The Rate of Interest or the Rate of Return: Estimating Intertemporal Elasticity of Substitution

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Abstract

This paper investigates whether the rate of interest such as the Treasury bill rate or the rate of return such as the return on a household portfolio is more relevant to the household's intertemporal decision making. In a current era, households are diversifiers (to use Tobin's 1958 term) and hold portfolios of assets rather than a simple loan. A portfolio of assets earns a composite return accounting for capital gains, taxes, and inflation, and rational agents make spending decisions based on expected total returns on a portfolio rather than on the return on a single asset. The total composite measure we use includes financial assets such as stocks and bonds and a real asset, residential housing. In particular, we estimate the intertemporal elasticity of substitution, namely, how a change in the asset or portfolio return affects household's consumption growth. The estimates obtained using real after-tax composite return are about 0.15-0.3 and are more robust to linear and nonlinear estimations, different consumption measures, and various time periods than those obtained by using individual asset returns such as the Treasury bill rate.

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I. Introduction

This paper investigates whether the rate of interest such as the Treasury bill rate or the rate of return such as the return on a household portfolio is more relevant to the household's intertemporal decision making. In a current era, households are diversifiers (to use Tobin's 1958 term) and hold portfolios of assets rather than a simple loan. A portfolio of assets earns a composite return accounting for capital gains, taxes, and inflation, and rational agents make spending decisions based on expected total returns on a portfolio rather than on the return on a single asset.

To assess whether an aggregate return is important for the household's intertemporal choice, the first order of business is to define and then compute one. We define the *net real rate of return* on a portfolio of assets as a weighted average of the rates of return on the component assets after accounting for capital gains, taxes, and inflation. Our asset classes include money, bonds, common stocks, and residential housing. Thus, an overall or total composite based on this wide array of assets can be considered as an approximation to the net real market rate of return of finance theory. After presenting new data on total composite return, we turn to the second order of business: an attempt to answer critical questions about the use of these data. Is the composite return relevant to the household's intertemporal problem? To what extent does the use of after-tax vs. before-tax returns affect the results?

The novelty of our research is not so much that returns are measured as after-tax after-inflation, or *net real* to use Feldstein's (1976) designation, but that we are introducing a new aggregate in place of the single assets in the analysis of the household's intertemporal consumption problem. A more detailed classification of assets considered in the portfolio are money defined as M2, U.S. Treasury notes (intermediate-term government bonds), U.S. Treasury bonds (long-term government bonds), tax-free municipal securities, corporate bonds, corporate equities in the Standard and Poor's 500 (S&P 500), and residential housing. Treasury bills are accounted for indirectly through assets in pension funds or other bundled collections.[1] In addition to the total composite, we compute sub-composites designated as the following nested components: composites for government bonds, all bonds, all interest-bearing assets including money (debt), and all financial assets including stocks. Each component of the composite measures has its own net real rate and is computed by using the Jorgenson and Yun's (2001) annual (variable) series on average marginal tax rates appropriate to each component.[2]

Net real total returns are significantly different from real rates computed from the Fisher equation. The "level effects" from comparing mean net real rates and the mean Fisher real rates are large. However, "time series effects" (period to period variations) are small because tax rate changes from one period to the next are relatively small in comparison to fluctuations in nominal rate values as well as the usual adjustments for inflation. In addition, an effective tax rate on capital gains is relatively small even though the annual changes in tax rates are relatively large in some instances. We report on both kinds of effects.

Level effects are especially large for Treasury bills, notes, and bonds and corporate bonds. Comparing our computed net real rates on a composite rate for government notes and bonds with the standard Fisher equation definition for the same composite of the same securities demonstrates the importance of taxes. Over the period of 1952-2000 the average Fisher real interest rate for a composite of Treasury securities is 2.98% whereas the after-tax return for the

[1] The Treasury bill rate also influences the rate of return on some M2 assets.

[2] We are indebted to Dale Jorgenson for supplying periodic updates to the time series on these average marginal tax rates. For the description of their computations, see Chapter 3 in *Investment: Volume 3, Lifting the Burden: Tax Reform, the Cost of Capital, and US Economic Growth*, 2001, by D. Jorgenson and K. Yun.

same composite is 2.0%. For corporate bonds the comparison is more stark—3.21% vs. 0.96%. In models that assume rational agents the implications of these results are striking. Large level effects certainly might influence research in consumption, investment, asset pricing and research in the real business cycles and public finance areas that depend critically on choosing a proper discount factor for calibration exercises.

There is a brief survey of literature relevant to our topic in Section II of this paper. We present an outline of an economic model in Section III. Section IV contains the computations for the total composite in addition to sub-composite measures. The next section is devoted to testing the composite return to determine whether its use in empirical consumption work makes a difference. Specifically, in Section V we estimate important parameters of the utility function, relative risk aversion and intertemporal elasticity of substitution. We find that the use of the total composite to estimate these parameters yields "reasonable" results and improves their reliability by standard tests of significance. We conclude the paper proper in Section VI followed by two appendices dealing with definitions, data sources, and exact manner of computation in addition to supporting tables.

II. Literature Review

Of course, the idea of holding a portfolio rather than a single asset is not new in economics. Tobin introduced this idea in 1958 in his justly famous article, "Liquidity Preference as Behavior towards Risk." Although portfolio holding is a focus of financial economics, it has been, by and large, ignored in research in macroeconomics. A recent paper by Mulligan (2002) brings forth similar issues and argues that the return on a large portfolio of capital assets rather than on a particular asset should be used in explaining consumption growth. The paper states that this return is not the Treasury bill or bond rate but rather the return on a capital stock. In contrast, our paper emphasizes the return on an aggregate portfolio of assets held by households rather than the return on capital. There is, certainly, a link between the return on capital and return on financial assets such as stocks, but we contend that the direct measure of the return to households is the composite return on their portfolio rather than on the aggregate capital stock.

Ibbotson and Fall (1979) combine a number of assets to compute a “market total” for the period 1953-1978. However, their market total does not take account of taxes, uses different measure of residential housing return, and is not applied to research questions in economics. Siegel and Montgomery (1995) have taken into account taxes for a special group of income earners with incomes of $75,000. The tax rates used in their study are for ordinary income and capital gains. They compute after-tax returns on common stocks, municipal bonds, long-term government bonds, and U.S. Treasury bills, but they do not compute a composite return. Hall (1988) employs effective marginal tax rates calculated by Barro and Sahasakul (1983) in computing after-tax rates on single asset measures but does not use the composite return as well.

Darby (1975), Feldstein (1976), Tanzi (1976), Feldstein, Green, and Sheshinski (1978), and Feldstein and Summers (1978) argued that the *net real* rate was the proper rate of interest to use for most purposes of empirical research in economics. By and large their arguments have been ignored. Some exceptions have been Cook and Hendershott (1978), Mishkin (1981), Peek and Wilcox (1984), Peek and Wilcox (1986), Mankiw (1987), Hall (1988), Hendershott and Peek (1992), Siegel and Montgomery (1995), and Brealey and Kwan (1999). These studies mainly used some constant tax rate, usually the tax rate on income.

The idea behind the famous Fisher equation goes back to 1896 when Fisher first put his stamp on the meaning of “appreciation.” Subsequently, the famous Fisher Equation formalized the relationship between real interest rate, nominal interest rate, and the rate of inflation. This definition of the real rate of interest is still used in virtually every textbook in macroeconomics. It may have been appropriate in 1896 when taxes were negligible. It is difficult to explain why this definition has persisted so long in an environment in which taxation is important. Shiller (1980) defended the Fisher definition by noting that the tax system was not neutral with respect to the rate of inflation. Borrowers and lenders are not likely to be in the same tax bracket and the tax effect depends critically on the use of borrowed funds. In essence these concerns are doubts about the relevance of representative agent models. Brealey and Kwan (1999) present a different perspective, claiming that almost universal use of a before-tax return "arises from its computational simplicity rather than its conceptual superiority." One can agree with this assessment but it begs the question of whether it makes a practical difference.

This article is the first, to our knowledge, that uses the *composite rate of return* along with *time varying differential tax rates* to account for the influence of the return measures in consumption research.

III. Economic Model and Methodology

The case to be made for a composite return rests on the assumption that a rational head of household wishes to maximize utility subject to his/her budget constraint by investing savings in a portfolio of assets. We assume that our agent need not pay attention to all activity in the market and that there is some mutual fund that keeps track of market activity and markets an index on the full array of assets available, including residential housing and money (M2) in addition to bonds and the S&P 500 index. This agent is also concerned with after-tax returns. Thus, our representative agent invests in an asset that earns a composite return, which is the weighted-average return on an array of assets in the mutual fund portfolio.

In particular, a household chooses a stochastic consumption plan to maximize the expected value of the lifetime utility function:

$$E_0\left[\sum_{t=0}^{\infty}\beta U_t\right],\ 0<\beta<1, \tag{1}$$

where β is a subjective discount factor; the expectations operator is conditioned on information available at time t; and U_t is of the isoelastic form:

$$U(c_t)=\frac{(c_t)^{1-\gamma}}{1-\gamma},\ \gamma>0, \tag{2}$$

where c_t is the agent's consumption and γ is the coefficient of relative risk aversion and is an inverse of the intertemporal elasticity of substitution as indicated in Section V. Our agent substitutes present for future consumption by trading a mutual fund. Let a_t be the holdings of the mutual fund in terms of the units of the consumption good, and let r_{t+1} be the return on the portfolio/mutual fund between t and $t+1$. This is the composite return we compute. Then, a feasible consumption and investment plan, $\{c_t, a_t\}$, must satisfy a sequence of budget constraints:

$$c_t + a_{t+1} \le (1+r_t)a_t + y_t, \tag{3}$$

where y_t represents real labor income at time t. The first-order condition for the composite asset, namely, the consumption Euler equation, is:

$$E_t\left[\beta\left(\frac{c_{t+1}}{c_t}\right)^{-\gamma}(1+r_{t+1})]\right]=1 \tag{4}$$

Equation (4) is then transformed into estimated equations discussed in Section V.

IV. The Total Composite Return

A. Data Description

The time period in our analysis is 1952-2000. Our data include series on quarterly and annual income and capital gain returns (crucial in computing after-tax measures) on Treasury bills, notes, and bonds, corporate and municipal bonds, money (M2), large-company corporate stocks (S&P 500), and residential housing (owner-occupied and nonowner-occupied dwellings). The data on returns are mainly taken from Ibbotson's *Stocks, Bonds, Bills, and Inflation* annual publications and from the Federal Reserve System. The data on average marginal tax rates are available in Jorgenson and Yun's *Investment: Volume 3* (2001). Among other tax rates, the authors compute rates on interest, dividends, and capital gains from equities and debt instruments. The tax rates by year used in our study are shown in Table 1 and they include taxes at the federal and state and local levels. We construct the return on residential housing using the data from the National Income and Product Accounts (NIPA) obtained from the Bureau of Economic Analysis (BEA) as well as the Flow of Funds Accounts (FFA) published by the Federal Reserve Board.[3] The nominal and net real rates of return for the 1952-2000 period for assets in consideration are displayed in Figures 1 through 8. The real returns are not depicted since they closely approximate the net real rates as discussed below. The detailed description of the computations, data sources, and adjustments along with the total composite return data are presented in the appendices.

The overall composite return and the return for various groups of assets require weighting. The weight assigned to each asset in a group is its proportionate share in the total

[3] For a full analysis of residential housing returns, see Hasanov (2003).

value of assets held in the household sector as indicated in the previous section or as seen from following definition:[4]

$$r^C = \frac{\sum_i r_i a_i}{\sum_i a_i} = \sum_i r_i \frac{a_i}{\sum_i a_i} = \sum_i r_i w_i \ , \tag{5}$$

where r^C is the composite return; r_i is the total return on asset i; a_i is asset holdings, and w_i is defined as the asset weight. We compute the composite rate of return using major asset classes in the representative household's portfolio mentioned above. Since pension fund and life insurance reserves are a major part of household wealth, we include them in our household portfolio as well. Total household holdings for each asset are taken from the Flow of Funds Accounts.

The weighting scheme is based on a two-period moving average to slightly smooth out large atypical fluctuations in the weights.[5] Thus,

$$w_t^i = \frac{1}{2}\left(\frac{a_t^i}{\sum_i a_t^i} + \frac{a_{t-1}^i}{\sum_i a_{t-1}^i} \right), \tag{6}$$

where w_t^i is the weight assigned to the i^{th} asset at time t, and a_t^i and a_{t-1}^i are the market values of asset i at t and $t-1$. Figure 9 illustrates the total household portfolio composition.

B. Discussion

Data presented in this section are computations on total returns. Total returns include returns on interest, dividends, net rental income from noncorporate and nongovernmental residential housing units, and capital gains. We have chosen to measure after-tax *total returns* rather than after-tax interest rates because rational household behavior does not depend strictly

[4] The weighting scheme arises from the portfolio analysis, and the weights are the market-based shares of each asset in the household portfolio.
[5] The use of the weights as shown in equation (5) does not change our statistics by any significant amount.

on before-tax interest returns. Rational individuals hold portfolios of assets and pay attention to capital gains. Certainly, household behavior cannot logically focus on a particular interest rate such as the Treasury bill rate. To show why, define permanent consumption conventionally as the annuity value of wealth. If the Treasury bill rate (or the rate on any government risk-free bond) were the relevant rate of return, permanent consumption would be practically zero as the real after-tax return on Treasury bills over a long period of time is close to zero. Such a result is inconsistent with observed behavior.

We begin with eight variables consisting of returns on Treasury bills, Treasury notes, Treasury bonds, corporate bonds, municipal bonds, money, common stocks, and residential real estate. These variables are grouped to form nested collections. Specifically there is a group for government bonds, all bonds (including municipal and corporate bonds), all debt (including money), financial assets (including stocks), and all assets (including residential real estate). One can think of the lowest level collection consisting of government bonds as representing a composite default risk-free rate and the highest level consisting of all financial assets and residential real estate as a proxy for the market rate of the CAPM.

Our focus in this section is primarily on the total composite return. We distinguish between nominal returns, real (after-inflation) returns defined in the manner of the Fisher equation, and net real returns that take account of taxes. Table 2 presents descriptive statistics on the aggregate rate of return and its seven component assets as well as other composite groups for the period 1952-2000 in the United States. Figures 10 through 14 illustrate nominal and net real rates for our five composite measures. Some stark contrasts must be noted even if none will be particularly surprising upon reflection. First, note the difference between nominal or real returns to government securities, frequently used in research, and their net real returns. For Treasury bills, specifically, the net real return over the period of forty-eight years was practically zero. The question asked much earlier, "Why is the risk-free rate so low?" becomes one of "Why is the risk-free rate almost zero?" If one were to think of the risk-free rate as a composite of government debt, the net real rate of return was 2.0%.[6] But there is an anomaly here. The standard deviation for the composite of government bonds is rather high at 7.47%. If one accepts the notion that total returns are a more important variable in household decision making than interest returns, as we are asserting, this anomaly raises an interesting question: "Why would government bonds be called risk free if the definition of risk were the standard deviation?" This question arises because we have dropped the assumption of a fixed holding period. In contrast, the standard deviation of the net real interest rate (income return) for Treasury notes and bonds is about 2%. Ignoring capital gain component makes a huge impact on the standard deviation but not on the mean. The mean nominal capital gain return for Treasury notes and bonds is practically zero since in the long run as bonds mature, capital gains and losses wash out.

In considering real rates of return, most analysts use the Fisher definition. Therefore, it is of interest to compare the data in the Fisher Real column with that in the Net Real column. One notes significant differences between the computations for Fisher real return and net real returns. It comes as no surprise that taxes make a difference. This difference made by taxes we call "level effects." For single asset returns except housing, the level effects are notable. For instance, the net real Treasury bond rate is 0.94% vs. the Fisher real rate of 3.08%. The level effects between Fisher real and net real rates for two composite measures are shown in Figures 15 and 16. In Figure 15, the Fisher measure of the government bond composite is compared with the net

[6] The reason why this composite figure is higher than the average of the values shown for government bond returns listed individually is that the weights in the composite are based on both household and pension fund holdings. The household portfolio contains Treasury notes and bonds both directly and indirectly and Treasury bills indirectly. Direct holdings are taxed at the average marginal tax rate on government interest. Indirect holdings through pension funds, etc. are not subject to tax, and as a result, the Fisher real, rather than net real, return is used.

real measure. The average difference is 0.98 percentage points. In Figure 16, the Fisher real composite for all assets is 6.09% vs. 5.13% for the net real composite. However, note strong correlations between the Fisher real and net real rate series. Differences in time variations, or time series effects, seem to be minimal.

