Measuring and Analyzing Returns on Aggregate Residential Housing

Fuad Hasanov and Douglas Dacy*

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Abstract

This paper computes an aggregate real after-tax rate of return on residential real estate in the United States. We account for net rental income, capital gain, and subsidies due to tax provisions for homeowners in constructing a total return measure. We also compute separate returns to owners and rentiers (that is, households who rent to others). Both quarterly and annual data over 1952-2000 period are used in the analysis. We compare our measure of return with that in the literature and analyze how housing compares to other assets in the household portfolio. Our approach provides a more comprehensive measure of return than that found in the literature. We confirm that residential housing provides a high average return and low volatility, has low correlation with other assets such as stocks and bonds, and exhibits high positive correlation with inflation. The efficient frontier analysis shows that the residential housing providing diversification should be an important part of the household portfolio. Our results also indicate that housing may be as good an investment as stocks (S&P 500).

* Fuad Hasanov: Department of Economics, School of Business Administration, Oakland University (Rochester, MI 48309), hasanov@oakland.edu. Douglas Dacy: Department of Economics, the University of Texas at Austin (Austin, TX 78712), dacy@eco.utexas.edu.

Measuring and Analyzing Returns on Residential Real Estate

I. Introduction

Traditionally in the United States residential real estate has been the principal asset held in most private portfolios. There are many reasons for home ownership but the focus in this paper is measurement and analysis of a rate of return. We pose many questions in route. What is a rate of return on residential housing? What are the returns to owner-occupants and "rentiers," that is, those who rent to tenants? What are the contributions of rental income return and capital gain return to total return? How does the return on residential housing compare to that on other assets such as stocks and bonds? Should housing be a major asset in the household portfolio, and what is its optimal share?

This study measures aggregate real after-tax income, capital gain, and total returns on residential housing to owner-occupants and rentiers, accounting for tax subsidies for owners due to the provisions in the US tax code. Because a long time series on returns is required to compare returns on residential real estate with returns on competing assets, we use aggregate data taken from the National Income and Product Accounts (NIPA) published by Bureau of Economic Analysis (BEA) and the Flow of Funds Accounts (FFA) released by the Federal Reserve Board. Rental income, a component of total returns, is taken from the former and wealth in housing and periodic change in wealth, needed to estimate capital gains, are derived from the latter. Performance of residential real estate return over the period of 1952-2000 is notable. Annual nominal return is 11.3% with standard deviation of 5.24%. Comparing this rate of return to the stock return (S&P 500) of 13.81% with standard deviation of 16.7%, we note, even before analysis, that the answer to the central question posed will not be surprising to financial analysts.

Of course, housing belongs in the portfolio as a major, if not dominating, asset. Even those individual portfolio managers without training in finance, most homeowners, sense that housing is a good investment and latch onto it for this reason as well as, perhaps, noneconomic reasons. It is important to note at the outset, then, that this paper is more concerned with measurement and methodology than in justifying the obvious. Most distinctively, our housing return series provide a more comprehensive measure of return, and our measurement differs from those used by others in treatment of taxes and subsidies faced by homeowners and incorporation of rentier returns into the total return measure.

This paper is divided into the following sections. The relevant literature is reviewed in section II. Section III presents measurement and descriptive analysis of returns on residential real estate. Comparison of housing returns to those on other assets is presented in section IV. Section V deals with the question of optimality, and section VI concludes.

II. Literature Review

Measuring and analyzing returns on real estate in general is a major theme in the real estate literature. Many researchers examined returns on both commercial and residential real estate. Sirmans and Sirmans (1987) provided a review of the real estate return literature with comparison of various real estate return measures. Zerbst and Cambon (1984) analyzed real estate returns and risk and compared different return measures with one another as well as with returns on other assets. Grissom and DeLisle (1998) also discussed and compared measures of real estate returns obtained from various data sources. Benjamin, Sirmans, and Zietz (2001) updated the earlier work and reviewed and summarized 128 papers on real estate risk and returns.

However, studies cited above mostly measure and analyze returns on commercial properties. The widely used data sources include National Council of Real Estate Investment Fiduciaries (NCREIF), American Council of Life Insurance (ACLI), National Real Estate Index (NREI), Commingled Real Estate Funds (CREFs), and Real Estate Investment Trusts (REITs). In addition to including industrial, retail, and office properties, some of the above (e.g. NCREIF, NREI) data sources include apartment properties as well. Both corporate and noncorporate institutions own these properties. However, the return on apartments is an imperfect measure for the return to rentiers (defined as nonfarm noncorporate business) due to inclusion of corporations and exclusion of houses. Our concern in this paper is the returns on residential real estate for households.

