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The remarkable strength of investment spending during the present expansion reflects, in part, the incentives to invest embodied in the 1981 and 1982 tax acts. One way to assess the impact of these incentives is to analyze how the changes in the tax code lowered firms' net cost-of-capital. Using this measure, it appears that, although the 1982 tax act offset some of the incentives of the 1981 tax act, their combined effect was to make several kinds of investment projects much more attractive, because of revised depreciation and investment tax credit rules.

THE LINK BETWEEN SAVINGS & INTEREST RATES: A Key Element in the Tax Policy Debate

Robert H. DeFina

An important goal of tax policy reform is to enhance people's incentives to save. But surveying the literature in economic research for a way to achieve this goal reveals few clear guidelines. The theories explaining the response of saving to changes in the rate of return suggest opposing effects; and the empirical tests of the saving response are just as ambiguous. Until further research clarifies this issue, policymakers should probably proceed with caution in reforming taxes to encourage saving.

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Tax Policy Effects on Investment:
The 1981 and 1982 Tax Acts

*Stephen A. Meyer**

Investment spending by businesses has grown with unusual vigor during the current economic expansion. During the first year-and-one-half of the current expansion, business fixed investment grew at a 17 percent annual rate, almost twice as fast as its average growth during the equivalent period in the six previous recoveries. Yet market interest rates have been high during the past three years, compared to historical experience; high interest rates tend to reduce investment, other factors being equal, by making it more costly for firms to finance investment. Why has investment spending been so strong?

Part of the answer is that changes in business tax laws enacted in 1981 and 1982 increase businesses' incentives to invest, on balance. The net effect of these changes is to lower, on average, the tax-adjusted real financing costs that firms face at any given interest rate. Thus the changes in tax law modify the historical relationship between investment behavior and interest rates by making it more attractive to invest at any given interest rate.

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One of the objectives of the 1981 tax act was to spur investment spending. The 1981 tax act did substantially increase incentives to invest in virtually all kinds of buildings and equipment. The 1982 tax act, however, took back much of the increase. The net effect of the two tax acts is to reduce incentives to invest in certain kinds of projects, while making other projects somewhat more attractive by reducing tax-adjusted real financing costs.

Of course, financing costs—even tax-adjusted real financing costs—are not the only factors affecting firms' investment decisions. Expected future profits from a new investment and the actual cost of the investment also will affect firms' decisions. But the cost of financing investment projects is one important element helping to determine how much investment firms will undertake.

In addition to increasing businesses' incentives to invest, on average, the 1981 and 1982 tax acts also change the relative attractiveness of various kinds of real investment. Even though such changes may be unintentional effects of the new tax laws, the 1981 and 1982 tax acts do help to explain changes in the composition of business investment, as well as its strength, during the current economic recovery.[1]

THE COST-OF-CAPITAL APPROACH

Businesses have undertaken more investment during the past three years than we would have expected on the basis of historical experience, given how high not only market interest rates have been, but also how high real interest rates have been. To get real interest rates, subtract expected inflation from market interest rates.[2] The inflation premium included in market interest rates should not be counted as part of firms' real financing costs, because firms can expect that inflation premium to be offset by rising prices for the goods they produce, on average.

The real interest rate alone does not give us the actual cost of financing an investment project. To get firms' actual financing costs we must also adjust for the effects of tax laws. Adjusting for inflation and also for the effects of tax laws gets us to the *net cost-of-capital*, which we can think of as the tax-adjusted real interest rate faced by a firm which borrows to finance an investment project.

An investment project is worthwhile only if the expected rate of return (net of actual depreciation) from the investment is at least as large as the cost (expressed as a rate) of financing the project. Because interest payments are a deductible expense in calculating taxable profits, and because the firm can benefit from investment tax credits, depreciation allowances, and other provisions of the tax code, the net cost-of-capital for financing the investment project differs from both market and real interest rates. One way of evaluating investment projects is to compare the expected rate of return (net of actual depreciation) on each project, before taxes, with the net cost-of-capital for borrowed funds. If the expected rate of return from an investment project is sufficiently larger than the *net cost of capital* for financing the project to compensate for the risk inherent in undertaking the project, then a firm will want to undertake that investment. A reduction in the net cost-of-capital increases the number of investment projects for which expected return is greater than financing cost, so a cut in the net cost-of-capital provides firms with an incentive to invest more.

The Tax Code and the Cost-of-Capital. The net cost-of-capital is affected by three major parts of the tax code. The *ability to deduct interest payments* as a business expense in calculating taxable income is one. Consider as an example a corporation that borrows money to finance some investment project. Each time the corporation pays out a dollar of interest on that loan, it also reduces its taxable income by one dollar. Because the statutory federal corporate income tax rate is 46 percent, our corporation saves 46 cents in federal corporate income tax when it reduces its taxable income by paying out one dollar of interest. In terms of cash flow, our corporation must pay out 54 cents, net, rather than one dollar,

[1]The 1981 and 1982 tax acts also changed personal income taxes. For a discussion of the economic effects of the *personal* tax changes, see S. A. Meyer, "Tax Cuts: Reality or Illusion?" this *Business Review*, (July-August 1983).

[2]For a discussion of the meaning of real (inflation-adjusted) interest rates, see H. Taylor, "Interest Rates: How Much Does Expected Inflation Matter?" this *Business Review*, (July-August 1982).

to meet its interest obligation. So the ability to deduct interest payments reduces the net cost-of-capital relative to market interest rates.

The *ability to deduct allowable depreciation* (as defined in the tax code) as a business expense is a second part of the tax code that affects the net cost-of-capital. When a firm undertakes some new investment, such as buying and installing a new machine, it also incurs some real costs of depreciation—the new machine must be maintained and eventually it will wear out and need to be replaced. The tax code recognizes that depreciation is a real cost of doing business; the tax code allows firms to subtract a depreciation allowance from gross profits to calculate their taxable income. But the depreciation allowances specified by the tax code rarely equal the *actual* depreciation costs incurred by a firm on its new machines. If the depreciation allowances written into the tax code are larger than actual depreciation incurred by the firm, then the tax code permits the firm to report taxable profits smaller than its actual profits (net of true depreciation) and thereby increases the net cash flows from investment in new machines by reducing cash outlays for tax payments.

To see exactly how much the depreciation allowances specified by the tax code differ from actual depreciation costs over the lifetime of a new investment project, the firm can look at the *net-present-value* (NPV) of depreciation allowances and costs. (NPV is the value today of future receipts or payments. One way to think of NPV is to ask: How much must I deposit in a bank today, earning today's interest rate, in order to be able to make a specified series of future payments?) If the NPV of depreciation allowances specified by the tax code is larger than the NPV of actual depreciation costs over the lifetime of the investment project, then the tax code will reduce the net cost-of-capital. This is so because the extra depreciation allowances reduce the firm's tax liability, which increases the net cash flows from the investment project by the amount that otherwise would have gone to pay taxes. The tax savings effectively reduce the real cost of borrowing to finance the project. On the other hand, if the NPV of depreciation allowances is smaller than the NPV of actual depreciation costs, then the tax code increases the net cost-of-capital for borrowing to invest in such a machine.[3]

The *opportunity to claim an investment tax credit* is the third major part of the tax code that affects the net cost-of-capital. When a firm undertakes some kinds of new investment, the tax code allows it to claim an investment tax credit which immediately reduces the firm's tax liability. So the firm can pay out less cash to the taxman. The reduction in cash outflows generated by the investment tax credit reduces the net cost-of-capital to the firm.

These three major aspects of the tax code—deductions for interest payments, depreciation allowances, and investment tax credits—combine with market interest rates and expected inflation to determine firms' net cost-of-capital for new investment projects. (For technical details on the net cost-of-capital see the APPENDIX: CALCULATING THE NET COST-OF-CAPITAL, p. 12.) The interplay among all these factors typically makes the net cost-of-capital lower than the market interest rate at which a firm can borrow, but the net cost-of-capital may be higher or lower than the real interest rate (the market rate less the expected inflation rate).

