy Model

The demand in each sector for imports of real goods from the other in the open-economy model is given by a simple function of income in the home sector and the real exchange rate. A more important way in which the representation of each of the two sectors in the open-economy model differs from that in the simpler U.S. model is that the portfolio of assets in which savers can invest their funds in either sector includes one more possibility: capital held in the other sector. If the interest rate in the other sector (adjusted for expected exchange-rate changes) rises relative to that in the home sector, wealthholders begin to invest some of their funds there instead of in domestic capital. This expands the stock of productive capital located in the other sector at the expense of that in the home sector. As the discussion below will show, however, the sensitivity of the flow of investment funds between sectors to differences in interest rates in the two sectors is not acute.

The exchange rate is determined by the balance of the demands for dollars and for rest-of-world currency: the dollar appreciates in response to higher net demands for dollars in order to buy either U.S. real goods or U.S.-issued financial assets, and vice-versa.

The Formal Open-Economy Model. Each of the two sectors of the open-economy model, representing the United States and the rest of the world, consists of the 14 equations given above for the closed-economy model with a few additions and replacements described here. First, each sector has a demand equation for imports of goods and services from the other sector:

(18) $$im_t = f\, y_t\, [p^*_t\, e_t/p_t]h$$

where p^*_t is the internal price level in the other sector and e_t is the nominal exchange rate expressed in terms of dollars per unit of foreign currency, f is a parameter, and h is the price elasticity of demand.

No distinction is drawn between traded and nontraded goods, nor between the price of domestically produced goods and the price of a consumption basket. The inaccuracy created by these assumptions is minimized by the fact that imports are assumed to be zero in the initial steady state.

The portfolio equations (13)-(14) in the U.S. model are replaced with:

$$(13^*) \qquad m_t/w_t = q_{11} + q_{12}\, i_t + q_{13}\, [i^*_t + (e_t/e_{t-1}) - 1]$$

$$(14^*) \qquad s_t/w_t = q_{21} + q22\, i_t + q_{23}\, [i^*_t + (e_t/e_{t-1}) - 1]$$

$$(19) \qquad f_t/w_t = q_{31} + q_{32}\, i_t + q_{33}\, [i^*_t + (e_t/e_{t-1}) - 1],$$

where f_t is claims on the capital stock of the other sector, denominated in the currency of the holder of the claim, and i^*_t is the nominal interest rate in the other sector. The Brainard-Tobin adding-up constraints apply to the coefficients q_{ij}.

In view of the potential availability of foreign investment in domestically located capital, equation (2) of the the U.S. model is modified in the open-economy version to

$$(2^*) \qquad k1_t + k2_t + k3_t + k4_t + k5_t = (s_t - d_t) + f^*_t\, e_t\, p^*_t\, N^*_t / p_t\, N_t,$$

where f^*_t, the rest of the world's holdings of U.S. capital, is converted from real per-rest-of-world-augmented-worker units of rest-of-world currency to real per-domestic-augmented-worker domestic currency by the factor e_t p^*_t N^*_t/p_t N_t. The ratio of the augmented labor forces in the two sectors, N^*_t/N_t, is assumed to be a constant and is the means by which the relative absolute scales of the two sectors are accounted for.

The exchange rate is determined in the balance-of-payments identity:

$$(20) \qquad (f_tN_tp_t - f_{t-1}N_{t-1}p_{t-1}) - f_{t-1}N_{t-1}p_{t-1}\, i^*_t + im_t =$$

$$e_t[(f^*_tN^*_tp^*_t - f^*_{t-1}N^*_{t-1}p^*_{t-1}) - f^*_{t-1}N^*_{t-1}p^*_{t-1}\, i_t +$$

$$im^*_t].$$

Imports and claims on each sector by the other are represented here in aggregate nominal rather than per-effective-worker real terms. Once the indicated versions of equations (18) and (19) are substituted for im_t, im^*_t, f_t, and f^*_t, the equation becomes a polynomial of degree $h+2$, where h is the elasticity of import demand with respect to the real exchange rate. To keep the computations tractable, a value of unity is assumed here for h.