Other studies use house price data published by governmental agencies or private organizations. For instance, in their analysis, Fogler, Granito, and Smith (1995) employ median/mean sales price of new single-family houses sold published by the Census Bureau; Coyne (1993) uses mean sales price of new single-family homes obtained from the Office of Thrift Supervision (US Treasury Department). Bond and Seiler (1998) use median sales price of existing homes by National Association of Realtors to measure the returns on residential housing.

To adjust for changes in quality of houses through time, Case and Shiller (1987, 1989, 1990) use the data on houses sold more than once obtained from the Society of Real Estate Appraisers. They construct an index of existing single-family house prices for four major metropolitan areas: Atlanta, Chicago, Dallas, and San Francisco. They employ a weighted repeat sales regression methodology to account for multiple sales of the same house. Chinloy and Cho (1997) use the same technique and utilize data from the Fannie Mae, Freddie Mac, and American

Housing Survey (AHS) for single-family houses in five metropolitan areas for their construction of total returns, including an income return computed using the rent component of the Consumer Price Index (CPI).

Peek and Wilcox (1991) assess various house price series in their work on determinants of house prices. In addition to the above-mentioned house price series, they also analyze median value of single-family homes purchased provided by Federal Housing Administration (FHA), Census Bureau's quality adjusted mean sales price series for new homes obtained via hedonic regression using housing characteristics, Bureau of Economic Analysis' implicit price deflator for residential investment expenditures, and Freddie Mac's house price index obtained using repeat sales technique. Peek and Wilcox argue that though Freddie Mac's index controls the changing composition of house sales, it does not control for changes in structure quality at a given location. They adjust Freddie Mac's index for upgrades using the data for net investment in the existing stock of houses. The authors' results indicate that the quality-adjusted series grow slower over time and show less variation.

Another way to compute the returns on residential housing was proposed by Ibbotson and Fall (1979). The capital gain return was computed using home purchase component of the CPI constructed using the data from the FHA, and income returns accounting for depreciation, maintenance, and management costs were taken from Sprinkel and Genetski (1977). The data spanned 1947-1978 time period, and Ibbotson and Siegel (1984) updated the data till 1982. In addition, Flavin and Yamashita (1998) used self-reported home values from the Panel Study of Income Dynamics (PSID) survey to compute total returns on owner-occupied housing.

It is evident that there are various ways that researchers attempted to measure the returns on residential real estate. Each method has its advantages and disadvantages. Thus, before

comparing some of the above-mentioned return measures, first we turn to the discussion of our return measure.

III. Returns on Residential Real Estate

A. Measurement

The total rate of return on residential housing is a value-weighted average rate of 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 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:

$$r_H^{bt} = w_O r_O^{bt} + w_{RNT} r_{RNT}^{bt} \tag{1}$$

Owners' total receipts 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 receipts are due to two sources, rental income, I_{RNT}, and capital gains, CG_{RNT}. Before-tax total returns on residential real estate are the sum for the two groups:

$$R_H^{bt} = I_O + S_O + CG_O + I_{RNT} + CG_{RNT} \quad (2)$$

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 on residential real estate are computed as:

$$R_H^{at} = I_O + S_O + CG_O + (1-\tau_{\text{int}})I_{RNT} + (1-\tau_{cg})CG_{RNT}1(CG_{RNT} \geq 0) + CG_{RNT}1(CG_{RNT} < 0), \quad (3)$$

where τ_{int} is the average marginal tax rate on interest (which is the same as the average marginal tax rate on income); τ_{cg} is the average marginal tax rate on noncorporate capital gains, and $1(\cdot)$ is an indicator function. The tax rates are taken from Jorgenson and Yun (2001) and Jorgenson.[1] 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 (2001), 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. Note that if the capital gain return is negative, then it is not taxed. Lastly, the after-tax *rate of return* (r_H^{at}) on residential real estate is:

$$r_H^{at} = \frac{\left(I_O + S_O + CG_O + (1-\tau_{\text{int}})I_{RNT} + (1-\tau_{cg})CG_{RNT}1(CG_{RNT} \geq 0) + CG_{RNT}1(CG_{RNT} < 0)\right)}{V} \quad (4)$$

Our source for rental income from owner-occupied housing and rentier owners is the Housing Sector Output table from the National Income and Product Accounts computed by the

[1] We thank D. Jorgenson for providing us with a complete data set.

