Articles

New Directions in the Relation Between Public and Private Debt

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Until the 1980s the outstanding indebtedness of government and private-sector borrowers in the United States exhibited sufficient negative covariation that total outstanding debt remained steady relative to nonfinancial economic activity. Three hypotheses—one based on lenders' behavior, one on borrowers' behavior, and one on credit market institutional arrangements—provide potential explanations for this phenomenon. Since 1980 the U.S. debt markets have departed from these previously prevailing patterns, however, as both government and private borrowing have risen sharply.

THE EMERGENCE DURING THE 1980S OF PERSISTENT U.S. government budget deficits on a scale unprecedented in the nation's prior peacetime experience, coupled with a strong increase in borrowing both by businesses and by individual Americans, has focused renewed attention on the long-standing question of what relation, if any, connects the economy's public- and private-sector indebtedness.

This unusual set of developments raises scientific questions as well as questions of public policy. The most widely discussed issue at the policy level has been the concern that so large a federal deficit, persisting even at near-full employment, is impairing the economy's long-run growth and competitiveness by absorbing so much saving as to "crowd out" investment in productive new plant and equipment. The private sector's mounting indebtedness has also raised concerns of financial fragility, in that business and individual borrowers may not be able to meet their obligations in the event of disappointing growth in their cash flows.

At a more fundamental level, this departure from previously prevailing regularities offers an opportunity to gain new perspectives on the underlying behavior of borrowers and lenders. Economics, after all, is not a laboratory science. Controlled experiments are impossible at the macroeconomic level, and the data available for empirical analysis, generated as they are by the complex interaction of market dynamics, government policies, and external shocks, too often exhibit insufficient variation to unravel the diverse causal forces at work. Observed outcomes exhibiting variation well outside the range of prior experience present new opportunities as well as new challenges.

Until the 1980s, a long-standing regularity characterizing the U.S. debt markets was that public- and private-sector borrowing exhibited sufficient negative covariation over time, both cyclically and secularly, that the combined indebtedness of all borrowers remained roughly steady in relation to U.S. nonfinancial economic activity. Yet there is no a priori reason why public and private debt need covary negatively, or why total debt outstanding need be constant in relation to income. Why then did these relations obtain for so long? Did they reflect the behavior of borrowers, lenders, or both? What implications do plausible hypotheses about borrowers' or lenders' behaviors in this context bear for other unsettled questions about economic behavior, or for policy issues like how government deficits affect private capital formation, or what level of private-sector indebtedness would threaten the economy's financial stability?

The sharp departure from prior relations exhibited by the U.S. debt markets since 1980 should now make it easier to answer questions like these. Given economists' limited opportunities to observe the phenomena they study, explanations for change are more accessible and more readily testable than explanations for invariance. If so major a feature of the U.S. financial system has now changed so markedly, then something else—plausibly related to financial outcomes through understandable representations of economic behavior—must have changed as well. Establishing the central connections involved, and exploring their implications for other behavioral and policy questions, is a research challenge of substantial importance. In economics as in other disciplines, diagnosis must precede prescription.

Public and Private Debt Before the 1980s

The stable pre-1980 relation between debt and economic activity is illustrated in Fig. 1, where the year-end credit market indebtedness of all U.S. obligors other than financial intermediaries, expressed as a percentage of fourth-quarter gross national product (GNP) (seasonally adjusted), is plotted for the period since the end of the Korean War (*1*). From 1953 to 1980 the economy's total debt ratio fluctuated narrowly, with mean 137.1% (that is, just over $1.37 of debt for every $1 of GNP), standard deviation 2.9%, high 142.8% (in 1964), and low 131.5% (in 1956). What little fluctuation occurred mostly followed the business cycle, with the debt ratio typically rising a point or two in recession years (when GNP, in the denominator, was below trend) and falling back during expansions. There is no evidence of any time trend.

This stability in the total debt ratio stands in contrast to the variation of the five underlying sector components shown in Fig. 1, which exhibited substantial variation throughout this period. In brief, the secular post-war rise in private debt outstanding largely mirrored a major decline (relative to GNP) in public debt, while cyclical bulges in public debt issuance (mostly due to recession-induced shortfalls of tax revenues) had their counterpart in recessionary reductions in private borrowing (*2*).

In Fig. 2 a broader historical perspective is shown with similar

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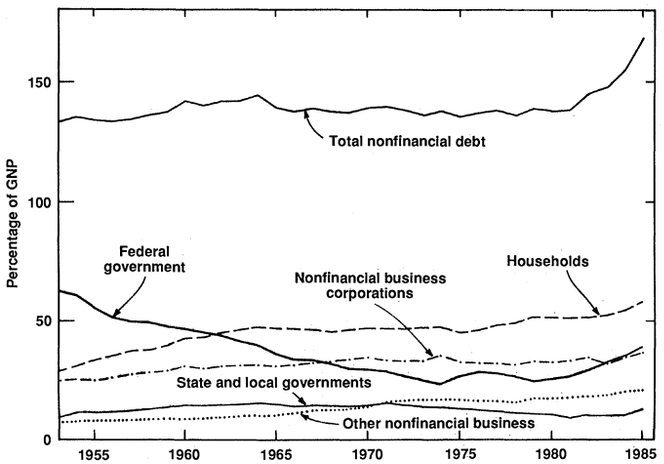