The production function in the open-economy model represents the determination of gross domestic product. Gross national product, by contrast, is approximated by:

$$(21) \qquad yn_t = y_t + MPK^*_t\, f_t - MPK_t\, f^*_t\, e_t\, p^*_t\, N^*_t/p_t\, N_t.$$

Here, MPK* is a vector of gross marginal products of capital in the rest-of-world sector, while MPK is the corresponding vector in the United States.

Net domestic product in each sector, yn, is derived from gross product by subtracting depreciation:

(22) $yd_t = y_t - \text{dep}\, k_t,$

where dep is a vector of depreciation rates shown in Table 10 corresponding to the five types of capital in this study. Net national product ynn_t is derived from gross national product in the same way:

(23) $ynn_t = yn_t - \text{dep}\, k_t.$

Calibrating the Models

The parameter values that were used in the simulations are shown in Table 11. To promote comparability of results, parameter values were chosen to match those in closely related models of Gramlich and Tobin. 38/ Unless otherwise noted, the values shown hold for both sectors.

The values q11 ....q33 result from an exercise with the capital-asset pricing model. Annual data for the period 1970-1979 were gathered on the one-year government note yield, consumer price index, and dollar exchange rate of each OECD country. 39/ The interest rates for the non-U.S. countries were adjusted for realized exchange-rate appreciation, and then converted to a composite non-U.S. weighted average using OECD figures on 1982 GDP shares of member countries as weights. 40/ These were in turn converted to real dollar yields by subtracting the rate of consumer-price inflation in the United States. What resulted were estimated real yields on three risky securities: U.S. government notes; a composite of non-U.S. OECD countries' government notes, adjusted for exchange appreciation; and holdings of U.S. government monetary liabilities (whose yield is the negative of the consumer-price inflation rate in the United States).

38. Edward M. Gramlich, "How Bad are the Large Deficits?", in Gregory B. Mills and John L. Palmer, eds., *Federal Budget Policy in the 1980's* (Washington: Urban Insititute, 1984), pp. 43-68; and James Tobin, "The Monetary-Fiscal Mix: Long-Run Implications," *American Economic Review* (May 1986), pp. 213-218.

39. The source of these data was the International Monetary Fund's *International Financial Statistics* (various issues).

40. Organization for Economic Cooperation and Development, *OECD Economic Outlook* (December 1985), pp. 19-20.

TABLE 11. PARAMETER VALUES IN THE GROWTH MODELS

Parameter	Value	Parameter	Value
N*/N	1.500	h	1.000
b	0.690	q11	0.080
m1	0.300	q12	0.000
m2	0.155	q13	0.000
o11	0.060	q21	0.920
o12	-0.020	q22	9.300
o21	0.940	q23	-9.300
o22	-0.020	q31	0.000
f	0.000	q32	-9.300
g	1.000	q33	9.300
a1	0.074	a2	0.037
a3	0.028	a4	0.086
a5	0.025		

NOTES: The values ai were chosen to add up to the 0.26 total capital share output that is used in Gramlich. The shares of this total that are imputed to the different types of capital are taken from Fullerton and Henderson, "The Impact of Fundamental Tax Reform...," Table 8, Column 1. The b value is chosen, as in Gramlich, in order to normalize output in the initial steady state at unity. Values for M1 and M2 were chosen to yield a steady state wealth/income ratio close to that used in Tobin. The oii values were chosen arbitrarily, as were the unit price and income elasticities of import demand. Higher price elastiticities in this context result in an exchange-rate equation that is of a higher order than cubic in the exchange rate, and thus present computational difficulties. The ratio (N*/N), representing the relative sizes of the rest-of-world and U.S. economies, is based on OECD estimates of real output in member countries in 1982.

