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The Measurement and Determination of Loanable-Funds Saving

Saving is taken to be the source of the resources needed to produce capital. It represents new materials and labor which could have been used for current consumption but which, instead, are held back (saved) in order to make possible the production of larger outputs in the future. Thus savings are the supply side of the supply and demand for new capital.—William J. Baumol[1]

WHILE there may be many reasons to be concerned about what determines the flow of saving in the U.S. economy, it is the role of saving as the supply side in the process of capital accumulation that seems to lie at the heart of the renewed interest in saving behavior in recent literature. That same view of saving is the focus of our attention and guides the choices we make in the empirical analysis presented here. Our major objective is to investigate the proposition that saving—in the sense of the flow of resources available for capital formation, or "loanable funds"—is determined in part by the rate of interest.

Note: We thank David M. Garman for his exceptionally competent research assistance. Our colleague, Theodore C. Bergstrom, and members of the Brookings panel made many helpful suggestions on earlier versions of this article.

1. William J. Baumol, *Economic Theory and Operations Analysis*, 4th ed. (Prentice-Hall, 1977), pp. 650–51.

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A critically important policy problem is at issue here. Suppose, as Feldstein has claimed, that the United States saves too little and therefore forgoes the benefits of unrealized additions to productive capacity.[2] Suppose further that, as a number of writers have recently suggested, part of the reason that the United States does not save a sufficiently large fraction of its income is that the tax structure drives a wedge between the marginal rate of return to private capital formation and the after-tax rate of return to private saving, and thus the latter is low relative to the former.[3] In that case, a change in the tax laws could be expected to change the ratio of saving to income. Specifically, if saving is positively related to the after-tax rate of return to saving, a reduction in the marginal tax rate on earnings from saving would raise saving at any given level of income; in other words, the reduction would raise the saving rate. For such a prescription to be useful to policymakers, two findings must emerge from the empirical analysis. First, it must be demonstrated that a positive, reliably measured partial derivative exists connecting loanable-funds saving and the appropriate interest rate. And if this can be shown, the second requirement is that the positive relationship must be "important" as well as significant. That is, policymakers cannot have much interest if the estimated response of the saving rate to a unit change in the rate of return to saving is 0.0001, regardless of how small the standard error on that 0.0001 might be.[4]

2. See Martin Feldstein, "Does the United States Save Too Little?" *American Economic Review*, vol. 67 (February 1977), pp. 116–21. Feldstein argues that realizing those additional benefits would increase economic welfare so that existing saving is inefficiently small.

3. See the excellent survey article on this and related topics: George M. von Furstenberg and Burton G. Malkiel, "The Government and Capital Formation: A Survey of Recent Issues," *Journal of Economic Literature*, vol. 15 (September 1977), pp. 835–78. Also see Michael J. Boskin, "On Some Recent Econometric Research in Public Finance," *American Economic Review*, vol. 66 (May 1976), pp. 102–09; Michael J. Boskin, "Taxation, Saving, and the Rate of Interest," *Journal of Political Economy*, vol. 86 (April 1978, pt. 2), pp. S3–S27; and Feldstein, "Does the United States Save Too Little?"

4. Presumably the fiscal issue here is not a net tax cut, but a tax reform that lowers the tax rate on interest income and then raises other tax rates (say, taxes on wage and salary income) to maintain fixed total tax revenue. We would then want to measure the responsiveness of saving to a change in the after-tax rate of return to saving, given the level of total tax revenue. This means that the fiscal authorities would have to raise the tax rate on wage and salary income by enough to offset the tax revenue lost on interest income from the entire stock of consumer saving, not just from the flow of saving from current income. Our final empirical results below

It is by no means true that all writers on this topic claim the existence of a positive relation between saving and the interest rate. In the Fisherian gospel that forms the theoretical basis for the analysis of saving behavior, it is well recognized that the response of an individual who is a net saver at interest rate R_0 to a change in the rate to $R_0 + \Delta R$ is, in general, indeterminate because the substitution and income effects are of opposite signs. Indeed the recent attack on neoclassical capital theory from Cambridge (England) includes the view that the effect of the interest rate on saving is likely to be negligible, and focuses on business decisions and the division of national income between workers and entrepreneurs as the major determinants of saving.[5]

To shed light on the role of the interest rate in determining loanable-funds saving, it is important that we know what interest rate to consider and that we are able to observe an empirical counterpart of loanable-funds saving. There is fair agreement, at least in principle, that the relevant rate of return to saving should be an expected, after-tax, real rate of return. There is less agreement on precisely how to measure the expected after-tax real rate.[6] As we indicate in the next section, the results can be quite sensitive to the choice of data on interest and inflation rates.

And what is loanable-funds saving? Observations of two saving flows are published regularly: saving in the national income and product accounts (hereafter NIPA) and saving in the flow-of-funds accounts (hereafter FF). We claim that neither of these is the appropriate measure of

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measure such an effect by treating the after-tax rate of return and personal tax payments as separate independent variables in a multiple regression explaining saving. This procedure is not the same as the one implied in the usual conceptual experiment of isolating the income and substitution effects of a change in the after-tax interest rate.

5. A concise and insightful discussion of the capital theory controversy may be found in Baumol, *Economic Theory and Operations Analysis,* pp. 653–70. Baumol concludes that "*a priori* surmise" cannot tell us what determines the flow of saving; "It is a matter for empirical investigation, and the issue is still far from being settled" (p. 657).

6. In the presence of uncertainty, is it only the expectation of a probability distribution that matters? If the interest rate, tax rate, and inflation rate are perceived to be random variables, is it appropriate simply to combine them into a single random variable (the after-tax real rate of return), or is the saving decision a more complex function of all three variables? Is a single interest rate all that matters, or is there an array of interest rates on alternative assets that affects the saving decision? In this paper we cannot treat all these issues, but we look at some of them.

saving for the proposition under consideration. No firm interested in borrowing (through the bond or equity markets or from the banking system) to finance capital formation can borrow either NIPA personal or FF personal saving. The former includes expenditure on owner-occupied dwellings and a number of imputations; the latter, expenditure on owner-occupied dwellings and all other consumer durables, and several imputations. What individuals contribute directly to the loanable funds available for business capital formation—and the quantity that might be affected by tax changes that alter the rate of return to saving—is their cash saving. This saving is the difference between total cash receipts and total cash expenditures on anything except those financial assets providing funds for capital expenditures either directly (such as corporate bonds) or indirectly (such as time deposits). Individuals spend money to purchase claims to retirement income, say, by participation in a private pension plan, and some or all of that may well be regarded by these individuals as a part of their personal saving. But is it part of personal loanable-funds saving? To the extent that the pension funds accumulate cash in excess of their operating expenditure (including the payment of pension benefits), those funds may become available for capital formation; if they do, they should be viewed as a component of the net cash flow in the business or nonpersonal sector of the economy.[7] How pension funds hold their net cash flow is a separate issue from whether the interest rate is a determinant of personal cash saving.[8] In what follows we use the terms "personal cash saving" and "personal loanable-funds saving" interchangeably. Our empirical analysis makes use of NIPA, FF, and cash saving, but our main focus is on cash saving.

Table 1 provides a detailed description of personal cash saving as it relates to NIPA personal saving and our concept of FF personal saving,

7. We do not deny that the purchase of pension rights may affect personal cash saving or that business cash flow may affect personal cash saving. Rather, we assert that the expenditure on such claims is not itself a component of personal loanable-funds saving. The behavioral relationship between business saving and personal saving has been treated in Paul A. David and John L. Scadding, "Private Savings: Ultrarationality, Aggregation and 'Denison's Law,'" *Journal of Political Economy*, vol. 82 (March-April 1974, pt. 1), pp. 225–49, and we address this in our empirical work below.

8. It is possible that changes in the interest rate may lead individuals to vary the amount saved in cash and through private pension funds. We treat such behavior at least indirectly by allowing for the possibility of substitution between these forms of saving.