Fig. 1. Outstanding debt of U.S. nonfinancial borrowers, 1953–1985.

data plotted beginning with the 1920s. For this longer sample as well, there is no evidence of any time trend in the total debt ratio. The 1921–1930 mean of 133.2% differs only marginally from the mean of 137.0% for 1971–1980. During these six decades the ratio rose significantly only during the depression years 1931 to 1935, when GNP had declined sharply and much of the private-sector debt on record had defaulted de facto (*3*). By comparison, World War II appears as only a minor episode from this perspective, since the enormous wartime bulge in federal debt was largely offset by a sharp decline in the relative indebtedness of borrowers in the economy's private sector.

What makes this stability of the total debt ratio especially striking is that it did not represent merely a sum of individually stable parts. The indebtedness of specific borrowing sectors exhibited substantial fluctuation, but typically in a sufficiently offsetting way that the total debt ratio stayed close to the norm of about 135%. In short, the respective sectors' debt ratios jointly exhibited substantial negative covariation over time.

The dimension of this negative covariation that bears most directly on key questions of economic behavior and public policy is that between public- and private-sector debt. This comovement is summarized by simple correlation coefficients relating the federal government's debt ratio to several different measures of the private sector's debt ratio, again based on year-end data (Table 1). The evidence of negative covariation persists between 1921 and 1980 as a whole and for several different subperiods (including one omitting the depression years), thereby indicating that the offsetting behavior of public and private debt before the 1980s was not due merely to a few outlier observations. Regression analysis, allowing for time trends and other factors like the use of GNP to scale the data, also show similar evidence.

Explaining the Stable Debt Ratio

There is no known reason, based on strictly a priori grounds, why an economy's outstanding public- plus private-sector debt need bear any specific relation to its level of output or income. Especially in an economy like that of the United States, both businesses and individuals can finance their activities in a rich variety of ways. In choosing whether to use their own or borrowed funds, and in the case of businesses whether to raise debt or equity, they presumably take into account not only market yield relations but also considerations like credit availability, tax rates, economy-wide risk levels, bankruptcy arrangements, and so on. Many of these basic determinants of private borrowing decisions have undergone major change over the course of this century and even just within the post-war period. Government at all levels also typically has broad latitude to spend much or little in relation to economic activity and to finance that spending through varying combinations of taxing and borrowing. The regularity highlighted in Figs. 1 and 2 is the more striking in that neither government nor private-sector borrowers make the decisions that determine their outstanding debt in a way that would necessarily impose any constancy in the relation of their combined debt to GNP, or that would necessarily enforce a negative covariation between public and private debt outstanding.

For every borrower, of course, there must be a lender. Throughout most of this century—again, until the 1980s—the United States ran an approximately balanced current account in its international economic relations, so that the funds supplied to the U.S. markets by foreign investors just about balanced the funds supplied abroad by U.S. investors (*4*). Hence the total borrowing done by U.S. borrowers approximately equaled the total lending done by U.S. lenders, so that the steady relation to GNP exhibited by total debt owed was also characteristic of total debt held. Just as in the case of borrowers, however, there is no a priori reason why an economy's lenders need invest their portfolios in such a way that their aggregate holdings of debt assets bear any specific relation to the economy's output or income.

Not only is there no a priori reason to account for the negative comovement of public and private debt that underlaid the U.S. economy's stable total debt ratio for so many years, but international comparisons indicate that other developed economies around the world have not exhibited so strong a regularity over time in this regard (*5*). Some behavioral factor (or factors) must therefore have been at work to bring about this phenomenon in the United States. Because of the U.S. economy's roughly balanced foreign position for many years, and hence the approximate equality between total debt owed and total debt held, whatever was responsible could have worked through the behavior of either borrowers or lenders, or both. Distinguishing among the several competing explanations for these phenomena is especially important in that different hypotheses carry different implications for major public policy issues like the effects of large government deficits and the risks of higher levels of private-sector debt.

A Hypothesis About Lenders' Behavior

The most straightforward available explanation for the U.S. economy's stable total debt ratio—and hence for the negative covariation between public and private debt, given any source of independent fluctuation in either—emerges on the addition of some strong assumptions about the substitutability of various categories of assets to standard economic representations of portfolio behavior. At least in principle, these assumptions, and hence the hypothesis to which they give rise, are empirically testable. The central question at issue is whether investors treat debt and other assets as close or distant substitutes in their portfolios.