The covariance matrix of these three yields around their sample means was computed, and the coefficients of the linear demand equations for the three risky assets were derived from this matrix using a value of 2.0 for the Pratt coefficient of relative risk aversion in the algorithm supplied by Friedman and Roley. 41/ The values that emerged from this resulted in computational difficulties because the relatively strong interest-rate responsiveness of the demand for money they implied introduced instability into the price level and inflation rate, and hence into the rest of the model. For this reason, the coefficient values were manipulated, using statistically-derived coefficients just described only for rough guidance.

The unadjusted and final coefficients are shown in Table 12. The most important figures here are the values showing the responses of the demands for domestic interest-bearing assets ("Securities") and for foreign interest-bearing assets ("Foreign Assets") to changes in their own and each other's yields. In general, the coefficient for the response of each demand to a change in its own yield will be a positive number and the coefficient showing its response to the other asset's yield will be negative of at least of roughly the same absolute magnitude. The larger this absolute magnitude--which is to say, the closer it is to being effectively equal to infinity--the closer are the assets to being perfect substitutes.

How closely substitutable these assets appear to be for the U.S. data underlying Table 12 can be taken to reflect how "open" the U.S. economy is with respect to international capital flows. As was pointed out earlier in this paper, a defining characteristic of (small) open economies is that financial assets there and elsewhere in the world (for a given degree of risk) are perfect substitutes.

The results in Table 12 are difficult to judge on inspection as to the degree of substitutability that they imply. Simulation results with these and other hypothetical values, show, however, that they embody a finite, but relatively low, degree of substitutability between assets denominated in different national currencies. Qualitatively, this result is consistent with indirect evidence provided by Feldstein and by Horioka and Feldstein that there is imperfect substitutability in financial portfolios between claims to capital located in different countries. 42/ As the discussion below will point out, the "open" economy model based in part on these coefficient estimates

41. Benjamin Friedman, and V. Vance Roley, "A Note on the Derivation of Linear Homogeneous Asset Demand Functions," National Bureau of Economic Research, Working Paper 345 (May 1979), equation 20.

42. Martin Feldstein, and Charles Horioka, "Domestic Saving and International Capital Flows," *Economic Journal* (June 1980), pp.314-329; and Martin Feldstein, "Domestic Saving and International Capital Movements in the Long Run and the Short Run," *European Economic Review* (1983), pp.129-151. Qualitatively, the portfolio sector of the growth model and the results of disturbing its steady state are quite similar to those in section 5 of Feldstein's paper.

TABLE 12. ESTIMATED PORTFOLIO DEMAND COEFFICIENTS

Variable	Assets: Money	Securities	Foreign Assets
	Unadjusted Values		
Constant	0.132	0.848	0.020
Domestic Real Rate	1.155	7.790	-8.945
Foreign Real Rate	-2.299	-8.945	11.245
Inflation Rate	1.144	1.155	-2.299
	Adjusted Values		
Constant	0.080	0.920	0.000
Domestic Real Rate	0.000	9.300	-9.300
Foreign Real Rate	0.000	-9.300	9.300
Inflation Rate	0.000	0.000	0.000

yields the result in simulations of the Tax Reform Act that the interest rate falls by about 86 percent of the amount by which it falls in closed-economy simulations. This can be taken to imply roughly that the U.S. economy is "86 percent closed," in that the interest rate would not fall at all if this were a (small) completely open economy.

Simulation Results: The Closed Economy. In order to estimate the effects of the change in tax law on the long-run properties of the economy, the closed-economy model was simulated using values of the effective tax rates on business capital both before and after implementation of the Tax Reform Act. These two sets of estimated effective tax rates were taken from Yolanda Henderson and are shown in Table 10. 43/ Henderson's estimates concern corporate capital only; thus the analysis leaves out of account certain other significant parts of the U.S. capital stock--most importantly, owner-occupied housing. Consequently the results in the present paper may significantly overstate the efficiency gains from the tax change, since the Tax Reform Act appears to widen rather than narrow the differential between the tax rates on housing and on other kinds of capital.