Table 1. Derivation of Alternative Concepts of Personal Saving, 1975
Billions of dollars

Item[a]	*Amount*	*Source*[b]
NIPA personal saving	80.2	*SCB*, table 2.1
Minus: Gross investment in owner-occupied buildings	43.6	*SCB*, table 8.3 (80 + 81)
Margin on owner-built houses	0.7	*SCB*, table 8.3 (87)
Plus: Capital consumption allowances with adjustment on owner-occupied buildings	28.0	*SCB*, table 8.3 (64 + 70 + 76)
Equals: NIPA personal saving, excluding imputations	63.8	*SCB*, table 8.3 (60)
Minus: Change in reserves of private pension and insurance plans	27.8	*FF* (13 + 14 + 15)
Equals: Personal cash saving	36.0	
Plus: Gross investment in owner-occupied buildings	43.6	*SCB*, table 8.3 (80 + 81)
Minus: Capital consumption allowances with adjustment on owner-occupied buildings	28.0	*SCB*, table 8.3 (64 + 70 + 76)
Plus: Net investment in consumer durables	22.7	*FF* (41)
Equals: FF personal saving[c]	74.3	

a. NIPA refers to items from the national income and product accounts; FF, to items from the flow-of-funds accounts of the Federal Reserve System.
b. *SCB* is *Survey of Current Business*, vol. 57 (July 1977), and *FF* is *Flow of Funds Accounts, 4th Quarter 1977* (Board of Governors of the Federal Reserve System, February 1978), p. 53. The numbers in parentheses refer to line numbers in the source table. Figures are rounded.
c. This item does not equal the category "personal saving, F/F basis" in the flow-of-funds accounts, which was $104.9 billion in 1975.

using 1975 data.[9] Briefly, the major difference between NIPA personal saving and our definition of personal cash saving is that the net investment in owner-occupied buildings and the net contribution to private pension and insurance plans are included in NIPA personal saving but excluded from personal cash saving.[10] Our FF personal saving adds net purchases of consumer durables and net investment in owner-occupied build-

9. The FF saving as defined here is conceptually the same as that in the published data of the Federal Reserve Board, but we have not reconciled it exactly with the published series.

10. Our treatment of private pension and insurance plans is thus consistent with the NIPA treatment of social insurance funds.

Table 2. Derivation of Alternative Concepts of Gross Private Saving, 1975
Billions of dollars

Item	*Amount*	*Source*[a]
Change in reserves of private pension and insurance plans	27.8	*FF* (13 + 14 + 15)
Plus: Undistributed corporate profits with inventory valuation and capital consumption adjustments	16.7	*SCB*, table 5.1
Wage accruals less disbursements	0.0	*SCB*, table 5.1
Corporate capital consumption allowances with adjustment	101.7	*SCB*, table 5.1
Noncorporate capital consumption allowances with adjustment	60.8	*SCB*, table 5.1
Minus: Capital consumption allowances with adjustment on owner-occupied buildings	28.0	*SCB*, table 8.3 (64 + 70 + 76)
Equals: Nonpersonal (business) private cash saving	179.0	
Plus: Personal cash saving	36.0	Authors' calculations from table 1
Equals: Gross private cash saving	215.0	
Plus: Gross investment in owner-occupied buildings	43.6	*SCB*, table 8.3 (80 + 81)
Margin on owner-built houses	0.7	*SCB*, table 8.3 (87)
Equals: NIPA gross private saving[b]	259.4	*SCB*, table 5.1

a. See table 1, note b.
b. NIPA refers to items from the national income and product accounts.

ings to personal cash saving. In this way we treat purchases of consumer durables and housing consistently. Table 2 makes the transition to gross private cash saving and NIPA gross private saving; the former is obtained by adding personal cash saving and the nonpersonal (business) gross cash saving. Table 3 outlines personal cash receipts and NIPA disposable personal income; table 4, private cash receipts and NIPA private receipts. All calculations are illustrated for calendar year 1975, based on published data as indicated. Variables such as personal cash saving or personal cash receipts are available only on an annual basis, and we calculated annual observations on all the relevant variables in tables 1 through 4 for the period 1951–74 for purposes of the empirical analysis. The last year we

Table 3. Relation of NIPA Personal Income to Personal Cash Receipts before and after Tax and Cash Flows Plus Noncash Receipts after Tax, 1975[a]
Billions of dollars

Item		Amount	Source[b]
Personal income without imputations[c]		1,217.0	*SCB*, table 8.3 (42)
Minus:	Investment income of private pension and insurance funds	20.6	*SCB*, table 8.2 (43) minus table 8.3 (35 + 38 + 56)
	Employer contributions for private pension and insurance funds	56.8	*SCB*, table 6.13
Plus:	Personal contributions for social insurance	50.4	*SCB*, table 2.1
	Benefits paid from private pension and insurance funds	45.2	*SCB*, table 6.13
Equals:	**Personal cash receipts[d]**	1,235.2	
Minus:	Personal tax and nontax payments	169.0	*SCB*, table 2.1
Equals:	**Personal cash receipts after tax**	1,066.2	
Plus:	Imputations[e]	36.2	*SCB*, table 8.3 (68 − 66 + 79 + 82 + 84 + 85 + 86 + 87)
	Employer contributions for social insurance and private pension and insurance funds	116.6	*SCB*, tables 1.13 and 6.13
Equals:	**Personal cash and noncash receipts after tax**	1,219.0	
Plus:	Investment income of private pension and insurance funds	20.6	*SCB*, table 8.2 (43) minus table 8.3 (35 + 38 + 56)
Minus:	Employer contributions for social insurance	59.8	*SCB*, table 1.13
	Benefits paid from private pension and insurance funds	45.2	*SCB*, table 6.13
	Personal contributions for social insurance	50.4	*SCB*, table 2.1
Equals:	**NIPA disposable personal income**	1,084.4	*SCB*, table 2.1

a. NIPA refers to items from the national income and product accounts.
b. *SCB* is *Survey of Current Business*, vol. 57 (July 1977). The numbers in parentheses refer to line numbers in the source table. Figures are rounded.
c. Personal income without imputations, as published, does not correspond to personal cash receipts because of the attribution of investment income of private pension and insurance funds to individuals (not regarded as an imputation by national income accountants), the inclusion of employer contributions to private pension and insurance funds, and the exclusion of personal contributions for social insurance (but not personal contributions for private pension and insurance) and benefits paid from private pension and insurance funds. We have simply reversed these items so that private pension and insurance contributions are treated exactly the same as social insurance contributions, and private "transfer payments" to individuals are treated exactly the same as government transfer payments.
d. Includes personal contributions for social and private pension and insurance funds.
e. Includes net imputed profit-type income on owner-occupied buildings, income in kind, and services furnished without payment by financial intermediaries except life insurance carriers.

Table 4. Relation of NIPA Private Receipts to Private Cash and Noncash Receipts after Tax, 1975[a]
Billions of dollars

Item	Amount	Source[b]
Nonpersonal private cash saving	179.0	Authors' calculations from table 2
Plus: Personal cash receipts after tax	1,066.2	Authors' calculations from table 3
Equals: Private cash receipts after tax	1,245.2	
Plus: Imputations	36.2	*SCB*, table 8.3 (68 − 66 + 79 + 82 + 84 + 85 + 86 + 87)
Employer contributions for social insurance and private pension and insurance funds	116.6	*SCB*, tables 1.13 and 6.13
Capital consumption allowances with adjustment on owner-occupied buildings	28.0	*SCB*, table 8.3 (64 + 70 + 76)
Equals: Private cash and noncash receipts after tax	1,426.0	
Plus: Investment income of private pension and insurance funds	20.6	*SCB*, table 8.2 (43) minus table 8.3 (35 + 38 + 56)
Minus: Employer contributions for social insurance	59.8	*SCB*, table 1.13
Benefits paid from private pension and insurance funds	45.2	*SCB*, table 6.13
Personal contributions for social insurance	50.4	*SCB*, table 2.1
Interest paid by consumers to business	22.9	*SCB*, table 2.1
Personal transfer payments to foreigners	0.9	*SCB*, table 2.1
Change in reserves of private pension and insurance plans	27.8	*FF* (13 + 14 + 15)
Equals: NIPA gross receipts of individuals and business	1,239.8	*SCB*, table 8.1

a. NIPA refers to items from the national income and product accounts.
b. *SCB* is *Survey of Current Business*, vol. 57 (July 1977), and *FF* is *Flow of Funds Acccounts, 4th Quarter 1977*, p. 53. The numbers in parentheses refer to line numbers in the source table. Figures are rounded.

included was 1974 because that was the most recent year (as of the start of this research) for which the data would no longer be subject to regular annual revision. Because the Korean War period may have been "special," we used 1955–74 as a separate subperiod in some cases.[11]

11. This argument seems less compelling than it once did in view of the extraordinary economic events that have occurred since the latter part of the 1960s.