The starting point for the construction of an applicable hypothesis about lenders' behavior is a familiar implication of Modigliani's "life cycle" hypothesis of saving: in a mature (albeit growing) economy with a stable population age distribution, individuals will save out of their incomes in such a way that the economy's aggregate accumulated wealth remains stable in relation to aggregate income (*6*). Although the U.S. population's age structure has varied during this century, most notably with the post–World War II "baby boom," the U.S. economy's aggregate wealth-to-income ratio has hovered near three-to-one for many decades (*7*). Given this stable wealth-to-

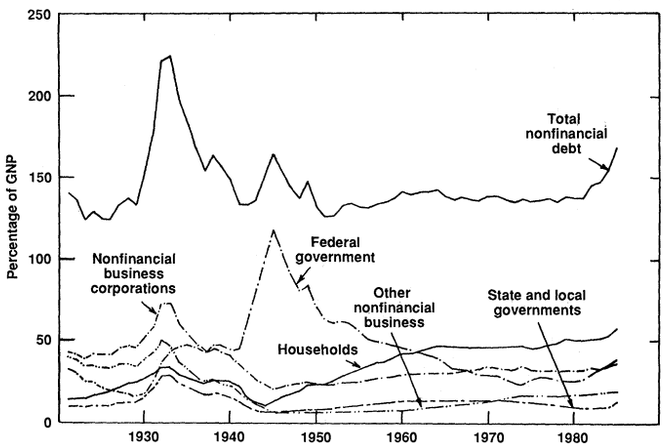

Fig. 2. Outstanding debt of U.S. nonfinancial borrowers, 1921–1985.

income ratio, a stable debt-to-income ratio is equivalent to a stable share of debt assets in the economy's aggregate wealth portfolio.

According to the standard theory of risk-averse portfolio behavior, investors allocate their portfolios to maximize expected return while minimizing risk. If two or more assets expose investors to similar risks, then investors will regard them as close substitutes and will simply choose whichever bears the greatest expected return. Stability in the portfolio shares allocated to assets that are close substitutes would therefore occur only if these assets' respective expected returns were always approximately equal, and even then only by chance.

By contrast, if two or more assets expose investors to highly disparate risks, then investors will regard them as only weak substitutes (or not as substitutes at all) and will prefer to hold such assets in whatever respective proportions reduce their overall risk posture. As long as investors are at least moderately risk-averse—as the available evidence indicates—stability in the portfolio shares allocated to assets that are no more than weak substitutes would occur even if these assets' respective expected returns varied widely compared to one another over time.

Expected asset returns are not observable, but realized returns are. Given the large systematic variation observed over time in the respective returns on different classes of assets in the United States (and in other countries too), it is implausible to suppose that investors' expectations of these returns do not fluctuate in relation to one another also. In that case, investors would hold different kinds of assets in roughly constant portfolio shares only if they regarded those assets as at best weak substitutes. More specifically, if investors regard debt securities as weak substitutes for other assets, including equities as well as real estate and tangibles, then over time they will allocate a stable share of their portfolios to holding debt, despite sometimes even wide variations in expected debt returns relative to expected returns on other assets. Given the economy's stable aggregate wealth-to-income ratio, the resulting stability of the share of total wealth that investors devote to holding debt assets will in turn imply a stable aggregate debt-to-income ratio.

Since the aggregate of debt held equals the aggregate of debt issued, the resulting stable ratio of total lending to income implies a stable ratio of total borrowing to income. The market mechanism that translates the stable ratio for debt held into a stable ratio for debt owed is just the movement of interest rates necessary to equate total demand and total supply in the debt market. A bulge in supply by any one borrower leads to higher interest rates, because of lenders' limited willingness to hold debt, and so causes other interest-sensitive borrowers to reduce their supply. Hence there will be negative comovements over time among the debt ratios of

Table 1. Simple correlations of public and private debt ratios, 1921–1980.

Private sectors included	1921–1980	1921–1930 1936–1980	1921–1952	1953–1980
All nonfederal	−0.71	−0.91	−0.71	−0.98
Business and household	−0.75	−0.93	−0.75	−0.98
Business only	−0.52	−0.66	−0.77	−0.98
Household only	−0.47	−0.48	−0.38	−0.92

individual borrowing sectors if any one or more sectors behave independently in this regard—for example, if wartime defense spending increases government borrowing or a demographically driven surge of homebuilding increases individuals' borrowing.

Is it plausible to suppose that U.S. investors, on average, treat debt securities as at best only weak substitutes for other assets? To the extent that the variation over time of realized asset returns exhibits a combination of systematic and unsystematic components, and that investors treat observed experience as at least a partial guide to the probabilities associated with future returns, data on realized returns admit inferences about perceived asset risk structures and hence, via standard portfolio theory, imply asset substitutabilities. Figure 3 shows the annual record of after-tax after-inflation returns from 1953 to 1985 on three major classes of financial assets in the United States: short-term debt, long-term debt, and equities (*8*). These returns are clearly positively correlated. (The simple correlation coefficients are 0.54 between short- and long-term debt, 0.50 between short-term debt and equity, and 0.53 between long-term debt and equity.) What matters for portfolio behavior is not realized returns and the associated variances and covariances, however, but expected returns and the risk perceptions associated with them. Before drawing inferences about asset substitutabilities, it is therefore necessary to separate out the expected and unexpected components in these series. The results of such empirical efforts to date, mostly based on data excluding the 1980s, have been mixed (*9*). It is too early to judge how the introduction of new data, incorporating sharp departures from prior relationships, will affect future analyses conducted along these lines.