43. Henderson, op.cit.

TABLE 13. STEADY-STATE VALUES OF MODEL VARIABLES

Variable	Value	Variable	Value
G	0.056	s	3.552
pd	0.016	d	0.454
H1	1.008	k	3.098
H2	1.303	f	0.000
H3	1.221	k1	0.488
H4	1.415	k2	0.504
H5	1.984	k3	0.434
y	1.000	k4	1.143
e	1.747	k5	0.529
yn	0.872	m	0.309
r	0.025	i	0.056
w	3.961	c	0.792
real growth rate:	0.025	inflation rate:	0.030

Initial domestic, rest-of-world price levels: 1.000

(These values are from the open-economy model. There are minor differences in the corresponding solution for the closed-economy model.)

A baseline steady state was computed using the effective tax rates for prior tax law. The properties of this steady state are shown in Table 13.

A new simulation was then done using the tax-rate estimates for the Tax Reform Act. These values were assumed to be implemented in the second year of the solution. The solution values in the first year are thus the baseline (steady-state) values that would hold continuously if there were no change in the effective tax rates from those in the previous law. The government was assumed to hold the stock of debt constant at its steady-state value through this exercise. All other policy variables are held constant at their baseline values.

The results of this simulation are shown by solid lines in Figures 9 and 10. The reduction in the variation in tax rates on capital income (increase in tax neutrality) causes an immediate increase in net output per effective worker of slightly more than one-tenth of a percentage point. 44/ There is a slight diminution in this level over time, however, and the new steady-

44. This magnitude is perhaps surprisingly small, but it should be borne in mind that other analysts have found similarly small magnitudes when estimating the effects of complete elimination of all tax distortions. See, for example, the two papers by Fullerton and Henderson cited earlier.

Figure 9.