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 taken from Jorgenson and Yun (2001) 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 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 are 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 for owners for the four i quarters in the year, I_q^i, are computed as:

$$I_q^i = I_a \frac{X_q^i}{X_a}, \tag{5}$$

Finally, we calculate Fisher real (after-inflation) and net real (after-tax after-inflation) rates:

$$r^a = \frac{1+r^b}{1+\pi} - 1, \tag{6}$$

where r^a is the after-inflation rate; r^b is the before-inflation rate, and π is the rate of inflation. The inflation rate used is the monthly change in the Consumer Price Index (CPI-U, US city average, all items) compiled by the Bureau of Labor Statistics (BLS). We compute the quarterly inflation rate as follows:

$$r^q = \prod_{i=1}^{3} (1 + r^i) - 1, \tag{7}$$

where r^q is the quarterly rate and r^i is the rate for month i in the corresponding quarter.

B. Data and Descriptive Statistics

In this subsection we present the data computations and statistics in figures and tables. The return data are presented in the Appendix. Table 1 illustrates the descriptive statistics for the total residential housing return, and Figure 1 plots the total nominal and Fisher real return series. Table 2 and Figure 2 present the annual data. The mean returns on residential real estate for nominal, Fisher real, and net real rates are positive and well above zero. The mean annual total nominal return for 1952-2000 period is 11.3% with a standard deviation of 5.24%. The mean Fisher real rate is 7.07%, and the net real return is 6.77%. The standard deviation falls to about 4%. It is evident that taxes slightly reduce the return—the difference of 0.3% is rather negligible. The effect of taxes is small due to the following reasons. First, the owners account for about 64% of total equity (sum of owners' and proprietors' equity) in 1952 and about 75% in 2000 (see figure 3), and owners do not pay taxes on rental income and, in our calculations, on capital gains as well. Thus, only returns to proprietors are taxed, 29.5% of total return on average for 1952-2000. Second, capital gain returns account for the major part of total returns, and the capital gain taxes are low, an average of 4.46% over 1952-2000 period, due to deferral and bequests.[2] Further, though there is a slight decrease in mean return due to taxes, the net real return series follow the Fisher real rate series very closely (a correlation coefficient of 0.999 for both quarterly and annual series). In the following figures, the net real rate series are thus not depicted.

[2] See chapter 3 in Jorgenson and Yun (2001) for a more detailed discussion.

Table 1. Descriptive Statistics on *Total* Residential Housing Return
(1952:I-2000:IV, quarterly rates)

	Rates		
	Nominal	*Fisher Real*	*Net Real*
Mean	0.0274	0.0175	0.0168
Standard Deviation	0.0153	0.0139	0.0138
Minimum	-0.0037	-0.0252	-0.0259
Maximum	0.0681	0.0582	0.0571
Autocorrelation	0.4928	0.2844	0.2819

Table 2. Descriptive Statistics on *Total* Residential Housing Return
(1952-2000, annual rates)

	Rates		
	Nominal	*Fisher Real*	*Net Real*
Mean	0.1130	0.0707	0.0677
Standard Deviation	0.0524	0.0408	0.0404
Minimum	0.0264	-0.0326	-0.0343
Maximum	0.2300	0.1561	0.1528
Autocorrelation	0.7253	0.4503	0.4452

Figure 1. *Total* Residential Housing Return
(1952:I-2000:IV, quarterly rates)