Review of Previous Studies

As a basis for our empirical work, we begin with a review of recent contributions to the empirical study of the role of interest rates in aggregate consumption and saving behavior. We compare and integrate three general approaches that appear in the literature. The first concentrates on aggregate consumption expenditure and introduces the interest rate in the consumption function. This approach is used by Boskin and others.[12] The second approach is based on the Houthakker-Taylor saving function in which aggregate or per capita saving is the dependent variable.[13] This work has led to the use of disaggregated income flows as separate independent variables in the saving function.[14] The third approach is concerned, at least implicitly, with a disaggregation of saving into personal and nonpersonal components. The work of Denison and David and Scadding is illustrative of this approach.[15]

These three approaches reach widely different conclusions about the interest elasticity of saving. It is therefore necessary to analyze each and, if possible, consolidate the approaches or at least understand how they differ.

AGGREGATE CONSUMPTION FUNCTIONS

In his recent paper, Boskin reports a positive and significant interest elasticity of saving.[16] This conclusion is based on an aggregate annual consumption function of the form

$$\text{(1)} \quad \ln C = a_0 + a_1 \ln YD + a_2 \ln YD_{-1} + a_3 \ln W_{-1} + a_4 \ln U + a_5(R - \pi) + a_6\pi,$$

12. Boskin, "Taxation." The studies by Martin Feldstein, "Social Security, Induced Retirement, and Aggregate Capital Accumulation," *Journal of Political Economy*, vol. 82 (September-October 1974), pp. 905–26, and Robert J. Barro, *The Impact of Social Security on Private Saving: Evidence from the U.S. Time Series* (American Enterprise Institute, 1978), also employ this general approach. Neither of these last studies is specifically concerned with the effects of the interest rate, however.

13. H. S. Houthakker and Lester D. Taylor, *Consumer Demand in the United States: Analysis and Projections*, 2d ed. (Harvard University Press, 1970), pp. 287–303.

14. See, for example, Lester D. Taylor, "Saving out of Different Types of Income," *BPEA, 2:1971*, pp. 383–407.

15. Edward F. Denison, "A Note on Private Saving," *Review of Economics and Statistics*, vol. 40 (August 1958), pp. 261–67, and David and Scadding, "Private Savings."

16. Boskin, "Taxation."

where

C = real per capita private consumption
YD = real per capita disposable private income
W = end-of-year real per capita wealth
U = unemployment rate
$R - \pi$ = the expected real after-tax return on capital
π = expected rate of inflation.

Fitting the equation to annual data for the period 1934–69 (excluding 1941–46), Boskin reports the estimated equation (after correction for first-order serial correlation of the residuals) as

$$\text{(2)}\quad \ln C = \underset{(-0.34)}{-0.456} + \underset{(4.75)}{0.569} \ln YD + \underset{(2.25)}{0.180} \ln YD_{-1} + \underset{(3.71)}{0.265} \ln W_{-1}$$

$$\underset{(-0.27)}{-0.002} \ln U - \underset{(-3.24)}{1.066} (R - \pi) - \underset{(-0.47)}{0.029}\, \pi,$$

with estimated t-statistics shown in parentheses (here and throughout the paper).[17] Boskin reports that virtually the same results were obtained using different interest rates, sample periods, and estimation techniques.[18]

The important feature of this equation for our purposes is the statistically significant, negative coefficient of the real rate of return. This implies a positive saving elasticity and hence an increase in the saving rate in response to an increase in the real interest rate. By defining saving implicitly as $S = Y - C$, it follows that

$$\text{(3)}\qquad \ln\left(1 - \frac{S}{Y}\right) = \ln\left(\frac{C}{Y}\right);$$

hence for fixed Y,

$$\text{(4)}\qquad \frac{\partial\left(\frac{S}{Y}\right)}{\partial R} = -\left(1 - \frac{S}{Y}\right)\left(\frac{\partial \ln C}{\partial R}\right).$$

An upper bound on the sensitivity of the saving rate to changes in the interest rate is thus $-\partial \ln C/\partial R$ when this quantity is positive. Because

17. The results shown here correct typographical errors in the coefficients for the inflation rate and the unemployment rate appearing in Boskin, "Taxation," p. S13. Here and in the remainder of this discussion, the interest and inflation rates are expressed as proportional rather than as percentage rates.

18. Ibid., p. S16.

equation 2 yields the estimate $-\partial \ln C/\partial R \cong 1.066$, Boskin's work implies that a 1 percentage point increase in the real rate of return (say, from 4 to 5 percent) would be expected to lead to (at most) a 1 percentage point increase in the saving rate (say, from 6 to 7 percent). Thus this estimate of the interest-rate effect is both statistically significant and sufficiently large to be meaningful for policy purposes.

An equation like the one employed by Boskin requires that saving, and hence the saving rate, be defined implicitly by the specific consumption and income data that are used. Boskin's consumption data exclude expenditures on all consumer durables and include the flow of services from durables, including owner-occupied buildings. The saving implicitly defined thereby comes closest to an FF saving concept, rather than a loanable-funds saving concept. It is not obvious to us why such saving should respond positively to the interest rate. In particular, FF saving includes net investment in consumer durables and housing. It is generally thought that purchases of consumer durables and housing would, if anything, vary inversely with the interest rate. Viewing FF saving essentially as an aggregate of cash saving and net investment in housing and other durables, one would expect the coefficient of the interest rate to be an average of the negative value deriving from the net investment component and a possibly positive value taken from the cash-saving component of FF saving. Boskin's finding of a large positive coefficient relating the rate of interest and FF saving is therefore a novel and intriguing result that calls for replication and further scrutiny.

Boskin provided us with the data used in his analysis. Most of these data derive directly from the calculations of Christensen and Jorgenson.[19] However, Boskin contributed a calculation that is of critical importance for the problem at hand. The real after-tax rate of return $(R - \pi)$, which appears in 2, results from Boskin's processing of the rate of return and the price data appearing in the work of Christensen and Jorgenson. Boskin applied a process of smoothing and forward projection to produce an $(R - \pi)$ that he regarded as an appropriate measure of the expected after-tax real rate of return. We were struck by two facts in our visual inspection of the $(R - \pi)$ series. The first was that the observation for 1934 seemed to be uniquely different from nearby observations; we therefore

19. See Laurits R. Christensen and Dale W. Jorgenson, "U.S. Income, Saving, and Wealth, 1929–1969," *Review of Income and Wealth*, series 19 (December 1973), pp. 329–62.

dropped it from the sample to determine whether it was exerting a peculiarly strong leverage on the regression. This experiment produced a coefficient of -0.877 on $(R - \pi)$, rather than the -1.066 reported by Boskin, with an estimated t-statistic of -1.62, which clearly calls into question the statistical significance of $(R - \pi)$.[20]

The second point we noticed was that the $(R - \pi)$ series resembled the inverted unemployment rate lagged two years. To test whether the interest rate played a purely cyclical role in the equation, we entered the unemployment rate lagged two years rather than the (insignificant) current unemployment rate; the result for the period 1936–40, 1949–69 is

$$\text{(5)}\quad \ln C = \underset{(-4.05)}{-3.547} + \underset{(4.73)}{0.675} \ln YD - \underset{(-0.26)}{0.044} \ln YD_{-1} + \underset{(27.19)}{0.680} \ln W_{-1}$$

$$\underset{(-4.62)}{-0.042} \ln U_{-2} - \underset{(-0.17)}{0.120} (R - \pi) + \underset{(0.39)}{0.059}\pi.$$

Durbin-Watson = 1.70; standard error of estimate = 0.013; ρ = 0.250.

The lagged unemployment rate has a significant negative coefficient, while the real interest rate is no longer statistically significant. A similar result holds for the postwar period; when $\ln U_{-2}$ rather than $\ln U$ is used in the equation, the t-statistic for the coefficient on the interest rate is -0.90, which makes its significance questionable.