Net Domestic Product in a Closed and an Open Economy

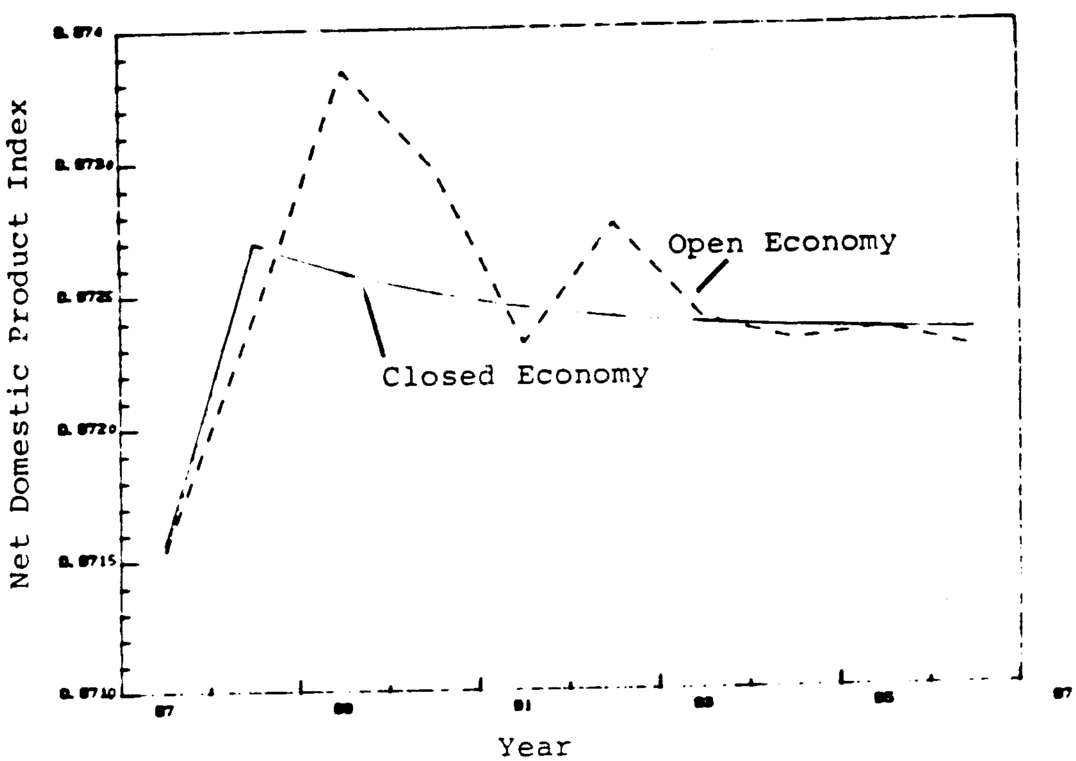
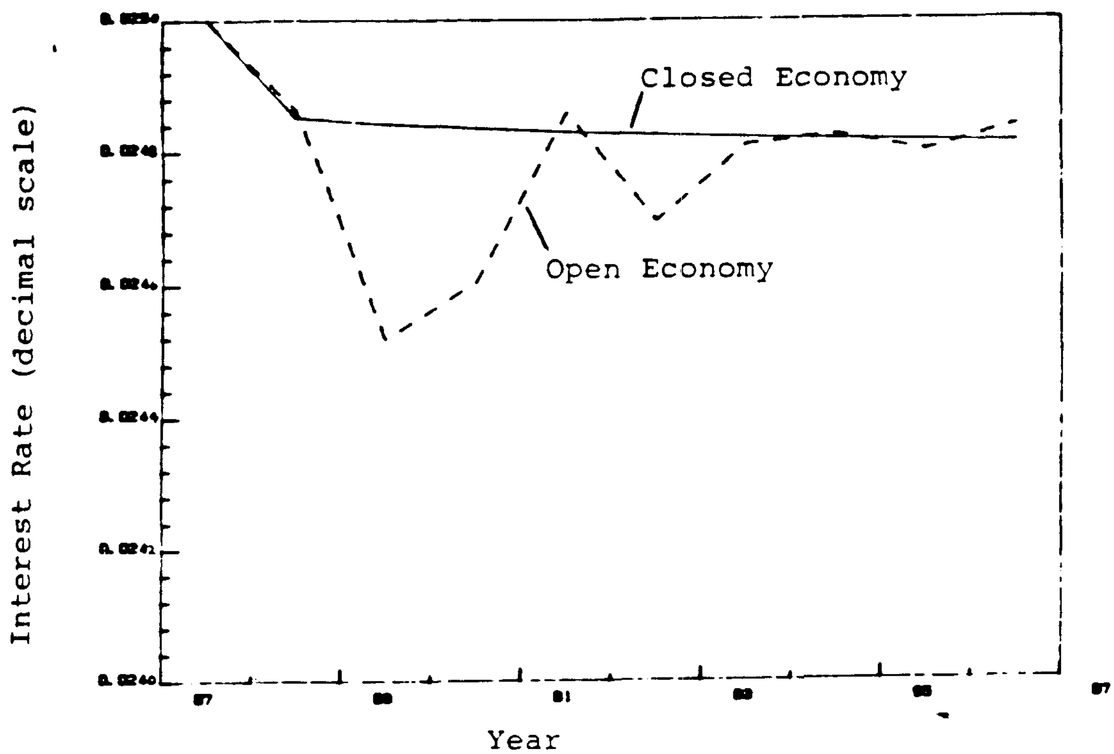


Figure 10.

Real Interest Rates in a Closed and an Open Economy



state level of real output per effective worker appears to be above the old steady-state value by slightly less than 0.1 percent. This diminution after an initial rise is caused by the dynamic adjustment of the aggregate capital stock to the disturbance represented by the increase in capital efficiency. The increase in output and income (from the once-and-for-all increase in capital efficiency) raises the flow of domestic private saving in dollar terms, since saving is a linear function of income, among other variables. The increased saving flow raises the growth rate of the aggregate capital stock, but this increase is only temporary. As the capital stock grows, the increased dollar saving flow becomes smaller and smaller relative to the capital stock--which is to say, the growth rate of capital falls steadily after its initial increase. The decline stops when the growth rate has fallen back to that of the augmented labor force, at which point a new steady state is established. This steady state represents higher levels of income and capital per worker than in the baseline solution. The increase in capital efficiency brought about by the increase in tax neutrality leads to a permanently higher path of income and therefore of private domestic saving, and this in turn leads to a permanently higher path of capital per worker than was true before the tax change.