A Hypothesis About Borrowers' Behavior

An alternative explanation for the pre-1980s stable total debt ratio and associated negative public-private debt covariation focuses on the behavior of borrowers. The central assumptions required for this

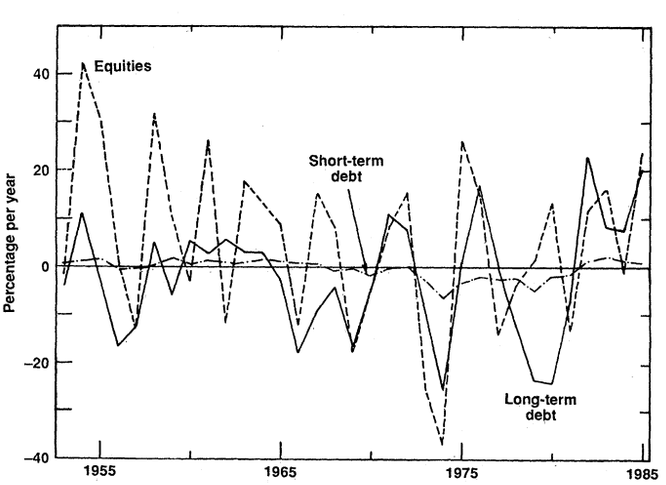

Fig. 3. After-tax real returns on financial assets, 1953–1985.

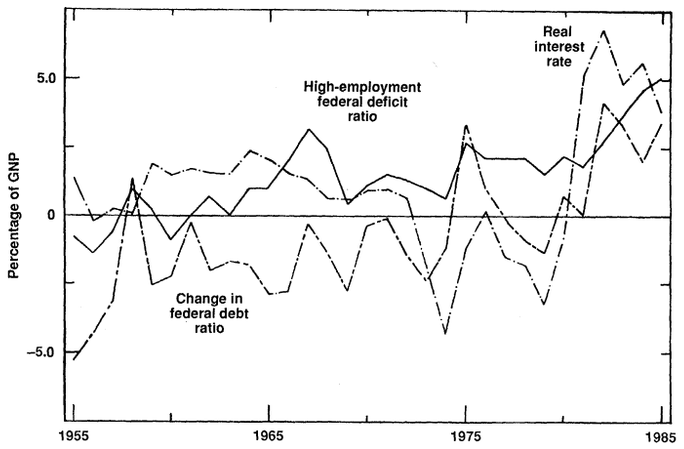

Fig. 4. Real interest rates and government borrowing, 1955–1985.

hypothesis pertain to borrowers' perceptions, as well as to their willingness to incur risk. Once again, at least in principle these assumptions are testable.

The starting point for a hypothesis along these lines is the pair of assumptions that borrowers are averse to the risks inherent in owing money and that they gauge these risks at least in part according to the relation between their outstanding debt and their incomes (*10*). Debt default and bankruptcy typically involve costs to borrowers as well as to lenders, usually involving the borrower's loss of control over either personal or business assets and consequent inability in many cases to proceed with ongoing affairs in a normal fashion (often with resulting human dislocations and loss of built-up intangible capital). Gauging the risk of indebtedness in relation to income is also a familiar idea, although it is not without potential drawbacks. For example, most debts do not require repayment in full on demand but obligate the borrower to meet a specific schedule of payments including interest and principal. Hence debt service requirements can vary in relation to income, even if debt owed remains steady, if interest rate levels change, or if the debt's average term to maturity changes. In addition, for given debt the probability of default is the greater the more uncertain is the borrower's cash flow and value of liquidatable assets. Hence the assumption that borrowers assess their debt risk by comparing outstanding debt to income can at best be only approximately true.

More importantly, by themselves the assumptions that borrowers seek to avoid default risk and that they measure default risk in this way imply a stable debt-to-income ratio not for the economy in total but for each borrower separately. Even after aggregation to allow for the shifting circumstances confronting different businesses and individuals, and for the fact that individuals own the businesses, this pair of assumptions implies a stable debt ratio for the economy's private sector as a whole, but not for the total debt ratio including the private sector plus the government. A further assumption—some direct link between the economy's public and private sectors—is needed to imply systematic negative covariation between public- and private-sector debt, and hence a stable total debt ratio (*11*).

The specific assumption along these lines advanced by Barro and others is that individuals not only treat as their own debt the liabilities issued by the businesses they own but also "see through the shell" of government (*12*). If individuals recognize that their tax payments are the sole source of revenue backing the government's debt, then more government debt outstanding means larger government debt service obligations, and hence higher tax payments. After passing through the filter of the tax system, therefore, government debt is really private debt. Given this additional assumption, the hypothesis that borrowers in general seek to maintain a steady debt risk level, as measured by outstanding debt relative to income, does imply a stable economy-wide total debt ratio, and hence negative covariation between public debt and private debt in the presence of independent variation in either.

