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PORTFOLIO CHOICE AND THE DEBT-TO-INCOME RELATIONSHIP

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ABSTRACT

The ratio of outstanding debt to gross national product in the United States has shown essentially no time trend over a period measured not in years but in decades. The research reported in this paper indicates that lenders' portfolio behavior exhibits characteristics that could provide a plausible explanation of this phenomenon.

Given the long-run stability of the U.S. economy's wealth in relation to income, the question of lenders' behavior explaining the stable aggregate debt-to-income ratio turns on whether investors treat debt and other assets as close or distant substitutes in their portfolios. Analysis of financial assets' respective risk properties indicates that debt and equity are indeed sufficiently distant substitutes for lenders' behavior to confine the debt-to-income ratio within relatively narrow limits. In particular, the substitutability of debt and equity securities is sufficiently limited that very large movements in expected return differentials — movements so large as presumably to elicit offsetting responses from borrowers — would be required to induce major changes in the debt share of investors' aggregate portfolio, and hence in the economy's aggregate debt-to-income ratio.

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PORTFOLIO CHOICE AND THE DEBT-TO-INCOME RELATIONSHIP

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The relationship between outstanding debt and economic activity has attracted growing attention in recent years. In the United States the principal focus of this attention thus far has been the empirical finding that, over time horizons ranging from a calendar quarter to a year or two, the outstanding indebtedness of all U.S. borrowers other than financial intermediaries bears as close a relationship to income and prices as does any of the more familiar monetary aggregates or the monetary base.[1] This finding has potentially important implications for the conduct of monetary policy, and since 1983 the Federal Reserve System's semi-annual reports to Congress have specified a growth range for "domestic nonfinancial credit" along with the growth ranges for three monetary aggregates.

A perhaps even more interesting aspect of the aggregate debt-to-income relationship in the United States is that the simple ratio of the U.S. economy's domestic nonfinancial debt to its gross national product has shown essentially no time trend over a period measured not in years but in decades.[2] This finding bears potentially important implications for fiscal policy, especially in an era of federal budget deficits that are large enough to increase rapidly the federal government's outstanding indebtedness in relation to GNP.[3] It is puzzling, however, in that many of the factors that familiar theory suggests would determine an economy's proclivity to finance its activity by issuing debt — for example, aggregate risk levels, tax rates, and bankruptcy arrangements — have changed dramatically over the decades during which the U.S. domestic nonfinancial debt ratio has remained approximately flat.

Any potential explanation for this phenomenon must, of course, focus on the behavior of lenders (debt holders) or borrowers (debt issuers), or both. The object of the research summarized in this paper is to see whether the behavior of investors in the U.S. financial markets could plausibly account for the economy's relatively stable debt-to-income ratio. This question turns on whether investors treat debt and other assets as close or distant substitutes in their portfolios. To anticipate, analysis of financial assets' respective risk properties indicates that debt and equity are indeed sufficiently distant substitutes for lenders' behavior to be a plausible source of the constraint confining the debt-to-income ratio within relatively narrow limits. At the same time, nothing in this finding precludes the possibility that borrowers' behavior could also be an equally or even more important part of the overall explanation.

I. Asset Risk and Asset Substitutability

The key link to lenders' behavior exploited here is the well known fact that the U.S. economy's total wealth-to-income ratio has been essentially trendless for many decades, as would be implied by the life cycle model of saving under standard conditions describing a mature (albeit growing) economy.[4] Over substantial periods of time, therefore, a stable debt-to-income ratio is equivalent to a stable share of debt assets in the economy's aggregate portfolio. In terms of familiar portfolio theory, if investors' behavior is imposing this constraint then the relevant substitution elasticities must be small (in absolute value) in comparison with the corresponding wealth and/or income elasticities. Whether in fact they are so is an empirical question.

According to the standard theory describing the portfolio behavior of risk-averse investors, the relevant asset substitutabilities that matter here depend on investors' perceptions of the risk associated with holding debt and other assets. Investors' willingness to hold different assets depends on their assessments of the respective risks to which holding these assets exposes them, and their treatment of some assets as substitutes for others in their portfolios likewise depends on the relationships they perceive among the associated risks to holding these assets as well as others. If two assets expose holders to essentially the same set of risks, investors typically treat the two as close substitutes and allocate their portfolios accordingly. Assets subject to quite disparate risks are typically more distant substitutes, or perhaps even complements.