For a different perspective, Table 3 presents a matrix showing how well the most frequently used measures of returns correlate with the net real return on a composite of all assets (a more complete matrix is given in Appendix B), and Table 4 shows correlations for the net real composite measures. Assuming for the present that the total composite is the appropriate measure for asset net returns, the data in Table 3 seem to indicate that neither of the commonly used risk-free rates is appropriate for empirical work. Both the Treasury bill and the Treasury bond rates are not well correlated with the total composite over the period of our study. Nor are they well correlated with the Fisher real total composite. However, Fisher real and net real composite measures are highly correlated. They are highly correlated because the standard deviations for the average marginal tax rates are much less than those for the rates of return. Note, too, that the correlations between stocks and both of the composite measures are high. However, as the next section on consumption will illustrate, a high correlation would not necessarily indicate choosing the return on common stocks, if one needed a single asset measure, in lieu of the total composite return.

The high correlation between Fisher real and net real composite returns indicates that, in the absences of knowledge about taxes, Fisher real return is a suitable proxy measure of total returns if time series fluctuations are the most important to consider in econometric work. However, if level effects are important, Fisher real rate will not serve well. We conclude from this analysis that there is no adequate substitute for a total rate of return that does not take account of taxes and is derived as a composite. In the next section we present results to indicate that an after-tax composite return has empirical as well as theoretical merit.

V. Estimation of Relative Risk Aversion and Intertemporal Elasticity of Substitution

The usefulness of the total composite rate of return can be determined empirically. We investigate whether the use of the total composite is useful in estimating relative risk aversion (CRRA) and intertemporal elasticity of substitution (IES). We show that results derived by using the total composite are different from those obtained by using, for instance, the T-bill rate.

In this section we test the validity of the consumption Euler equation using alternative measures of the rate of return. Previous attempts to validate the Euler approach to consumption theory with time series aggregate data generally have been unsuccessful. Lack of success could be due to one or more of four explanations: (1) the model is truly wrong, (2) specification of the utility function has been faulty, (3) aggregate consumption data are flawed, and (4) researchers have employed the wrong measure of the rate of return. Given our emphasis on the after-tax after-inflation total composite return, it seems reasonable to test its usefulness by applying it to the conventional approach in consumption economics. Accordingly, we focus on the fourth mentioned possible cause for rejection of the Euler approach. Our tests are conducted using an array of returns consisting of some singular measures and five composite measures. In our discussion, we first focus on the analysis of the total composite return, which represents a total household portfolio return, and the T-bill rate, which is a standard measure of the interest rate in consumption literature.

A. Major Previous Studies

Table 5 gives the results of some of the estimates of relative risk aversion and intertemporal elasticity of substitution from some well-known previous studies. We chose the specific estimates for the table because they were the ones most comparable with our estimates presented below. Using value-weighted and equally weighted NYSE stock returns as the measure of return and data on nondurables plus services (NDS) to represent consumption, Hansen and Singleton (1982) estimated the parameters of the CES expected utility function using nonlinear version of the Euler equation. Their monthly data covered the period 1959:2-1978:12. They employed both instrumental variables and maximum likelihood approaches for estimation. When only the return on stocks was used and instrumental variables specified, the Hansen and Singleton's estimate of relative risk aversion was statistically significant and there was no evidence against overidentifying restrictions of the model. However, their multiple return model that used both value- and equally weighted stock returns, rejected restrictions and provided evidence against the model.

Hansen and Singleton (1983) returned to the problem by formulating a restricted log-linear time series model to estimate the parameters of the CES utility function. They tested the model with value-weighted stock returns and the nominal risk-free Treasury bill rate using monthly data for the same period as previously. In the study they found statistically insignificant values for relative risk aversion using stock returns. Their estimate of relative risk aversion was statistically significant, but evidence against overidentifying restrictions was strong using the rate on Treasury bills as the measure of return. Hall (1988) estimated intertemporal elasticity of substitution with a log-linear model but rejected the Hansen-Singleton one-period lagged instruments. He employed three definitions of return: *net real* Treasury bill rate, saving rate, and

S&P stock index returns. Hall found what he considered to be a reasonable range of values for IES, very close to zero. He did not test for overidentifying restrictions, however.

Epstein and Zin (1991) questioned the use of the expected utility model. In its place they substituted a more general nonexpected utility approach that permitted the disentangling of relative risk aversion and elasticity of substitution among other advantages. They chose four measures of consumption, three lag structures and two measures of returns (NYSE value weighted stocks and stocks plus bonds), comprising a total of 24 models to be tested. They used monthly data for the time period used earlier by Hansen and Singleton and an extended time period, 1959:4-1986:12. Their generalized method of moments (GMM) estimates showed that the estimated parameter values were sensitive to model specification. Testing for overidentifying restrictions, the models were rejected in fourteen out of twenty-four tests.

Attanasio and Weber (1995) argued against the use of time series data in estimating Euler equations. They constructed panels from Consumer Expenditure Survey (CEX) data set for each year for 1982-1990. Using the yield on municipal bonds and specifying utility as CES, their estimate of IES was not statistically different from zero but there was no evidence against overidentifying restrictions. Switching to nonhomothetic utility, the authors obtained a statistically significant estimate of IES (0.67) with little evidence of overidentification.

B. Empirical Methodology

We conclude that the studies cited above find at best weak support for the CES model in time series tests and most of the estimates for IES are statistically insignificant using stock returns or the T-bill rate. We speculate that failure of the model has been due as much to misspecification of the rate of return variable as, perhaps, to misspecification of the utility function. In a representative agent and one asset world model, the relevant rate of return cannot be that of a T-bill or stocks. The representative agent holds a portfolio of assets. We need to recognize that the return of concern is the return on the portfolio and not each individual return. Therefore, we test the conventional CES model while insisting that the representative consumer is also a CAPM-type investor, and that finance theory has a role to play in estimating parameters of an expected utility model.

Yet, a researcher must exercise some caution. Our task is not to see whether we can generate unambiguously "good" estimates of the parameters of a consumption Euler equation. Rather we only intend to investigate whether the use of the total composite net real rate as a measure of return yields different results than those obtained from single asset measures of return. Accordingly, we employ the conventional CES model used in early tests and substitute the composite return for the rate of return variables used in earlier studies. It is probable that using our total composite return with some other assumption about utility would produce better (worse) results; but experimenting with other utility functions is not our goal. Our experiments do not use any new technique, complicated utility functions or require panel data. Our estimated equations are the same as the relatively simple linear and nonlinear equations (derived from Euler equation (4)) that were standard in most of the tests of models undertaken earlier, namely:

$$\Delta \ln c_{t+1} = \kappa + \sigma \ln(1 + r_{t+1}) + \mu_{t+1} \tag{7}$$

and

$$\beta \left(\frac{c_{t+1}}{c_t} \right)^{-\gamma} (1 + r_{t+1}) - 1 = \varepsilon_{t+1} \tag{8}$$

where σ and γ are the IES and CRRA, respectively. We use the GMM estimator of Hansen (1982) and perform our estimations in TSP. In addition to a constant and two, three, and four period lagged net real (or real if the real rate is used in estimations) T-bill rate and nondurable consumption (ND) growth rate, we include two period lagged bond default premium,

$\left(\frac{1+R_t^{LT\ CORP.BONDS}}{1+R_t^{LT\ GOVE'T\ BONDS}}\right)$, and two period lagged bond horizon premium, $\left(\frac{1+R_t^{LT\ GOVE'T\ BONDS}}{1+R_t^{ST\ GOVE'T\ BONDS}}\right)$, in

our instrument set.[7] The R^2 (adjusted R^2) of the first stage regression is 0.51 (0.49) for the net real T-bill rate and 0.1 (0.06) for the total composite return. The instruments are lagged at least two periods due to the MA(1) component of the error term arising from aggregation (Hall 1988).

We estimate parameters in these equations using our quarterly data for the whole sample, 1952-2000. We also perform estimations for the time period selected by Hansen and Singleton (1983), Epstein and Zin (1991) (Hall's 1988 time period plus three years), other periods, 1959-1996, 1965-2000, and 1979-2000, and a longer period, 1959-2000. Various time periods are used because we are interested in determining whether our results are independent of the periods selected for the experiments. We also utilize two measures of consumption, NDS for nondurables and services and ND for nondurables taken from Table 7.1 (former Table 8.7) in the NIPA. In our discussion, we first focus on the analysis between the T-bill rate and the total composite return estimations. We also perform estimations using other single asset rates of return as well as several composite measures to represent the rate of return.

C. T-bill vs. Total Composite

Table 6 presents estimates for the net real T-bill rate and total composite return equations for both linear and nonlinear estimations as well as NDS and ND measures of consumption. First, with two measures of consumption and a linear estimation, for both returns the model is not rejected as indicated by the J-test of overidentifying restrictions while the IES parameters are estimated with precision. Using NDS, we note that the IES estimate is about 0.28 for the T-bill

[7] We also used combinations of these instruments in addition to the stock return as well as nominal returns and the inflation rate in the instrument set for the T-bill and total composite estimations. The results do not change by any significant amount.

rate equation versus 0.15 for the total composite return equation. With ND, the IES estimate using the T-bill rate is slightly higher at 0.38 while the estimate using the total composite rises from 0.15 to 0.24. Intuitively, a 1% increase in the expected total composite rate increases the expected consumption growth rate by 0.24%.

However, for the nonlinear estimation, the J-test rejects the overidentifying restrictions for the model with the T-bill rate, unlike that with the total composite, at the 5% level for NDS and ND. The CRRA estimates for the total composite are substantially larger (2.91 vs. 1.16 for NDS and 2.55 vs. 0.82 for ND). In the table, we also present the corresponding IES estimates since in the CES utility model, the IES is an inverse of the CRRA (the standard errors are computed using the delta method). Given this relationship and our estimates, we test whether this relationship is valid for both measures of return.[8] The results are similar for NDS with p-values of 0.03 for both returns thus rejecting the hypothesis at the 5% level. For ND, the relationship holds for the total composite return at the 10% level (p-value of 0.14) but for the T-bill, it only holds at the 5% level (p-value of 0.07).

We also perform an empirical test of whether the total composite return has explanatory power in the linear model. We run the following regression:

$$\Delta \ln c_{t+1} = \kappa + \sigma \ln\left(1 + r_{t+1}^{T-bill}\right) + \delta \ln\left(\frac{1 + r_{t+1}^{T-bill}}{1 + r_{t+1}^{Composite}}\right) + \mu_{t+1} \tag{9}$$

and test whether $\delta = 0$. The results in Table 6 show that the hypothesis is rejected at the 5% level for both NDS and ND. Alternatively, equation (9) can be rewritten:

$$\Delta \ln c_{t+1} = \kappa + (\sigma + \delta)\ln\left(1 + r_{t+1}^{T-bill}\right) + (-\delta)\ln\left(1 + r_{t+1}^{Composite}\right) + \mu_{t+1} \tag{10}$$

[8] The test is a t-test derived using the influence functions of the GMM estimator and the delta method.

The estimation results of equation (10) show that the coefficient on the T-bill rate is statistically insignificant while it is significant for the total composite as indicated by the estimate of δ. These results suggest that the total composite is more relevant than the T-bill in the household's intertemporal problem.

Table 7 presents the estimation results for real and net real rates and different sample periods. The shaded rows indicate that (i) the J-test values for overidentifying restrictions are not met at the 5% level, or (ii) given that the J-test does not reject the null of overidentifying restrictions, the estimates for the parameters for relative risk aversion and intertemporal substitution are not significant at the 5% level. For linear estimations, we note that the IES estimates using the total composite return do not vary much from the 1952-2000 estimates. For the T-bill rate, for the 1959-1978 and 1965-2000 sample periods, the IES estimate is statistically insignificant, and for the 1979-2000 time period, the estimate is much larger. The results for nonlinear estimations also suggest that the IES estimates using the total composite return do not change much across sample periods. We also note that the J-test rejects the net real T-bill rate model in four (three) additional sample periods for ND (NDS).

Lastly, the issue of taxation seems to be much more important if using the T-bill rate than using the total composite return. This is not surprising as the fluctuations in the total composite return are much larger than the fluctuations in the tax rates with the correlation of the net real and real total composite rates of 0.99. For the T-bill rate, however, taxes seem to matter as fluctuations in the rate of return are not as large relatively to the tax rates changes with the correlation of the net real and real T-bill rates of 0.94. The IES parameter using the net real total composite return is slightly higher and more precisely estimated than that using the real total composite rate. The difference is more pronounced for the T-bill return estimations. The IES parameters are larger for the net real T-bill rate, for instance, 0.28 vs. 0.09 for the 1952-2000 period using NDS. In addition, the IES estimate using the net real T-bill rate is much more precisely estimated across different sample periods for both linear and nonlinear estimations.

In summary, taking into account different sample periods, NDS and ND consumption measures, and linear and nonlinear estimations, the total composite produces robust results in the Euler equation estimations. In addition, the test of the regression in equation (9) indicates that the total composite rate is more important in explaining the household's consumption growth. The IES estimates are lower than those obtained using the T-bill rate and are in 0.15-0.3 range. However, we should note that in linear estimations, use of the T-bill rate also results in precisely estimated IES coefficients although the estimates are larger. Not surprisingly, a correlation coefficient between the T-bill rate and ND (NDS) consumption growth rate series is about 0.28 (0.23), which is slightly higher than that for the total composite, 0.2 (0.18).

D. Other measures of return

Tables 8 and 9 present estimates for linear and nonlinear estimations for other measures of return. For linear estimations, the J-test does not reject the null of overidentifying restrictions at the 5% level for all measures of returns and consumption as well as time periods. However, for all return measures except for the total and financial composites, the IES parameter is imprecisely estimated for some time periods. Note that the IES estimate for the money return is quite similar to that of the T-bill rate, which is expected given that the M2 own rate follows closely the T-bill rate. The IES estimates using the T-note, bond and government bond composites are similar at about 0.05, but are imprecisely estimated. The estimate for the debt composite, whose main asset is money, is a little larger at 0.1 for NDS and 0.16 for ND for the 1952-2000 period. The use of the financial composite, whose main component is stocks, results in a higher estimate of the IES (0.06-0.2) as compared to that for stocks (0.03-0.09). In general, the IES parameter estimates are lower than those for the total composite when using other asset measures except for money, which is comparable to the T-bill.

The nonlinear estimations suggest that in 9 out of 14 cases, the J-test rejects overidentifying restrictions for the T-bill and money rates equations. Using Treasury notes, the model is not rejected except in 3 cases, but estimates of about 2 are statistically insignificant except for the 1959-1986 sample period. For the debt composite, the estimates are slightly larger (about 2) than for the money equation. Yet for the debt composite equation, the overidentifying restrictions are rejected in 8 out of 14 cases and the parameters are imprecisely estimated in 2 cases. Results derived by using the government bond composite produce mainly insignificant estimates although estimates are close to those for the T-notes. The use of the bond composite results in insignificant estimates in 5 cases while the CRRA estimates are a little larger than those for the total composite for some sample periods.

Stocks meet both tests except in 4 cases, but the estimates of CRRA for some time periods will appear to be too high. When the total composite is used as the rate of return, all tests are met and the coefficient of relative risk aversion falls within a range of 2.12-4.91 clustering around 2.5-3.5. By standards of the past, these estimates will seem reasonable to many researchers. The financial composite, which comprises all assets except residential real estate, performs similar to stocks. However, the estimates for CRRA are quite larger (3.47-8.48) than the estimates for the total composite although lower than those for stocks (3.64-18.07). There is not much support in the literature for CRRA estimates above 5. The reason is that we do not observe insurance rates as high as one would expect to see if, in fact, CRRA for the representative consumer fell within, for instance, the range of 5-10.[9] Even CRRA in the range of 4-5 is considered to be very high. In contrast, the use of the total composite provides more reasonable estimates mostly in the range of about 2.5-3.5.