As a final check on the sensitivity of the Boskin result, we used several alternative interest rates in place of Boskin's interest rate. These rates were of the form $(R - \pi)$, where π is Boskin's expected rate of inflation, and R is the Aaa, Baa, or municipal rate. Averaged and exponentially smoothed $(R - \pi)$ rates were also used. We were never able to reproduce Boskin's result using any other interest rates with or without averaging or exponential smoothing. Indeed, when we restricted the consumption regressions to postwar data (1947–69), the coefficients for the interest rate were invariably positive, and in most cases exceeded their standard errors by a factor of two or more.

Perhaps no regression equation would withstand all the sensitivity tests that we performed. In this case, however, we found that the positive and significant saving elasticity reported by Boskin is extremely sensitive to the sample period he used, the timing of variables in the equation, and, finally, to the way in which the interest-rate series was processed. In

20. The remainder of the equation was quite robust when we dropped 1934.

view of this sensitivity, it is difficult to have much confidence in the reported result for the interest rate. Moreover, as indicated earlier, the saving concept to which this result is appropriate is not the personal or private loanable-funds concept in which we are interested.

AGGREGATE SAVING FUNCTIONS

In contrast to Boskin, Taylor uses saving rather than consumption as the dependent variable in his work.[21] His basic model draws upon the theory of saving developed by Houthakker and Taylor.[22] In brief, the main premise of this theory is that desired wealth is a function of income and the interest rate,

$$W^* = b_1^* Y + b_2^* R. \tag{6}$$

Saving is then assumed to be proportional to the difference between desired and actual wealth so that

$$S = \lambda(W^* - W_{-1}). \tag{7}$$

Differencing 7 and substituting 6 for desired wealth yields the saving equation,

$$S = b_1 S_{-1} + b_2 \Delta R + b_3 \Delta Y, \tag{8}$$

which forms the basis for empirical work.

The major recent innovation by Taylor is the disaggregation of income by type, based on the NIPA identity,

$$YD = L + P + TR - SI - TX, \tag{9}$$

where

YD = NIPA disposable personal income
L = labor income
P = property income
TR = government transfer payments to individuals
SI = personal contributions for social insurance
TX = personal tax and nontax payments.

21. Taylor, "Saving out of Different Types of Income."

22. Houthakker and Taylor, *Consumer Demand in the United States.* See also Lester D. Taylor, "Price Expectations and Households' Demand for Financial Assets," *Explorations in Economic Research,* vol. 1 (Fall 1974), pp. 258–339, where income and the interest rate are treated in a parallel manner.

This decomposition leads to the extended model,

$$(10)\quad S = b_1S_{-1} + b_2\Delta R + b_3\Delta L + b_4\Delta P + b_5\Delta TR + b_6\Delta SI + b_7\Delta TX.$$

In his empirical work, Taylor found that the coefficients on labor and property income did not differ greatly, and most of his work combined these two sources of income (designated as LP).

The original result reported by Taylor for aggregate personal saving, in constant 1958 dollars, is

$$(11)\quad \underset{(45.27)}{S = 0.953\,S_{-1}} + \underset{(5.11)}{0.418\,\Delta LP} + \underset{(2.87)}{0.890\,\Delta TR} - \underset{(-4.92)}{2.194\,\Delta SI}$$

$$-\underset{(-4.92)}{0.884\,\Delta TX} + \underset{(2.50)}{4.011\,\Delta Baa.}$$

Two important conclusions emerge from Taylor's analysis. First, the coefficients on different types of income are substantially different. Second, the significance of the interest rate is higher using disaggregated income than when disposable income is used alone in the equation.[23] The variable *Baa* used by Taylor is the nominal yield on Baa corporate bonds. As we mentioned above, it is generally agreed that the interest rate appropriate in a saving function is the expected real rate. If so, the Taylor equation may be specified incorrectly because it uses a nominal interest rate but no expected rate of inflation.

Juster and Wachtel have extended the Houthakker-Taylor saving model to include consideration of inflationary expectations and uncertainty about the rate of inflation.[24] For this purpose, inflationary expectations are measured by the mean expected price change obtained from survey data collected by the Survey Research Center at the University of Michigan. Uncertainty about inflation has been measured by the standard deviation of the observed distribution of expected price changes.[25] Juster and Wachtel have found that uncertainty about inflation has a significant

23. This last conclusion follows from an examination of the alternative regressions shown in table 1 of Taylor, "Saving out of Different Types of Income," p. 391.

24. See, for example, F. Thomas Juster, "A Note on Prospective 1977 Tax-Cuts and Consumer Spending" (University of Michigan, Institute for Social Research, January 1977); and Paul Wachtel, "Inflation, Uncertainty, and Saving Behavior since the Mid-1950s," *Explorations in Economic Research*, vol. 4 (Fall 1977), pp. 558–78.

25. The details of the methods used to construct these series as well as the series themselves are given in F. Thomas Juster and Robert Comment, "A Note on the Measurement of Price Expectations" (University of Michigan, Survey Research Center, n.d.).

impact on consumer saving, with growing uncertainty leading to an increase in saving. But little is said about the effects of the interest rate in their work and, as in the case of Taylor's research, the focus is on NIPA or FF saving rather than personal cash saving.

DISAGGREGATED SAVING FUNCTIONS

In a recent reexamination of Denison's law, David and Scadding confirm Denison's original finding that the private saving rate, adjusted for the business cycle, has remained remarkably stable over time.[26] The model that forms the basis for their empirical investigation is

$$S = c_1 GNP + c_2 \Delta GNP^*, \tag{12}$$

where

S = NIPA gross private saving
GNP = gross national product
ΔGNP^* = difference between the last "high-employment" year GNP and current GNP.

For the period 1921–64 (excluding 1941–47), they report the following result:

$$\underset{(161.52)}{S = 0.1552\, GNP} - \underset{(-7.407)}{0.1376\, \Delta GNP^*}. \tag{13}$$

The ratio of the standard error of the regression to the mean value of S is 0.049. This relatively small standard error, together with the stability of the estimated equation over various subperiods, is taken as support for Denison's law—namely, that year-to-year changes in the saving rate are small and that there is no long-run trend in the saving rate.

One explanation offered for the stability of the saving rate thus defined is that households are "ultrarational": personal saving decisions are conditional on the amount of nonpersonal (that is, corporate) saving. Suppose the basic saving equation is rewritten as

$$S_p = c_1 GNP + c_2 \Delta GNP^* + c_3 S_n, \tag{14}$$

where S_p and S_n are personal and nonpersonal saving, respectively. Then the ultrarationality hypothesis is tantamount to the restriction that $c_3 = -1$. Statistical analysis of this last relationship would provide the basis for a more direct test of the rationality conjecture.

26. David and Scadding, "Private Savings," and Denison, "A Note on Private Saving."

The relative constancy of the private saving rate is sometimes taken as evidence that private saving is insensitive to interest and tax rate changes. As Boskin has argued, such a conclusion is not warranted for a number of reasons.[27] In any event, a direct test of the hypothesis of interest-rate insensitivity is clearly desirable. To do this, in the context of the David and Scadding model, it would be necessary to modify the personal saving function above to include the effect of the real interest rate,

$$S_p = c_1GNP + c_2\Delta GNP^* + c_3S_n + c_4(R - \pi). \tag{15}$$

A direct test of the hypothesis $c_4 = 0$ is possible using this model.

None of the empirical work that we reviewed provides a direct test of the interest sensitivity of saving decisions within the context of a model that allows for the ultrarationality of David and Scadding. Boskin includes corporate saving as part of income but not as a separate variable. This procedure restricts the corporate saving coefficient to being the same as the income coefficient (presumably positive) and hence does not, in general, allow for rationality of the David and Scadding variety. Taylor uses NIPA personal saving as his dependent variable, which does not have a direct loanable-funds interpretation. Moreover, corporate saving is not included as one of the determinants of personal saving. David and Scadding do not directly investigate the potential effect of the interest rate on saving but rather argue indirectly that the effect must be small. Hence previous work is not adequate, in our opinion, to draw any definitive conclusions about the interest elasticity of personal saving decisions. Because the theoretical arguments for the effect of the interest rate are generally given in terms of personal decisions about loanable-funds saving, an investigation of this concept of saving is needed.

A First Look at Loanable-Funds Saving

In this section we take another look at the saving decision in what might be called the new public finance framework that Boskin uses.[28]

27. Boskin, "Taxation."

28. A similar econometric approach is found not only in Boskin's work but in that of Feldstein, Barro, and others who have advanced quite dramatically the application of econometrics to crucially important questions in the field of public finance. Interestingly, as far as consumption behavior is concerned and despite the acceptance of a high level of aggregation, these researchers have taken a direction quite different from the familiar one in the long history of work associated with the major macroeconometric models of the U.S. economy.