Changes in the tax code can raise or lower the net cost-of-capital, even though market interest rates and expected inflation remain unchanged. Because the net cost-of-capital measures firms' cost of borrowing to finance an investment project, changes in the tax code can make investment less or more attractive even with no change in interest rates. In other words, changes in the tax code, especially in the three major aspects of the tax code that we identified earlier, can change the relationship between observed, market interest rates and investment spending.

HOW DID THE 1981 AND 1982 TAX ACTS CHANGE THE COST-OF-CAPITAL?

The 1981 tax act, formally called the Economic Recovery Tax Act of 1981, liberalized two of the

[3]The tax code bases depreciation allowances on the initial, or historical, cost of investment projects. Actual depreciation costs depend on the replacement, or current, cost of comparable machines. So in an economy which is experiencing inflation, it is likely that the NPV of depreciation allowances will be smaller than the NPV of actual depreciation costs, which raises the net cost-of-capital. And the higher the inflation rate, the larger will be the amount by which depreciation allowances understate actual depreciation costs.

three major aspects of the tax code that affect the cost-of-capital—allowable depreciation and investment tax credits. The 1981 tax act shortened the period over which assets can be depreciated, which substantially increased depreciation allowances for the early years of useful life of most types of investment, and thus raised the NPV of tax depreciation allowances. The new depreciation rules let firms which undertake new investment pay less tax than they would have before 1981, at least in the first few years after undertaking the investment. Even though firms may eventually have to pay those taxes, postponing the tax payments is equivalent to obtaining an interest-free loan and thus improves firms' cash flow. Because the new depreciation rules reduce the cash outlays associated with new investment, they reduce the net cost-of-capital.

The 1981 tax act also liberalized the investment tax credit for purchasing new short-lived capital equipment, that with a useful life of less than seven years (under 1980 tax law). Increasing the investment tax credit reduces the net cost-of-capital because it provides new tax savings that reduce the cash outlays required to undertake investments which qualify for the tax credit.

The 1982 tax act, officially named the Tax Equity and Fiscal Responsibility Act of 1982, continued the accelerated depreciation methods enacted in 1981; however, it introduced a new requirement that firms subtract one-half of the investment tax credit available on new investment projects from the cost of such projects, and then calculate allowable depreciation deductions on the remainder. (So a firm would calculate depreciation allowances using 95 percent of the cost of a project which qualifies for a 10 percent investment tax credit, for example.) This new requirement reduces the NPV of depreciation allowances, compared to 1981.[4] So this new requirement raises the net cost-of-capital, compared to 1981 tax law. Neither the 1981 nor 1982 tax acts changed the provisions of the tax code which specify that interest payments are a tax-deductible business expense.

HOW MUCH WAS THE NET COST-OF-CAPITAL CHANGED?

Exactly how much the 1981 and 1982 tax acts changed the cost-of-capital for a particular investment project depends upon the kind of investment being undertaken, and also upon the level of interest rates and expected inflation. But the changes in net cost-of-capital for most kinds of investment *within* a few broad categories that encompass all kinds of investment are quite similar, even though the effects of tax changes differ *across* those categories.

Let us take a coupon interest rate of 13.5 percent and an expected inflation rate of 5 percent as representative of the situation that a firm faces today if it wants to borrow to finance an investment project.[5] Using those rates, one can calculate the net cost-of-capital under 1980 tax law, and under current tax law, as described in the Appendix.

Taking a weighted average of the change in net cost-of-capital for *all* the different kinds of investment undertaken in the U.S. economy shows that the net effect of the 1981 and 1982 tax acts was to reduce the *average* net cost-of-capital by slightly more than one-eighth, from 2.64 percent to 2.29 percent.[6] For other combinations of market interest rates and expected inflation, the reductions in net cost-of-capital may be larger or smaller. But for all combinations of market interest rates between 10 and 16 percent and expected inflation between 4 and 8 percent, the net effect of the 1981 and 1982 tax acts was to

[4]For a more detailed treatment of depreciation allowances on various types of investments, and a description of how the new tax laws change depreciation allowances for each specific kind of investment, see C. R. Hulten and J. W. Robertson, "Corporate Tax Policy and Economic Growth: An Analysis of the 1981 and 1982 Tax Acts," Urban Institute Discussion Paper (December 1982).

[5]In principle, one should choose for each investment an interest rate that measures the cost of borrowing over the lifetime of the project. Thus one normally would use a higher interest rate to calculate the net cost-of-capital for a long-lived project than for a short-lived project. Because market interest rates are now essentially equal for all maturities of three years or more, I have simplified the argument by using one interest rate for all types of investment.

[6]The weights used in calculating this average net cost-of-capital are the shares of each kind of investment (as a fraction of total fixed investment) in the U.S. in 1982. Weights are calculated from data in the July 1983 issue of the *Survey of Current Business* (U.S. Department of Commerce).

reduce the average net cost-of-capital by at least one-tenth.[7]

Breaking down investment into the broad categories used by the U.S. Department of Commerce for the National Income and Product Accounts reveals the degree to which "the 1981 tax law giveth and the 1982 tax law taketh away" (see Table 1). For the two categories covering most construction, the 1981 tax act cut the net cost-of-capital and the 1982 tax act left those cuts virtually untouched. The 1981 tax act cut the net cost-of-capital for *building new plant* (such as factories and commercial buildings) by about one quarter. The cut in the net cost-of-capital results from the larger NPV of depreciation allowances generated by the new accelerated depreciation methods introduced in the 1981 tax act.[8] The 1982 tax act did not change the tax treatment of buildings further. The 1981 tax act also cut the net cost-of-capital associated with borrowing to finance *residential construction*, such as construction of new apartment buildings. The change in depreciation rules for rental housing cut the net cost-of-capital for this kind of investment by roughly one-sixth.

While most kinds of construction activity benefited from large cuts in net cost-of-capital, the tax-adjusted real cost of borrowing to finance investment in the kinds of structures built by utilities did not benefit much from the 1981 and 1982 tax acts, on balance. The net cost-of-capital for this type of investment was barely cut.

Investment in *equipment* benefited from the largest cut in net cost-of-capital under the 1981 tax act, but that cut was largely reversed by the 1982 tax act, on average. The effect of the accelerated depreciation rules and liberalized investment tax credits introduced by the 1981 tax act was to reduce the net cost of capital for investment in equipment by nearly one-half, on average. But the 1982 tax act raised the net cost-of-capital by allowing firms to depreciate less than the full cost of a project that qualifies for an investment tax credit. The net effect of the 1981 and 1982 tax acts was to reduce the net cost-of-

[7] For combinations of market interest rates and expected inflation rates which imply a before-tax real interest rate less than 5 percent, the net cost-of-capital becomes negative, on average, under current tax law. The net effect of the 1981 and 1982 tax acts is still to reduce the net cost-of-capital, on average.

[8] The 1981 tax act also cut the cost-of-capital for *rehabilitating* existing factories and commercial buildings by substantially increasing an investment tax credit (from 10 percent to as much as 25 percent) for rehabilitation expenditures on buildings more than 30 years old. The provisions of the tax code which apply to such projects are so complicated, however, that it is not possible to calculate the change in net cost-of-capital for rehabilitation of existing buildings except on a project-by-project basis. But the net cost-of-capital for financing the rehabilitation portion of such a project (but not the purchase of the old building and its site) was cut by roughly 35 percent, given the rates used in our example.

TABLE 1

NET COST-OF-CAPITAL (%)

Category	Net Cost-of-Capital (%) (Rounded to nearest hundredth) 1980	1981	1982
Buildings	4.58	3.36	3.36
Residential Structures	3.59	2.97	2.97
Utilities and Structures	2.92	2.77	2.83
Equipment	1.55	0.84	1.49

NOTES: (1) The figures in this table were calculated using a coupon interest rate of 13.5 percent and an expected inflation rate of 5 percent, roughly corresponding to market conditions in mid-1984.

(2) The disaggregation shown here corresponds to that given by the U.S. Department of Commerce when it presents detailed National Income and Product Accounts data for the United States in the July issue of *Survey of Current Business* each year.

capital associated with borrowing to finance investment in equipment by one-twentieth from its 1980 level.