E. Alternative Measure of Consumption

Lastly, we use adjusted personal consumption expenditures (PCE) compiled by Slesnick (1998) and repeat the above exercise. These data account for service flows from durable goods and incorporate adjustments on expenditures by nonprofit institutions and insurance and medical care spending by households. The data are available annually for the 1952-1993 period. Our estimates are presented in Table 10 for the IES and Table 11 for the CRRA. Table 10 reveals that the IES estimates do not change much from those of ND and NDS consumption measures given the annual or quarterly 1952-1993 sample period. Thus the IES estimates are quite robust to data frequency. Moreover, the IES estimates with the adjusted PCE data are similar to those with NDS and ND. Note that the estimate for the total composite is 0.2 and is lower than that for the T-bill, 0.33. The nonlinear estimations suggest higher CRRA parameters for the annual data. The use of the adjusted PCE data results in the parameter estimates for the total composite of about 3 and for the T-bill of about 1.6, within the ranges obtained previously. As before but with a different consumption measure, the parameter estimates obtained using the total composite rate differ from those obtained using the T-bill rate.

VI. Concluding Remarks

We have constructed composite *net real rates of return* for five nested groups of assets: the government bonds, all bonds including municipal and corporate bonds, debt instruments

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[9] If a representative consumer had a relative risk aversion in the range of 5-10, he/she would be willing to pay 40% of his/her income to avoid a fair coin flip to gain or lose 50% of his/her income.

including money, financial assets including corporate ownership shares (stocks), and a representative portfolio of all major household assets including residential real estate. Each component return of each composite are computed as *net real total returns.* They include periodic capital gains as well as income payments (interest and dividends) net of appropriate periodic tax rates and inflation. The components are value weighted to form composite rates of return.

Comparisons have been made between *net real* returns and Fisher real returns that do not take account of taxes. Taxes are important for their level effects but not for time series effects. *Net real* returns and Fisher real returns are highly correlated because tax rate changes from period to period are small relatively to other changes. However, taxes claim on average over the past fifty years 30-40% of income due to interest and dividends and about 5% on capital gains. Capital gains and losses, both in stocks and bonds, are the main cause for the high volatility in component and composite returns.

We have attempted to answer the question, “Are composite returns, especially the total composite return, useful for consumption economics?” To answer this important question we have conducted an experiment using the household’s intertemporal problem. Noting that previous research to estimate parameters of consumption Euler equations (with CES utility and returns based on single assets) did not validate those models or produce precise parameters with aggregate time series data, we substituted the total composite return for single asset returns. The total composite return was more relevant to the intertemporal optimization than other composite measures and single asset returns. With linear and nonlinear estimations, different consumption measures, and various time periods, the use of the total composite return, the weighted-average portfolio return of a representative household, suggests that the IES is about 0.15-0.3 and the

CRRA is about 2.5-3.5. Our results thus show that the total composite return has a role to play in the household's intertemporal consumption choice.

Ours will not be the last word on the usefulness of a macro-based measure of returns. Much work needs to be done. The idea behind our research seems reasonable; but to convince others of its usefulness requires better collection, processing, and understanding of data better than we can claim. Just as there is a large staff to compile national income accounts and prices, a relatively large staff will be needed to collect and process detailed information on rates of return. We have painted with a broad brush. A staff, perhaps, at the U. S. Commerce Department or Federal Reserve would include expertise in areas of data collection, financial accounting, and statistical analysis. Undoubtedly, such a staff would want to include additional categories of assets and study in more detail the special characteristics of them.

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Table 1. Average Marginal Tax Rates on Household Income and Capital Gains, 1952-2000

Year	Income from					
	Interest	Corporate Interest	Government Interest	Corporate Dividends	Capital Gains	Noncorporate Capital Gains
1952	0.3251	0.3182	0.2260	0.4862	0.0608	0.0406
1953	0.3093	0.3083	0.2153	0.4506	0.0563	0.0387
1954	0.2731	0.3182	0.1864	0.4411	0.0551	0.0341
1955	0.2740	0.2628	0.1941	0.4536	0.0567	0.0342
1956	0.2860	0.2276	0.2073	0.4680	0.0585	0.0357
1957	0.2820	0.1843	0.1548	0.4498	0.0562	0.0353
1958	0.2782	0.2361	0.2010	0.4473	0.0559	0.0348
1959	0.2809	0.2177	0.2113	0.4570	0.0571	0.0351
1960	0.2711	0.2123	0.2042	0.4435	0.0554	0.0339
1961	0.2713	0.2239	0.2035	0.4478	0.0560	0.0339
1962	0.2669	0.2191	0.2041	0.4382	0.0548	0.0334
1963	0.2878	0.2298	0.2248	0.4609	0.0576	0.0360
1964	0.2584	0.1991	0.2044	0.4230	0.0529	0.0323
1965	0.2329	0.1717	0.1884	0.3877	0.0485	0.0291
1966	0.2376	0.1752	0.1977	0.3929	0.0491	0.0297
1967	0.2464	0.1854	0.2030	0.4006	0.0501	0.0308
1968	0.2725	0.2082	0.2255	0.4318	0.0540	0.0341
1969	0.2843	0.2189	0.2419	0.4465	0.0558	0.0355
1970	0.2813	0.2243	0.2369	0.4151	0.0519	0.0352
1971	0.2718	0.2205	0.2280	0.4099	0.0512	0.0340
1972	0.2808	0.2292	0.2363	0.4183	0.0523	0.0351
1973	0.2911	0.2400	0.2507	0.4324	0.0541	0.0364
1974	0.3018	0.2525	0.2655	0.4405	0.0551	0.0377
1975	0.3035	0.2620	0.2641	0.4507	0.0563	0.0379
1976	0.3105	0.2729	0.2685	0.4610	0.0576	0.0388
1977	0.3157	0.2780	0.2761	0.4630	0.0579	0.0395
1978	0.3145	0.2780	0.2786	0.4603	0.0575	0.0393
1979	0.3292	0.2896	0.2964	0.4767	0.0477	0.0329
1980	0.3489	0.3061	0.3158	0.4883	0.0488	0.0349
1981	0.3578	0.3146	0.3255	0.4743	0.0474	0.0358
1982	0.3226	0.2814	0.2956	0.4093	0.0409	0.0323
1983	0.2977	0.2608	0.2730	0.3946	0.0395	0.0298
1984	0.2997	0.2654	0.2781	0.3923	0.0392	0.0300
1985	0.3010	0.2698	0.2801	0.3855	0.0385	0.0301
1986	0.2959	0.2612	0.2730	0.3944	0.0394	0.0296
1987	0.2800	0.2508	0.2604	0.3193	0.0798	0.0700
1988	0.2557	0.2305	0.2391	0.2842	0.0711	0.0639
1989	0.2625	0.2398	0.2458	0.2873	0.0718	0.0656
1990	0.2615	0.2401	0.2459	0.2856	0.0714	0.0654
1991	0.2619	0.2413	0.2441	0.2886	0.0721	0.0655
1992	0.2605	0.2394	0.2408	0.2885	0.0721	0.0651
1993	0.2827	0.2609	0.2599	0.3076	0.0769	0.0707
1994	0.2851	0.2653	0.2669	0.3082	0.0771	0.0713
1995	0.2913	0.2737	0.2739	0.3168	0.0792	0.0728
1996	0.2952	0.2802	0.2796	0.3199	0.0800	0.0738
1997	0.3007	0.2877	0.2847	0.3463	0.0866	0.0752
1998	0.2947	0.2840	0.2801	0.3193	0.0798	0.0737
1999	0.2964	0.2877	0.2833	0.3168	0.0792	0.0741
2000	0.2955	0.2887	0.2828	0.3159	0.0790	0.0739

Table 2. Descriptive Statistics on Composite and Component Returns (1952-2000)

Assets	*Nominal* Mean	*Nominal* Std. Dev.	*Fisher Real* Mean	*Fisher Real* Std. Dev.	*Net Real* Mean	*Net Real* Std. Dev.
T-bills	0.0536	0.0286	0.0171	0.0193	0.0035	0.0166
T-notes	0.0668	0.0649	0.0301	0.0650	0.0112	0.0607
T-bonds	0.0671	0.1088	0.0308	0.1104	0.0094	0.1037
Municipal bonds	0.0538	0.1150	0.0184	0.1175	0.0184	0.1175
Corporate bonds	0.0684	0.1017	0.0321	0.1034	0.0096	0.0974
Stocks	0.1381	0.1670	0.1004	0.1708	0.0737	0.1626
M2	0.0368	0.0201	0.0010	0.0193	-0.0095	0.0191
Housing	0.1148	0.0534	0.0760	0.0425	0.0728	0.0420
Total Composite	0.0985	0.0537	0.0609	0.0588	0.0513	0.0572
Financial Composite	0.0879	0.0800	0.0512	0.0885	0.0372	0.0864
Debt Composite	0.0469	0.0383	0.0109	0.0416	0.0027	0.0409
Bond Composite	0.0641	0.0959	0.0280	0.0982	0.0239	0.0971
Gov't Bond Composite	0.0663	0.0759	0.0298	0.0769	0.0200	0.0747

Table 3. Correlation Matrix for Net Real Rates and Inflation (1952-2000)

	T-Bill	*T-Note*	*T-Bond*	*Municipals*	*Corp. Bonds*	*Stocks*	*Money*	*Housing*	*Total Composite*	*Inflation*
T-Bill	1.000									
T-Note	0.606	1.000								
T-Bond	0.536	0.956	1.000							
Municipals	0.530	0.903	0.889	1.000						
Corp. Bonds	0.551	0.956	0.960	0.938	1.000					
Stocks	0.382	0.275	0.303	0.347	0.392	1.000				
Money	0.921	0.593	0.550	0.582	0.592	0.498	1.000			
Housing	0.062	-0.007	0.046	0.080	0.015	0.092	0.002	1.000		
Total Composite	0.505	0.412	0.436	0.481	0.506	0.905	0.578	0.360	1.000	
Inflation	-0.662	-0.396	-0.386	-0.419	-0.420	-0.470	-0.851	0.046	-0.486	1.000

Table 4. Correlation Matrix for Net Real Composite Rates (1952-2000)

	Total	*Financial*	*Debt*	*Bond*	*Gove't Bond*
Total Composite	1.0000				
Financial Composite	0.9545	1.0000			
Debt Composite	0.5706	0.6245	1.0000		
Bond Composite	0.4883	0.5324	0.9553	1.0000	
Gove't Bond Composite	0.4194	0.4581	0.9481	0.9690	1.0000

Table 5. Estimates of CRRA and IES from Previous Studies

Author	Hansen/Singleton (1982)	Hansen/Singleton (1983)	Hall (1988)	Epstein/Zin (1991)	Attanasio/Weber (1995)
Time period	1959:2-1978:12	1959:2-1978:12	1959:4-1983:12	1959:4-1986:12	1982:3-1990:4
Data interval	Monthly	Monthly	Monthly	Monthly	CEX, quarterly
Method	GMM, MLE	MLE	Hayashi/Sims	GMM	GMM
Utility function	CES	CES	CES	Nonexpected	CES, Nonhomothetic (NT)
Parameter	CRRA	CRRA	IES	CRRA, IES	IES
Consumption measure	NDS, ND	NDS, ND	ND	NDS, ND	ND
Stocks, value-weighted	NDS: α = .68 (.19) χ^2 = 6.35, p = .5* ND: α = .82 (.07) χ^2 = 7.88, p = .5*	NDS: α = .26 (1.84) χ^2 = 6.69, p = .54* ND: α = .83 (.75) χ^2 = 8.43, p = .7*	σ = .03 (.1) No J-test	NDS: α = .18 (1.58), σ = .25 (.56) χ^2 = 7.8, p = .8** ND: α = .11 (.34), σ = .18 (.07) χ^2 = 8.1, p = .78**	
Stocks, VWR and EWR	ND: α = .56 (.1) χ^2 = 40.2, p = .98*				
Treasury bills		NDS: α = 1.29 (.09) χ^2 = 30.8, p = .99* ND: α = .18 (.06) χ^2 = 33.48, p = .99*	σ = -.03 (.38) No J-test		
Stocks (quarterly data)		ND: α = 2.67 (9.3) χ^2 = 10, p = .8*			
Stocks, bonds				NDS: α = .59 (1.1), σ = .41 (.32) χ^2 = 5.37, p = .94** ND: α = .0042 (.37), σ = .19 (.08) χ^2 = 9.55, p = .66**	
Municipal bonds					CES: σ = .33 (.32) χ^2 = 13.06, p = .84** NT: σ =.67 (.19) χ^2 = 18.4, p = .56**

Standard errors for parameter estimates are in parentheses; p indicates p-values.

* Reject null if P > .95; ** Reject null if P < .05.

VWR = value-weighted return; EWR = equally weighted return.

Specific tests in papers reviewed were selected for comparability with tests made in this study.

Table 6. T-bill Rate vs. Total Composite Return (1952:I-2000:IV)

		Linear		Nonlinear		Nonlinear	
		T-bill	Total Composite	T-bill	Total Composite	T-bill	Total Composite
		IES		*CRRA*		*Corresponding IES*	
NDS	Parameter	0.28	0.15	1.16	2.91	0.86	0.34
	St. error	0.11	0.05	0.33	1.07	0.25	0.13
	J-test	10.98	9.59	18.27	11.02	18.27	11.02
	P-value	0.14	0.21	0.01	0.14	0.01	0.14
Test for IES=1/CRRA	Statistic	-2.11	-2.21				
	P-value	0.03	0.03				
Equation (9) Test	σ	0.104					
	P-value	0.361					
	δ	-0.170					
	P-value	0.028					
ND	Parameter	0.38	0.24	0.82	2.55	1.22	0.39
	St. error	0.16	0.06	0.21	0.63	0.32	0.10
	J-test	11.33	8.39	19.11	10.13	19.11	10.13
	P-value	0.12	0.30	0.01	0.18	0.01	0.18
Test for IES=1/CRRA	Statistic	-1.79	-1.60				
	P-value	0.07	0.11				
Equation (9) Test	σ	0.068					
	P-value	0.709					
	δ	-0.334					
	P-value	0.003					

Table 7. T-bill Rate vs. Total Composite Return (linear and nonlinear estimations)

Linear Estimation

Assets		1952-2000		1959-2000		1965-2000		1979-2000		1959-1978		1959-1986		1959-1996	
		NDS		NDS		NDS		NDS		NDS		NDS		NDS	
		Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real
T-bill	IES	0.09	0.28	0.07	0.26	0.05	0.21	0.52	0.96	0.03	0.10	0.15	0.35	0.03	0.25
	St. error	0.09	0.11	0.10	0.11	0.10	0.11	0.20	0.29	0.20	0.14	0.10	0.12	0.11	0.12
	J-test	13.09	10.98	10.38	8.02	10.66	8.79	8.81	5.48	6.14	6.36	7.09	4.42	9.86	7.91
	P-value	0.07	0.14	0.17	0.33	0.15	0.27	0.27	0.60	0.52	0.50	0.42	0.73	0.20	0.34
Total Composite	IES	0.12	0.15	0.10	0.14	0.10	0.13	0.23	0.24	0.15	0.16	0.11	0.16	0.08	0.14
	St. error	0.05	0.05	0.04	0.05	0.04	0.04	0.08	0.07	0.06	0.05	0.05	0.05	0.05	0.05
	J-test	11.54	9.59	8.93	6.55	8.96	6.78	6.18	5.73	1.86	1.81	6.84	6.27	10.46	9.08
	P-value	0.12	0.21	0.26	0.48	0.26	0.45	0.52	0.57	0.97	0.97	0.45	0.51	0.16	0.25

Assets		1952-2000		1959-2000		1965-2000		1979-2000		1959-1978		1959-1986		1959-1996	
		ND		ND		ND		ND		ND		ND		ND	
		Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real
T-bill	IES	0.14	0.38	0.11	0.36	0.08	0.30	0.21	0.82	0.23	0.24	0.20	0.46	0.02	0.29
	St. error	0.13	0.16	0.14	0.16	0.13	0.16	0.19	0.32	0.36	0.27	0.14	0.17	0.14	0.18
	J-test	12.98	11.33	10.46	8.45	10.56	8.83	10.98	6.83	9.03	9.25	8.24	6.12	9.45	8.01
	P-value	0.07	0.12	0.16	0.29	0.16	0.26	0.14	0.45	0.25	0.23	0.31	0.53	0.22	0.33
Total Composite	IES	0.20	0.24	0.18	0.24	0.18	0.22	0.25	0.26	0.31	0.32	0.23	0.28	0.17	0.25
	St. error	0.06	0.06	0.06	0.06	0.06	0.06	0.10	0.10	0.09	0.08	0.07	0.06	0.07	0.07
	J-test	9.80	8.39	8.36	6.11	8.42	6.51	6.35	5.59	4.86	5.04	5.52	4.20	9.98	8.05
	P-value	0.20	0.30	0.30	0.53	0.30	0.48	0.50	0.59	0.68	0.66	0.60	0.76	0.19	0.33