The basic framework of analysis used here is the familiar discrete-time theory relating risk-averse portfolio choice to expected asset returns. The investor's single-period objective, given initial wealth W_t, is to choose a vector of asset holding proportions $\underline{\alpha}_t$, satisfying $\underline{\alpha}_t'\underline{1} = 1$, to maximize expected utility $E[U(\tilde{W}_{t+1})]$. Under the conditions that $U(W)$ is any power or logarithmic function (so that the Pratt-Arrow coefficient of relative risk aversion is constant), that the investor perceives the vector of real net asset returns $\underline{r}_t$ to be distributed normally (or lognormally) with expectation $\underline{r}_t^e$ and variance-covariance structure Ω_t, and that no available asset is riskless in real terms,[5] solution of this problem yields

$$\underline{\alpha}_t^* = B_t(\underline{r}_t^e + \underline{1}) + \underline{\pi}_t \tag{1}$$

where

$$B_t = \left\{ \frac{-U'[E(\tilde{W}_{t+1})]}{W_t \cdot U''[E(\tilde{W}_{t+1})]} \right\} \cdot [\Omega_t^{-1} - (\underline{1}'\Omega_t^{-1}\underline{1})^{-1}\Omega_t^{-1}\underline{1}\,\underline{1}'\Omega_t^{-1} \tag{2}$$

$$\underline{\pi}_t = (\underline{1}'\Omega_t^{-1}\underline{1})^{-1}\Omega_t^{-1}\underline{1}. \tag{3}$$

If the time unit is sufficiently small to render W_t a good approximation to $E(\tilde{W}_{t+1})$ for purposes of the underlying expansion, then the first (scalar) term within brackets in (2) is simply the reciprocal of the constant coefficient of relative risk aversion.

Matrix B_t in (1), expressing the response of each proportional asset demand to movements in the expected real returns on that and other assets, contains the set of relative asset substitutabilities that determine how stable the respective shares of the typical investor's portfolio will be. The solution for B_t in (2) makes clear the central role of investors' risk perceptions in governing this behavior. The asset substitutabilities in B_t depend only on the investor's risk aversion and risk perceptions, here parameterized by a variance-covariance matrix Ω_t that in general may vary over time.

II. Substitutability Among Financial Assets

The upper panel of Table 1 shows the variances and covariances, calculated from quarterly data for 1960-80, of the realized after-tax real per annum returns on three broad classes of U.S. financial assets that differ fundamentally from one another according to the risks associated with holding them: Short-term debt (S) includes all assets bearing real returns that are risky, over a single year or calendar quarter, only because of uncertainty about inflation. Long-term debt (L) is risky because of uncertainty not only about inflation but also about changes in asset prices directly reflecting changes in market interest rates. Equity (E) is risky because of uncertainty about inflation and about changes in stock prices.[6]

The lower panel of Table 1 indicates the implications of this observed 1960-80 covariance structure for investors' portfolio behavior by showing the transformation of Ω given in (2), up to but not including multiplication by the reciprocal of the coefficient of relative risk aversion. Apart from the risk aversion coefficient, these values for B indicate the marginal responses of the proportional portfolio allocations $\underline{\alpha}$ to changes in expected asset returns $\underline{r}^e$. Hence they also indicate by what amount the structure of expected returns would have to change in order to induce any given shift in the composition of the typical investor's portfolio.

For plausible values of the risk aversion coefficient, the B values shown in Table 1 indicate that short- and long-term debt are fairly close substitutes for one another, but not for equity. For relative risk aversion equal to four,[7] for example, the increase in the expected short-term debt return (relative to the two other returns) that would be required to raise the short-plus-long debt share of the typical investor's portfolio by .01 is .63%. The corresponding required increase in the expected long-term debt return is .27%. Because the model is linear in expected returns, the analogous increase required

TABLE 1

ASSET RETURN RISKS AND IMPLIED PORTFOLIO RESPONSES

Variance-Covariance Matrix

	r_S	r_L	r_E
r_S	11.18		
r_L	29.91	209.35	
r_E	30.24	161.77	597.86

Portfolio Response Matrix

	r_S	r_L	r_E
α_S	.641		
α_L	-.578	.727	
α_E	-.0635	-.150	.213

Notes: Asset returns scaled in per cent per annum.
Portfolio responses based on relative risk aversion equal to one.

to generate greater portfolio shifts are proportionally greater.

One potentially serious shortcoming of drawing such inferences on the basis of an unconditional sample variance-covariance structure is that it attributes too little information to investors by disregarding their knowledge, at each point in time, of the most recent realizations of asset returns and their principal determinants. During the 1960-80 period the after-tax real returns on all three classes of assets considered here exhibited substantial serial correlation.[8] When returns are serially correlated, information about the most recent actual values is a useful ingredient in forming expectations about returns in the immediate future. Ignoring that information can lead to excessively large estimates of the uncertainty surrounding these expectations.