We have already alluded to two important difficulties with Boskin's work—namely, saving is defined only implicitly and the data used appear to be most relevant to the analysis of FF saving rather than to loanable-funds saving. In our efforts to overcome these difficulties, we first translate the logarithmic consumption function into a saving function and then apply the latter to several alternative saving concepts.

We begin with the logarithmic consumption function of equation 1 and subtract ln Y from both sides. Using the implicit definition of saving, $S = Y - C$, it follows that

$$\text{(16)} \quad \ln\left(1 - \frac{S}{Y}\right) = a_0 + (a_1 - 1)\ln Y + a_2 \ln Y_{-1} + a_3 \ln W_{-1} + a_4 \ln U + a_5(R - \pi) + a_6\pi.$$

For small S/Y, the left-hand side of this equation is closely approximated by $-S/Y$ itself, which implies

$$\text{(17)} \quad \frac{S}{Y} \cong -a_0 + (1 - a_1)\ln Y - a_2 \ln Y_{-1} - a_3 \ln W_{-1} - a_4 \ln U - a_5(R - \pi) - a_6\pi.$$

Thus the logarithmic consumption function implies an equation for the *saving rate* with the same independent variables.

We applied 17 to three basic saving rates derivable from the definitions contained in tables 1 through 4:

NIPA personal saving rate = *NIPA personal saving* divided by NIPA disposable personal income

personal cash saving rate = *personal cash saving* divided by personal cash and noncash receipts after tax

FF personal saving rate = *FF personal saving* divided by personal cash and noncash receipts after tax.[29]

29. The basic summary statistics for these three saving rates for 1951–74 are as follows.

Saving rate	*Mean*	*Standard deviation*
NIPA personal saving rate	0.0636	0.0086
Personal cash saving rate	0.0022	0.0142
FF personal saving rate	0.0559	0.0149

The regression results in table 5 are rather insensitive to whether the FF personal saving rate is defined with personal cash and noncash receipts after tax or with NIPA disposable personal income in the denominator.

Table 5. Saving Rate Equations, 1951–74[a]

Equation and concept of saving rate		Independent variable: Constant	ln Y	ln Y_{-1}	ln W	ln U	*Baatax*	π	*SD*	Summary statistic: Durbin-Watson	$\bar{R}^2$	Standard error of estimate
5-1	NIPA personal	1.131	0.073	0.075	−0.130	−0.008	0.002	...	...	2.29	0.403	0.0067
		(3.26)	(0.90)	(0.82)	(−3.07)	(−1.24)	(0.49)					
5-2	NIPA personal	1.162	0.102	0.029	−0.132	−0.006	0.002	0.001	...	2.24	0.386	0.0068
		(3.28)	(1.11)	(0.26)	(−3.07)	(−0.94)	(0.57)	(0.71)				
5-3	NIPA personal	0.962	0.090	0.030	−0.110	−0.007	0.0015	−0.001	0.0025	2.13	0.370	0.0069
		(2.16)	(0.96)	(0.26)	(−2.07)	(−1.05)	(0.36)	(−0.24)	(0.75)			
5-4	Personal cash	0.106	−0.142	0.200	−0.015	−0.016	0.003	...	...	2.29	0.672	0.0081
		(0.24)	(−1.41)	(1.78)	(−0.29)	(−2.13)	(0.58)					
5-5	Personal cash	0.114	−0.130	0.180	−0.016	−0.015	0.003	0.0005	...	2.26	0.654	0.0084
		(0.25)	(−1.12)	(1.26)	(−0.29)	(−1.85)	(0.60)	(0.24)				
5-6	Personal cash	0.219	−0.123	0.178	−0.028	−0.015	0.004	0.002	−0.001	2.32	0.634	0.0086
		(0.38)	(−1.02)	(1.22)	(−0.40)	(−1.73)	(0.64)	(0.38)	(−0.30)			
5-7	FF personal	1.573	0.237	−0.037	−0.183	−0.026	0.004	...	...	2.01	0.773	0.0071
		(4.09)	(2.69)	(−0.37)	(−3.93)	(−3.97)	(0.84)					
5-8	FF personal	1.574	0.238	−0.038	−0.183	−0.026	0.004	0.0000	...	2.01	0.760	0.0073
		(3.97)	(2.35)	(−0.31)	(−3.82)	(−3.60)	(0.81)	(0.02)				
5-9	FF personal	1.002	0.200	−0.029	−0.119	−0.028	0.0015	−0.005	0.007	1.87	0.801	0.0067
		(2.23)	(2.14)	(−0.25)	(−2.23)	(−4.26)	(0.35)	(−1.75)	(2.13)			

Sources: The NIPA personal saving rate is NIPA personal saving divided by NIPA disposable personal income; the personal cash and FF personal saving rates use personal cash and noncash receipts after tax as the denominator. These series are defined in tables 1 through 4 and are from national income and product accounts data of the U.S. Department of Commerce and flow-of-funds accounts data of the Board of Governors of the Federal Reserve System. The income variables, Y and Y_{-1}, are the personal income concept that appears in the denominator of the corresponding saving rate, expressed in real per capita terms. W is the real per capita net worth of households and is from Robert J. Barro, *The Impact of Social Security on Private Saving: Evidence from the U.S. Time Series* (American Enterprise Institute, 1978). The unemployment rate, U, is from the U.S. Bureau of Labor Statistics. π, the mean expected price change, and *SD*, the standard deviation of the observed distribution of expected price changes, are from F. Thomas Juster and Robert Comment, "A Note on the Measurement of Price Expectations (University of Michigan, Survey Research Center, n.d.). *Baatax* equals $(1 - t)$ *Baa*, where *Baa* is the corporate bond rate and is from Moodys Investors Service, Inc., while t, the marginal federal tax rate applicable to income from capital, was provided by Joseph A. Pechman of the Brookings Institution.

a. The numbers in parentheses are t-statistics.

The income variable, Y, used on the right-hand side is the personal income concept that appears in the denominator of the corresponding saving rate, adjusted to be measured in real per capita terms; W is real per capita net worth of households at the beginning of the year;[30] and U is the unemployment rate. The results of estimating 17 for various saving rates are given in table 5.

We experimented with interest rate data that included the municipal bond rate (which should already be an after-tax rate), the corporate Aaa rate, and the corporate Baa rate measured in percent. The best results (in the sense of the strongest effects of the interest rate on saving) were obtained using an after-tax Baa rate defined as

$$Baatax = (1 - t)Baa,$$

where the tax rate, t, is the marginal federal tax rate applicable to income from capital.[31] We employed the mean expected price change variable, π, derived from Survey Research Center data cited in the preceding section, as a separate variable to allow for both the effect of a real rate of return on saving and a separate inflation effect. To measure uncertainty about inflation we used the standard deviation, SD, of the expected inflation variable defined above. The equations were estimated using annual data for the period 1951–74 as well as for the subperiod 1955–74. The same basic story is told in both cases, and the results are shown only for 1951–74.

Table 5 shows that the form of the equation under consideration explains little of the variation in the NIPA saving rate. Only the wealth variable makes any significant contribution. Personal cash saving is not explained well either. Only the FF personal saving rate—and that is the one closest to the saving rate implicit in Boskin's work—seems to be explained by this form of equation. Allowing for the parameter transformations implicit in the use of S/Y rather than $\ln C$ as the dependent variable, the coefficients on current income and wealth in the regressions for the FF personal saving rate are generally similar to those reported by Boskin. The effect of the unemployment rate on FF saving is negative and sig-

30. The data correspond to that used in the Fed-MIT-Penn model and were taken from Barro, *The Impact of Social Security on Private Saving.*

31. The original data for this tax rate appear in Colin Wright, "Saving and the Rate of Interest," in Arnold C. Harberger and Martin J. Bailey, eds., *The Taxation of Income from Capital* (Brookings Institution, 1969), p. 300. Joseph A. Pechman of the Brookings Institution provided us with an updated series.

nificant, rather than insignificantly positive as reported by Boskin. The coefficient on the interest rate is always positive, whether or not inflation variables are included, but it never becomes statistically significant. Inflation is a significant determinant of the FF personal saving rate if both π and SD are included (making the coefficient on the interest rate zero). In that event, it appears that higher expected inflation reduces FF saving, while greater uncertainty about inflation increases it.