A tax-induced reduction in the net cost-of-capital makes it less costly for firms to undertake new investment, at any given interest rate. It follows that the business tax changes enacted in the 1981 and 1982 tax acts are part of the reason why investment spending has been strong even though interest rates seem high by historical standards. Firms have discovered that the real, after-tax, cost of borrowing to finance new investment is much lower than market interest rates, and lower than would have been the case if the tax laws had not been changed since 1980.

DIFFERENTIAL EFFECTS OF THE 1981 AND '82 TAX CHANGES

Looking at the average change in net cost-of-capital due to the 1981 and 1982 tax acts does not tell us all that we would like to know, however. We have already seen that the reduction in net cost-of-capital was larger on average for investment in plant than for investment in equipment. The differences in the tax laws' effect upon the net cost-of-capital for some *specific* kinds of investments is even larger. (For complete details see: NET COST-OF-CAPITAL FOR 35 TYPES OF INVESTMENT PROJECTS.) The two tax acts reduced the net cost-of-capital for some kinds of investment by much more than the average, not at all for some other kinds of investment, and raised the net cost-of-capital for some types. These differences are important because they can affect the composition of new investment in the U.S. economy.

Some Investments Benefited Greatly. The net cost-of-capital associated with borrowing to finance the purchase of *automobiles* for business use was cut by the largest amount. Suppose we continue with our example of a firm which borrows at a coupon interest rate equal to 13.5 percent, and which expects 5 percent inflation each year over the useful life of its investments. Following the steps laid out in the Appendix, such a firm would find that the 1981 and 1982 tax acts reduced the net cost-of-capital for investing in new automobiles by almost one-third on balance. This reduction is more than twice as large as the average cut in the net cost-of-capital; recall that the average net cost-of-capital, averaging over all kinds of investment, was cut by slightly more than one-eighth. The large reduction in net cost-of-capital for *automobiles* stems from changes in the investment tax credit (ITC). For automobiles used in business, the ITC is now 6 percent of the value of the investment, almost twice the 3.3 percent credit allowed under 1980 tax law.

For *ships and boats* used in business, the reduction in net cost-of-capital was almost as large, and still substantially larger than the average cut for all investment. The net cost-of-capital associated with borrowing to finance purchases of ships and boats for business use was cut by more than one-quarter. The net cost-of-capital for financing purchases of *engines and turbines* was also cut substantially more than the average. For this kind of machinery the net cost-of-capital was cut by one-quarter, on balance, by the 1981 and 1982 tax acts (still assuming that the firm borrows at a 13.5 percent market rate and expects continuing 5 percent inflation).

The large reductions in net cost-of-capital for financing purchases of *ships and boats,* and of *engines and turbines,* stem from the new accelerated depreciation rules enacted in 1981. The time period over which these investments can be depreciated was shortened so substantially that the NPV of depreciation allowances is higher under current tax law than under 1980 tax law, even though the firm cannot now depreciate the full cost of such investments.

Finally, investments in new buildings, especially *commercial buildings,* benefited from large reductions in the net cost-of-capital. The new depreciation rules included in the 1981 tax act reduced the net cost-of-capital for this type of building by three-tenths. *Industrial buildings* benefited almost as much; the net cost-of-capital for financing construction of such buildings was cut by one-fifth. The 1982 tax act did not change the net cost-of-capital for buildings further.

Utilities' Structures Benefited Much Less. While some kinds of investments benefited from larger than average reductions in net cost-of-capital, the tax-adjusted real cost of borrowing to finance investment in the kinds of structures built by utilities did not benefit much, if at all, from the 1981 and 1982 tax acts. The net cost-of-capital for financing investment in *telephone and telegraph*

NET COST-OF-CAPITAL FOR 35 TYPES OF INVESTMENT PROJECTS

	Net Cost-of-Capital (%) (Rounded to nearest hundredth)		
	1980	1981	1982
Largest to Smallest Cuts in Net Cost-of-Capital:			
Automobiles	2.04	0.62	1.44
Commercial Buildings	4.58	3.24	3.24
Hospital Buildings	4.47	3.19	3.19
Ships and Boats	2.41	1.39	1.74
Religious Buildings	4.24	3.08	3.08
Educational Buildings	4.24	3.08	3.08
Engines and Turbines	2.30	1.36	1.72
Other Nonfarm Buildings	5.05	3.79	3.79
Industrial Buildings	4.54	3.54	3.54
Other Nonbuilding Facilities	4.18	3.35	3.35
Railroad Equipment	2.16	1.45	1.76
Residential Buildings	3.59	2.97	2.97
Metalworking Machinery	1.87	1.07	1.59
General Industrial Equipment	1.87	1.07	1.59
Electrical and Communications Equipment	1.87	1.10	1.61
Special Industry Machinery	1.89	1.20	1.65
Fabricated Metal Products	1.90	1.27	1.69
Trucks, Buses, and Trailers	1.34	0.20	1.20
Farm Structures	3.52	3.22	3.22
Gas Storage and Distribution Structures	2.51	2.14	2.30
Petroleum Pipelines	2.58	2.18	2.39
Tractors	1.56	0.80	1.47
Instruments	1.61	0.91	1.52
Little or No Change in Net Cost-of-Capital:			
Railroads	2.57	2.41	2.52
Telephone and Telegraph Structures	2.69	2.56	2.72
Electric Light and Power Structures	2.66	2.53	2.68
Mining, Shafts and Wells	3.01	2.92	2.92
Smallest to Largest Increases in Net Cost-of-Capital:			
Agricultural Machinery	1.56	1.24	1.67
Furniture and Fixtures	1.51	1.15	1.63
Other Equipment	1.36	0.91	1.52
Mining and Oil Field Machinery	1.29	0.79	1.47
Service Industry Machinery	1.29	0.79	1.47
Construction Machinery	1.27	0.74	1.45
Aircraft	0.91	0.67	1.41
Office, Computing, and Calculating Machinery	0.43	0.07	1.15

NOTES: (1) The figures in this table were calculated using a coupon interest rate of 13.5 percent and an expected inflation rate of 5 percent, roughly corresponding to market conditions in mid-1984.

(2) The disaggregation shown here corresponds to that given by the U.S. Department of Commerce when it presents detailed National Income and Product Accounts data for the United States in the July issue of *Survey of Current Business* each year.

structures, and in *electric light and power systems* was left unchanged. The net cost-of-capital for financing investment in *railroad structures, gas storage and distribution structures*, and *petroleum pipelines* was cut by the new tax laws, but not appreciably. Compared to 1980 tax law, the 1981 and '82 tax acts cut the net cost-of-capital for such investments less than one-tenth, on balance.

The 1981 tax act shortened the number of years over which utilities are allowed to depreciate most of these investments. Doing so modestly reduced the net cost-of-capital for these investments. The investment tax credit offset enacted in 1982 reduced the size of depreciation allowances for many kinds of investment projects undertaken by utilities, and thus raised the net cost-of-capital. On balance, the net cost-of-capital for most investments undertaken by utilities was not changed appreciably by the new tax laws.

Some Investments Were Adversely Affected. While the new accelerated depreciation schedules introduced in the 1981 tax act substantially reduced the net cost-of-capital for financing investment in all kinds of equipment, the 1982 tax act took back much of the cut. Indeed, the tax-adjusted real cost of financing purchases of some kinds of equipment was raised substantially, after 1982.

For *office, computing and calculating machinery* (the category covering electronic computers, including personal computers), the net cost-of-capital was almost tripled by the new tax laws. The net cost-of-capital for such investments remains lower than for any other type, however.

The large increase in net cost-of-capital for office, computing, and calculating equipment results from the investment tax credit offset built into the 1982 tax act. The 1981 tax act shortens the period over which firms calculate depreciation allowances from 7 years to 4 1/2 years for office, computing, and calculating equipment. But the 1982 tax act, which prevents firms from depreciating the full cost of such equipment, more than reverses those gains.