Table 2 presents a set of analogous results based on a procedure that takes much more careful account of what information investors did and did not have at any particular time. As of the beginning of each calendar quarter, investors presumably know the stated interest rates on short-term debt instruments, the current prices and the coupon rates on long-term debt instruments, the current prices and (approximately) the dividends on equities, and the relevant tax rates. The three uncertain elements that they must forecast over the coming quarter, in order to form expectatations of the after-tax real returns on the three broad classes of assets considered here, are inflation, the capital gain or loss due to changing bond prices, and the capital gain or loss due to changing stock prices.

The procedure underlying the results reported in Table 2 represents investors as forming expectations of these three uncertain return elements, at each point in time, by estimating a linear regression model relating each element to past values of itself and the other two, using all data observed through the immediately preceding period.[9] In addition to providing forecast values of the three uncertain elements for the period ahead, the linear regression model at each point in time also directly indicates the variances and covariances associated with the forecasts

TABLE 2

IMPLICATIONS OF CONTINUALLY UPDATED RETURN FORECASTING

Variance-Covariance Matrix

	r_S	r_L	r_E
r_S	1.25		
r_L	3.62	76.61	
r_E	6.45	48.09	317.27

Portfolio Response Matrix

	r_S	r_L	r_E
α_S	1.57		
α_L	-1.41	1.61	
α_E	-.161	-.204	.365

Notes: See Table 1.

derived in this way. After each period elapses, investors can then repeat the same procedure, incorporating the one new observation on inflation and on long-term debt and equity capital gains into the data used to re-estimate the linear regression model to make forecasts for the next period.

Given the simple arithmetic connection between asset returns and these underlying uncertain elements, and given investors' presumed knowledge of the other elements comprising returns, these one-period-ahead forecasts of inflation and the respective capital gains on long-term debt and equity directly imply one-period-ahead forecasts of the after-tax real returns on all three classes of assets at each point in time. Similarly, the variances and covariances associated with the forecasts of inflation and the two capital gains directly imply the variances and covariances associated with the corresponding forecasts of the three asset returns.

The upper panel of Table 2 shows the means of these implied return variances and covariances for the 84 quarters of the sample. These values are smaller than the corresponding values shown in Table 1, indicating the importance of investors' having (and using) information about recent actual returns.

The lower panel of Table 2 shows the transformation of this Ω given in (2), again up to but not including multiplication by the risk aversion reciprocal. The reduced uncertainty, in comparison with Table 1, makes investors more willing to re-allocate their portfolios in response to changes in expected returns. Even so, most of the asset substituability is still between short- and long-term debt. With relative risk aversion again equal to four, the increases in the expected returns on short- and long-term debt required (individually) to raise the overall debt share of the typical investor's portfolio by .01 are .25% and .20%, respectively.

III. Substitutability Between Financial and Nonfinancial Assets

An important limitation of the analysis reported in Section II is its restriction to financial assets only. On a net basis, most of the total U.S.

national wealth that has remained relatively stable in relation to U.S. economic activity consists of nonfinancial assets. Even for the household sector alone, yearend 1980 total wealth included \$2.8 trillion of residential real estate and \$1.0 trillion of consumer durables in addition to \$3.5 trillion of financial assets. If wealth holders are willing to substitute not just among financial assets but also between financial and nonfinancial assets, then the results presented in Section II presumably overstate the movements in the expected return structure required to change the share of debt in their portfolios, and hence also overstate the likely resulting stability of aggregate debt holdings in relation to either wealth or income.

Table 3 presents the results of applying the forecasting procedure underlying Table 2 to the after-tax real returns on the same three classes of financial assets together with two classes of nonfinancial assets, <u>residential real estate</u> (H) and <u>consumer durables</u> (D), based on annual data for 1964-81.[10] Apart from the use of an annual time unit, the treatment of the uncertain elements of the financial asset returns is just analogous to that described in Section II. In order to generate forecasts of the respective returns on housing and durables, however, the forecasting equation here also includes the change in the constant-quality housing price index and the change in the implicit price deflator for durables.

Not surprisingly, given the role of inflation in making asset returns uncertain, the resulting variance-covariance matrix shown in the upper panel of Table 3 indicates that both categories of nonfinancial assets are less risky in real terms than any of the three financial assets. More importantly for the purposes of the analysis here, the transformation of this variance-covariance structure shown in the lower panel of the table indicates that the implied responsiveness of portfolio allocations to changes in expected returns is far greater than suggested by the analysis in Section II of financial assets alone. With relative risk aversion equal to four, the increase in the expected short-term debt return (again, relative to all other returns) required to raise the total debt share of the typical investor's

TABLE 3

CONTINUALLY UPDATED RETURN FORECASTING INCLUDING NONFINANCIAL ASSETS

Variance-Covariance Matrix

	r_S	r_L	r_E	r_H	r_D
r_S	2.31				
r_L	6.62	43.76			
r_E	11.92	49.92	191.03		
r_H	.47	1.24	4.47	1.19	
r_D	.67	1.87	2.99	.16	.27

Portfolio Response Matrix

	r_S	r_L	r_E	r_H	r_D
α_S	176				
α_L	-14.5	6.25			
α_E	-4.49	-.628	.942		
α_H	34.0	6.79	-2.95	168	
α_D	-191	2.12	7.13	-206	387

Notes: See Table 1.

portfolio by .01 is only .025%. A comparison of the elements in the first column of the matrix makes clear that more than all of this portfolio re-allocation occurs at the expense of the share invested in durables. Because of the cross-effects of the substitutability of short-term debt with both durables and long-term debt, however, the corresponding movement in the expected long-term debt return required to raise the total debt share by .01 is a decline of .48%.