The real interest rate falls very slightly (by slightly less than two basis points, or 0.02 percentage point).

Stimulation Results: The Open Economy. In order to investigate the role of intersectoral capital flows, the same simulations that are reported above were done in the open-economy version of the growth model. The results are shown with dashed lines in Figures 9 and 10, and in Figure 11.

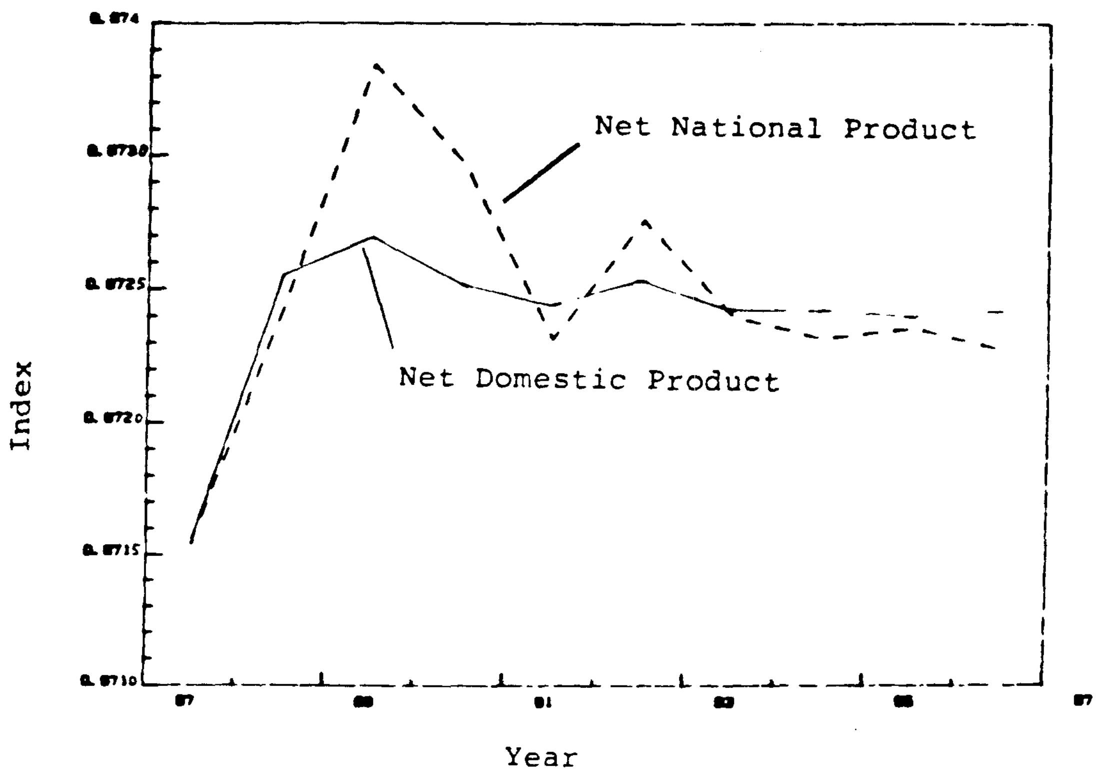
In the open-economy calculations, the tax bill's effect in lowering the U.S. interest rate causes a net capital outflow after some adjustment. This outflow ultimately mitigates the U.S. interest-rate decline, although not by very much; after ten years, the decline in the rate is about 86 percent of the decline in the closed-economy simulation.

In and of itself, the capital outflow causes a small reduction in net domestic product of about 0.01 percent after 10 years. This partly offsets the increase caused by the tax change through its reduction in the differences among tax rates on different types of capital.