A similar, although smaller, increase occurred in the net cost-of-capital for financing purchase of aircraft. The net effect of the 1981 and 1982 tax acts was to raise the net cost-of-capital by one-half. (Again, these results are based upon a market interest rate of 13.5 percent and 5 percent expected inflation.) The net cost-of-capital for financing investments in construction machinery, mining and oil field machinery, and service industry machinery also rose as a result of the combined tax changes, by roughly one-seventh. In all of these cases the new investment tax credit offset introduced in 1982 outweighs the depreciation rules introduced in 1981.

Did Tax Changes Affect the Composition of Investment? The fact that the 1981 and 1982 tax acts changed the net cost-of-capital for various kinds of investment by different amounts has implications for the composition of investment during the current economic recovery and expansion. Large cuts in the net cost-of-capital for financing investment in ships and boats, in engines and turbines, in automobiles, and in new commercial buildings, suggest that business firms would have an incentive to undertake larger purchases of those items. In fact, the net cost-of-capital for almost all kinds of buildings was cut substantially by the 1981 and 1982 tax acts. We might expect firms to respond to the reductions in net cost-of-capital by investing more in new buildings, in general. On the other hand, utilities might be reluctant to undertake new construction, because the kinds of structures that they use received almost no cut in the net cost-of-capital.

And the increases in net cost-of-capital for financing purchases of office, computing and calculating machinery, of aircraft, and of some other kinds of machinery suggest that firms will be less likely to undertake investment projects which require purchases of those types of equipment. The net effect of the 1981 and '82 tax acts was to make such investment projects relatively less attractive.

Did the composition of new investment undertaken by firms in the U.S. actually change in the way suggested by changes in the net cost-of-capital? In general, the answer is that changes in the composition of investment do seem to be related to the changes in net cost-of-capital that were generated by the 1981 and 1982 tax acts, but not very closely. Construction of new factories and commercial buildings has grown more rapidly than in previous expansion periods, as suggested by large cuts in the net cost-of-capital for financing such investments. Construction of new buildings and structures grew at a 7 percent annual rate during the first six quarters of this expansion. That rate is about one quarter higher than the average growth rate during comparable periods in six previous recoveries. Utilities have undertaken very little investment during the current economic expansion, consistent with unchanged cost-of-capital for their investment.[9] On the other hand, new investment in equipment, including office equipment and computers, has grown especially strongly during the current economic expansion even though the net cost-of-capital for equipment was cut only slightly, on average. Business investment in equipment in general grew at nearly a 22 percent annual rate during the first year-and-a-half of the current economic expansion. That rate is twice as fast as the average growth rate of equipment investment during the same period in six previous expansions, and faster than during any other expansion since World War II.[10]

The observation that tax-induced changes in the net cost-of-capital for financing investments do not fully explain the changing composition of business investment should not be surprising. Changes in expected future profits from investment projects, and in the actual cost of projects, as well as in tax-adjusted real financing costs, all influence firms' investment decisions. Investment in high-technology equipment, such as computers, illustrates the point. Prices of computers have fallen so dramatically as the number of potential applications has risen, that computers are more attractive investments than they were in 1980. Even though the real, tax-adjusted cost of financing investment in computers was increased by changes in tax law, the expected rate of return from investing in computers has risen even more. While the changes in net cost-of-capital which resulted from the 1981 and 1982 tax acts are not the only reason for the pattern of investment that has occurred in the current economic expansion, they have played a role in determining the composition as well as the strength of new investment.

SUMMARY AND CONCLUSIONS

The net effect of the 1981 and 1982 tax acts was to make new investment more attractive by reducing the net cost-of-capital compared to what it would be under 1980 tax law. The *net cost-of-capital* is a measure of the tax-adjusted real financing cost faced by a firm that borrows to finance an investment project. Furthermore, the 1981 and 1982 changes in business taxes cut the net cost-of-capital for some investment projects more than for others. So these tax acts also changed the relative attractiveness of various kinds of investment projects.

The 1981 tax act made two major changes in business taxes: it increased the net present value of depreciation allowances, as specified by the tax code, for most kinds of new investment; and it increased investment tax credits for some kinds of investment. Both of these changes generate tax savings which reduce the net cost-of-capital. The 1982 tax act introduced a new investment tax credit offset which reduced the net present value of depreciation allowances for many kinds of investment, especially for equipment. The net effect of the changes in business taxes that were enacted in 1981 and 1982 is to reduce the net cost-of-capital for firms which borrow to finance new investment by one-eighth, on average, from what it would be under prior tax law (using an example in which market interest rates are 13.5 percent and inflation is expected to be 5 percent per year over the useful life of the investment project).

Because the net cost-of-capital measures the financing cost (in real terms) faced by firms which borrow to finance an investment project, firms will undertake more investment if the net cost-of-capital is reduced than they would otherwise. By reducing the net cost-of-capital, the 1981 and 1982 tax acts made firms more willing to undertake new investment. And investment projects which benefit from the largest cuts in net cost-of-capital will appear especially attractive. The net cost-of-capital for financing construction of new buildings was cut substantially more than was the net

[9] Sluggish investment by utilities reflects both slower growth of demand for energy, and increased construction costs for utilities' structures. Construction of nuclear power generating stations has been particularly hard hit by these two factors. These factors reduce the expected return on new investment by utilities, and thus make investment less attractive even at a constant net cost-of-capital.

[10] These observations about investment behavior are based on data published by the U.S. Department of Commerce in *Survey of Current Business,* July 1984 and earlier issues.

cost-of-capital for investing in new equipment. But within the equipment category, some types of equipment benefited from large cuts in net cost-of-capital, while other types faced large increases.

Investment has grown exceptionally strongly during the current economic recovery and expansion, considering how high interest rates have been. The strength of investment is explained, in part, by reductions in the net cost-of-capital which resulted from the 1981 and 1982 tax acts. The changes in the composition of investment spending that occurred during the first year-and-a-half of the current economic expansion do not appear to be closely tied to the changes in relative cost-of-capital that were generated by the two tax acts, however. These results indicate that while the business tax changes contained in the 1981 and 1982 tax acts did provide some stimulus to investment, they can explain only part of the unusually strong growth of investment spending during the current economic expansion.

APPENDIX
CALCULATING THE NET COST-OF-CAPITAL

A mathematical expression for the net cost-of-capital is derived from the condition that firms will seek to undertake investment projects as long as the price of the project (including installation and start-up costs) is not greater than the net present value of the after-tax cash flows generated by the project. That is, it will be profitable for a firm to undertake an investment project as long as:

$$q \leqq \sum_{t=0}^{\infty} \frac{(1-\mu)(1-d)^t(1+\pi)^t c+\mu\, qz_t}{[1+i(1-\mu)]^t} + kq \qquad (1)$$

where q is the price of the project today, μ is the statutory corporate income tax rate, d is the actual depreciation rate for the type of investment goods used in this project, π is the expected future inflation rate, c is the value (at today's prices) of the additional income (net of wages and input costs) that the firm will generate in each period by selling the new output produced by the project, i is the market interest rate at which the firm borrows to finance the project, z_t is the depreciation allowance specified by the tax code (per dollar invested) for this type of project for each period t from now into the future, k is the investment tax credit rate that applies to this project, and t rises from period to period to denote the passage of time. Strictly speaking, this expression applies for a firm which is profitable and which pays corporate income tax.

The right-hand-side of this expression is the net present value of the after-tax cash flows generated by this project. In the numerator, the net income generated by the project grows at the inflation rate, π, but simultaneously declines at the actual rate of depreciation, d, as the investment wears out or becomes obsolete over time. The firm gets to keep a fraction, $(1-\mu)$, of the additional profits; the rest is paid out as taxes. The term μqz_t is the tax saving in each period which comes from the depreciation allowances specified by the tax code. The denominator serves to discount future cash flows at the after-tax interest rate the firm pays on its debt. So the summation tells us how much future net cash flows are worth today, which is when the firm must pay for the investment. The remaining term on the right-hand-side, kq, is the immediate tax saving from the investment tax credit.