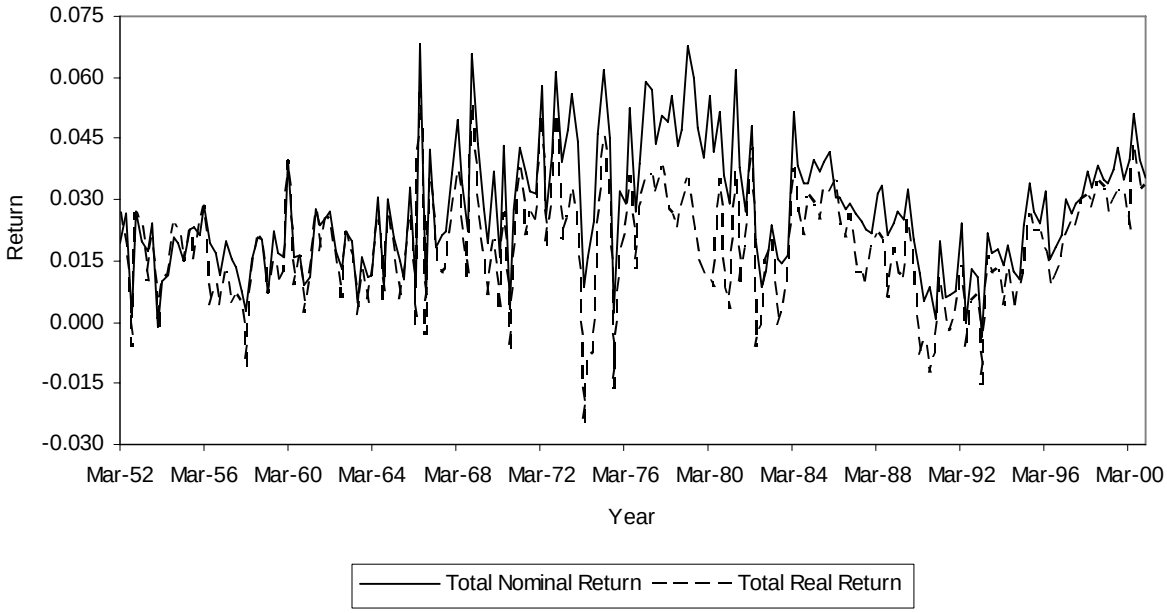


Figure 2. *Total* Residential Housing Return
(1952-2000, annual rates)

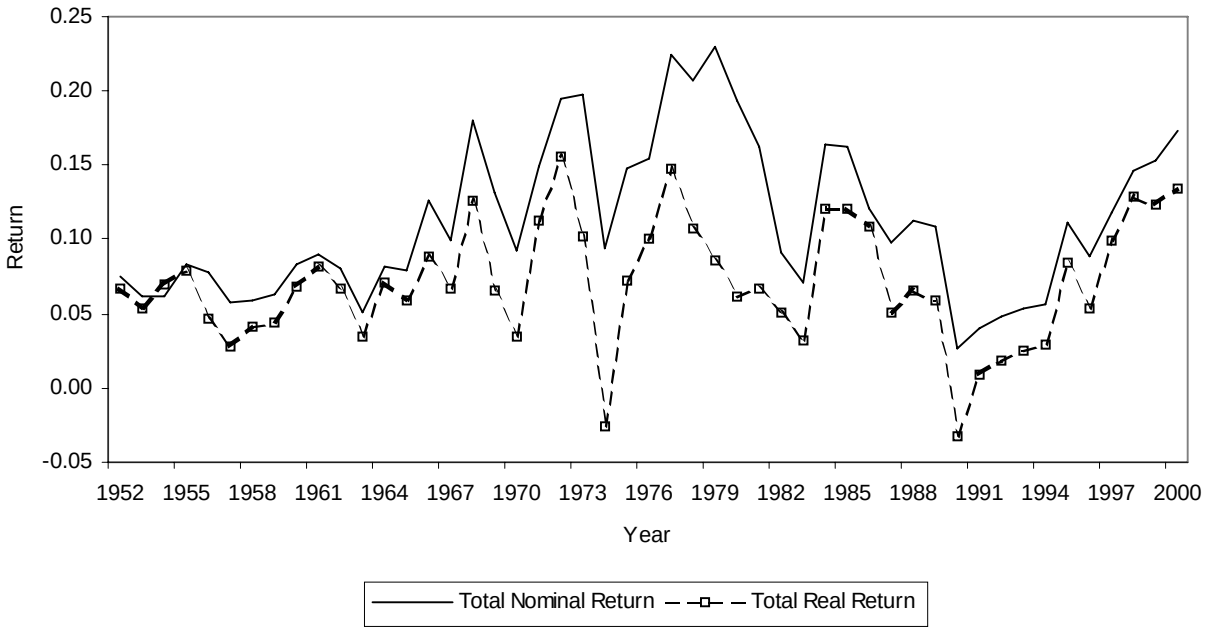
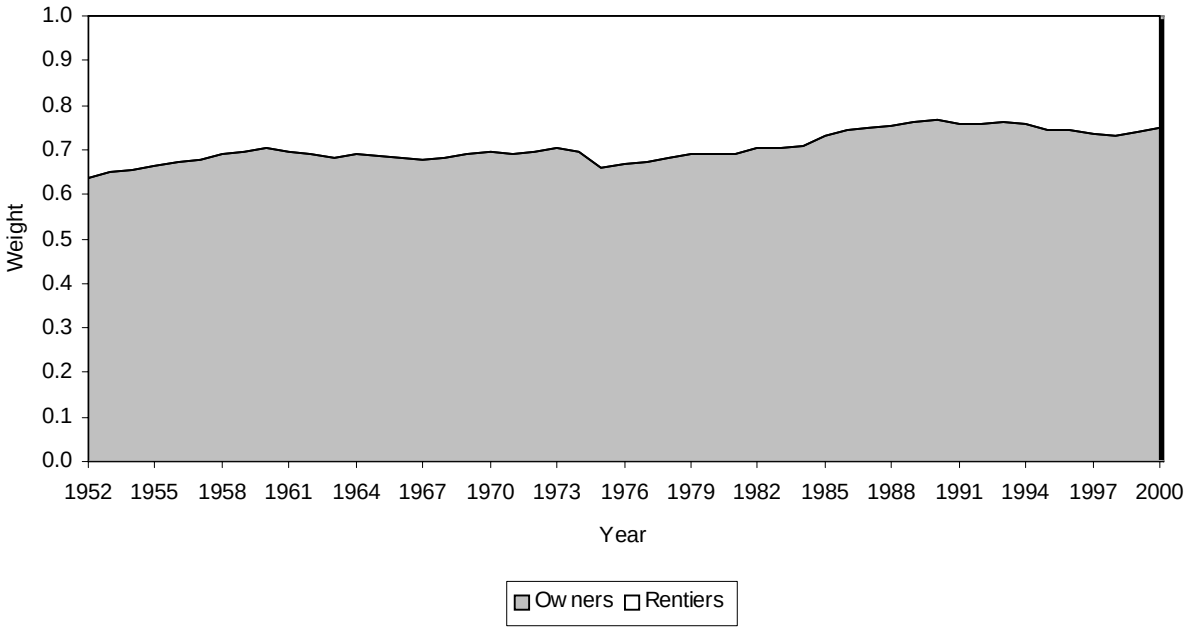