Is the assumption that individuals treat government debt as equivalent to their own plausible? Because individuals' attitudes toward government debt service obligations are difficult to measure directly, empirical testing of this proposition to date has been indirect, focusing on two of its chief implications (*13*). One is the implication that government borrowing should not affect interest rates (or asset returns and prices more generally). Not surprisingly, in light of the many forces impinging on interest rate determination, investigation of this proposition has again led to conflicting results (*14*). Figure 4 shows the after-inflation interest rate on U.S. Treasury bills plotted against two potentially relevant measures of federal government debt and deficits from 1955 to 1985: the change in the federal debt ratio (see Fig. 1) and the ratio of the federal budget deficit to GNP, with both the deficit and GNP computed on a high-employment basis (*15*). The real interest rate series is positively related to both of these federal borrowing measures (with simple correlation coefficients 0.37 and 0.35, respectively), thereby casting some doubt on the "public debt is private debt" assumption. The positive relation is even stronger in the second half of the sample. Even so, there is clearly range for differences of interpretation, especially in the context of efforts to control for additional causal influences.

The other implication of the "public debt is private debt" assumption on which empirical research has focused is the proposition that individuals, either directly or through the businesses they own, increase their saving to offset government deficits so that the economy's total saving rate is more stable than that of the private sector alone. Here the evidence is more straightforwardly negative. Figure 5 shows the net saving of the economy's private sector (including individuals, businesses, and state and local governments), the federal government's surplus, and the resulting economy-wide total net saving, all stated as percentages of GNP, from 1955 to 1985 (*16*). There is little here to support the idea that private saving fluctuates so as to insulate total saving from variations in the federal budget position. During the 1980s, for example, the private saving rate actually declined slightly in the face of record-size government deficits. For the sample as a whole, the private saving and federal surplus measures are not significantly correlated (correlation coefficient −0.02), so that the economy's total saving does covary strongly and positively with the federal surplus (correlation coefficient 0.89).

A Hypothesis About Market Imperfections

Finally, a third potential explanation for the stable U.S. total debt ratio places primary emphasis on neither borrowers nor lenders but on the market setting in which they interact, including in particular the asymmetry of information distinguishing borrowers from lenders: most potential borrowers inevitably know more about their own intentions and prospects than potential lenders can possibly know.

As a result of this asymmetry, in conjunction with standard legal procedures governing defaults, lenders face a problem of "adverse selection." At any given interest rate, borrowers whose probability of default is higher are more likely to seek to borrow than are those with greater likelihood of meeting their obligations. Moreover, raising the interest rate to compensate for this enhanced probability of default will only further discourage low-risk borrowers in comparison to high-risk ones. Hence lenders not only seek information

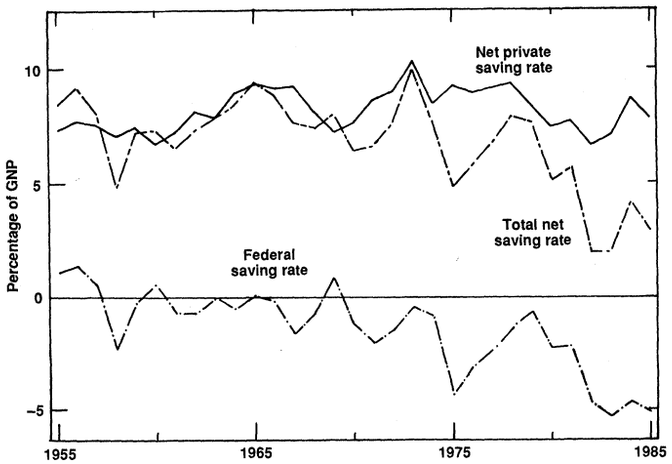

Fig. 5. Government deficits and net private saving, 1955–1985.

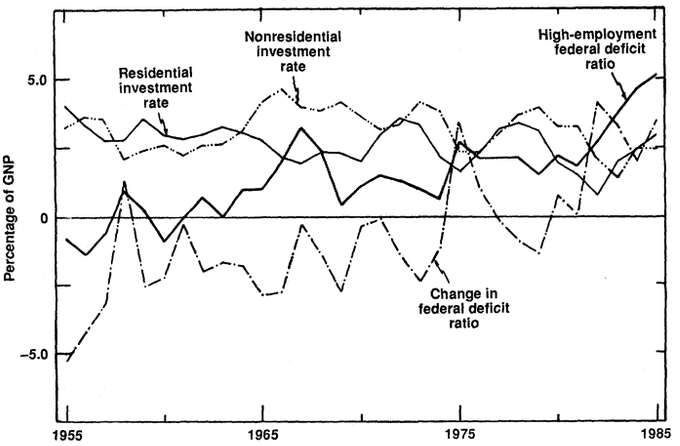

Fig. 6. Government borrowing and private capital formation, 1955-1985.

to distinguish one would-be borrower from another ("credit analysis") but also discriminate by granting credit to some but not to others, even when all are willing to accept the same terms ("credit rationing").

A further way for lenders to protect against default risk is by requiring collateral—that is, the pledging of assets to be forfeited by the borrower in the event of default. Collateral not only limits the lender's potential loss should a default occur, but can also provide an effective way of discriminating low-risk from high-risk borrowers. Various collateral arrangements have long been typical of many debt markets, both in the United States and elsewhere.