Nonlinear Estimation

Assets		1952-2000		1959-2000		1965-2000		1979-2000		1959-1978		1959-1986		1959-1996	
		NDS		NDS		NDS		NDS		NDS		NDS		NDS	
		Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real
T-bill	CRRA	0.70	1.16	0.49	1.42	0.31	1.19	0.58	0.68	0.21	0.83	1.20	1.86	0.08	1.24
	St. error	0.32	0.33	0.31	0.40	0.31	0.38	0.24	0.21	0.25	0.34	0.51	0.51	0.29	0.38
	J-test	30.27	18.27	26.25	13.79	27.39	19.58	7.53	4.29	16.14	15.35	14.04	5.12	23.81	15.16
	P-value	0.00	0.01	0.00	0.05	0.00	0.01	0.38	0.75	0.02	0.03	0.05	0.65	0.00	0.03
Total Composite	CRRA	2.00	2.91	2.09	3.71	1.85	3.38	2.55	2.91	4.95	4.91	2.71	3.41	0.81	2.12
	St. error	1.02	1.07	1.20	1.30	1.18	1.30	0.90	0.84	1.69	1.58	1.10	1.08	0.98	0.98
	J-test	13.39	11.02	12.19	7.96	12.71	9.23	6.79	6.35	1.87	1.78	9.73	7.19	12.06	10.92
	P-value	0.06	0.14	0.09	0.34	0.08	0.24	0.45	0.50	0.97	0.97	0.20	0.41	0.10	0.14

Assets		1952-2000		1959-2000		1965-2000		1979-2000		1959-1978		1959-1986		1959-1996	
		ND		ND		ND		ND		ND		ND		ND	
		Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real	Real	Net Real
T-bill	CRRA	0.66	0.82	0.56	0.96	0.49	0.90	0.42	0.56	0.16	0.42	0.79	1.11	0.23	0.82
	St. error	0.22	0.21	0.21	0.26	0.22	0.26	0.26	0.24	0.14	0.18	0.30	0.31	0.20	0.26
	J-test	26.79	19.11	23.68	15.92	25.52	19.66	10.13	5.80	15.65	16.03	13.41	8.78	23.86	18.69
	P-value	0.00	0.01	0.00	0.03	0.00	0.01	0.18	0.56	0.03	0.02	0.06	0.27	0.00	0.01
Total Composite	CRRA	2.21	2.55	2.55	2.97	2.44	2.87	1.98	2.26	2.26	2.21	2.67	2.82	1.59	2.24
	St. error	0.67	0.63	0.78	0.70	0.75	0.72	0.86	0.88	0.63	0.60	0.70	0.63	0.63	0.60
	J-test	12.09	10.13	10.76	7.09	11.79	8.77	6.89	6.45	3.68	3.91	6.35	4.50	12.02	9.70
	P-value	0.10	0.18	0.15	0.42	0.11	0.27	0.44	0.49	0.82	0.79	0.50	0.72	0.10	0.21

Table 8. Estimates of the IES (linear estimation, net real rates)

Assets		1952-2000		1959-2000		1965-2000		1979-2000		1959-1978		1959-1986		1959-1996	
		NDS	ND	NDS	ND	NDS	ND	NDS	ND	NDS	ND	NDS	ND	NDS	ND
T-bill	IES	0.28	0.38	0.26	0.36	0.21	0.30	0.96	0.82	0.10	0.24	0.35	0.46	0.25	0.29
	St. error	0.11	0.16	0.11	0.16	0.11	0.16	0.29	0.32	0.14	0.27	0.12	0.17	0.12	0.18
	J-test	10.98	11.33	8.02	8.45	8.79	8.83	5.48	6.83	6.36	9.25	4.42	6.12	7.91	8.01
	P-value	0.14	0.12	0.33	0.29	0.27	0.26	0.60	0.45	0.50	0.23	0.73	0.53	0.34	0.33
Money	IES	0.25	0.35	0.23	0.32	0.19	0.28	0.71	0.68	0.11	0.16	0.30	0.41	0.22	0.26
	St. error	0.09	0.13	0.09	0.13	0.09	0.13	0.18	0.19	0.13	0.23	0.09	0.14	0.09	0.14
	J-test	10.87	10.93	8.08	8.49	8.77	8.73	5.70	6.77	6.56	9.70	4.34	5.71	7.99	7.96
	P-value	0.14	0.14	0.33	0.29	0.27	0.27	0.58	0.45	0.48	0.21	0.74	0.57	0.33	0.34
T-note	IES	0.05	0.07	0.05	0.08	0.04	0.06	0.07	0.03	0.17	0.45	0.08	0.11	0.04	0.06
	St. error	0.03	0.05	0.03	0.05	0.03	0.05	0.03	0.03	0.12	0.23	0.03	0.05	0.04	0.05
	J-test	13.71	12.60	10.27	9.38	10.22	9.78	12.76	11.29	4.70	5.35	6.52	6.88	9.72	8.79
	P-value	0.06	0.08	0.17	0.23	0.18	0.20	0.08	0.13	0.70	0.62	0.48	0.44	0.21	0.27
Stocks	IES	0.04	0.07	0.04	0.07	0.03	0.07	0.07	0.06	0.04	0.09	0.04	0.07	0.03	0.06
	St. error	0.01	0.02	0.01	0.02	0.01	0.02	0.03	0.04	0.02	0.02	0.01	0.02	0.02	0.02
	J-test	11.31	10.84	8.26	9.32	8.99	8.68	9.73	8.78	1.56	3.73	7.15	5.30	9.28	9.73
	P-value	0.13	0.15	0.31	0.23	0.25	0.28	0.20	0.27	0.98	0.81	0.41	0.62	0.23	0.20
Total Composite	IES	0.15	0.24	0.14	0.24	0.13	0.22	0.24	0.26	0.16	0.32	0.16	0.28	0.14	0.25
	St. error	0.05	0.06	0.05	0.06	0.04	0.06	0.07	0.10	0.05	0.08	0.05	0.06	0.05	0.07
	J-test	9.59	8.39	6.55	6.11	6.78	6.51	5.73	5.59	1.81	5.04	6.27	4.20	9.08	8.05
	P-value	0.21	0.30	0.48	0.53	0.45	0.48	0.57	0.59	0.97	0.66	0.51	0.76	0.25	0.33
Financial Composite	IES	0.07	0.12	0.07	0.12	0.06	0.11	0.14	0.15	0.10	0.20	0.08	0.15	0.06	0.11
	St. error	0.02	0.03	0.02	0.03	0.02	0.03	0.04	0.06	0.03	0.05	0.03	0.04	0.03	0.04
	J-test	11.76	10.39	8.44	8.74	8.79	8.62	7.74	7.78	1.82	4.40	6.61	5.02	9.71	9.35
	P-value	0.11	0.17	0.30	0.27	0.27	0.28	0.36	0.35	0.97	0.73	0.47	0.66	0.21	0.23
Debt Composite	IES	0.10	0.16	0.10	0.16	0.08	0.14	0.16	0.09	0.26	0.60	0.14	0.21	0.10	0.13
	St. error	0.05	0.07	0.05	0.07	0.05	0.07	0.06	0.06	0.13	0.20	0.05	0.08	0.05	0.08
	J-test	13.26	12.18	9.96	9.28	10.15	9.65	12.94	10.98	4.95	8.10	5.59	5.81	9.33	8.57
	P-value	0.07	0.09	0.19	0.23	0.18	0.21	0.07	0.14	0.67	0.32	0.59	0.56	0.23	0.29
Bond Composite	IES	0.04	0.07	0.04	0.07	0.03	0.06	0.05	0.02	0.17	0.33	0.06	0.09	0.04	0.06
	St. error	0.02	0.04	0.02	0.04	0.02	0.04	0.02	0.02	0.07	0.11	0.02	0.04	0.02	0.04
	J-test	13.88	12.14	10.54	9.15	10.70	9.68	13.67	11.35	2.00	2.66	6.18	5.52	9.80	8.56
	P-value	0.05	0.10	0.16	0.24	0.15	0.21	0.06	0.12	0.96	0.91	0.52	0.60	0.20	0.29
Gove't Bond Composite	IES	0.04	0.05	0.03	0.05	0.02	0.04	0.05	0.02	0.22	0.47	0.06	0.10	0.03	0.04
	St. error	0.03	0.05	0.03	0.05	0.03	0.04	0.03	0.03	0.16	0.27	0.03	0.05	0.03	0.05
	J-test	14.15	13.08	10.92	10.25	10.81	10.40	13.38	11.55	4.51	5.46	7.24	7.26	10.13	9.20
	P-value	0.05	0.07	0.14	0.17	0.15	0.17	0.06	0.12	0.72	0.60	0.40	0.40	0.18	0.24

Table 9. Estimates of the CRRA (nonlinear estimation, net real rates)

Assets		1952-2000		1959-2000		1965-2000		1979-2000		1959-1978		1959-1986		1959-1996	
		NDS	ND	NDS	ND	NDS	ND	NDS	ND	NDS	ND	NDS	ND	NDS	ND
T-bill	CRRA	1.16	0.82	1.42	0.96	1.19	0.90	0.68	0.56	0.83	0.42	1.86	1.11	1.24	0.82
	St. error	0.33	0.21	0.40	0.26	0.38	0.26	0.21	0.24	0.34	0.18	0.51	0.31	0.38	0.26
	J-test	18.27	19.11	13.79	15.92	19.58	19.66	4.29	5.80	15.35	16.03	5.12	8.78	15.16	18.69
	P-value	0.01	0.01	0.05	0.03	0.01	0.01	0.75	0.56	0.03	0.02	0.65	0.27	0.03	0.01
Money	CRRA	1.39	1.02	1.81	1.23	1.54	1.13	1.01	0.93	1.29	0.57	2.31	1.42	1.60	1.08
	St. error	0.37	0.24	0.45	0.30	0.42	0.29	0.26	0.25	0.42	0.18	0.56	0.37	0.44	0.30
	J-test	19.29	19.98	15.90	18.35	21.72	21.86	5.86	8.69	12.08	14.44	5.34	9.45	17.79	21.62
	P-value	0.01	0.01	0.03	0.01	0.00	0.00	0.56	0.28	0.10	0.04	0.62	0.22	0.01	0.00
T-note	CRRA	1.79	1.40	2.39	1.79	2.46	1.72	2.18	0.94	1.85	0.96	4.55	2.53	2.18	1.37
	St. error	1.22	0.85	1.36	0.99	1.41	1.00	1.60	1.62	1.14	0.57	1.80	1.28	1.37	1.00
	J-test	16.41	13.67	14.61	11.97	15.09	12.98	12.18	12.17	3.17	3.27	7.98	8.15	14.07	12.27
	P-value	0.02	0.06	0.04	0.10	0.03	0.07	0.09	0.09	0.87	0.86	0.33	0.32	0.05	0.09
Stocks	CRRA	9.32	7.35	9.77	7.83	7.61	7.41	3.64	3.76	18.07	8.63	11.53	9.21	6.61	6.75
	St. error	3.46	2.13	4.30	2.47	4.15	2.42	2.66	2.64	5.98	2.27	4.25	2.58	4.00	2.49
	J-test	13.33	12.01	11.20	9.11	12.43	9.59	7.55	6.94	1.56	2.96	9.40	5.34	13.12	10.67
	P-value	0.06	0.10	0.13	0.24	0.09	0.21	0.37	0.44	0.98	0.89	0.23	0.62	0.07	0.15
Total Composite	CRRA	2.91	2.55	3.71	2.97	3.38	2.87	2.91	2.26	4.91	2.21	3.41	2.82	2.12	2.24
	St. error	1.07	0.63	1.30	0.70	1.30	0.72	0.84	0.88	1.58	0.60	1.08	0.63	0.98	0.60
	J-test	11.02	10.13	7.96	7.09	9.23	8.77	6.35	6.45	1.78	3.91	7.19	4.50	10.92	9.70
	P-value	0.14	0.18	0.34	0.42	0.24	0.27	0.50	0.49	0.97	0.79	0.41	0.72	0.14	0.21
Financial Composite	CRRA	5.26	4.59	6.28	5.05	5.10	4.77	3.76	3.47	8.48	3.90	6.90	5.09	4.03	4.18
	St. error	1.73	1.03	2.11	1.14	2.03	1.14	1.34	1.36	2.59	0.93	2.00	1.12	1.78	1.07
	J-test	16.50	14.52	13.76	12.09	16.04	13.98	8.40	8.26	2.05	3.61	8.54	5.42	16.68	14.52
	P-value	0.02	0.04	0.06	0.10	0.02	0.05	0.30	0.31	0.96	0.82	0.29	0.61	0.02	0.04
Debt Composite	CRRA	1.67	1.48	2.29	1.90	1.93	1.73	1.13	0.88	1.63	0.82	3.86	2.52	2.08	1.64
	St. error	0.64	0.48	0.75	0.57	0.75	0.55	0.85	0.75	0.61	0.27	1.04	0.78	0.74	0.57
	J-test	21.96	18.89	19.77	16.66	21.36	17.99	13.62	12.79	5.58	6.57	7.24	8.47	19.02	17.55
	P-value	0.00	0.01	0.01	0.02	0.00	0.01	0.06	0.08	0.59	0.47	0.40	0.29	0.01	0.01
Bond Composite	CRRA	3.00	2.70	3.84	3.51	3.77	3.41	1.96	1.22	4.25	2.21	7.32	4.97	3.76	3.29
	St. error	1.71	1.21	1.91	1.41	1.98	1.42	2.24	2.26	1.77	0.80	2.50	1.91	1.95	1.48
	J-test	14.24	12.15	13.05	10.32	13.43	11.05	11.34	11.00	1.79	2.14	6.60	6.03	12.39	10.63
	P-value	0.05	0.10	0.07	0.17	0.06	0.14	0.12	0.14	0.97	0.95	0.47	0.54	0.09	0.16
Gove't Bond Composite	CRRA	1.73	1.46	2.10	1.79	2.17	1.79	1.55	0.85	1.57	0.82	4.30	2.64	2.03	1.49
	St. error	1.38	0.95	1.48	1.05	1.53	1.08	1.80	1.95	1.10	0.57	1.91	1.41	1.49	1.09
	J-test	15.32	13.38	14.14	12.02	14.32	12.64	10.78	10.90	2.70	2.87	7.91	7.77	13.03	11.63
	P-value	0.03	0.06	0.05	0.10	0.05	0.08	0.15	0.14	0.91	0.90	0.34	0.35	0.07	0.11

Table 10. Estimates of the IES (linear estimation, adjusted PCE, net real rates)