Figure 3. Owners' and Rentiers' Equity as a Fraction of the Total Equity
(1952-2000, annual)



Next, we examine autocorrelation of the return series. The annual series is more autocorrelated (0.73) than the quarterly series (0.49). This is also evident from the figures above illustrating that the annual series is smoother. The notable aspect of Figures 1 and 2 is larger volatility of quarterly series. The coefficient of variation (standard deviation over mean) for nominal quarterly series is 0.56 and is higher than that of annual series, which is 0.46. In addition, the Fisher real return on housing is negative only in a few quarters and in a couple of years. The residential real estate has earned relatively high returns with low volatility. In the 1970s, in the period of high inflation, the Fisher real returns were positive in all years except 1974, with an average of 8.93% in 1970-1979 (8.65% for the net real rate). The 1980s witnessed a fall in the returns but returns still remained positive. The 1990s started with a negative return followed by the rise in the returns throughout the rest of the decade.

Extensive descriptive statistics are presented in Tables 3 and 4 for owners, rentiers, and income and capital gain components of the total return. Table 4 shows that though the mean return to owners is a little higher (11.65%) than to rentiers (10.63%), the statistics between these two groups are quite similar. The exception is the autocorrelation coefficient for the capital gain return, which is 0.66 for owners versus 0.79 for rentiers. Note that the mean return to owners is higher than that to rentiers suggesting, among other reasons, favorable tax treatment of homeowners and more likely, a different mix of properties for these groups.

As we mentioned earlier, the capital gain return accounts for a large portion of the total return. For instance, with the mean total nominal return of 11.3% per year, the mean income return is 3.18% and the mean capital gain rate is 8.12%. In addition, income return series are much less volatile; the standard deviation for the total income return is only 0.72% for the annual series. Figure 4 confirms the smoothness of the income return series varying between about 2

and 4.3 percent. The total capital gain return is shown in Figure 5. The series are more volatile and resemble the total return series due to being a major part of the total return. Figures 6 and 7 illustrate the total returns to owners and rentiers. There is some difference in the time pattern of returns. Before 1965, the returns to rentiers were more volatile; in the 1970s-80s the pattern reversed, and the 1990s witnessed somewhat smother rise in returns to rentiers.