The crucial role played by collateral requirements in explaining a stable debt-to-income ratio is that they provide a link between assets held and the ability to borrow. Not only is the U.S. economy's aggregate wealth relatively stable in relation to aggregate income, but most of this wealth consists of business assets (plant, equipment, and inventories) and personal assets (mostly houses and consumer durables) which can and do serve as collateral in private loan arrangements. If the ability to borrow depends in part on the ownership of assets that can serve as collateral, and the total of such assets is stable in relation to income, then the debt of at least the private sector will also be stable in relation to income. If, in addition, individuals do not regard government debt as equivalent to their own (in contrast to the assumption made above), then they will regard the government debt that they hold as part of their net wealth. If total wealth is stable in relation to income, therefore, over time they will adjust their accumulation of other assets so as to offset fluctuations in their holdings of government debt. As a result, the private sector's ability to provide collateral, and hence to borrow, will also covary negatively with the outstanding government debt (*17*).

The empirical importance of collateral requirements is straightforward enough. Borrowing against tangible assets in the form of home mortgage and consumer installment credit has traditionally constituted 80 to 90% of all debt owed by individuals in the United States. Commercial mortgages, inventory financing, and other forms of secured credit also account for a major share of business debt. The chief question mark, once again, lies in the assumption about how individuals (and businesses) react to the issuance of government debt.

Is it plausible to assume that increased holdings of government debt directly reduce the accumulation of wealth in other forms (*18*)? Figure 6 shows aggregate U.S. net investment in residential and nonresidential capital, respectively, both stated as percentages of GNP, plotted against the two measures of government borrowing introduced in Fig. 4, for the same periods. Each form of investment exhibits significant negative covariation with both measures of government borrowing. (For net residential investment, the simple correlations with the change in the federal debt ratio and the high-employment deficit ratio are −0.74 and −0.77, respectively; the corresponding correlations for nonresidential investment are −0.84 and −0.62, respectively.) Here, however, controlling for other factors is of particular importance because even the most basic conceptions of how government borrowing plausibly affects private capital formation crucially depend on whether the economy is or is not at full employment. Hence distinguishing effects of government borrowing from effects due to the business cycle is essential in this context, despite the complication that stems from the cyclical character of government borrowing itself.

Public and Private Debt Since 1980

At year-end 1980 the U.S. economy's total debt ratio stood at 137.7%, well within 1 standard deviation of the 1953–1980 mean. By year-end 1985 the debt ratio was 169.2%, more than 11 standard deviations higher, and above any prior U.S. debt level recorded in this century except for the 1931–1935 period. As Table 2 shows, all major classes of U.S. nonfinancial borrowers except farmers participated in this increased indebtedness since 1980. In particular, the negative covariation between public- and private-sector debt that had characterized prior decades' experience disappeared. The data indicate a statistically significant break at 1980 in each of the four correlations reported in Table 1, with 1981 to 1985 values not just positive but uniformly in excess of 0.90.

The experience of different categories of borrowers in the U.S.

Table 2. Increase in the U.S. debt ratio between 1980 and 1985.

Borrower	Debt ratio		Change
	1980	1985	
Households	50.9%	58.5%	7.6%
Businesses	50.3	57.9	7.4
Corporations	32.1	36.8	4.8
Farms	5.6	4.4	−1.2
Other	12.6	16.6	4.0
State-local governments	10.4	13.3	2.9
Federal government	26.1	39.4	13.4
All nonfinancial borrowers	137.7%	169.2%	31.5%

debt markets has varied markedly during this period. After only modest variation in their indebtedness relative to GNP between 1960 and 1975, U.S. households sharply increased their debt position in the late 1970s and again in the early 1980s. During the late 1970s home mortgage borrowing accounted for substantially all of the increased household indebtedness, but during the early 1980s all forms of household indebtedness rose, including home mortgages and especially consumer credit. At the same time, rising prices of real estate in the 1970s and of equity securities in the 1980s increased holdings of both nonfinancial and financial assets during this period, so that household net worth showed little change relative to GNP despite the sharply higher debt.

By contrast, as of year-end 1985, the U.S. corporate sector's financial and tangible assets both stood at approximately the same point in relation to GNP as they did in 1975 or 1980. Hence there are no additional assets behind the new accumulation of corporate debt, which has resulted simply from debt-for-equity exchanges on the other side of the corporate sector's balance sheet. In 1984–1985 alone, mergers, acquisitions, leveraged buy outs, and other corporate reorganizations resulted in net retirement of $156 billion of equity.

Among noncorporate businesses, the experience has been mixed. Between 1980 and 1985 the U.S. farm sector actually reduced its indebtedness relative to GNP. By contrast, borrowing by other noncorporate businesses raised the total debt ratio by almost as much as corporate borrowing despite a far smaller initial noncorporate debt level. This rise in nonfarm noncorporate business indebtedness, however, was consistent with earlier trends. Almost all of these businesses' increased debt has been in the form of mortgage financing, and it has taken place against even more substantially enlarged holdings of tangible assets (mostly land and residential real estate, but also including some business plant and equipment), so that the aggregate net worth of the nonfarm noncorporate business sector modestly increased between 1980 and 1985.