IV. Conclusions

Whether or not investors' behavior can plausibly account for the U.S. economy's trendless debt-to-income ratio depends crucially on the proper treatment of wealth holding in nonfinancial forms. Among financial assets only, the substitutability of debt and equity securities is sufficiently limited that very large movements in expected return differentials — movements so large as presumably to elicit offsetting responses from borrowers — would be required to induce major changes in the debt share of investors' aggregate portfolio. Given the long-run stability of the economy's wealth in relation to income, this lack of asset substitutability along the relevant dimension also implies a stable debt-to-income ratio.

By contrast, a parallel analysis applied to financial and nonfinancial assets together suggests that only quite modest movements in the structure of expected returns would suffice to induce even very large changes in the debt share of total assets, and hence in the aggregate debt-to-income ratio. The main reason for this result is the close substitutability of short-term debt and consumer durables implied by the respective risks associated with these two assets' after-tax real returns.

Especially since the key substitutability on which this difference hinges is to durables, rather than housing, the most sensible interpretation of these results is probably to discount the findings including nonfinancial assets and conclude that the portfolio behavior of risk-averse investors can plausibly account for a stable debt share of assets, and hence also (given the stability of wealth in relation to income in the United States) the observed stable debt-to-income ratio. One reason for drawing this conclusion is simply that asset-type considerations of risk and return alone probably do not constitute an adequate description of the demand for consumer durables. In a more fully developed description of that demand, the willingness to substitute holdings of short-term debt instruments for ownership of consumer durables would no doubt be much more limited. A second reason is that, to a far greater extent than in the case of return indexes for aggregates of financial assets (or even housing), the variation of the return index for the aggregate of all consumer durables presumably understates the risk associated with any individual's holding. A more accurate representation of that risk would also probably indicate less correlation with other asset risks, hence less substitutability for other assets, and hence less responsiveness of asset demands to changes in relative returns.

With this qualification, therefore, the behavior of lenders in the U.S. financial market does exhibit characteristics that could account for the observed stability of the economy's aggregate debt-to-income ratio over long periods of time. This conclusion, however, in no way precludes the behavior of borrowers being as important, or more so, in explaining this phenomenon. That possibility remains a subject for future research.

Footnotes

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1. See, for example, the evidence in Friedman (1983).

2. The typical value for the U.S. domestic nonfinancial debt ratio is about 1.45; see again, for example, Friedman (1983).

3. The federal government's debt ratio declined (as is usual in peacetime) from a peak of 1.03 in 1946 to a low of .25 in 1974. At yearend 1980 it was still .27. By midyear 1984 it had risen to .35.

4. See Modigliani (1966) for a clear exposition of this proposition at a theoretical level, and, for example, Goldsmith (forthcoming) for empirical evidence. The U.S. wealth-to-income ratio is typically around three.

5. Alternatively, if one asset is riskless, it is necessary to partition the asset demand system so that the expression equivalent to (1) gives the demands for risky assets only. In that case Ω^{-1} replaces the second (matrix) term in (2), and $\underline{\pi}$ in (3) is a vector of zeroes.

6. See Friedman (1984) for details of the construction of these three after-tax real return series.

7. This value is about in the middle of the range of available empirical estimates. Friend and Blume (1975) suggested a value in excess of two, Grossman and Shiller (1981) suggested four, and Friend and Hasbrouck (1982) suggested six.

8. The first-order serial correlation coefficients are .86 for short-term debt, .51 for long-term debt, and .33 for equity.

9. See Friedman (1984) for details of the estimated vector autoregression and the calculations based on it.

10. The nominal after-tax return for housing combines the BEA implicit rent and depreciation series, the FHA series on maintenance costs, the MPS series on property taxes, and changes in the Census Bureau constant-quality price index,

using Barro and Sahasakul's (1983) average marginal income tax rate series. The nominal (untaxed) return on durables combines the BEA service value estimate and changes in the relevant BEA deflator. In both cases the corresponding real return follows from subtracting the percentage change in the consumer price index. Use of an annual time unit in this part of the analysis reflects the unavailability of several of these series on a quarterly basis.

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