For our purposes this expression will be more useful if we rearrange it to focus on the relationship between the real rate of return (net of actual depreciation) on the investment and the real net cost-of-capital, including tax factors. By rearranging equation (1), we can see that it will be profitable for a firm to undertake an investment project as long as the real rate of return (net of actual depreciation) is at least as large as the net cost-of-capital:

$$(2) \qquad (c/q)-d \geqq \frac{(1-\mu z-k)}{\sum_{t=0}^{\infty} [(1-\mu)(1-d)^t(1+\pi)^t] / [1+i(1-\mu)]^t} - d$$

where $z = \sum_{t=0}^{\infty} \frac{z_t}{[1+i(1-\mu)]^t}$ is the net present value of the depreciation allowances (per dollar invested) specified by the tax code for each period of the project's life. The right-hand-side of equation (2) is the *net cost-of-capital* for borrowing at rate i to finance the investment project. It shows the tax-adjusted real cost of financing a particular investment project.

To compute the net cost-of-capital for various types of investment projects, it is convenient to make the simplifying assumption that cash flows occur continuously, rather than once per period. With this assumption, and some calculus, equation (2) simplifies to:

$$(3) \qquad (c/q)-d \geqq \frac{i(1-\mu) - \pi + d}{(1-\mu)} (1-\mu z-k) - d$$

where $z = \int_0^{\infty} z_t e^{-i(1-\mu)t} dt$ is the discounted present value of the depreciation allowances specified by the tax code. The right-hand-side of equation (3) is the *net cost-of-capital*. In equation (3), i, π, and d are interpreted as continuously compounded rates.

We can see from equation (3) that higher interest rates, i, increase the net cost-of-capital (if other factors are unchanged). Higher expected inflation, π, on the other hand, reduces the net cost-of-capital. A cut in the corporate income tax rate, μ, will reduce the net cost-of-capital, as will increases in either depreciation allowances, z, or the investment tax credit rate, k.

For the values of net cost-of-capital presented in this article, i, π, and μ are kept the same for all types of investment. The interest rate, i, is set at 13 percent (0.13). This is a continuous rate; it is equivalent to an annual market interest rate of 13.5 percent paid semiannually (as is the case for corporate bonds). The expected future inflation rate, π, is set equal to 5 percent (0.05). The statutory corporate income tax rate, μ, is 46 percent (0.46) under current law; it was the same in 1980. These numerical values were chosen to be roughly representative of market conditions in mid-1984. Investment Tax Credit rates, k, for various kinds of investment are specified in the 1981 tax act.

To calculate the net present value of depreciation allowances, z, one must refer to the relevant sections of the tax code, or to a business tax guide. Prior to passage of the 1981 tax act, the tax code allowed firms to choose among various depreciation procedures for many kinds of investments. The calculations in this paper are based on the assumption that firms chose the most advantageous depreciation rule (i.e., the rule that minimized tax payments) in each year of each asset's lifetime. The depreciation allowances for each year are then discounted at the after-tax nominal interest rate, $i(1-\mu)$, to find the net present value of depreciation allowances, z. Since 1981, the tax code has specified the exact amount of depreciation that a firm may claim per dollar invested, for each general class of investment projects and in each year of a project's life.[a]

Estimates of *actual* depreciation rates, d, for various types of business investment are presented in Charles R. Hulten and Frank C. Wykoff, "The Measurement of Economic Depreciation," in C. R. Hulten (ed.), *Depreciation, Inflation and Taxation of Income from Capital* (Washington, D.C.: The Urban Institute Press, 1981).

[a]For a detailed explanation and description of tax depreciation allowances and discounting, see Don Fullerton and Yolanda Henderson, "Long-Run Effects of the Accelerated Cost Recovery System," Working Paper no. 828, National Bureau of Economic Research.

An example may help to make this discussion clear. Consider the calculations required to arrive at the net cost-of-capital for *trucks, buses, and trailers.* We wish to evaluate the numerical value of the right- hand-side of equation (3). Set $i = 0.13$, $\mu = 0.46$, and $\pi = 0.05$; these are the values assumed in our examples. The actual depreciation rate, d, for this type of equipment is $d = 0.254$, which means that the equipment loses one-fourth of its remaining value with each passing year.

Under 1980 tax law the investment tax credit for this kind of equipment is 6.7 percent because the equipment's useful life was set at five years, so $k = 0.067$. The most advantageous depreciation rule under 1980 tax law (for this kind of equipment) is to use the double-declining-balance depreciation rule initially, with a switch to the sum-of-the-year's-digits depreciation rule when the latter rule yields higher depreciation allowances for the remainder of the equipment's useful life. Taking advantage of the half-year convention written into the tax code, which allows firms to treat all assets as if they were purchased on July 1 (halfway through the year), a firm would have used the double-declining- balance rule for one-and-one-half years, and then switched to the sum-of-the-year's-digits rule for the remaining three-and-a-half years of the investment's useful life. These depreciation rules yield depreciation allowances (per dollar invested) of $z_1 =$ \$0.20 in the first half-year, $z_2 = 0.32$ in the first full taxable year, $z_3 =$ \$0.21, $z_4 =$ \$0.15, and $z_5 =$\$0.09 in each of the next three years, respectively, and $z_6 =$ \$0.03 in the final half-year of the equipment's useful life. With these values for depreciation allowances, the net present value of depreciation allowances, z, turns out to be $z = 0.884$ (assuming that the firm pays taxes quarterly). Plugging all of these values into equation (3) yields the net cost-of-capital under 1980 tax law for *trucks, buses, and trailers,* at a continuous interest rate of $i = 0.13$ (13 percent) and an expected inflation rate of $\pi = 0.05$ (5 percent). The result is:

$$\text{Net Cost-of-Capital} = \frac{.13(1 - .46) - .05 + .254}{(1 - .46)} (1 - .46 \times .884 - .067) - .254$$
$$= .0134 \qquad \text{or } 1.34 \text{ percent}$$

This is the net cost-of-capital for borrowing to finance investment in *trucks, buses, and trailers,* under 1980 tax law (given the assumed interest rate and expected inflation rate).

To calculate the net cost-of-capital for this same equipment under 1984 tax law, we need to update the numbers for the investment tax credit rate, k, and the present value of depreciation allowances, z. The new tax laws adopted in 1981 and 1982 raised the investment tax credit rate for this kind of equipment to 10 percent, so $k = 0.1$ under 1984 tax law. And the new laws also accelerated the allowable depreciation write-offs, so z is higher. Under current tax law the firm must deduct 15 percent of the "basis" of this equipment in the first half-year, 22 percent in the first full year, and 21 percent in each of the next three years. (The "basis" is defined by current law as the purchase price of the equipment, less one-half of the applicable investment tax credit.) Under current law, $z = 0.818$ per dollar invested, for our example in which the before-tax (continuous) interest rate is 13 percent. The net cost-of-capital under current tax law is thus:

$$\text{Net Cost-of-Capital} = \frac{.13(1 - .46) - .05 + .254}{(1 - .46)} (1 - .46 \times .818 - .1) - .254$$
$$= .0120 \qquad \text{or } 1.2 \text{ percent}$$

The net cost-of-capital is lower under current tax law than under 1980 tax law because the investment tax credit is increased, and because the new accelerated depreciation rules increase the net present value of depreciation write-offs allowed by the tax code.

The Link Between Savings and Interest Rates: A Key Element in the Tax Policy Debate

*Robert H. DeFina**

If the "supply-side revolution" in economic thinking did anything, it highlighted the interplay of our fiscal system with people's day-to-day financial decisions. Taxes, subsidies, and tariffs all create incentives that can influence how much a person buys and sells, works and plays. And knowing this, policymakers have become more aware of the consequences that their revenue measures have for individual behavior.

So it is with the amount that people save. As things stand now, several elements of our tax code reduce the rate-of-return that savers earn, the reward for postponing today's spending. Understandably, policymakers are concerned that this government-created reduction in the real (inflation-adjusted) return stacks the deck against thriftiness and thereby stunts the private sector's contribution to the nation's pool of savings.

Saving is, of course, crucial to a growing economy because it makes resources available for the production of physical capital and for the research and development needed to fuel economic growth and enhance our standard of living.