The remaining portion of the large increase between 1980 and 1985 in the U.S. economy's total debt ratio not due to the federal government has reflected increased indebtedness of state and local governments. This development represented a sharp reversal of the trend that had prevailed since the late 1960s. More than all of this increased debt has reflected a form of financial intermediation by state and local governments, as these authorities have borrowed, in anticipation of potential restrictions on their ability to issue tax-exempt securities, to fund many of their needs in advance and then, for the time being, simply reinvested the proceeds.

Finally, nearly half of the post-1980 rise in the U.S. economy's total debt ratio has consisted of increased indebtedness of the federal government. The steady, unbroken growth of the U.S. government's outstanding debt between 1980 and 1985, despite a major business expansion during 1983 to 1985, is clearly the element of the overall debt ratio rise that is most out of character with prior U.S. historical experience, not just since World War II but throughout the nation's existence. Until the 1980s, significant sustained increases in federal government debt relative to GNP took place only during wartime. The contrary pattern, which has resulted in large part from the record-size tax reductions legislated in 1981, stands as the hallmark of post-1980 fiscal policy.

In sum, the two underlying factors behind the post-1980 debt ratio increase that seem most out of character with prior U.S. experience are the dramatic change in the federal government's fiscal policy and, with distinctly less importance, the corporate reorganization movement. At a more fundamental level, however, what has been absent in the 1980s to date is the long-standing negative covariation among the debt-issuing behavior of public- and private-sector borrowers. Bulges in the debt of one borrowing sector or another have occurred before, but in the past they have been approximately offset by reductions (at least relative to GNP) in the debt of others. The experience of the early 1980s has sharply departed from that historical pattern.

Concluding Comments

The breakdown of a long-standing but little understood regularity in observed behavior presents puzzles but also provides opportunities. Data incorporating hitherto unseen variation can be invaluable in resolving questions not just about why behavior has shifted but about what stood behind the initial regularity in the first place. The sharply changed relation since 1980 between total debt and income in the U.S. economy—and, within the total, between the respective debt of the economy's public and private sectors—presents such a puzzle, and correspondingly provides an opportunity. At least three fundamentally different hypotheses about economic behavior could, in principle, have accounted for the pre-1980s stability of the debt-to-income relation. Empirical analysis incorporating the more recent experience may now help distinguish which one (if any) in fact describes the working of the U.S. debt market.

Distinguishing among these competing explanations is also important because they carry sharply different implications for major issues of public policy. Does the continuing large federal government deficit impair the economy's ability to undertake productive capital formation? The answer is yes under the hypothesis based on lenders' behavior, no under that based on borrowers' behavior, and again yes under that based on market imperfections. Does the increased indebtedness of private borrowers potentially threaten the economy's financial stability? The answer is yes under the hypothesis based on lenders' behavior, no under that based on borrowers' behavior, and again no under that based on market imperfections. Finding the right explanation for the observed relation between debt and income, and between public debt and private debt would be a good start on deciding how to approach either of these current issues.

REFERENCES AND NOTES

1. See B. M. Friedman [in *Macroeconomics, Prices and Quantities*, J. Tobin, Ed. (Brookings Institution, Washington, DC, 1983, pp. 161–189)] for a description of these data. Data on debt are from the Federal Reserve Board and on GNP from the U.S. Department of Commerce.
2. The data used here represent debt at par rather than market values. Adjusting to a market-value basis would alter the year-to-year pattern somewhat but would not affect such long-term properties as the small coefficient of variation and the absence of any time trend.
3. The debt ratio peak (224.7%) occurred in 1933, which was also the trough year of the depression.
4. The current account balance is the broadly defined difference between U.S. exports of goods and services and U.S. imports of goods and services. Because such differences must be financed by capital account transactions, current account deficits imply net inflows of foreign capital into the United States, whereas current account surpluses imply net outflows of U.S. capital abroad. Between 1914 and 1981, the cumulative net capital flow was $141 billion of U.S. funds going abroad, or an average of only some $2 billion per year.
5. R. W. Goldsmith, "The stability of the ratio of nonfinancial debt to income," *Banca Naz. Lavoro Q. Rev.* (1984), pp. 285–305.
6. F. Modigliani, *Soc. Res.* **33**, 160 (1966).
7. R. W. Goldsmith and R. E. Lipsey, *Studies in the National Balance Sheet of the United States* (Princeton Univ. Press, Princeton, NJ, 1963), vol. 1. Federal Reserve Board data confirm this regularity for subsequent years.
8. See B. M. Friedman [in *Corporate Capital Structures in the United States*, B. M. Friedman, Ed. (Univ. of Chicago Press, Chicago, IL, 1985), pp. 197–233] for a description of these data. The underlying sources are the Federal Reserve Board, U.S. Treasury Department, and Standard & Poor's Corporation.
9. For example, findings reported by B. M. Friedman ["Crowding out or crowding in? Evidence on debt-equity substitutability" (National Bureau of Economic Research, Cambridge, MA, 1984), mimeographed; *Am. Econ. Rev.* **75**, 338 (1985)] support the hypothesis of weak substitutability, at least between debt and other financial assets, but the findings of J. A. Frankel [*Q. J. Econ.* **100**, 1041 (1985)] do not.
10. It is also necessary for the amount of risk that borrowers are willing to bear to be roughly constant in relation to their incomes. Given the absence of much variation

in the wealth-to-income ratio, however, this property follows from standard models of risk aversion.