If a negative relation exists between the interest rate and expenditures on durable goods, one would expect that to be evident in the FF saving rate equations because FF saving includes net expenditures on all consumer durables, including housing. One would also expect, however, that the cash saving rate, which contains no expenditures on durable goods, would be the most likely to show a positive relation with the interest rate. It might be possible to find a hint of such an outcome in equations 5-3, 5-6, and 5-9. Judging by the coefficient values alone, a 1 percentage point increase in the after-tax interest rate increases the FF and NIPA saving rates by 0.15 percentage point (say, from 6 percent to 6.15 percent), while the corresponding increase for the cash saving rate is 0.4 percentage point. These are small compared with Boskin's point-for-point outcome; none of them is anywhere near statistical significance. In fact, no coefficient on the interest-rate variable in table 5 has a t-statistic greater than 0.84. From the table it seems that no personal saving rate—whether cash or some other form—responds to variations in the real after-tax rate of return.

In the following section we investigate the determination of cash saving in more detail by bringing together the most promising aspects of the research reviewed above.

A Closer Look at Loanable-Funds Saving

One framework that has been used successfully for the analysis of saving is the Houthakker-Taylor model as expanded by the work of Juster, Wachtel, and others to include consideration of the effects of inflation—an issue long discussed in the work of Katona.[32] We apply a similar frame-

32. Some of the relevant work of Juster and Wachtel has already been cited. See also George Katona, *The Powerful Consumer: Psychological Studies of the American Economy* (McGraw-Hill, 1960).

work, with further modification, to the analysis of cash or loanable-funds saving. The theory underlying the Houthakker-Taylor analysis implies an estimating equation of the form (including the stochastic error term, u)

$$S = a_1 S_{-1} + a_2 \Delta Y + a_3 \Delta R + u \tag{18}$$

if the level of income, Y, and the interest rate, R, determine the desired or equilibrium level of personal wealth. To this basic model we add the disaggregation of income (from the work of Taylor), expectations about inflation and uncertainty regarding inflation (from Katona, Juster, and others), the interrelations of personal and nonpersonal saving (the ultra-rationality hypothesis from David and Scadding), and our own views on the most appropriate definitions of the saving and income flows.

To cover all these issues we must rely on annual data for the calculation of cash or loanable-funds saving and the corresponding cash income flows. Earlier successes with the Houthakker-Taylor saving model, by Taylor himself and by Juster in the incorporation of inflation variables into the analysis, have been achieved within the framework of quarterly data. If a calendar quarter is the appropriate time frame from the viewpoint of the underlying economic behavior, the use of calendar-year data as though they were quarterly data involves a time-aggregation error of specification that is potentially serious. If we begin with 18 for the basic equation with quarterly data and average the four successive quarters referring to a given year, say 1970, we obtain

$$\begin{aligned} \bar{S}_{70} = {} & a_1 S_{69:4-70:3} + a_2 \frac{1}{4}(Y_{70:4} - Y_{69:4}) \\ & + a_3 \frac{1}{4}(R_{70:4} - R_{69:4}) + \bar{u}_{70}. \end{aligned} \tag{19}$$

The dependent variable, $\bar{S}$, is saving for calendar year 1970 as usually measured (assuming the quarterly flow data are seasonally adjusted at annual rates). But the lagged dependent variable is now a calendar year of saving defined over the four quarters from 1969:4 to 1970:3, and the quarterly change variables (ΔY and ΔR in the original equation) are transformed into changes measured from 1969:4 to 1970:4.[33] Plainly, this is not the same set of independent variables that would result from

33. If the quarterly error term, u, is homoscedastic and serially independent, so is the average calendar-year error term, $\bar{u}$. If u is first-order serially correlated, the serial properties of $\bar{u}$ are considerably more complicated.

the use of calendar-year data on all variables, and we know of no way to derive an equation using calendar-year saving as the dependent variable that does not also require observations on within-year data (assuming that the quarterly specification is appropriate). In order to use the saving and income concepts defined in tables 1 through 4, we are limited to calendar-year data. The same is not true of data on the interest rate (and inflation). Changes in the interest rate are readily available, as shown in the aggregated equation 19 above. We experimented with annual equations of the following two types:

(20-A)
$$\bar{S}_{70} = a_1^* \bar{S}_{69} + a_2^*(Y_{70} - Y_{69}) + a_3^*(R_{70} - R_{69}) + a_4^*(\pi_{70} - \pi_{69}) + \ldots$$

(20-B)
$$\bar{S}_{70} = a_1^{**} \bar{S}_{69} + a_2^{**}(Y_{70} - Y_{69}) + a_3^{**}(R_{70:4} - R_{69:4}) + a_4^{**}(\pi_{70:4} - \pi_{69:4}) + \ldots$$

Almost uniformly, the type B forms that employ "proper aggregation" for interest rate and inflation variables outperform the type A forms when judged on the basis of overall fit and the significance of the interest rate and inflation variables as a set. In addition—and of greatest importance—the conclusions that would be drawn about the significance of the interest rate are not sensitive to whether type A or type B equations are estimated. The measurement of the effects of the interest rate is sensitive to the inflation and ultrarationality issues but not to whether changes in the interest rate are measured on the basis of a calendar year or from fourth quarter to fourth quarter.[34] The results given below correspond to the type B form of the equation.

The income decomposition used by Taylor follows the NIPA breakdown shown in 9. We begin instead with the definitions

(21)
$$YCASH = LPCASH + TRCASH + SI - TX$$

(22)
$$YCNC = YCASH + IMP + FRINGE,$$

34. The time aggregation may even have some advantages. Suppose the quarterly framework is correct, but that the interest rate enters as ΔR_{-1}, rather than ΔR. The use of ΔR could produce serious errors in the parameter estimates of the incorrectly specified quarterly equation. In contrast, the use of $(R_{70:4} - R_{69:4})$ rather than the appropriate $(R_{70:3} - R_{69:3})$ in the type B annual equation may involve a minor specification error compared to the corresponding error in the quarterly equation.

where

$YCASH$ = personal cash receipts after tax (table 3)
$LPCASH$ = labor and property cash income (defined implicitly in 21 above)
$TRCASH$ = cash transfers to individuals (the sum of government transfers and benefits paid from private pension and insurance funds (the latter shown in table 3)
SI, TX = as in 9
$YCNC$ = personal cash and noncash receipts after tax (table 3)
IMP = imputations (table 3)
$FRINGE$ = employer contributions for social insurance and private pension and insurance funds (table 3).

We then combine 21 and 22 to obtain

$$YCNC = LPCASH + TRCASH + (SI + FRINGE) + IMP - TX \tag{23}$$

as our basic income decomposition. A number of fundamental differences between our components and the NIPA components are of interest. *LPCASH* excludes imputations, personal contributions for social insurance, and the change in reserves of private pension and insurance funds; *LP* includes all three.[35] *TRCASH* includes social insurance benefit payments (as does *TR*) and private pension and insurance benefit payments that are logically similar. The variable ($SI + FRINGE$) includes payments to private and social pension and insurance funds made on behalf of individuals, as well as the social insurance payments made by the individuals.

To address the issue of ultrarationality, we modify the Houthakker-Taylor saving model in the following way. We first define aggregate personal income, Y^T, as

$$Y^T = YCNC + \theta_1 BCS + \theta_2 GCS, \tag{24}$$

where

BCS = business cash saving
GCS = government cash saving.

This formulation allows for the possibility that individuals impute to themselves the fraction θ_1 of business cash saving and the fraction θ_2 of

35. *LPCASH* (and *LP*) includes personal contributions for private pension and insurance plans that we were unable to separate.

government cash saving as income. Similarly, aggregate personal saving is defined as

$$S^T = S + \mu_1 BCS + \mu_2 GCS, \tag{25}$$

where S is personal cash saving. Again, the coefficients μ_1 and μ_2 are presumably nonnegative, but their values are not prescribed a priori. If households perceive that some fraction of the saving of business and government ultimately accrues to them as individuals, that would imply $0 < \mu_1 \leq 1$ and $0 < \mu_2 \leq 1$.

We then assume that the saving decision is described by

$$S^T = d_1 Y^T + d_2(W^* - W_{-1}), \tag{26}$$

where

W = personal cash wealth
W^* = desired personal cash wealth.