To quantify the relationship between the series presented in the figures, the correlation coefficient matrix for nominal returns is constructed (see Tables 6 and 7). Correlation is higher for the annual data than for the quarterly data. The correlation coefficient between the total nominal return and inflation is 0.41 for the quarterly series and 0.58 for the annual series. It is evident that inflation and the total nominal return are highly positively correlated indicating that the residential housing could act as a hedge against inflation. There is a high correlation of 0.98 (annual data) between the total return and the total return to owners. This is expected since the return to owners is a large part of the total return. The returns to owners and rentiers are also highly positively correlated, a coefficient of 0.76. Note that the income return is negatively correlated with the capital gain return and inflation, whereas the capital gain return and inflation are positively correlated with a correlation coefficient of 0.62. The negative correlation between the income return and inflation could be due to inflation eroding the rental income. Thus, as the inflation rises, the income return falls. The positive correlation of inflation with the capital gain return is due to the house prices and residential values rising with inflation. In addition, high correlation between the total capital gain return and the total return is explained by the smoothness of the income return series.

Table 3. Descriptive Statistics on Residential Housing Returns (1952:I-2000:IV, quarterly rates)

Return		*Owners*			*Rentiers*			*Total*		
		Income	Capital Gain	Total	Income	Capital Gain	Total	Income	Capital Gain	Total
Nominal	Mean	0.0085	0.0197	0.0282	0.0062	0.0197	0.0258	0.0077	0.0196	0.0274
	Standard Deviation	0.0023	0.0177	0.0174	0.0018	0.0150	0.0143	0.0018	0.0157	0.0153
	Minimum	0.0046	-0.0146	-0.0073	0.0022	-0.0141	-0.0055	0.0047	-0.0112	-0.0037
	Maximum	0.0125	0.0701	0.0771	0.0106	0.0619	0.0653	0.0107	0.0620	0.0681
	Autocorrelation	0.9932	0.4312	0.4065	0.9749	0.6355	0.5953	0.9918	0.5264	0.4928
Fisher Real	Mean	-0.0011	0.0099	0.0183	-0.0034	0.0099	0.0160	-0.0018	0.0099	0.0175
	Standard Deviation	0.0093	0.0161	0.0161	0.0095	0.0131	0.0131	0.0093	0.0139	0.0139
	Minimum	-0.0357	-0.0469	-0.0389	-0.0388	-0.0204	-0.0119	-0.0366	-0.0318	-0.0252
	Maximum	0.0159	0.0499	0.0610	0.0130	0.0473	0.0541	0.0149	0.0477	0.0582
	Autocorrelation	0.7313	0.2502	0.2476	0.7425	0.3633	0.3515	0.7313	0.2930	0.2844
Net Real	Mean	-0.0011	0.0099	0.0183	-0.0051	0.0090	0.0134	-0.0023	0.0043	0.0168
	Standard Deviation	0.0093	0.0161	0.0161	0.0092	0.0126	0.0126	0.0092	0.0118	0.0138
	Minimum	-0.0357	-0.0469	-0.0389	-0.0400	-0.0204	-0.0141	-0.0370	-0.0424	-0.0259
	Maximum	0.0159	0.0499	0.0610	0.0113	0.0456	0.0508	0.0142	0.0312	0.0571
	Autocorrelation	0.7313	0.2502	0.2476	0.7253	0.3505	0.3366	0.7264	0.2497	0.2819

Table 4. Descriptive Statistics on Residential Housing Returns (1952-2000, annual rates)

Return		*Owners*			*Rentiers*			*Total*		
		Income	Capital Gain	Total	Income	Capital Gain	Total	Income	Capital Gain	Total
Nominal	Mean	0.0350	0.0815	0.1165	0.0252	0.0811	0.1063	0.0318	0.0812	0.1130
	Standard Deviation	0.0091	0.0582	0.0570	0.0073	0.0537	0.0505	0.0072	0.0545	0.0524
	Minimum	0.0200	-0.0004	0.0208	0.0094	-0.0151	0.0192	0.0208	0.0046	0.0264
	Maximum	0.0497	0.2150	0.2427	0.0425	0.1890	0.2020	0.0426	0.2069	0.2300
	Autocorrelation	0.9716	0.6638	0.6388	0.9369	0.7905	0.7591	0.9706	0.7523	0.7253
Fisher Real	Mean	-0.0035	0.0403	0.0741	-0.0129	0.0399	0.0642	-0.0065	0.0400	0.0707
	Standard Deviation	0.0328	0.0454	0.0459	0.0336	0.0390	0.0388	0.0327	0.0407	0.0408
	Minimum	-0.0930	-0.0920	-0.0621	-0.1059	-0.0429	-0.0150	-0.0970	-0.0532	-0.0326
	Maximum	0.0464	0.1344	0.1698	0.0328	0.1046	0.1300	0.0417	0.1242	0.1561
	Autocorrelation	0.8207	0.3737	0.3622	0.8310	0.5951	0.5762	0.8227	0.4703	0.4503
Net Real	Mean	-0.0035	0.0403	0.0741	-0.0198	0.0365	0.0539	-0.0085	0.0390	0.0677
	Standard Deviation	0.0328	0.0454	0.0459	0.0322	0.0372	0.0368	0.0323	0.0403	0.0404
	Minimum	-0.0930	-0.0920	-0.0621	-0.1097	-0.0429	-0.0222	-0.0982	-0.0535	-0.0343
	Maximum	0.0464	0.1344	0.1698	0.0259	0.0998	0.1144	0.0394	0.1221	0.1528
	Autocorrelation	0.8207	0.3737	0.3622	0.8197	0.5762	0.5544	0.8197	0.4631	0.4452