11. A link by interest rates—for example, along the lines that heavy government borrowing drives up interest rates and thereby discourages private borrowing—would ultimately be based on the behavior of lenders, not borrowers.
12. R. J. Barro, *J. Polit. Econ.* **82**, 1095 (1974).
13. It is also necessary, of course, that individuals be aware of the government's debt service obligations in the first place. Although taxpayers' awareness should be easier to investigate directly than their attitudes, no one (to my knowledge) has yet attempted to do so. The reason is probably the general disrespect for survey data that pervades the economics literature.
14. See J. Tobin and W. H. Buiter, [in *The Government and Capital Formation*, G. von Furstenberg, Ed. (Ballinger, Cambridge, MA, 1980), pp. 73–151] and J. J. Seater [*J. Monetary Econ.* **16**, 121 (1985)] for surveys emphasizing positive and negative findings, respectively.
15. The source of high-employment deficit and GNP data is the U.S. Dept. of Commerce.
16. The private and total saving measures are net of depreciation to existing capital stocks. The data plotted in Fig. 5 are from the U.S. Department of Commerce.
17. See B. M. Friedman [in *The Changing Roles of Debt and Equity in Financing U.S. Capital Formation*, B. M. Friedman, Ed. (Univ. of Chicago Press, Chicago, IL, 1982), pp. 91–110]; B. S. Bernanke, *Am. Econ. Rev.* **71**, 155 (1981), and B. S. Bernanke and M. Gertler ["Agency costs, collateral, and business fluctuations" (National Bureau of Economic Research, Cambridge, MA, 1986), mimeographed].
18. Once again, a link through interest rates would ultimately be based on the behavior of lenders.
19. I am grateful to the National Science Foundation and the Alfred P. Sloan Foundation for supporting the research on which this article draws, to D. I. Laibson for research assistance and helpful discussions, and to R. W. Goldsmith and R. M. Solow for comments on an earlier draft.

Catalysis: New Perspectives from Surface Science

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One-sixth of the value of all goods manufactured in the United States involves catalytic processes. However, in spite of this dramatic economic impact, little is known about this broad subject at the molecular level. In the last two decades a variety of techniques have been developed for studying at the atomic level the structure, composition, and chemical bonding at surfaces. These techniques have been used to study adsorption and reaction on metal single crystals in an ultrahigh vacuum environment or to analyze catalysts before and after reaction. An important new development has been the coupling of an apparatus for the measurement of reaction kinetics at elevated pressures with an ultrahigh vacuum system for surface analysis. This approach has demonstrated that metal single crystals can be used to successfully model many important catalytic reactions and has established a direct link between the results of ultrahigh vacuum surface measurements and the chemistry that occurs under typical catalytic-processing conditions.

THE APPLICATION OF MODERN SURFACE SCIENCE TECHniques to fundamental catalytic studies has advanced our understanding of elementary surface reactions at the atomic level and in particular the relation between surface characteristics (that is, structure and composition) and catalytic properties. Most surface-sensitive techniques require an ultrahigh vacuum (UHV) environment and are best suited for studying well-characterized, low-surface-area materials such as metal single crystals. In contrast, many catalytic processes of practical interest are catalyzed by active metals dispersed on an oxide support with a high surface area (typically 100 to 200 m^2/g) at pressures of 1 atm or greater. Because of these differences in the catalyst materials and in the pressure regimes, questions have been raised with regard to the applicability of the work conducted at low pressures on idealized surfaces of single crystals to catalysis at much greater pressures on supported catalysts with high surface area. Good correlations between the data for single crystals and for supported catalysts would allow the chemical information obtained from model catalyst studies to be used to gain a detailed understanding of "real" catalyst systems. This information could be useful in improving existing catalysts or in developing new ones.

As a step toward bridging the pressure gap alluded to above, experimental systems have been developed (*1–3*) in the last decade that consist of a reaction chamber linked to a UHV surface analysis system. With such an apparatus it is possible to conduct both kinetic measurements at atmospheric pressures and surface characterization under UHV conditions without removing the sample from the controlled environment. Such experimental systems have been used to measure the kinetics of several important catalytic reactions (*4–9*). Comparisons of kinetic data from these single crystal model catalysts with the reaction rates measured over supported catalysts in the same reactant environment have shown excellent correlations. Valuable information on reaction mechanisms has become available from surface analytical data obtained after reaction (*4, 5, 7, 8, 10, 11*). Furthermore, the role of surface impurities in either promoting or inhibiting certain surface reactions (*9, 12, 13*) and the origins of the enhanced catalytic properties of mixed-metal systems (*14*) have been explored.

In this article we highlight the application of surface science to several pivotal questions related to heterogeneous catalysis. This article is not intended to be a broad review of surface science or of its application to the area of catalysis. Rather, we concentrate on specific applications and use work by the authors to illustrate the impact that surface science can have on understanding surface-catalyzed reactions.

We begin with a brief discussion of the type of instrumentation used in this work. We then outline examples of reactions that

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