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Coupling this important role of saving with the anxiety of policymakers, it is not surprising that legislators have backed tax reforms aimed at eliminating perceived anti-saving biases in the code. These proposed reforms include sweeping changes, such as substituting taxes on consumption for the present income tax, as well as piecemeal adjustments, such as granting tax-deferred status to certain forms of saving.

Unfortunately, the push to amend the tax structure, while well-intentioned, is curiously premature from an economic perspective. To be sure, the income tax unquestionably reduces the reward to savers, a fact that gives legitimate cause for concern. Nonetheless, available evidence suggests the presumption of a sizable negative saving response to such a reduction in the real return may be unwarranted, however intuitively appealing that key assumption might be.

SAVING AND REAL INTEREST RATES: WHAT DO ECONOMISTS KNOW?

In order to systematize their thinking about what influences saving, economists have developed behavioral models of the "typical" individual. Although these models generally focus on spending behavior, saving behavior is described simultaneously. The reason is that once a person's spending is determined, his saving can be calculated simply as his unspent income. This only reflects the obvious: that spending and saving are opposite sides of the income coin.

The conventional framework used by economists envisions people as long-run, or life-cycle, planners who consider not only today's economic conditions but also expected future conditions when scheduling their spending plans. Moreover, the framework views individuals as free to borrow and lend. An important implication of this freedom is that people's current spending is not constrained by their current income; rather, it is limited only by their lifetime earnings, or "human wealth," as it has been called.[1] Such models essentially argue that individuals prefer a smooth pattern of consumption over their lifetimes, with consumption (c) in each period equal to some proportion (a) of their total wealth (w); that is, $c = aw$.

How does the rate-of-return to saving get into the picture?[2] As it turns out, the rate-of-return is important in the spending/saving decision because it influences both the proportion of one's wealth that a person consumes in the current period and the amount of an individual's lifetime wealth. The rub is that the rate-of-return affects the determinants of spending in offsetting ways. As a result, the net impact on spending due to a change in interest rates is conceptually indeterminate. Appeals have been made to empirical analysis in an attempt to arbitrate this ambiguity; unfortunately, such appeals have been answered with results that buttress several competing views.

Theoretically, Anything Goes. . . In theory, a change in the rate-of-return can influence the fraction of wealth going to today's spending through two channels.[3] The first is by changing the relative financial attractiveness of spending and saving.

One motivation for putting off today's spending is that it yields a reward. That reward takes the form of even greater consumption in some future period: by forgoing a dollar of spending today, a person can enjoy more than a dollar's worth of spending in the future. How big an increment do individuals receive? They receive an amount equal

[1] It may be noted here that people's wealth takes a variety of forms, including stocks, bonds, and property in addition to human wealth. We confine our attention to human wealth for consistency with the conventional framework employed by economists and for ease of exposition. Nonetheless, the basic life-cycle model can be amended to incorporate nonhuman wealth, such as stocks, bonds and property with no substantive implications for the following discussion.

[2] Charles Steindel, "The Determinants of Private Saving," in Jared J. Enzler, ed., *Public Policy and Capital Formation* (Board of Governors of the Federal Reserve System, 1980), pp. 101-114 contains a lucid mathematical exposition of the points discussed here.

[3] Technically, one cannot simply discuss the effect of a change in interest rates on saving without first specifying the way in which the change comes about. The present discussion may be thought of as referring to a change in interest rates arising from a switch from an income tax to a consumption tax, where each tax is set to raise the same amount of revenue. Moreover, the present discussion considers only so-called partial equilibrium effects, excluding the impact of the change on other markets and prices and the subsequent feedback. Lawrence Summers, "Tax Policy, The Rate of Return, and Savings," *National Bureau of Economic Research Working Paper No. 995* (September 1982) provides a useful elaboration of these points.

to the real, after-tax interest rate for each dollar of present consumption they postpone.[4]

In a sense, consumers can be bribed to refrain from indulging in the pleasures of spending today with the promise of even greater spending tomorrow. And, quite naturally, the higher this bribe or reward, the more willing people are to exercise spending restraint. So, from at least one angle, it appears that the tax-induced reduction in the return to saving would increase the fraction of wealth that is spent today. Or, in other words, the lower return means less saving.

The story does not end there, however. Indeed, people have another motivation to save, namely, to accumulate funds to meet payments that would otherwise strain current period income. And in this case, a lower return would spark more, not less saving.

To see why, imagine an individual who, at the beginning of the year, is trying to accumulate $4,600 by the end of year in order to meet a law school tuition payment. Assume that the person already has $4,000 in a bank account and that the after-tax interest rate is 10 percent. Under these circumstances, this individual will hit his target of $4,600 by saving $200. At year-end, he will have the $4,000 he has saved already plus the $400 in interest earned on it ($4,000 x 10%) plus the new saving of $200 which equals $4,600. But suppose the after-tax return falls to 8 percent from 10 percent. Now, if he decides to save $200, this individual will fall short of his target by $80 because his interest income will decline to $320 ($4,000 x 8%) from $400. In order to reach his year-end goal of $4,600 with the lower rate-of-return, then, he must *increase* his new saving to $280 from $200.

Although this discussion relies on a particular example, the conclusion holds in general. Whether they are socking away money for retirement, for their children's education, or for a weekend jaunt to Samoa, "target" savers will respond to a reduction in the rate-of-return by boosting their saving (that is, by decreasing the fraction of lifetime wealth consumed today). In that way, they compensate for any prospective shortfall due to reduced interest earnings on their existing accumulation of saving.

In addition to the two conflicting ways in which interest rate changes affect the proportion of wealth spent in the current period, movements in the real return can alter saving in a third way: by changing the value of wealth available for spending and saving.[5] Earlier, we mentioned that individuals can be thought of as spending a given proportion of their lifetime wealth each period. It follows logically, then, that an increase in wealth due to an interest rate change increases today's spending and, hence, diminishes saving; a decrease in wealth due to an interest rate change has the opposite effect.[6] The question of concern to policymakers that remains is: how does a change in the real return alter the value of wealth?

The answer is unequivocal: an increase in real rates of return diminishes wealth, while a decrease augments it (see HUMAN WEALTH AND INTEREST RATES, p. 18). Consequently, a tax-induced reduction in real rates inflates individuals' wealth, increasing their current period spending and, hence, lowering their saving.

Overall, then, theoretical considerations create a quandary. To recap, a lowering of interest rates influences the amount that people save in three competing ways. Two of these ways, a diminution in the attractiveness of saving relative to spending, and an enhancement of wealth, work to reduce people's saving; the third way, a lowering of the interest earnings of "target" savers, works to boost people's saving. As a result, saving could either rise or fall in response to a drop in real rates, depending on which of the three effects is dominant.

Which effect is, in fact, dominant? No amount of theorizing can determine that. Instead, actual data must be brought to bear on the issue. Unfortu-

[4]For instance, if a person in the 30 percent tax bracket receives a real return of 10 percent on her saving, her after-tax rate of return is 7 percent ((1-.3) x .1 = .07).

[5]This avenue has been neglected in many earlier discussions of the relationship between interest rates and saving. Both Charles Steindel, "The Determinants...," and Lawrence Summers, "Tax Policy...," can be credited with highlighting the importance of this channel.

[6]It is useful at this point to recall that saving plus consumption equals disposable income. If only wealth changes without an associated income change, then the resulting variation in consumption must be offset exactly by variation in saving. Consequently, if wealth rises, causing current period consumption to rise, current period saving will fall, and conversely.

Human Wealth and Interest Rates

People generally have some idea of what their earnings will be during future periods of their life. In measuring human wealth, individuals try to judge how much their future stream of earnings is worth today. That is, each person answers the following question: "Suppose that I stop working today. How large a lump-sum payment must I receive today to ensure that when I reach retirement age I have exactly as much money as I would have had if I had continued working?"

A crucial element in this determination is the level of interest rates. The reason is that the person will be able to invest his lump-sum payment for all the years until retirement age. The lower the prevailing level of interest rates, the greater the lump-sum payment that is required to match the future earnings stream, because the less that interest income will augment the initial lump payment. That is, human wealth and interest rates are inversely related.