Thus we postulate two major determinants of saving: the level of income, broadly defined, and the discrepancy between desired and actual personal cash wealth. Finally, following Houthakker and Taylor, desired wealth is specified as

$$W^* = b_1^* Y^T + b_2^* R. \tag{27}$$

When 24 through 27 are combined and differenced to eliminate the stock of personal cash wealth, the saving equation that forms the basis of our empirical work is obtained:

$$\begin{aligned} S = {} & (d_1 + d_2 b_1^*)\Delta YCNC + d_2 b_2^* \Delta R + (1 - d_2)S_{-1} \\ & + [\theta_1(d_1 + d_2 b_1^*) - \mu_1]\Delta BCS + [\theta_2(d_1 + d_2 b_1^*) - \mu_2]\Delta GCS. \end{aligned} \tag{28}$$

The equation for personal cash saving that we propose to estimate can now be written as

$$\begin{aligned} S = {} & a_0 + a_1 S_{-1} + a_2\Delta(LPCASH) + a_3\Delta(TRCASH) \\ & + a_4\Delta(SI + FRINGE) + a_5\Delta(IMP) + a_6\Delta(TX) \\ & + a_7\Delta(BCS) + a_8\Delta(GCS) + a_9\Delta(Baatax - \pi) \\ & + a_{10}\Delta(\pi) + a_{11}\Delta(SD) + u. \end{aligned} \tag{29}$$

The dependent variable, S, is calendar-year personal cash saving measured in 1967 dollars per capita; the income components are changes in calendar-year values measured in 1967 dollars per capita; and the interest rate and inflation are measured as changes from fourth quarter to fourth quarter as in 20-B. The variable *BCS* is business cash saving as defined in table 2 above, and *GCS* is cash saving of the federal government, defined as the government surplus (NIPA basis) minus the surplus in the social insurance account. Both *BCS* and *GCS* are measured in 1967 dollars per capita.

The variable *BCS* is directly relevant to the ultrarationality argument of David and Scadding. This hypothesis maintains that business saving is viewed by the rational consumer as a component of income and saving, with θ_1 and μ_1 both equal to unity. Thus we should find that $a_2 = a_7 - 1$, provided that the coefficient of labor and property cash income is also appropriate for the business cash saving component of income.[36] David and Scadding do not consider government cash saving to be a substitute for personal cash saving; rather, they propose that government saving and private investment are substitutes. We take an agnostic position on this issue and include government cash saving in the saving function.

The variable ($SI + FRINGE$) is relevant to the controversy between Feldstein and Barro about whether social security depresses personal saving.[37] This variable combines the corresponding social and private contributions because it seems unlikely that individuals are more aware of their social security rights than they are of their private pension rights.

The result of estimating the personal cash saving equation as specified in 29 is shown in table 6. The estimate shown in 6-1 was obtained using annual data for the period 1951–74. Several variations of the basic equation were also examined. Equation 6-2 gives the results when the variables for inflation and uncertainty are omitted. When the cash saving variables for business and government are deleted, the results shown in 6-3 are obtained. Finally, 6-4 indicates what happens when the sample is limited to the 1955–74 period.

The overall impression that emerges from these parameter estimates can be characterized as follows. The coefficients of the income components are broadly consistent with previous results but not all are estimated with sufficient precision to warrant sharp distinctions. Business and gov-

36. This follows directly from 28 in which a_2 is identified as $d_1 + d_2b_1^*$ and $a_7 = d_1 + d_2b_1^* - 1$ if $\theta_1 = \mu_1 = 1$.

37. This may be viewed as another part of the ultrarationality argument. See Feldstein, "Social Security, Induced Retirement, and Aggregate Capital Accumulation," and Barro, *The Impact of Social Security on Private Saving*. Feldstein claims that social security depresses personal saving; Barro says the claim is unwarranted.

Table 6. Personal Saving Equations Based on Authors' Income Decomposition, 1951–74

Equation, sample period, and concept of saving		Constant	S_{-1}	Δ (*LPCASH*)	Δ (*TRCASH*)	Δ (*SI* + *FRINGE*)	Δ (*IMP*)	Δ (*TX*)
			Independent					
6-1	Personal cash	−4.657	0.550	0.278	0.682	−0.842	−0.693	−0.121
1951–74		(−0.61)	(4.05)	(2.75)	(1.73)	(−1.73)	(−0.60)	(−0.49)
6-2	Personal cash	−3.068	0.649	0.369	0.082	0.327	−0.550	−0.562
1951–74		(−0.31)	(3.63)	(2.80)	(0.17)	(0.43)	(−0.35)	(−2.12)
6-3	Personal cash	−7.403	0.355	0.095	1.390	−1.573	0.634	0.233
1951–74		(−0.61)	(1.79)	(0.78)	(2.54)	(−2.26)	(0.41)	(0.79)
6-4	Personal cash	−8.274	0.609	0.387	0.893	−0.848	1.444	−0.475
1955–74		(−0.92)	(5.23)	(4.35)	(2.34)	(−2.16)	(1.32)	(−2.28)
6-5	NIPA personal	27.547	0.771	0.344	0.573	−0.671	−0.819	−0.363
1951–74		(1.60)	(5.46)	(3.38)	(1.59)	(−1.42)	(−0.72)	(−1.33)
6-6	FF personal	2.391	0.894	0.521	0.810	−0.643	−2.037	−0.387
1951–74		(0.27)	(12.88)	(6.15)	(3.03)	(−1.50)	(−1.97)	(−1.72)

Sources: Derived from data in the national income and product accounts (NIPA) of the U.S. Department of Commerce. In addition, *S* uses data from the flow-of-funds accounts (FF) of the Board of Governors of the Federal Reserve System. For definitions and sources of *Baatax*, π, and *SD*, see table 5.

a. *TRCASH* is cash transfers to individuals; *SI* is personal contributions for social insurance; and *TX* is personal tax and nontax payments. *LPCASH* is labor and property income and equals personal cash receipts after tax (defined in table 3) minus *TRCASH* and *SI*. *FRINGE* is employer contributions for social insurance and private pension and insurance funds; *IMP* is the NIPA imputations included in table

ernment cash savings are significant determinants of personal cash saving. Neither the real interest rate nor the rate of inflation is an important determinant of personal cash saving, but the uncertainty with which inflationary expectations are held is in itself a significant determinant of saving.

When we compared 6-1 and 6-4 for instances of coefficient instability between 1951–74 and 1955–74, we found the following. The variables S_{-1}, (*SI* + *FRINGE*), and *SD* are highly significant and their coefficients are robust with respect to sample period. *LPCASH* is highly significant, and although its coefficient increases from about 0.3 to about 0.4 when the early years are dropped from the sample, the change is clearly not statistically significant. The coefficient of the imputations variable, *IMP*, is particularly unstable, but the variable is insignificant. The tax variable, *TX*, is insignificant in the full sample period (6-1) but is quite significant in the 1955–74 period (6-4) when its absolute value differs little from the coefficient of labor and property cash income, *LPCASH*. It is also clear that the size of the coefficient on tax payments is heavily dependent on whether or not the inflation variables are included, indicating an obvious correlation between real taxes and inflation.

The variable measuring cash receipts from social and private pensions and insurance, *TRCASH*, has a marginally significant coefficient of about shorter sample period yields a corresponding effect of 19 cents. These results indicate that there is less than complete substitution of government saving for personal saving.

The evidence on social plus private pensions and insurance seems to favor the view that there is substitution between (*SI* + *FRINGE*) and personal cash saving. However, the estimate of this effect is quite sensitive to whether the inflation variables appear in the equation.

Finally, we turn to the major question of whether there exists an interest rate effect. By this time we think it is unlikely. In the presence of our income decomposition and the variables measuring cash saving by business and government, inflation, and uncertainty, the interest rate is clearly insignificant. Indeed, the real after-tax interest rate is insignificant even if we drop the expected inflation and uncertainty variables (π, *SD*) or the variables for business and government saving (*BCS, GCS*). It is possible that equations indicating a strong effect of the interest rate on saving give inadequate attention to nonpersonal saving and inflation. An obvious negative correlation exists between *BCS* and the interest rate because higher interest charges reduce profits; and there is a positive correlation between the interest rate and the inflation rate. This implies the potential for spurious correlation with a vengeance.