Assets		1952-1993 (Annual)			1952-1993 (Quarterly)	
		NDS	ND	Adj. PCE	NDS	ND
T-bill	IES	0.27	0.35	0.33	0.29	0.30
	St. error	0.11	0.14	0.12	0.12	0.18
	J-test	1.53	1.68	4.05	10.81	11.32
	P-value	0.82	0.79	0.40	0.15	0.13
Money	IES	0.25	0.26	0.28	0.26	0.29
	St. error	0.11	0.12	0.11	0.10	0.15
	J-test	1.67	2.58	4.34	10.81	10.90
	P-value	0.80	0.63	0.36	0.15	0.14
T-note	IES	0.08	0.12	0.10	0.05	0.05
	St. error	0.05	0.07	0.06	0.03	0.05
	J-test	2.22	1.84	4.37	13.23	12.29
	P-value	0.69	0.77	0.36	0.07	0.09
Stocks	IES	0.05	0.07	0.06	0.03	0.06
	St. error	0.02	0.03	0.02	0.01	0.02
	J-test	0.77	1.20	1.57	12.92	11.37
	P-value	0.94	0.88	0.81	0.07	0.12
Total Composite	IES	0.17	0.22	0.20	0.15	0.24
	St. error	0.07	0.10	0.07	0.05	0.06
	J-test	1.15	1.88	2.69	13.08	10.78
	P-value	0.89	0.76	0.61	0.07	0.15
Financial Composite	IES	0.09	0.14	0.13	0.07	0.11
	St. error	0.04	0.06	0.04	0.03	0.03
	J-test	0.63	0.87	1.53	13.72	11.62
	P-value	0.96	0.93	0.82	0.06	0.11
Debt Composite	IES	0.13	0.16	0.16	0.11	0.13
	St. error	0.07	0.08	0.07	0.05	0.08
	J-test	1.85	2.16	4.08	12.70	11.95
	P-value	0.76	0.71	0.40	0.08	0.10
Bond Composite	IES	0.06	0.08	0.08	0.05	0.06
	St. error	0.03	0.04	0.04	0.02	0.04
	J-test	2.33	2.37	3.97	13.26	12.02
	P-value	0.68	0.67	0.41	0.07	0.10
Gove't Bond Composite	IES	0.07	0.09	0.08	0.04	0.04
	St. error	0.04	0.05	0.05	0.03	0.05
	J-test	2.72	2.27	5.07	13.48	12.41
	P-value	0.61	0.69	0.28	0.06	0.09

Table 11. Estimates of the CRRA (nonlinear estimation, adjusted PCE, net real rates)

Assets		1952-1993 (Annual)			1952-1993 (Quarterly)	
		NDS	ND	Adj. PCE	NDS	ND
T-bill	CRRA	2.98	2.14	1.59	1.01	0.63
	St. error	1.14	0.80	0.63	0.31	0.21
	J-test	2.39	2.42	6.53	17.90	22.17
	P-value	0.66	0.66	0.16	0.01	0.00
Money	CRRA	3.16	2.05	1.82	1.23	0.81
	St. error	1.29	0.86	0.72	0.35	0.24
	J-test	2.08	4.20	5.68	19.54	23.69
	P-value	0.72	0.38	0.22	0.01	0.00
T-note	CRRA	6.20	5.15	2.84	1.83	1.11
	St. error	3.25	2.51	1.78	1.21	0.85
	J-test	3.19	2.56	4.54	15.02	13.50
	P-value	0.53	0.63	0.34	0.04	0.06
Stocks	CRRA	16.71	10.48	12.45	7.84	6.67
	St. error	6.64	3.71	4.24	3.27	2.13
	J-test	1.66	1.38	3.28	15.75	14.19
	P-value	0.80	0.85	0.51	0.03	0.048
Total Composite	CRRA	4.82	3.32	3.05	1.97	1.95
	St. error	1.89	1.33	1.18	0.83	0.53
	J-test	2.27	2.20	5.51	14.06	13.39
	P-value	0.69	0.70	0.24	0.05	0.06
Financial Composite	CRRA	9.31	6.13	6.42	4.05	3.81
	St. error	3.85	2.40	2.28	1.49	0.95
	J-test	1.02	0.90	2.66	19.12	17.64
	P-value	0.91	0.93	0.62	0.01	0.01
Debt Composite	CRRA	5.24	3.91	2.67	1.70	1.23
	St. error	2.33	1.69	1.18	0.63	0.47
	J-test	2.71	3.21	5.24	19.89	19.54
	P-value	0.61	0.52	0.26	0.01	0.01
Bond Composite	CRRA	10.67	8.19	6.31	3.22	2.45
	St. error	4.97	3.55	2.88	1.71	1.24
	J-test	2.76	2.72	4.93	13.16	12.30
	P-value	0.60	0.61	0.29	0.07	0.09
Gove't Bond Composite	CRRA	7.06	6.26	3.50	1.91	1.23
	St. error	3.60	3.02	1.86	1.37	0.97
	J-test	3.50	2.97	5.07	13.54	12.64
	P-value	0.48	0.56	0.28	0.06	0.08

Figure 1. Nominal and Net Real Returns on Treasury Bills

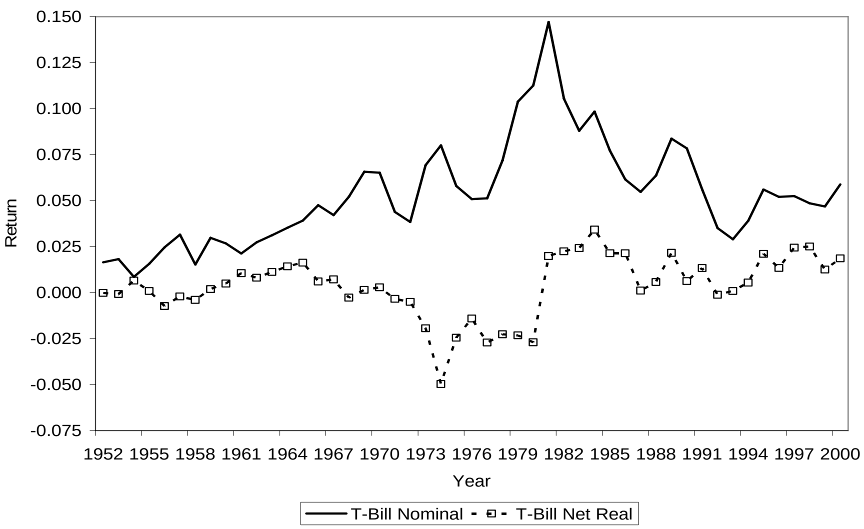


Figure 2. Nominal and Net Real Returns on Treasury Notes

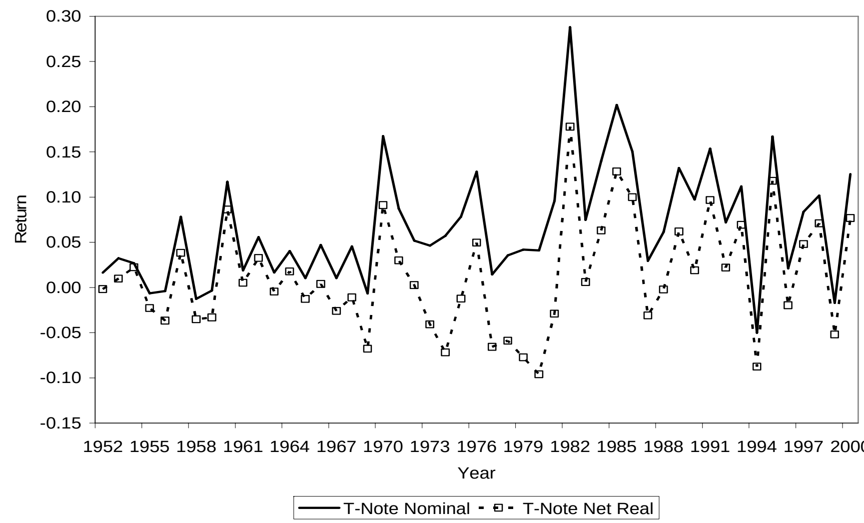


Figure 3. Nominal and Net Real Returns on Treasury Bonds

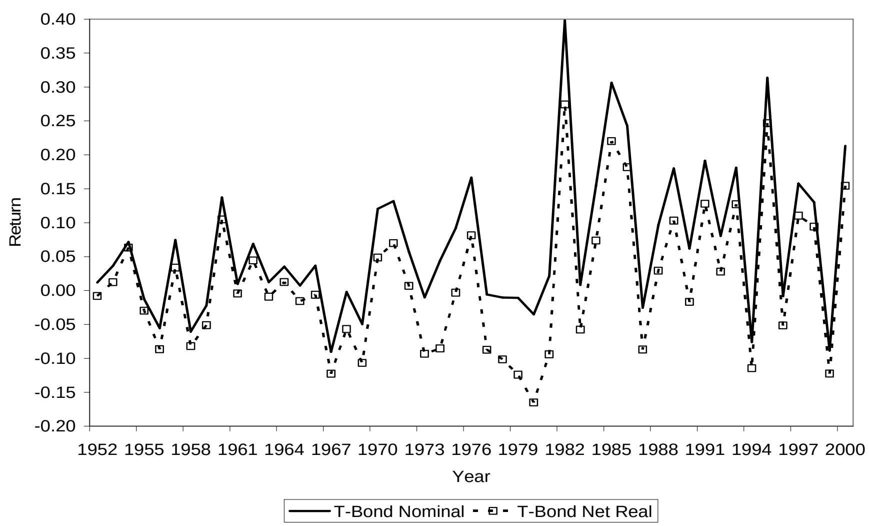


Figure 4. Nominal and Net Real Returns on Corporate Bonds

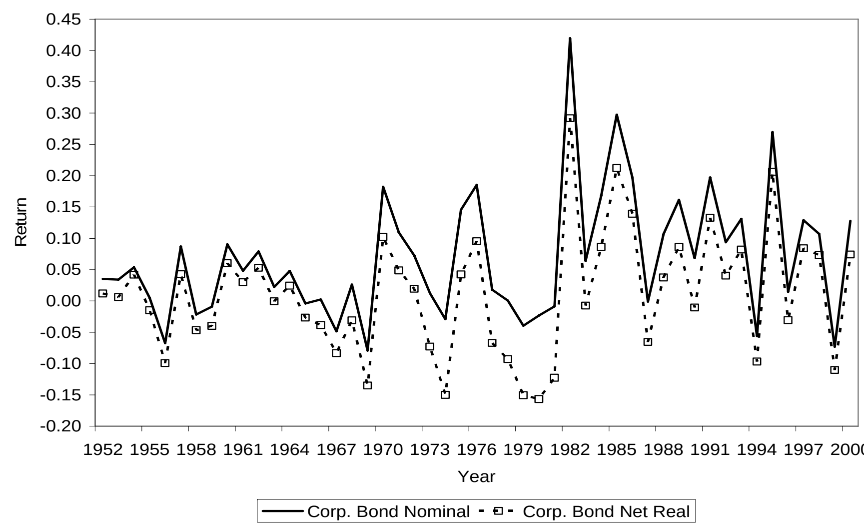


Figure 5. Nominal and Net Real Returns on Municipal Bonds

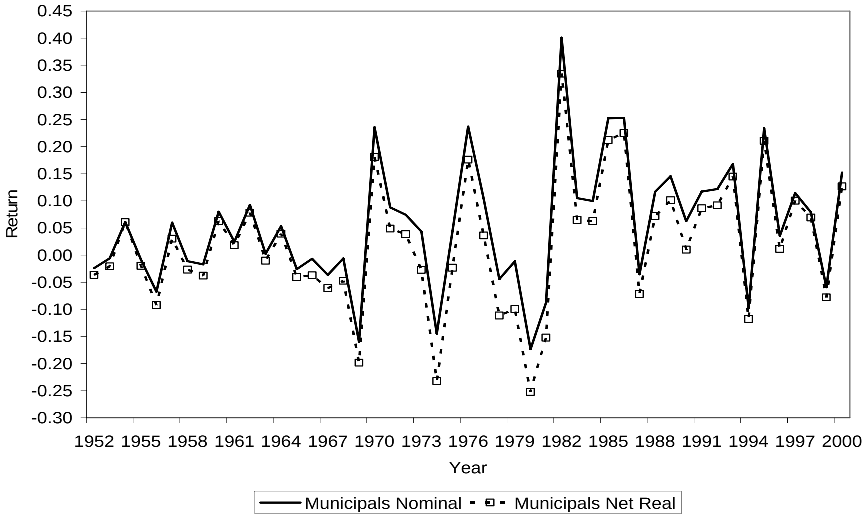


Figure 6. Nominal and Net Real Returns on Corporate Stocks

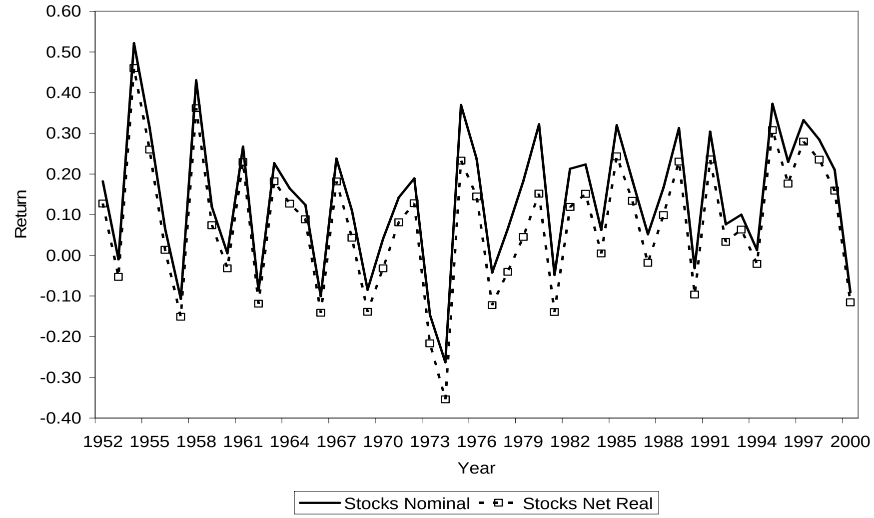


Figure 7. Nominal and Net Real Returns on Money

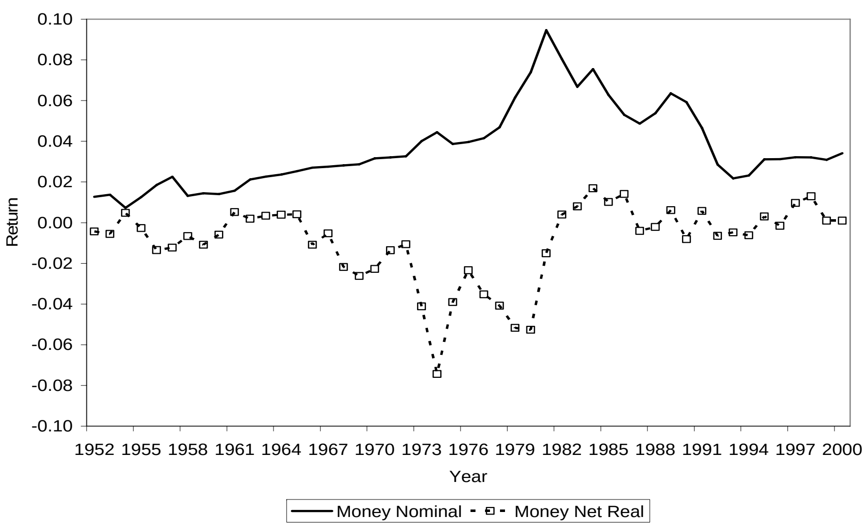


Figure 8. Nominal and Net Real Returns on Residential Housing

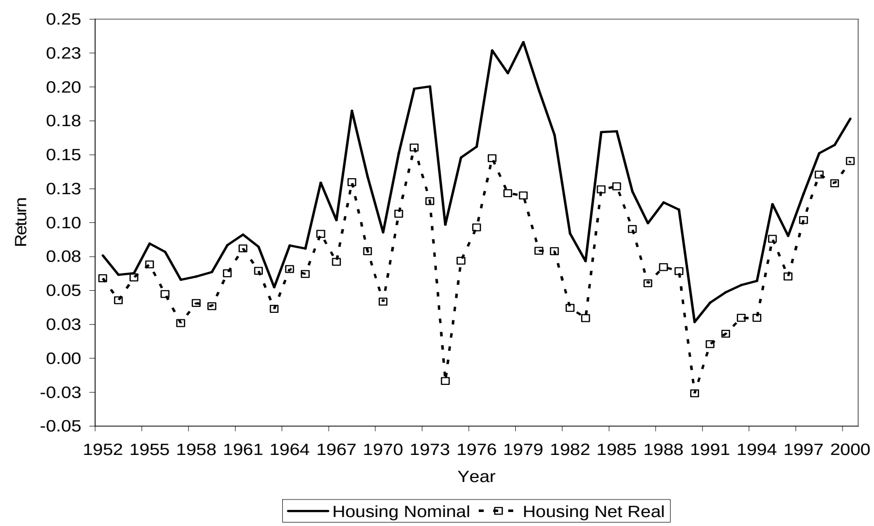


Figure 9. Total Household Portfolio Composition (Household Assets & Pension Funds)