Figure 4. Total Income Return on Residential Housing
(1952-2000, annual rates)

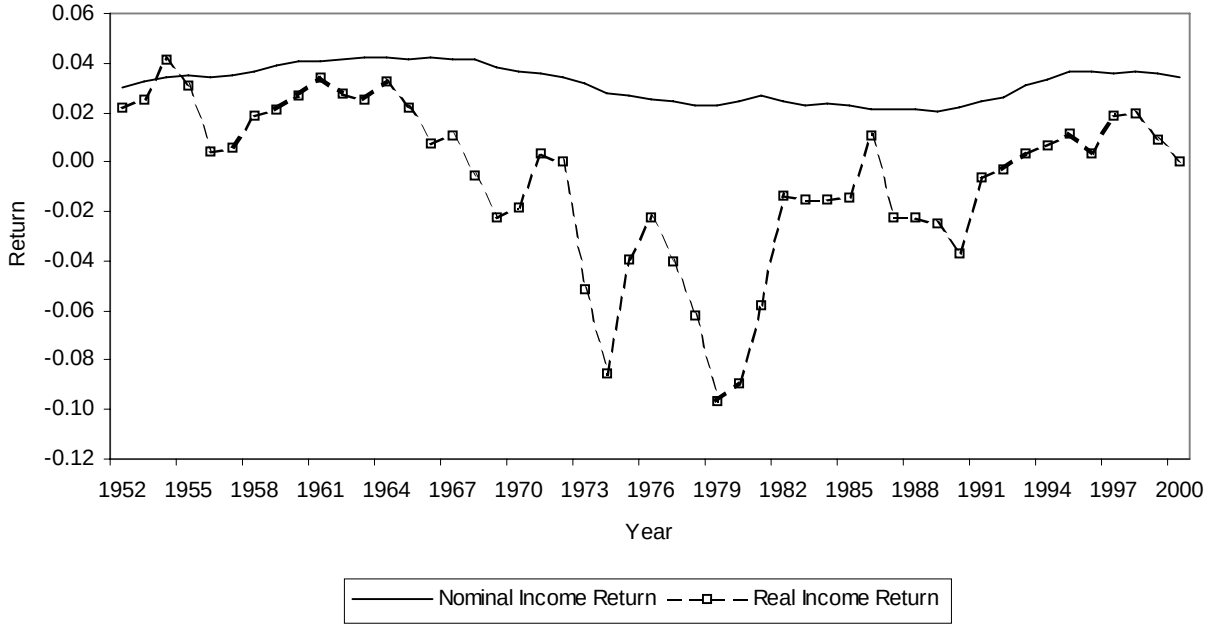


Figure 5. Total Capital Gain Return on Residential Housing
(1952-2000, annual rates)