An example will help clarify these notions. Suppose that a person lives for two periods. In the first period she earns $100 and in the second period she earns $150. Also, suppose that a 10 percent real return will prevail throughout her working life. Now, presuming that she gets paid at the end of each period and saves all of her earnings, she will have $260 at retirement: the $100 earned in the first period, plus $10 interest income on the $100 invested throughout the second period, plus the $150 earned during the second period equals $260.

What is the human wealth implied by her earning stream? It is the amount that, when invested today for the following two periods at the real return of 10 percent, will yield $260. Calculation reveals this to be $214.88: at the end of the first period, she has $236.36 after investing the $214.88 at 10 percent; by reinvesting the $236.36 at 10 percent during the second period, her investment grows to $260.

Computations similar to those above indicate that the lower the interest rate, the higher the person's wealth. For instance, if the real return in the above example were 5 percent instead of 10 percent, the person's human wealth would be $231.29 instead of $214.88; if the real return were 2 percent, human wealth would be $242.21. Although the focus here is on numerical examples, the essential point will always be true; namely, that human wealth and interest rates are inversely related.

nately, even empirical analysis has yet to provide a clear answer.

. . . **And Empirical Estimates Are Hard To Pin Down.** A number of researchers have used statistical techniques to measure the historical relationship between households' saving and movements in interest rates. A common empirical approach is to implement life-cycle type models of individuals' spending behavior in an attempt to measure the interest elasticity of saving. This elasticity is a summary measure of the responsiveness of saving to interest rate movements, and equals the percentage change in saving due to a 1 percent change in interest rates. For example, if the elasticity is 0.7, this means that for each 1 percent change in interest rates (say, from 5 percent to 5.5 percent), saving would rise by 0.7 of a percent (say, from $53 billion to $53.6 billion). To relate this concept to the earlier theoretical discussion, if the amount saved falls as a result of a rise in interest rates, the measured elasticity will be negative; if the amount saved rises as a result of a rise in interest rates, the measured elasticity will be positive; if the amount saved is unaffected by a rise in interest rates, the measured elasticity will be zero.

The results of these statistical studies have been of only limited use to policymakers. The reason is that nothing resembling a consensus on the interest elasticity has emerged. At one level of the debate, there is disagreement on the qualitative impact on saving of interest rate changes. Although a majority of studies have found that the interest elasticity is positive, implying that a reduction in interest rates lowers saving, a sizable minority find that saving is insensitive to fluctuations in rates (that is, the elasticity is zero). At another level of the debate, there is disagreement even among those studies that find a positive interest elasticity. Some researchers have estimated that the elasticity is 0.03; that is, for every 1 percent fall in interest rates, saving falls by 0.03 percent. Based on the figures for 1983, this implies an inflation- adjusted increase in personal saving of $16 million for each 1 percent rise in interest rates. Others have estimated that the elasticity is in excess of 5.0, well over one hundred times as great. (See THE ELUSIVE INTEREST ELASTICITY OF

SAVING.) So, even if one were to cast one's vote with the majority of studies that argue for a positive elasticity, the magnitude of the elasticity is still very much open to discussion.

In a sense, the disparity in the estimates is not surprising. Any attempt to determine the interest elasticity of saving is fraught with practical and conceptual difficulties. One significant stumbling block is that many of the variables needed to implement models of consumer spending are unobservable. A case in point is the real, after-tax interest rate. Roughly, the real interest rate is equal to a nominal rate, which can be observed, less the inflation expected during the time period to which the rate applies. The problem occurs because inflation expectations cannot be directly observed; rather, they must be approximated from available data. As yet, economists do not agree on the best way of carrying out the approximation. And, the estimates of the interest elasticity vary depending on how the approximation is done. This problem of how best to represent theoretically required variables is not limited to the interest rate; instead, it concerns such variables as human wealth and spending as well.[7]

Compounding the problems caused by data deficiencies are questions about the appropriate empirical specification of the conceptual model. Although theory gives some guide as to the form of the empirical framework, it does leave room for interpretation. For instance, it is up to the researcher's judgement as to what lags in the relationship between variables might reasonably be expected, what is the most suitable time period for the analysis, and to what extent special factors, such as auto strikes and wars, should be accounted for. Different opinions on these issues can lead to

[7]Gerald Carlino and Robert H. DeFina, in "Inflationary Expectations and the Consumer," *Federal Reserve Bank of Philadelphia Working Paper No. 84-1*, survey the different empirical assumptions that have been employed in studies of consumer spending.

The Elusive Interest Elasticity of Saving

Empirical estimates of the interest elasticity of saving—the percentage change in saving associated with a 1 percent change in real rates—vary considerably. The table below summarizes the results of a representative group of empirical studies, giving the author(s) of the study, the date of the study, and the corresponding estimate. For example, Boskin's 1978 study finds that a 1 percent increase in the real rate of return will increase saving 0.4 percent.

Author(s)[a]	Interest Elasticity of Saving
Alan Blinder (1975)	0.03
Michael Boskin (1978)	0.4
Gerald Carlino (1982)	0
Gerald Carlino and Robert DeFina (1983)	0
Thorvaldur Gylfason (1981)	0.3
Dale Heien (1972)	1.8
E. Philip Howrey and Saul Hymans (1978)	0
Charles Steindel (1980)[b]	5.8
Lawrence Summers (1982)[b]	1.3
Lester Taylor (1971)	0.8
Colin Wright (1967)	0.2

[a]Full citations are in the Bibliography.

[b]Both Steindel and Summers present a range of estimates of the interest elasticity of saving. In each of their formulations, the value of the interest elasticity depends both on assumptions about other parameters in the models and on the particular fiscal policy change that precipitates the interest rate change. The estimates listed in the table are chosen because they reflect each author's judgement about likely values for the other parameters in the model and a policy initiative that substitutes a tax on consumption for a tax on capital income while holding tax revenue constant.

different estimates of the interest elasticity of saving.

Needless to say, the equivocal nature of available results when considered as a group diminishes their usefulness to policymakers. But even if there were unanimity on the interest elasticity of saving, or if there were one study that could be accepted with confidence, this would not solve policymakers' problems. The reason is that historically based estimates of the interest elasticity of saving pose special problems when used to draw inferences about the impact of a policy change.[8]

One problem arises from the type of variation in interest rates that is used to infer the interest elasticity. Much of the variation reflected in the data arises from the normal ebb and flow of economic activity. Consequently, any given change in rates is unlikely to persist for an extended period. The continuing shift of economic activity will, instead, evoke further rate changes that either reinforce or dampen previous fluctuations. In contrast, movements in interest rates that result from a tax change are permanent, not transitory, in nature. That is, a tax change moves the net return to savers to a permanently lower or higher level, depending on the direction of the policy adjustment.

Because available evidence depends primarily on the relationship between saving behavior and *transitory* interest rate changes, it is of limited use to policymakers. In essence, the data on which the studies rely are inappropriate and can result in misleading estimates. At least one author has argued that this problem causes an underestimate of the interest elasticity of saving.[9] While the exact nature and significance of the bias may be questioned, this issue at least makes existing findings suspect.

Another difficulty in interpreting previous research results stems from the way in which people's expectations of future economic variables are tied to the fiscal and monetary policies that are in place. In the present context, people's expectations about such things as inflation and future real earnings are important because they influence the amount that individuals save and spend today. The common view among economists is that people's expectations of future economic conditions are rational; that is, their expectations reflect the most efficient usage of all available information. If this is so, then it follows that people's present economic decisions depend on the particular policy structure, or regime, that is currently in place. A person who forms expectations rationally cares about existing monetary and fiscal policies, such as the kinds of taxes that are levied, because they provide clues about the likely future course of economic conditions. This person will, then, use policy information when forecasting variables that influence her behavior.