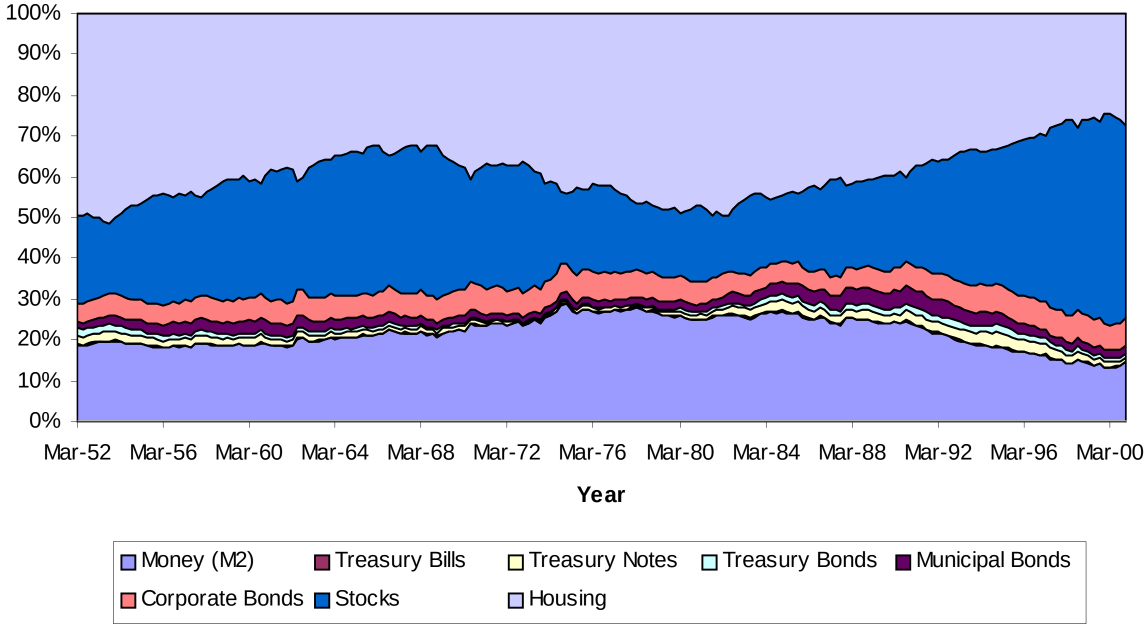


Figure 10. Nominal and Net Real Returns on Total Composite

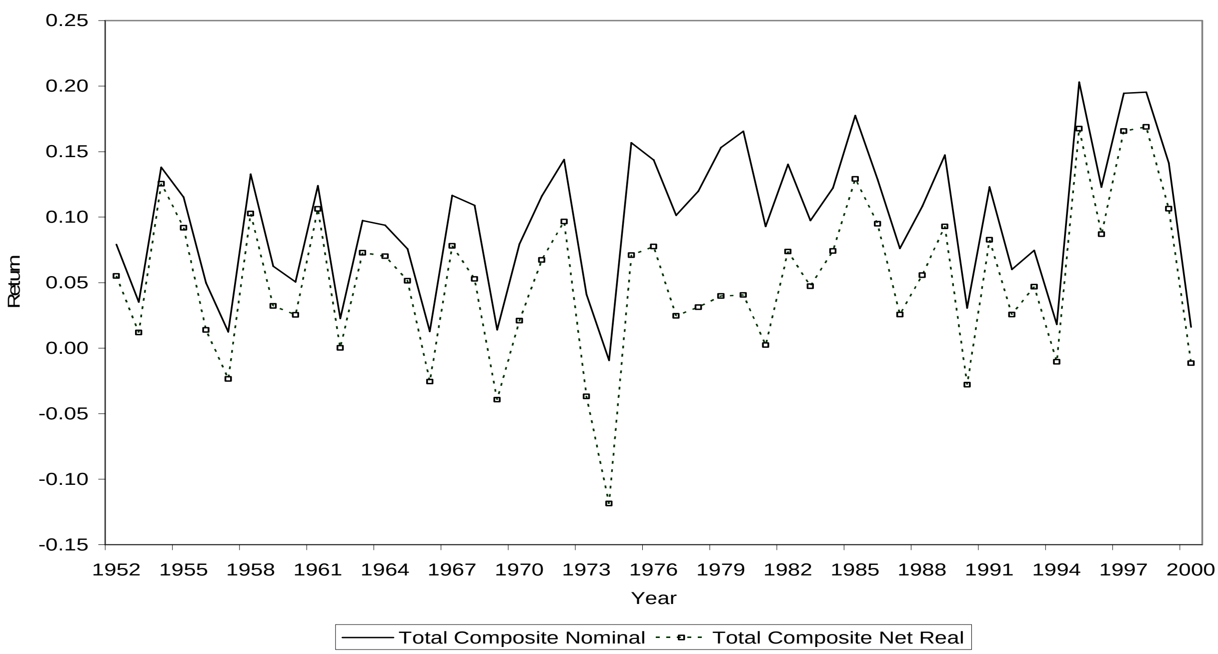


Figure 11. Nominal and Net Real Returns on Financial Composite

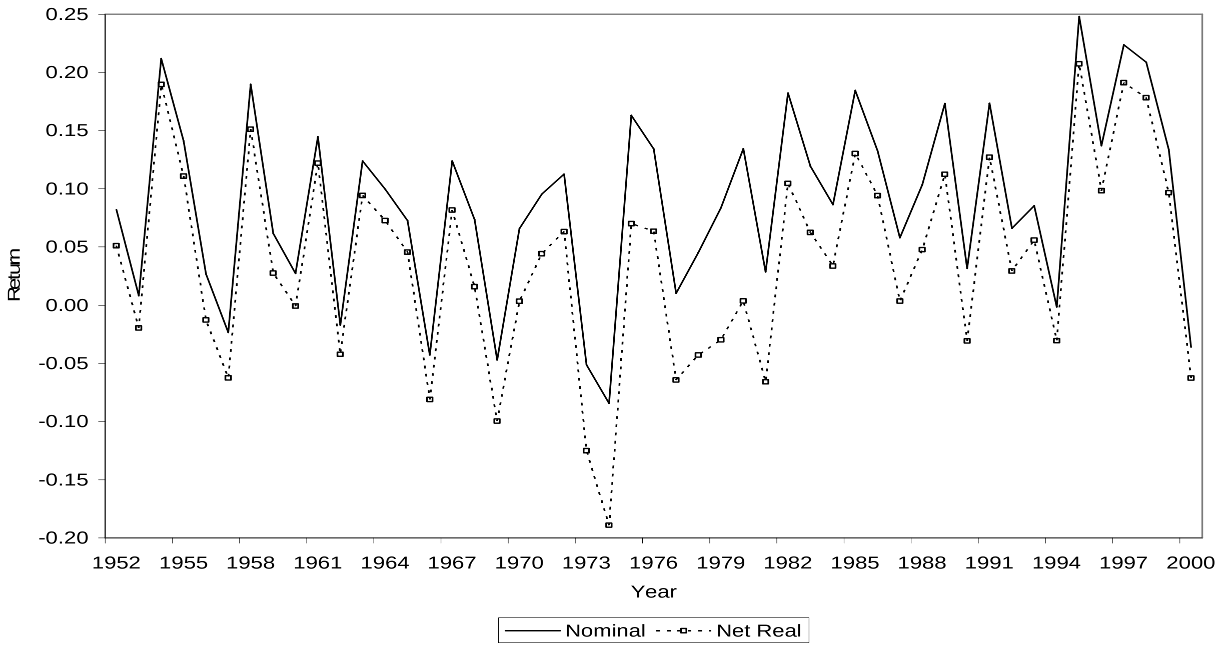


Figure 12. Nominal and Net Real Returns on Debt Composite

Figure 13. Nominal and Net Real Returns on Bond Composite

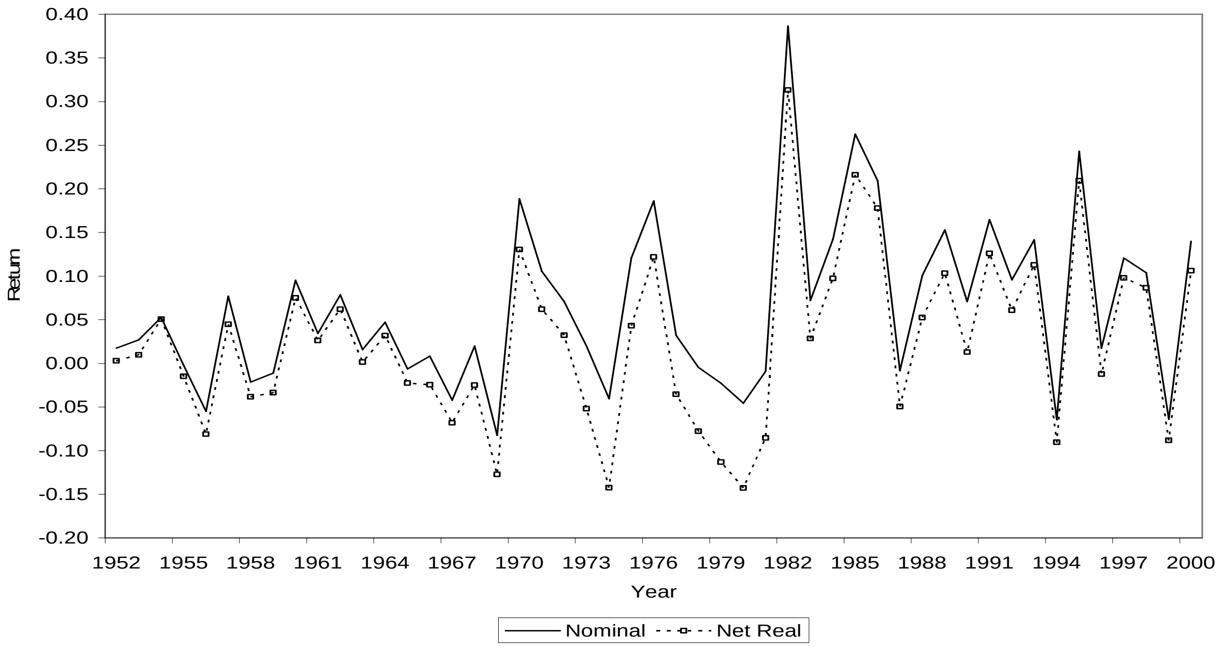


Figure 14. Nominal and Net Real Returns on Government Bond Composite

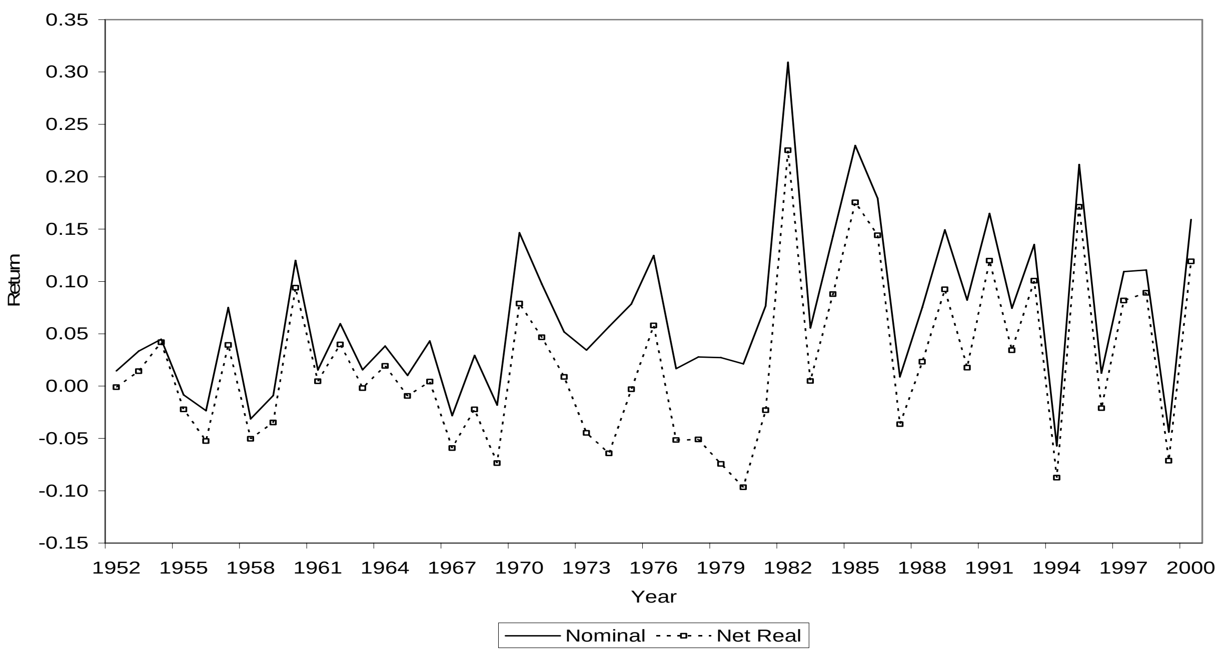


Figure 15. Fisher Real and Net Real Returns on Government Bond Composite

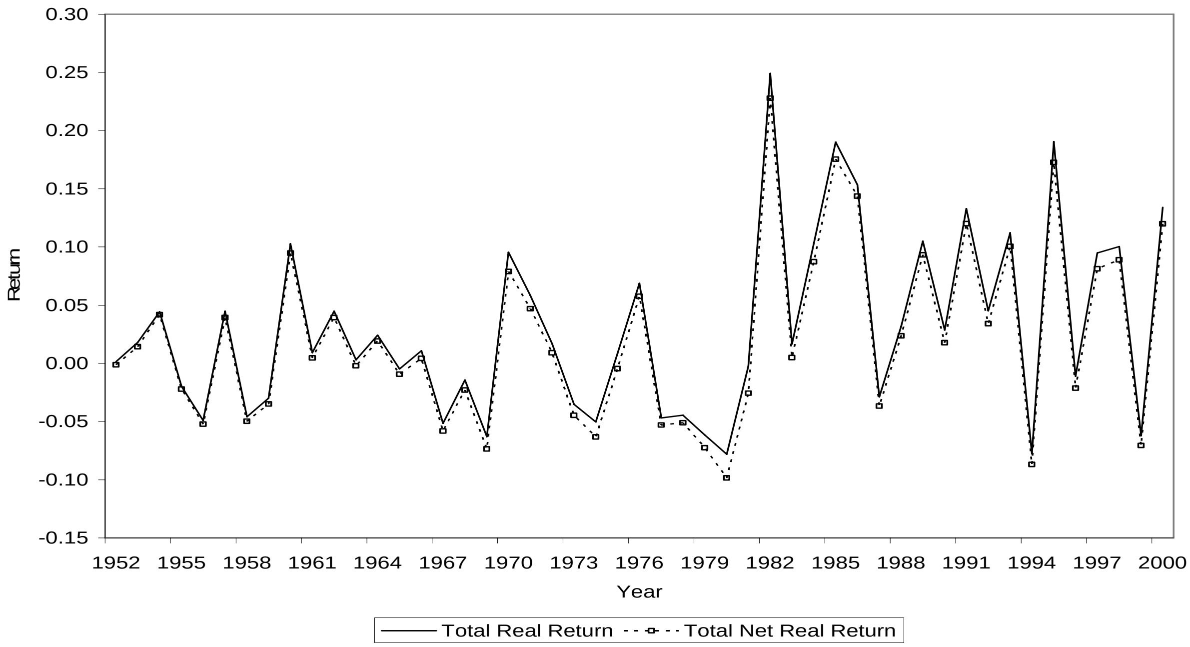
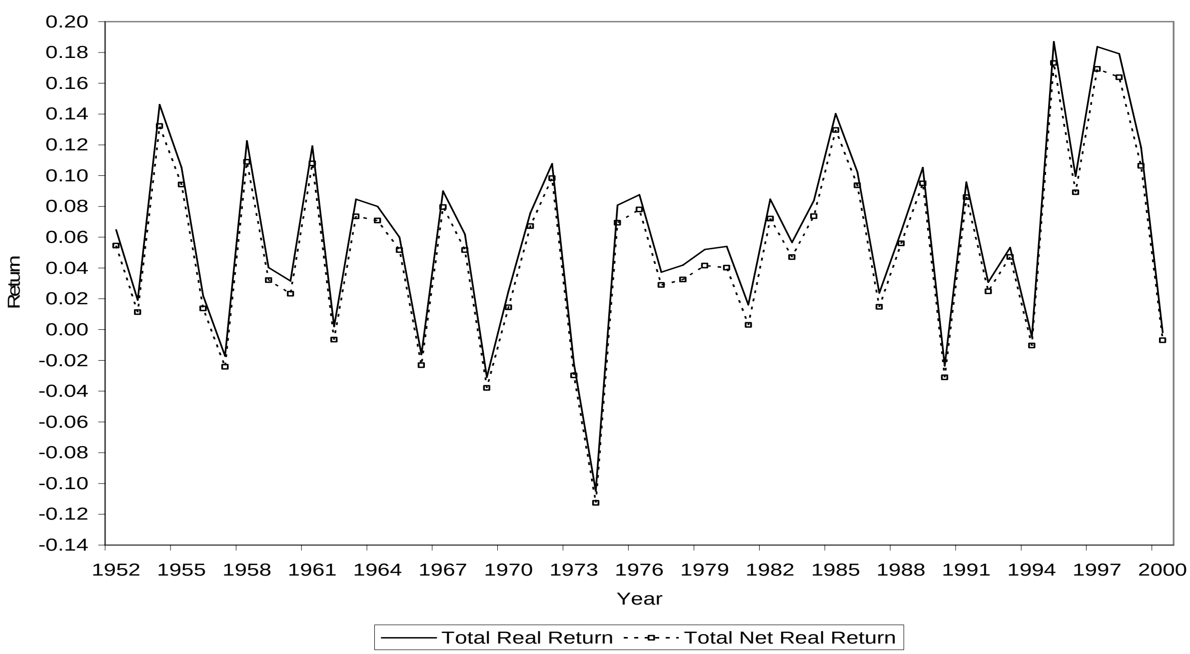