In the simulations, the net effect of the capital outflow on national (as opposed to domestic) product is small--about 0.02 percent. This is because the funds that flow out of the country are invested in capital abroad, where they pay a return to U.S. nationals that is quite close to what they paid when invested in assets located within the country. Thus the overall

Figure 11.

Net Domestic Product and Net National Product in an Open Economy



effect of tax reform on national product in the U.S. is a little over one tenth of baseline output (about 0.12 percent). This figure primarily reflects the efficiency gains from more equal tax rates on different capital assets, but also includes a small net contribution from the substitution of capital held abroad for capital held domestically.

As a distributional matter, the increase in national product at the expense of domestic product is likely to be primarily reflected in increased payments to capital owners rather than to workers. That is, the increase in national product is an increase earned by capital, and in particular capital held abroad; the income to which it gives rise will flow to the owners (stockholders and bondholders) of that capital. By contrast, the lower level of domestic product is likely to be reflected primarily in the incomes of workers.

Principal Sources of Uncertainty

The results described here depend on a number of parameters about which only sketchy information is available. The most prominent of these is the elasticity of substitution in financial portfolios among claims to capital located in different countries (that is, valued in different currencies). The estimate underlying the results shown above is derived using data on the correlations among real exchange-adjusted returns on one-year bonds in different countries. While this may represent a good first guess at the needed parameter value, it could be in error. From one point of view, this estimate seems likely to be too high, since it is derived using data for relatively short-term securities: it is likely that investors view short-term securities denominated in different currencies as closer substitutes than they do real assets like corporate capital. From another point of view, however, the elasticity estimate appears too low, because it results in very modest capital-flow responses to international interest-rate differentials.

Private Domestic Saving. The interest rate might fall even less if private domestic saving were more responsive to changes in this rate, as the discussion earlier in this section suggested. To investigate this possibility, alternative calculations were done using the higher degree of saving responsiveness estimated by Boskin. 45/ This change made little difference to the results, in part because the Tax Reform Act introduces a relatively small change in interest rates and in part because the Boskin responsiveness estimate, while larger than many, is still small in absolute

45. Michael J. Boskin, "Taxation, Saving, and the Rate of Interest," *Journal of Political Economy* (April 1978), pp. S3-S27.

terms. The much larger saving elasticities discussed more recently by Summers were not investigated, but they might have made a difference to the results. 46/

The Elasticity of Substitution in Production. The production function assumed in the model incorporates a unit elasticity of substitution among different types of capital. This assumption is commonly used in other studies. Fullerton and Henderson, however, report empirical estimates by various authors of elasticities of substitution between equipment and structures that are higher than unity, and show that higher values would increase the output gain from more neutral taxation. 47/

46. Lawrence Summers, "Capital Taxation and Accumulation in a Life Cycle Growth Model," *American Economic Review* (September 1981), pp. 533-544 (1981a).

47. Fullerton and Henderson, "A Disaggregated Equilibrium Model."

APPENDIX

APPENDIX I

IDENTITIES IN THE SHORT-RUN ECONOMETRIC MODEL

Gross Corporate Product

$$Y = GNP82$$

[the (change in) real gross corporate product is assumed to equal that in real GNP];

User Costs for Business Capital, Housing, Consumer Durables

$$\begin{aligned} cpde &= f(r;....) \\ cnrst &= f(r;....) \\ cho &= f(r;....) \\ chr &= f(r;....) \\ cc &= f(r;....) \\ co &= f(r;....) \end{aligned}$$

[The (changes in) the user costs for producers' durable equipment, nonresidential structures, owner-occupied housing, rental housing, consumer automobiles, and other consumer durables were computed using the CBO rental-price model. This model, which is described elsewhere in the text, incorporates a conventional user-cost formulation. In the model calculations, static impacts on spending were computed by first calculating changes in user costs implied by the Tax Reform Act as regards depreciation deductions, investment tax credit rates, and statutory tax rates; these calculations were based on values from the current CBO baseline forecast for all economic variables entering the user costs, such as relative asset prices, nominal interest rates, the dividend/price ratio, and inflation rates. In the full-model calculations, these static impacts were augmented by computing changes in user costs implied by changes in the nominal Treasury-bill rate from the model solution. All interest rates entering the user cost were assumed to change by this amount. No other economic variables were assumed to change.]