Why does this limit the usefulness of available studies? The reason is that available statistical analyses are based on observations of people's saving behavior under a given policy regime. So, while estimates of the interest elasticity of saving might be accurate for that regime, they simply may not apply under a new regime because people's behavior is likely to change. In other words, it is not legitimate to infer automatically that people's saving will be just as responsive to interest rate changes after policy actions are taken to increase rates of return as before those actions are taken.[10]

This is a relevant concern in the ongoing debate about saving because suggested solutions to the perceived problem entail changes in the fiscal policy regime. An example is the switch from an income tax to a consumption tax, such as a value-added tax. Statistical techniques to account for this policy-dependence issue are being developed. As yet, however, they have been applied to the interest elasticity question only in a rough-and-ready fashion. Consequently, the associated results are not yet really reliable.

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[8]See, Lawrence Summers, "Tax Policy. . .".

[9]This discussion draws heavily from Lawrence Summers, "Tax Policy. . .".

[10]The general problem of evaluating policy when regimes change, of which this is a special case, was first articulated by Robert E. Lucas, "Econometric Policy Evaluation: A Critique," *The Phillips Curve and Labor Markets,* Carnegie-Rochester Conference Series on Public Policy, Vol. 1, eds. Karl Brunner and Allan H. Meltzer, (Amsterdam: North-Holland Publishing Company), pp. 19-46. For a nontechnical discussion of this issue see Richard W. Lang, "Using Econometric Models to Make Economic Policy: A Continuing Controversy," this *Business Review,* (January/February 1983), pp. 3-10.

CONCLUSION

Whether or not our tax system depresses personal saving is an issue of considerable importance. It is certainly true that the tax system lowers the net return to savers. But from an economic perspective, it is unwarranted to presume that the reduced rate-of-return ultimately reduces saving, however intuitive that presumption might seem. Neither economic theory nor empirical analysis unequivocally support that view.

This is not to say that the issue is resolved in favor of the "no-effect" position. Much work remains to be done in refining our empirical understanding of the situation and in clarifying the ambiguity of available evidence. And until those tasks are completed, policymakers should proceed slowly with costly fiscal reforms. For although there may be other reasonable motivations for wanting to undertake fiscal policy initiatives, our present level of understanding does not lead us to include a perceived bias in the tax code against saving as one of them.

BIBLIOGRAPHY

Interested readers should consult these articles for other studies on the topic.

Blinder, Alan, "Distribution Effects and the Aggregate Consumption Function," *Journal of Political Economy* 83 (June 1975), pp. 447-475.

Boskin, Michael, "Taxation, Saving, and the Rate of Interest," *Journal of Political Economy* 86, part 2, (April 1978), pp. S3-S27.

Carlino, Gerald, "Interest Rate Effects and Intertemporal Consumption," *Journal of Monetary Economics,* (March 1982), pp. 223-234.

Carlino, Gerald and Robert DeFina, "Inflationary Expectations and the Consumer," *Federal Reserve Bank of Philadelphia Working Paper No. 84-1,* (December 1983).

Gylfason, Thorvaldur, "Interest Rates, Inflation, and the Aggregate Consumption Function," *The Review of Economics and Statistics,* 63, (May 1981), pp. 223-245.

Howrey, E. Philip and Saul Hymans, "The Measurement and Determination of Loanable Funds Saving," *Brookings Papers on Economic Activity,* (3, 1978): pp. 655-685.

Heien, Dale, "Demographic Effects and the Multiperiod Consumption Function," *Journal of Political Economy* 80 (January/February 1972), pp. 125-138.

Steindel, Charles, "The Determinants of Private Saving," in Jared J. Enzler, ed., *Public Policy and Capital Formation,* (Board of Governors of the Federal Reserve System, 1980), pp. 101-114.

Summers, Lawrence, "Tax Policy, the Rate of Return, and Savings," *National Bureau of Economic Research Working Paper No. 995* (September 1982).

Taylor, Lester, "Saving Out of Different Types of Income," *Brookings Papers on Economic Activity* (2, 1971), pp. 383-415.

Wright, Colin, "Some Evidence on the Interest Elasticity of Consumption," *American Economic Review* 57 (September 1967), pp. 850-854.

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83-1

UNION-NONUNION WAGE DIFFERENTIALS AND THE FUNCTIONAL DISTRIBUTION OF INCOME: SOME SIMULATION RESULTS FROM A GENERAL EQUILIBRIUM MODEL

Robert H. DeFina

During the past two decades, a number of studies have established the ability of unions to obtain wages for their members that exceed the payment to similar, but nonunionized workers. This article investigates empirically the impact that this wage differential has on the real incomes of union labor, nonunion labor, and capital. The analysis is accomplished by solving explicitly a numerically specified general equilibrium system with and without the union wage premium. Comparison of real factor incomes in each equilibrium yields the desired information. The findings indicate that union labor gains as a result of the differential, while nonunion labor and capital lose. This outcome is realized both in terms of real income levels and in a redistributive sense.

Selected Abstracts 1983

83-3

INTERNATIONAL CAPITAL MOBILITY AND THE COORDINATION OF MONETARY RULES

Nicholas Carlozzi
and
John B. Taylor

The paper develops a two-country model with flexible exchange rates and perfect capital mobility for evaluating alternative macroeconomic policy rules. Macroeconomic performance is measured in terms of *fluctuations* in inflation and output. Expectations are rational, and prices are sticky; wage setting is staggered over time. The countries are linked by aggregate spending effects, relative price effects, and mark-up pricing arrangements. The model is solved and analyzed through deterministic and stochastic simulation techniques. The results suggest that international capital mobility is not necessarily an impediment to efficient domestic macroeconomic performance. Changes in the *expected* appreciation or a depreciation of the exchange rate along with differentials between *real* interest rates in the two countries can permit macroeconomic performance in one country to be relatively independent of the policy rule chosen by the other country. The results depend on the particular parameter values used in the model and suggest the need for further econometric work to determine the size of these parameters.

83-4

PITFALLS IN ANALYZING INFLATION AND UNEMPLOYMENT

Brian R. Horrigan

When can we know whether deficits cause inflation or inflation causes deficits? The correlation we observe between deficits and inflation does not permit an inference about causality. In steady state, higher inflation is always associated with higher deficits, regardless of what caused the inflation. The causal relation between deficits and inflation can only be inferred from a study of disequilibrium situations. In disequilibrium, the inflation-adjusted deficit is a better measure of the stance of fiscal policy than the conventional deficit.

83-5

THE ROLE OF THE DISCOUNT WINDOW IN MONETARY POLICY UNDER ALTERNATIVE OPERATING PROCEDURES AND RESERVE REQUIREMENT SYSTEMS

Herb Taylor

The paper uses a simple model of the reserves market to demonstrate the implications of discount window administration procedures for short-run money control. It is shown that when the Fed uses a funds rate operating procedure to control the money stock, discount window procedures do not affect the volatility of the money stock. When the Fed uses a reserves operating procedure combined with lagged reserve requirements, a relatively liberal discount window policy is shown to improve money control. With contemporaneous reserve requirements, the case for a more restrictive discount window policy is stronger, though a penalty discount rate does not necessarily maximize short-run money control.

83-6

CARRYING COSTS AND TREASURY BILL FUTURES

Brian C. Gendreau

Researchers have consistently found that yields on Treasury bill futures differ significantly from corresponding forward rates implicit in the term structure of interest rates. This paper focuses on the borrowing costs faced by investors as the source of that difference. Rates of return attainable on forward bills created implicitly by financing Treasury bills with term repurchase agreements are calculated and found to be not significantly different from yields on Treasury bill futures contracts. These results suggest that risk premia in the repurchase market are reflected in Treasury bill futures yields, and can explain why those yields differ from forward rates.

83-7

METROPOLITAN CENTRAL CITY POPULATION AND EMPLOYMENT GROWTH DURING THE 1970s

by Edwin S. Mills

This paper studies the determinants of Metropolitan Central City Population and Employment Growth from 1970 to 1980 using census data for metropolitan areas with at least 250,000 population. Central city and suburban population and employment growth are analyzed in a four-equation model. Population and employment growth reinforce each other strongly in central cities. Suburban population growth stimulates central city employment growth, but suburban employment growth is at the expense of central city employment growth. Central city population and employment growth are affected strongly by variables over which communities have control. Many eastern and northern central cities could have replaced decline with substantial growth by better control of crime and taxes and by improved educational systems.

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