Figure 16. Fisher Real and Net Real Returns on Total Composite



Appendix A

A. Data on returns on interest income, dividends, and capital gains and inflation rate

Returns from Treasury bills, notes, and bonds, corporate bonds, and corporate stocks are taken from Ibbotson Associates annual publications, *Stocks, Bonds, Bills, and Inflation, 2001 Yearbook*. We chose this source over others because of its broad acceptance in the finance industry and, importantly, because it is easily accessible to any researcher concerned with the subject. It also contains both income and capital gain returns; the total return is defined as the sum of these two components. Quarterly returns (r^q) are computed as the quarterly compounded values of the monthly returns (r^i) in the source:

$$r^q = \prod_{i=1}^{3}(1+r^i)-1 \tag{A1}$$

Annual returns are computed by compounding the quarterly rates.

Treasury notes (intermediate-term government bonds) have maturities of five years, and Treasury bonds (long-term government bonds) are those with maturities of twenty years. Corporate bond returns are represented by a high-grade long-term bond index and have maturities of approximately twenty years. Since income returns are unavailable, we assume that monthly income returns are monthly yields on Moody's AAA corporate bonds. The yields are taken from *H.15 Selected Interest Rates* released by the Federal Reserve Board. The capital gain return is computed as the total return taken from the Ibbotson's publication (2001) minus the income return.

Returns on municipal bonds are computed using the Bond Buyer Index yield data. The 1953-2000 yields are taken from *H.15 Selected Interest Rates*. The 1952 data is taken from the National Bureau of Economic Research (NBER) historical series. The index used is mixed quality Bond Buyer Index. The monthly income returns are monthly yields. The capital gain return is calculated using the Ibbotson's methodology (2001). Assuming the twenty years to maturity, coupon equal the yield in the previous month, and the price equal the par, we calculate the new price using the standard present value bond formula. Then, the capital gain return is readily computed. Since the municipal bond returns are tax-exempt, the Fisher real and net real returns are the same.

Ibbotson distinguishes between large company stocks and small company stocks. For large company stocks, he uses S&P 500; thus, the stocks we consider are those of large companies. We omit small company stocks only because we have no time series on the value weights of stocks of large and small companies and our aggregates depend critically on value weighting. This omission is not serious even though it is well known that total returns to small company stocks have exceeded those of large company stocks. In 1996 the DFA Small Company Fund contained about 2,600 stocks but its total weighted market capitalization was only $163 million compared to about $5 trillion for large company stocks (S&P 500). [10]

The rate of inflation used in the study is constructed from the quarterly personal consumption expenditures (PCE) deflator from the NIPA. The annual inflation rates are computed as compounded quarterly rates as indicated above.

Money is defined as M2 and the return on money is the "own rate" on M2 as compiled by the Federal Reserve System and reported by the Federal Reserve Bank of St. Louis on its web page FRED. The M2 own rate is a weighted-average rate of return on the components of M2.[11] Since the data for 1952-1958 are unavailable, we estimate the missing data using the linear

[10] Ibbotson (1997), p.53 for DFA stocks and CRSP database for S&P 500.
[11] Because our data pertain only to household deposits, our total for M2 is slightly less than the total reported by the Federal Reserve. Our total is taken from the Federal Reserve Flow of Funds Accounts, Table B.100, "Balance Sheet of Households and Nonprofit Organizations." The own rate we use is based on a slightly larger total than ours taken from Flow of Funds. In addition, the rate we use may be slightly lower since business deposits, which are excluded from household flow of funds, most likely earn minimal interest returns. Therefore, if the own rate were calculated only on household deposits, it would be slightly larger.

regression of the T-bill yield on the M2 own rate for 1959-2000. The R-squared of the regression is 0.85.

B. Data on average marginal tax rates for interest, dividends, and capital gains

As mentioned in the text, the average marginal tax rates are available in Jorgenson and Yun's *Investment: Volume 3* (2001). We briefly describe how they have been computed, and for a detailed discussion the reader needs to consult Chapter 3 in the book cited above.

Adjusted gross income (AGI) data are used to allocate household income from various assets to the different tax brackets in order to obtain an average marginal tax rate. The distribution of household income from each asset to a tax bracket is assumed to be the same as the percentage of total AGI in that tax bracket and the percentages so determined are the weights assigned to each tax bracket for computing the average marginal tax rate.

The average marginal tax rate on capital gains from corporate equities is an "effective" tax rate in that payment of capital gains is deferred to the time that the asset is actually sold and not the year in which the capital gain is recorded in the data. It is standard in the literature to assume that deferral of payment reduces the effective capital gains rate by 50% and that no payment of the capital gain tax as a *capital gains tax per se* results in another reduction in the effective capital gains tax by another 50% (The tax rolls over into an estate tax).

C. Returns on residential housing

The total rate of return from residential housing is a value-weighted average of the return received by owners of homes they live in (owner-occupied) and the returns received by owners of residential real estate they rent out to others. For the purpose of our discussion we shall refer to the first group simply as "owners" (O) and the second group as "rentiers" (RNT). Let V_O equal the total equity value (assets minus debt) of owner homes and V_{RNT} equal the total equity value of rentier residences; thus, $V_O + V_{RNT} = V$. Then, the weight assigned to owners, w_O, is $\frac{V_O}{V}$ and the weight assigned to rentiers, w_{RNT}, is $\frac{V_{RNT}}{V}$. Let r_O^{bt} be the before-tax total rate of return to owners and r_{RNT}^{bt} be the before-tax total rate of return to rentiers. Then, the average before-tax total rate of return on residential housing (r_H^{bt}), measured as a return on equity, not market value, is:

$$r_H^{bt} = w_O r_O^{bt} + w_{RNT} r_{RNT}^{bt} \tag{A2}$$

Owners' total returns is the sum of three components, imputed rental income, I_O, a subsidy measured as a tax saving due to the exemption of interest payments on mortgage and property taxes, S_O, and returns due to capital gains, CG_O. Rentier returns are due to two sources, rental income, I_{RNT}, and capital gains, CG_{RNT}. Before-tax total returns to residential real estate are the sum for the two groups:

$$R_H^{bt} = I_O + S_O + CG_O + I_{RNT} + CG_{RNT} \tag{A3}$$

Note that the second term on the right-hand side is the subsidy realized by owners who occupy their own homes due to the exemption of mortgage interest and property taxes in the U. S. tax code.

After-tax total returns to residential real estate are computed as:

$$R_H^{at} = I_O + S_O + CG_O + (1-\tau_{\text{int}})I_{RNT} + (1-\tau_{cg})CG_{RNT}, \tag{A4}$$

where τ_{int} is the average marginal tax rate on interest in Table 1 (which is the same as the average marginal tax rate on income) and τ_{cg} is the average marginal tax rate on noncorporate capital gains. Note that before-tax and after-tax returns to owners are the same. They pay no tax on imputed rental income and, of course, on the tax subsidy. Following Jorgenson and Yun, they pay no capital gains tax, either. Rather, the capital gains tax for this group is minimal due to the favorable roll over provision and to the deferral of capital gains taxes due to long-term ownership and no capital gains tax (as such) at death. Rentiers are treated as businesses. They pay taxes on net rental income, enjoy no roll over provision regarding capital gains taxes and, presumably, sell homes more frequently than owner-occupiers. Lastly, the after-tax rate of return (r_H^{at}) on residential real estate is:

$$r_H^{at} = \frac{\left(I_O + S_O + CG_O + (1-\tau_{\text{int}})I_{RNT} + (1-\tau_{cg})CG_{RNT}\right)}{V} \tag{A5}$$

Our source for rental income from owner-occupied housing and rentier owners is the Housing Sector Output table from National Income and Product Accounts (NIPA) computed by the Bureau of Economic Analysis (BEA). I_O is taken from Table 8.21 (Imputations in the National Income), entries “proprietors’ income with capital consumption adjustment” (farm owner-occupied housing) and “rental income with capital consumption adjustment.” I_{RNT} is net rental income from Table 8.12 (Housing Sector Output), “proprietors’ income with capital consumption adjustment” (primarily engaged in the real estate business) and “rental income with capital consumption adjustment” less I_O. Above entries are compiled after costs (maintenance, property taxes, depreciation, etc.). To determine the tax subsidy received by owner-occupiers, we multiply the average marginal tax rate on income (that is, the average marginal tax rate on interest, τ_{int}) by mortgage interest and property tax payments. The net interest paid by owners is taken from Table 8.21 in the NIPA, and property taxes are computed as the product of property tax rates provided by Dale Jorgenson and market values of residential real estate.

Data on the value of residential real estate for each group is taken from the Flow of Funds Accounts (FFA) released by the Federal Reserve, Tables B.100 (Balance Sheet of Households and Nonprofit Organizations, line 51) and B.103 (Balance Sheet of Nonfarm Noncorporate Business, line 4 minus line 16). Since the data are at the end of the period, in computing rate of returns, we use the previous period for housing values (V_O , V_{RNT} , and V). Capital gains are obtained from Tables R.100 and R.103, which are changes in net worth accounting for new construction and improvements. However, since Table R.100 does not separate households (owners) from nonprofit organizations, we impute the capital gain component for households by multiplying the total capital gain by the ratio of household real estate to total real estate. Thus, we use only the portion of capital appreciation attributable to households.

We encountered the following problem with our data source. Data on rental income and net interest are annual series whereas we require quarterly estimates. Our solution to this problem is to find proxy series in the annual data that have quarterly data series. Our method for imputing quarterly estimates where none exist in the primary source is to assume that the quarterly-annual proportions in the two series will be the same.

We need to estimate the NIPA entries mentioned above, namely, "rental income with capital consumption adjustment" and "proprietors' income with capital consumption adjustment" for owners and rentiers and "net interest" for owners. We use the same quarterly and annual entries but from Table 1.14 (National Income by Type) as our proxy series. These entries are the components of total national income and thus include not only a housing sector. For example, let I_a equal the net rental income of owners reported annually and X_a equal the annual data on net rental national income (the proxy variable). Let X_q^i equal the reported quarterly values of net rental national income. Then, our estimates of the quarterly values of net rental income to owners for the four i quarters in the year, I_q^i, are computed as:

$$I_q^i = I_a \frac{X_q^i}{X_a}, \quad \text{(A6)}$$

D. After-tax returns

In our computations, we present Fisher real (after-inflation) and net real (after-tax after-inflation) returns. The Fisher real rate is calculated as follows:

$$r_k^F = \frac{1 + r_k^n}{1 + \pi} - 1, \quad \text{(A7)}$$

where r_k^F is the Fisher real rate for asset k; r_k^n is the nominal rate, and π is the rate of inflation. In turn, the net real rate is derived using the following equation:

$$r_k^{nr} = \frac{1 + r_k^{nn}}{1 + \pi} - 1, \quad \text{(A8)}$$

where r_k^{nr} is the net real rate, and r_k^{nn} is the net nominal (after-tax nominal) rate. In estimating the after-tax nominal return, we apply average marginal tax rates as reported in Table 1 to corresponding components of assets in consideration. The net nominal return is given by:

$$r_k^{nn} = i_k^n (1 - \tau_k^i) + g_k^n (1 - \tau_k^g) 1(g_k^n \geq 0) + g_k^n 1(g_k^n < 0), \quad \text{(A9)}$$

where i_k^n is the nominal income (e.g. interest, dividend, or rental income) return; g_k^n is the nominal capital gain return; τ_k^i is the average marginal tax rate on interest, dividend, or rental income, and τ_k^g is the average marginal tax rate on capital gains. Note that if the capital gain return is negative, then it is not taxed. We apply the average marginal tax rate on government interest to total return on Treasury bills and income returns on Treasury notes, Treasury bonds, and municipal bonds.[12] The tax rate on corporate interest is applied to the income return on corporate bonds, and the tax rate on interest (same as the tax rate on income) is applied to return

[12] Since Treasury bills' maturity is 3 months, the tax rate applied to total return is the tax rate on government interest income due to taxation of short-term capital gains at the income tax rate.

on money and income returns on stocks and residential housing. The corporate capital gains tax rate is applied to all assets except residential housing. Rather, the noncorporate capital gains tax rate is employed for rentier housing.

E. Composite Rate of Return

We use the 1952-2000 Flow of Fund Accounts to obtain the composition of the household portfolio. In particular, we extracted data from Table B.100 (Balance Sheet of Households and Nonprofit Organizations). Since the table contains assets for nonprofit organizations as well, we exclude them in our computations using the data in Table L.100.a (Nonprofit Organizations), available for the period of 1987-1999 and using the average for other years. The ratios of nonprofit assets in Table L.100.a to the household and nonprofit assets in Table B.100 do not vary much except for corporate bonds (20%-44%, average of 29%). Since this does not affect the computation of the composite in any substantial way (the corporate bonds weight is stable and about 10%), we use the average ratios to eliminate the nonprofit portion of the assets in Table B.100.

We add checkable deposits and currency, time and savings deposits, and money market fund shares to obtain our measure of money. We also add corporate equities and mutual fund shares to get the value of stocks. The entries for corporate bonds and municipal securities are also taken from the table. However, we do not have entries for T-bills, T-notes, and T-bonds in the table; rather, we have the Treasury securities (excluding savings bonds) entry. To get a breakdown of the Treasury securities, we use the data from the Treasury Survey of Ownership tables published quarterly by the Treasury Department in *Treasury Bulletin* for 1946-1982 years and from the Federal Debt tables also published in *Treasury Bulletin* for 1982-2000 period.

Treasury Survey of Ownership provides the amount outstanding on T-bills, T-notes, and T-bonds held by private investors (banks, insurance companies, pension funds) for 1946-1982 period. It also provides the amount outstanding by final maturity period for 1960-1982. The Federal Debt tables provide the amount outstanding of securities held by private investors by final maturity period for 1976-2000. Thus, we have the quarterly data for *private investors* by final maturity period for 1960-2000. Since we define the T-notes as intermediate-term bonds (maturity of 5 years), we use the securities with 1-10 years to maturity to calculate the amount of T-notes in the household portfolio. We use bonds above 10 years to maturity to represent the amount of T-bonds, and, to be consistent, we use the securities within one year to maturity to get the value of T-bills. However, we also need to obtain the data for 1952-1959 period. We regress the securities within one year to maturity (short-term) on the T-bills for 1960-1982, and then using the estimates, we calculate the missing series for the short-term securities. The R-squared of the regression is 0.98. We also regress the securities with 1-10 years to maturity (intermediate-term) on the T-notes for 1960-1982 to get the series for intermediate-term bonds; the R-squared is 0.94. At last, we regress the securities above 10 years to maturity (long-term) on the T-bonds for 1960-1974. The R-squared is 0.82.