Residential Investment

$$Ir = \exp(QEH \times N)$$

Stocks of Business Capital, Housing, and Consumer Durables

$$Kpde = (1\text{-}dpde)Kpde_{t-1} + Ipde$$

$$Knrst = (1\text{-}dnrst)Knrst_{t-1} + Inrst$$

$$(KH1 + KH5) = ((1\text{-}dh1)KH1 + (1\text{-}dh5)KH5)_{t-1} + Ir$$

$$CSTOCK = (1\text{-}dc)CSTOCK_{t-1} + EC$$

$$OSTOCK = (1\text{-}do)OSTOCK_{t-1} + EO$$

[The real net stocks of producers' durable equipment, nonresidential structures, houses, consumer autos, and other consumer durables were computed using the perpetual-inventory identities given above. The "di" terms are real depreciation rates. In the simulations, only the changes in these stocks from their baseline levels were needed, and not the levels. The change in each stock is computed using a variant of the above equations of the form (delta K) = (delta I) + (1-d)(delta I)$_{t-1}$ + (1-d)2(delta I)$_{t-2}$ + ..., where as many lagged terms were included in a given period as were required to sum over all investment changes back to the beginning of the simulation period.]

Population

$$N = N_{t-1}(1 + g_{1985})$$

[Estimated population is projected forward using its observed 1985 growth-rate.]

Effective Mortgage Rate

$$RMEFF = RTB$$

[Changes from the baseline in the effective mortgage rate were assumed to equal those in the Treasury bill rate.]

Unemployment Rate

$$U = U_{baseline}$$

[Given the relatively small changes in GNP that emerged from the calculations, possible changes in the unemployment rate were neglected.]

Values of Other Asset Stocks

$DBT = DBT_{baseline}$

$ASF = ASF_{baseline}$

$VST = VST_{baseline}$

$VCNF = VCNF_{baseline}$

[Changes from baseline in financial stock values were neglected.]

$VCNR = KH1 + CSTOCK + OSTOCK$

Real GNP

$GNP82 = CON + EC + EO + Ipde + Inrst + Ir - IM$

[The change in real GNP is taken to be the sum of the changes in consumption and investment minus the change in imports.]

Nominal GNP

$GNP = GNP82 \times PGNP_{baseline}$

[The path of the GNP deflator is assumed to be unchanged in the simulations.]

Income Shares

$YL = (YL/GNP)_{1985:4} \times GNP$

$YTR = (YTR/GNP)_{1985:4} \times GNP$

$YPR1 = (YPR1/GNP)_{1985:4} \times GNP$

$YPR2 = (YPR2/GNP)_{1985:4} \times GNP$

[Income shares were assumed to remain constant at their 1985:4 values.]

M2 Opportunity Cost

$$\begin{aligned} OPP &= RTB - (a1_{1985:4} RCB_{1985:4} + a2_{1985:4} RTB) \\ &= RTB (1 - a2_{1985:4}) - a1_{1985:4} RCB_{1985:4}, \end{aligned}$$

where RTB is the 91-day Treasury bill yield, RCB is the yield on commercial bank passbook accounts, a1 is the share of M2 represented by NOW accounts and passbook savings deposits, and a2 is the share of M2 represented by deposits paying roughly market rates. RCB, a1, and a2 are both held fixed at their 1985:4 values during the forecasts.

Treasury Bill Rate

$$RTB = (OPP + a1_{1985:4} RCB_{1985:4}) / (1 - a2_{1985:4}).$$

[Changes in the Treasury bill rate were calculated from changes in the M2 opportunity cost, OPP, which were determined by the model.]