For the sake of completeness, we review the last two equations in table 6. Equation 6-5 presents the results obtained using NIPA personal saving as the dependent variable, and 6-6 shows the results for FF personal saving. We have argued that neither of these saving concepts is relevant for an analysis of the supply of loanable funds. In any event, these equations show that our result for the interest elasticity of saving is not unique to our use of personal cash saving. Neither NIPA saving nor FF saving shows a significant effect of the interest rate. Indeed, as we anticipated earlier when we discussed the effect of including durable goods and purchases of homes in these saving concepts, the coefficients on the interest rate in these equations are both negative, with FF saving having a particularly high value.

Principal Findings

In this article we address the interest sensitivity of the resources that individuals make available for financing business capital formation. We argue that neither of the traditional measures of saving, NIPA personal

and Subperiod[a]

variable					Summary statistic		
Δ (*BCS*)	Δ (*GCS*)	Δ (*Baatax-π*)	Δ (*π*)	Δ (*SD*)	Durbin-Watson	$\bar{R}^2$	Standard error of estimate[b]
−0.484 (−2.10)	−0.336 (−4.04)	7.079 (0.69)	−0.724 (−0.07)	29.966 (3.12)	2.00	0.908	12.45
−1.014 (−4.25)	−0.394 (−3.61)	−3.344 (−0.76)	...	...	2.36	0.833	16.75
...	...	14.853 (0.92)	−2.469 (−0.16)	51.547 (4.08)	1.76	0.766	19.82
−0.701 (−3.66)	−0.191 (−2.18)	8.469 (0.96)	0.348 (0.04)	26.247 (3.24)	2.01	0.955	9.15
−0.169 (−0.78)	−0.288 (−3.56)	−1.455 (−0.14)	−7.228 (−0.72)	23.549 (2.42)	1.99	0.919	12.15
−0.095 (−0.50)	−0.085 (−1.15)	−11.286 (−1.22)	−22.177 (−2.45)	20.681 (2.29)	2.25	0.974	11.00

3; *BCS* is business cash saving as defined in table 2; and *GCS* is the NIPA government surplus less the surplus on the social insurance account. *S* is either personal cash, FF personal, or NIPA personal saving, as defined in table 1. All the above variables are expressed in real (1967 dollars), per capita terms. Δ(*LPCASH*), Δ(*TRCASH*), Δ(*SI* + *FRINGE*), Δ(*IMP*), Δ(*TX*), Δ(*BCS*), and Δ(*GCS*) are first differences of calendar-year data. Δ(*Baatax-π*), Δ(*π*), and Δ(*SD*) are measured as changes from fourth quarter to fourth quarter. The numbers in parentheses are *t*-statistics.

b. In 1967 dollars per capita.

0.7 in the full sample, but a clearly significant coefficient of about 0.9 for 1955–74. This may not be much of a mystery because the coefficients are insignificantly different from unity in each of the periods; if 1.0 is the true value, in the short run every dollar reduction in pension and insurance benefits results in a dollar reduction in cash saving.

Table 6 contains some important results for the ultrarationality hypothesis. For the full sample (6-1) the point estimate implies that a one dollar increase in business cash saving reduces personal cash saving by about 48 cents. The corresponding result for the 1955–74 period indicates a substitution of about 70 cents. In either case it is not possible to reject the hypothesis that business cash saving is regarded as both "personal" income and "personal" saving in the sense of David and Scadding. A formal statement of this rationality hypothesis is $a_2 - a_7 = 1$ in equation 29, on the assumption that business cash saving is viewed as an addition to labor and property income. The data do not reject this hypothesis for either sample period. Government cash saving also has a significant negative impact on personal cash saving, although it is somewhat less pronounced than the business saving effect. The point estimate in equation 6-1 implies a reduction of 34 cents in personal cash saving per dollar increase in government saving in the full sample period. The saving or FF personal saving, is the appropriate empirical counterpart for personal loanable-funds saving. We believe that the appropriate loanable-funds concept is personal cash saving, which, unlike NIPA and FF saving, excludes expenditures on both owner-occupied buildings and consumer durables.

If this view is correct, the empirical evidence of previous studies is not directly relevant to the major question regarding interest-sensitivity. Virtually all the studies of which we are aware are concerned with the more traditional saving concepts. Our review of previous research produces a number of reasons to question the conclusion that there is a significant positive relationship between personal saving, however defined, and the rate of interest. The sensitivity of these empirical results to small variations in the sample period, to the definitions of variables, and to the dynamic specification of the saving equation weaken substantially our confidence in such results. Moreover, none of the previous studies we reviewed has dealt adequately with the ultrarationality hypothesis discussed by David and Scadding.

Based on this review and our empirical work we conclude that David and Scadding were correct in claiming that the current data uphold Denison's law. Stated more conservatively, the data we examined are consistent with the following formulation of the equilibrium function for personal loanable-funds saving:

$$S \cong d_1(YCNC + \theta_1 BCS + \theta_2 GCS) - \mu_1 BCS - \mu_2 GCS. \tag{30}$$

Our empirical results are consistent with $\theta_1 = \mu_1 = 1$, but not with $\theta_2 = \mu_2 = 1$; rather, they suggest that θ_2 and μ_2 are less than unity but not zero. Thus the results are not in conflict with the proposition that business saving is a nearly perfect substitute for personal saving. Government saving is also apparently viewed as a substitute for personal saving, though not to the same extent as is business saving. In general, the parameter estimates are sensitive both to the sample period used and to the way inflation and uncertainty are treated, but the following approximation appears to tell the essence of the story. With $\mu_1 \cong 1$ and $\theta_1 \cong 1$, equation 30 can be rewritten as

$$\frac{S + BCS}{YCNC + BCS} \cong d_1 + (d_1\theta_2 - \mu_2)\frac{GCS}{YCNC + GCS}. \tag{31}$$

This implies that the gross private loanable-funds saving rate is approximately constant in the long run. Approximate constancy follows both because $(d_1\theta_2 - \mu_2)$ is estimated to be small and because *GCS* is negligible in comparison with $(S + BCS)$. Over the 1951–74 period, for example, *GCS* averaged only 8 percent of the average value of gross private loanable-funds saving. Equations 30 and 31 neglect short-run variability arising from variability in the relative shares of the components of total income and in changes in uncertainty about inflation.[38] As for the major question, there simply is no strong evidence that loanable-funds saving can be manipulated by policy aimed at changing the after-tax rate of return to saving.

Our nonresult—that we have been unable to isolate a significant interest rate effect—is not surprising. There are good reasons to find the nonresult believable. The microeconomic theory of saving permits any effect from interest rates (positive, negative, or none) for a net saver, and the net cash savers surely outweigh the net cash dissavers. Two factors in our analysis cancel the positive effect of the interest rate that others have found. The first is the effect of inflation on saving. Taking advantage of the recently developed option of measuring both expectations and uncertainty about inflation, we find evidence in support of the proposition long espoused by Katona, Juster, and others. The incentive to "save for a rainy day" has a strong effect when uncertainty (*SD*) increases. And it is easy to see how the interest rate could enter the picture as a proxy for the direct influence of uncertainty effects in saving equations. The second factor is ultrarationality: the apparent substitutability between direct personal saving and saving done "on an individual's behalf" by the business sector. One could argue, we suppose, that the significance of business cash saving derives from sources unrelated to ultrarationality; for example, times are bad or are getting bad when *BCS* declines, so individuals save more. Because *BCS* has a greater negative impact on saving in the absence of *SD* than when *SD* is present in the saving function (table 6), the possibility exists that the *BCS* variable represents the reaction to uncertainty. But *SD* should and apparently does pick that up and still leaves *BCS* with a statistically significant effect. And even if the *BCS* effect does not measure ultrarationality, but rather a different aspect of uncertainty than that contained in *SD*, it is clearly doing so better than the interest rate with

38. Variation in income components relative to total income and in the inflation variables are obviously more detailed, and perhaps behavioral, alternatives to adjusting for the business cycle by means of the unemployment rate or the GNP gap.

which it is correlated. It is difficult to turn the argument around and claim that there is an important effect of the rate of return that is better measured by *BCS* than by the rate of return itself.

There are many good reasons for tax reform, but there is no good evidence to support the view that a positive interest elasticity of loanable-funds saving is one of them.