Using the values of short-term, intermediate-term, and long-term securities held by private investors, we calculate their respective weights, and then apply these weights to the Treasury securities held by households. However, in applying the weights, we assume that households do not hold the short-term securities, and thus Treasury securities are divided between the T-notes (intermediate-term) and the T-bonds (long-term).

We would also like to account for the pension fund and life insurance reserves of the household portfolio since they represent a significant part of the household wealth. Using tables

L.119 (Private Pension Funds), L.120 (State and Local Government Employee Retirement Funds), and L.117 (Life Insurance Companies) from the FFA, we obtain the relevant asset values. To obtain the breakdown for the Treasury securities, we use the data from the Treasury Survey of Ownership, *Treasury Bulletin*, for private pension funds and life insurance companies for 1960-1982, and for state and local government pension funds for 1961-1982. We impute the data for the other years using the rate of growth in Treasury holdings by private investors (discussed above) for the corresponding years:

$$Y_t = Y_{t-1} \cdot \frac{X_t}{X_{t-1}}, \qquad \text{(A10)}$$

where Y is the Treasury holdings by pension funds, and X is the Treasury holdings by private investors. Since we only need to include the assets of the pension fund and life insurance reserves held by the life insurance companies, we weigh the assets of the life insurance companies by the ratio of the pension fund and life insurance reserves to the total financial assets held by the life insurance companies. We then can construct the pension fund portfolio that consists of the assets studied. The effective marginal tax rate on the pension fund portfolio is zero. Thus, in computing the composite net real return, we weigh the private pension fund assets by the Fisher real returns rather than the net real returns.

Appendix B

Table B1. Correlation Matrix for the Total Composite Return and its Components

	T-Bill Nominal	*T-Bill Real*	*T-Bill Net Real*	*T-Note Nominal*	*T-Note Real*	*T-Note Net Real*	*T-Bond Nominal*	*T-Bond Real*	*T-Bond Net Real*
T-Bill Nominal	1.0000								
T-Bill Real	0.4750	1.0000							
T-Bill Net Real	0.0286	0.8903	1.0000						
T-Note Nominal	0.4510	0.5161	0.3635	1.0000					
T-Note Real	0.1577	0.5921	0.5982	0.9265	1.0000				
T-Note Net Real	0.0145	0.5322	0.6059	0.8708	0.9884	1.0000			
T-Bond Nominal	0.2232	0.4604	0.4104	0.9285	0.9372	0.9119	1.0000		
T-Bond Real	0.0537	0.4939	0.5339	0.8617	0.9532	0.9533	0.9762	1.0000	
T-Bond Net Real	-0.0328	0.4549	0.5357	0.8244	0.9418	0.9562	0.9567	0.9955	1.0000
Municipals Nominal	0.0638	0.4005	0.4284	0.8238	0.8818	0.8790	0.8619	0.8695	0.8633
Municipals Real	-0.0809	0.4263	0.5302	0.7562	0.8847	0.9035	0.8340	0.8824	0.8891
Corp. Bond Nominal	0.2047	0.4564	0.4181	0.9253	0.9380	0.9128	0.9557	0.9351	0.9156
Corp. Bond Real	0.0261	0.4906	0.5470	0.8527	0.9527	0.9544	0.9308	0.9604	0.9568
Corp. Bond Net Real	-0.0652	0.4515	0.5514	0.8116	0.9396	0.9564	0.9080	0.9539	0.9598
Stocks Nominal	-0.1437	0.2065	0.2848	0.0952	0.2128	0.2247	0.1900	0.2516	0.2542
Stocks Real	-0.2499	0.2280	0.3642	0.0706	0.2395	0.2682	0.1932	0.2836	0.2964
Stocks Net Real	-0.2593	0.2388	0.3823	0.0686	0.2446	0.2749	0.1954	0.2898	0.3034
Money Nominal	0.9487	0.5310	0.1176	0.5235	0.2643	0.1249	0.3166	0.1630	0.0778
Money Real	0.0245	0.8504	0.9492	0.3996	0.6226	0.6234	0.4548	0.5696	0.5665
Money Net Real	-0.2925	0.6793	0.9207	0.2340	0.5449	0.5933	0.3582	0.5247	0.5505
Housing Nominal	0.4844	-0.0275	-0.2918	0.0656	-0.1435	-0.2151	-0.0063	-0.1234	-0.1658
Housing Real	0.1305	0.1305	0.0644	0.0245	0.0107	-0.0067	0.0666	0.0578	0.0469
Housing Net Real	0.1316	0.1281	0.0616	0.0257	0.0107	-0.0067	0.0663	0.0568	0.0461
Composite Nominal	0.1899	0.3215	0.2415	0.2960	0.3024	0.2664	0.3247	0.3205	0.2930
Composite Real	-0.1539	0.3920	0.4991	0.2167	0.3893	0.4064	0.3339	0.4232	0.4276
Composite Net Real	-0.1679	0.3900	0.5046	0.2154	0.3933	0.4124	0.3380	0.4301	0.4356
Inflation	0.7271	-0.2585	-0.6625	0.0956	-0.2857	-0.3959	-0.1088	-0.3211	-0.3857

Table B1, continued.

	Municipals Nominal	*Municipals Real*	*Corp. Bond Nominal*	*Corp. Bond Real*	*Corp. Bond Net Real*	*Stocks Nominal*	*Stocks Real*	*Stocks Net Real*	*Money Nominal*
Municipals Nominal	1.0000								
Municipals Real	0.9817	1.0000							
Corp. Bond Nominal	0.9164	0.8850	1.0000						
Corp. Bond Real	0.9188	0.9308	0.9734	1.0000					
Corp. Bond Net Real	0.9117	0.9375	0.9511	0.9949	1.0000				
Stocks Nominal	0.2449	0.2945	0.2851	0.3437	0.3464	1.0000			
Stocks Real	0.2619	0.3363	0.2826	0.3721	0.3857	0.9890	1.0000		
Stocks Net Real	0.2694	0.3468	0.2832	0.3769	0.3917	0.9853	0.9991	1.0000	
Money Nominal	0.2009	0.0659	0.3295	0.1657	0.0760	-0.0407	-0.1395	-0.1474	1.0000
Money Real	0.4996	0.5914	0.4883	0.6065	0.6054	0.3635	0.4333	0.4489	0.2015
Money Net Real	0.4456	0.5823	0.3891	0.5622	0.5918	0.3753	0.4788	0.4980	-0.1263
Housing Nominal	-0.0448	-0.1513	-0.0390	-0.1632	-0.2083	-0.0724	-0.1573	-0.1642	0.4124
Housing Real	0.0957	0.0796	0.0361	0.0256	0.0146	0.1076	0.0892	0.0927	0.1057
Housing Net Real	0.0972	0.0802	0.0373	0.0259	0.0151	0.1080	0.0890	0.0923	0.1087
Composite Nominal	0.3427	0.3320	0.3982	0.3879	0.3596	0.8433	0.7982	0.7921	0.2676
Composite Real	0.4018	0.4713	0.4035	0.4923	0.4982	0.8822	0.9016	0.9043	-0.0436
Composite Net Real	0.4100	0.4815	0.4068	0.4985	0.5057	0.8805	0.9019	0.9054	-0.0546
Inflation	-0.2398	-0.4188	-0.1276	-0.3504	-0.4201	-0.3186	-0.4517	-0.4704	0.6267

	Money Real	*Money Net Real*	*Housing Nominal*	*Housing Real*	*Housing Net Real*	*Composite Nominal*	*Composite Real*	*Composite Net Real*	*Inflation*
Money Real	1.0000								
Money Net Real	0.9448	1.0000							
Housing Nominal	-0.2899	-0.4389	1.0000						
Housing Real	0.0493	0.0036	0.8551	1.0000					
Housing Net Real	0.0485	0.0020	0.8567	0.9999	1.0000				
Composite Nominal	0.3191	0.2249	0.3450	0.4379	0.4373	1.0000			
Composite Real	0.5546	0.5669	0.0571	0.3620	0.3600	0.8990	1.0000		
Composite Net Real	0.5610	0.5777	0.0498	0.3617	0.3597	0.8920	0.9996	1.0000	
Inflation	-0.6367	-0.8506	0.5541	0.0429	0.0458	-0.0399	-0.4722	-0.4860	1.0000

Table B2. The Total Composite Return (1952:I-2000:IV)

Year	Nominal				Fisher Real				Net Real			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
1952	0.0197	0.0230	-0.0004	0.0349	0.0159	0.0228	-0.0074	0.0329	0.0135	0.0202	-0.0091	0.0297
1953	0.0018	0.0021	0.0131	0.0180	-0.0019	0.0007	0.0075	0.0135	-0.0036	-0.0014	0.0059	0.0110
1954	0.0284	0.0265	0.0372	0.0395	0.0232	0.0272	0.0404	0.0404	0.0207	0.0247	0.0377	0.0370
1955	0.0128	0.0435	0.0293	0.0252	0.0093	0.0422	0.0252	0.0221	0.0076	0.0390	0.0229	0.0196
1956	0.0339	0.0038	-0.0018	0.0133	0.0296	-0.0029	-0.0115	0.0073	0.0267	-0.0046	-0.0130	0.0052
1957	0.0013	0.0257	-0.0176	0.0034	-0.0076	0.0191	-0.0252	-0.0016	-0.0093	0.0163	-0.0268	-0.0035
1958	0.0184	0.0305	0.0344	0.0436	0.0056	0.0285	0.0332	0.0433	0.0034	0.0259	0.0301	0.0400
1959	0.0081	0.0253	0.0011	0.0270	-0.0005	0.0228	-0.0041	0.0217	-0.0021	0.0205	-0.0055	0.0192
1960	0.0017	0.0194	-0.0035	0.0325	-0.0003	0.0138	-0.0075	0.0277	-0.0020	0.0117	-0.0090	0.0248
1961	0.0462	0.0109	0.0240	0.0379	0.0445	0.0111	0.0202	0.0368	0.0410	0.0096	0.0182	0.0338
1962	0.0082	-0.0521	0.0189	0.0504	0.0039	-0.0556	0.0163	0.0474	0.0023	-0.0572	0.0143	0.0436
1963	0.0295	0.0192	0.0213	0.0239	0.0266	0.0178	0.0165	0.0202	0.0239	0.0154	0.0142	0.0175
1964	0.0262	0.0279	0.0183	0.0184	0.0214	0.0257	0.0150	0.0150	0.0190	0.0234	0.0130	0.0130
1965	0.0175	0.0009	0.0316	0.0238	0.0141	-0.0040	0.0278	0.0207	0.0124	-0.0055	0.0253	0.0185
1966	-0.0069	0.0090	-0.0281	0.0399	-0.0146	0.0009	-0.0355	0.0319	-0.0161	-0.0008	-0.0371	0.0294
1967	0.0563	0.0081	0.0360	0.0121	0.0533	0.0031	0.0265	0.0034	0.0497	0.0014	0.0239	0.0016
1968	-0.0010	0.0546	0.0266	0.0252	-0.0115	0.0441	0.0160	0.0138	-0.0134	0.0405	0.0137	0.0117
1969	0.0089	0.0014	-0.0067	0.0106	-0.0009	-0.0114	-0.0191	-0.0011	-0.0028	-0.0132	-0.0209	-0.0030
1970	0.0087	-0.0348	0.0553	0.0506	-0.0030	-0.0453	0.0451	0.0370	-0.0048	-0.0472	0.0415	0.0340
1971	0.0509	0.0124	0.0167	0.0317	0.0412	0.0011	0.0068	0.0254	0.0383	-0.0005	0.0052	0.0232
1972	0.0416	0.0146	0.0299	0.0509	0.0306	0.0085	0.0208	0.0422	0.0283	0.0070	0.0187	0.0396
1973	0.0011	0.0037	0.0398	-0.0036	-0.0112	-0.0153	0.0212	-0.0237	-0.0128	-0.0171	0.0188	-0.0257
1974	-0.0030	-0.0122	-0.0387	0.0464	-0.0317	-0.0390	-0.0636	0.0207	-0.0336	-0.0410	-0.0657	0.0179
1975	0.0755	0.0558	-0.0214	0.0410	0.0559	0.0426	-0.0395	0.0237	0.0523	0.0395	-0.0412	0.0212
1976	0.0499	0.0307	0.0233	0.0327	0.0383	0.0218	0.0079	0.0167	0.0353	0.0198	0.0060	0.0145
1977	0.0171	0.0377	0.0181	0.0251	-0.0005	0.0201	0.0029	0.0106	-0.0026	0.0179	0.0009	0.0084
1978	0.0175	0.0411	0.0408	0.0157	0.0006	0.0200	0.0229	-0.0031	-0.0015	0.0175	0.0204	-0.0053
1979	0.0491	0.0408	0.0372	0.0182	0.0298	0.0134	0.0124	-0.0057	0.0271	0.0109	0.0097	-0.0083
1980	0.0132	0.0666	0.0384	0.0388	-0.0161	0.0415	0.0148	0.0137	-0.0191	0.0380	0.0118	0.0101
1981	0.0218	0.0297	-0.0002	0.0390	-0.0040	0.0130	-0.0165	0.0235	-0.0072	0.0098	-0.0198	0.0200
1982	0.0227	0.0173	0.0452	0.0485	0.0100	0.0077	0.0291	0.0370	0.0069	0.0049	0.0261	0.0341
1983	0.0369	0.0328	0.0113	0.0132	0.0281	0.0234	-0.0018	0.0064	0.0256	0.0209	-0.0039	0.0042
1984	0.0236	0.0145	0.0480	0.0315	0.0127	0.0047	0.0399	0.0250	0.0104	0.0023	0.0371	0.0227
1985	0.0400	0.0473	0.0152	0.0650	0.0289	0.0394	0.0087	0.0567	0.0263	0.0370	0.0067	0.0540
1986	0.0592	0.0273	0.0055	0.0317	0.0516	0.0267	-0.0020	0.0244	0.0489	0.0246	-0.0037	0.0225
1987	0.0641	0.0191	0.0231	-0.0301	0.0523	0.0104	0.0127	-0.0382	0.0484	0.0083	0.0105	-0.0399
1988	0.0334	0.0326	0.0162	0.0221	0.0245	0.0213	0.0042	0.0122	0.0224	0.0192	0.0027	0.0103
1989	0.0318	0.0453	0.0412	0.0216	0.0197	0.0319	0.0346	0.0132	0.0174	0.0292	0.0320	0.0115
1990	-0.0011	0.0248	-0.0239	0.0315	-0.0157	0.0139	-0.0360	0.0183	-0.0172	0.0117	-0.0375	0.0159
1991	0.0486	0.0067	0.0282	0.0346	0.0408	0.0012	0.0210	0.0265	0.0378	-0.0002	0.0189	0.0241
1992	0.0016	0.0135	0.0223	0.0215	-0.0060	0.0071	0.0152	0.0150	-0.0072	0.0057	0.0138	0.0133
1993	0.0223	0.0148	0.0216	0.0140	0.0170	0.0083	0.0181	0.0087	0.0152	0.0070	0.0166	0.0073
1994	-0.0137	0.0060	0.0214	0.0046	-0.0176	0.0006	0.0124	0.0001	-0.0188	-0.0007	0.0105	-0.0012
1995	0.0517	0.0566	0.0412	0.0398	0.0467	0.0508	0.0368	0.0355	0.0436	0.0475	0.0341	0.0329
1996	0.0263	0.0234	0.0217	0.0465	0.0199	0.0169	0.0177	0.0396	0.0176	0.0147	0.0158	0.0365
1997	0.0186	0.0885	0.0482	0.0278	0.0139	0.0865	0.0454	0.0244	0.0121	0.0809	0.0422	0.0224
1998	0.0779	0.0292	-0.0283	0.1089	0.0771	0.0275	-0.0315	0.1048	0.0726	0.0255	-0.0328	0.0986
1999	0.0311	0.0419	-0.0188	0.0827	0.0285	0.0352	-0.0242	0.0763	0.0262	0.0324	-0.0252	0.0714
2000	0.0260	0.0013	0.0103	-0.0210	0.0171	-0.0036	0.0057	-0.0254	0.0155	-0.0047	0.0046	-0.0265