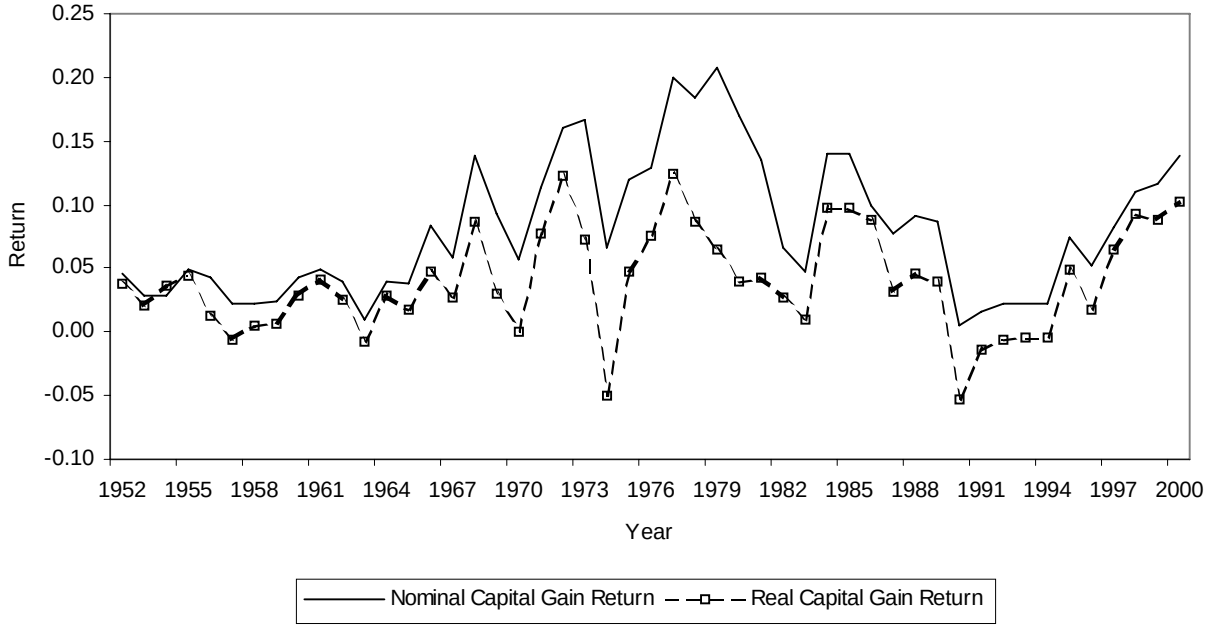


Figure 6. Total Return on Residential Housing for Owners
(1952-2000, annual rates)

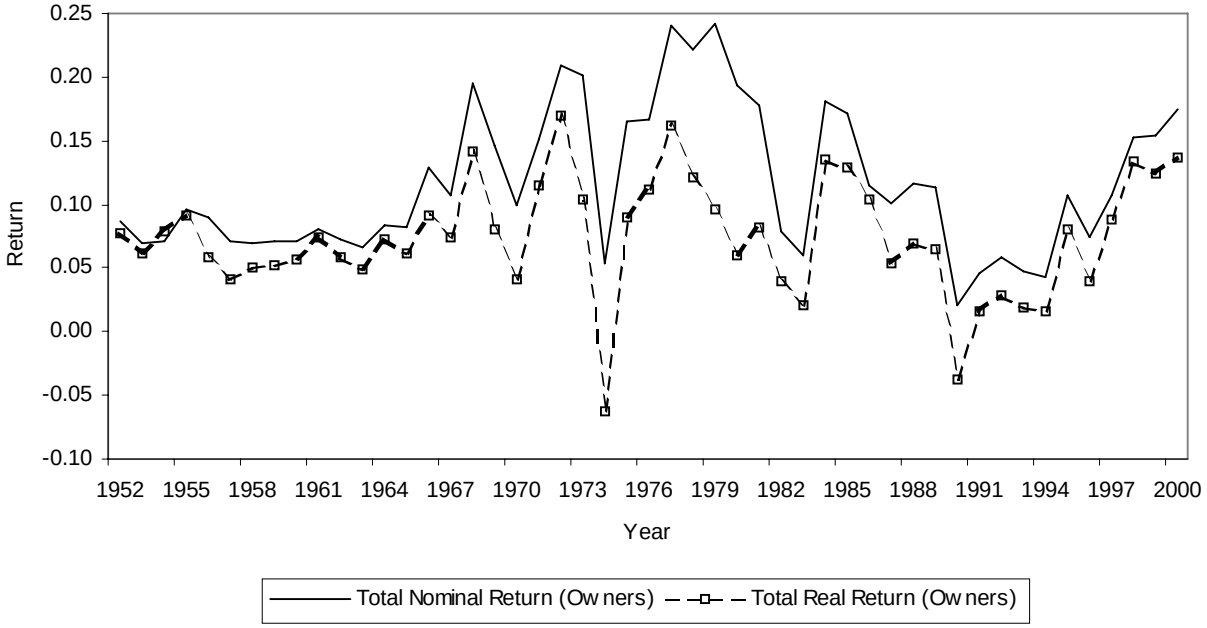


Figure 7. Total Return on Residential Housing for Rentiers
(1952-2000, annual rates)

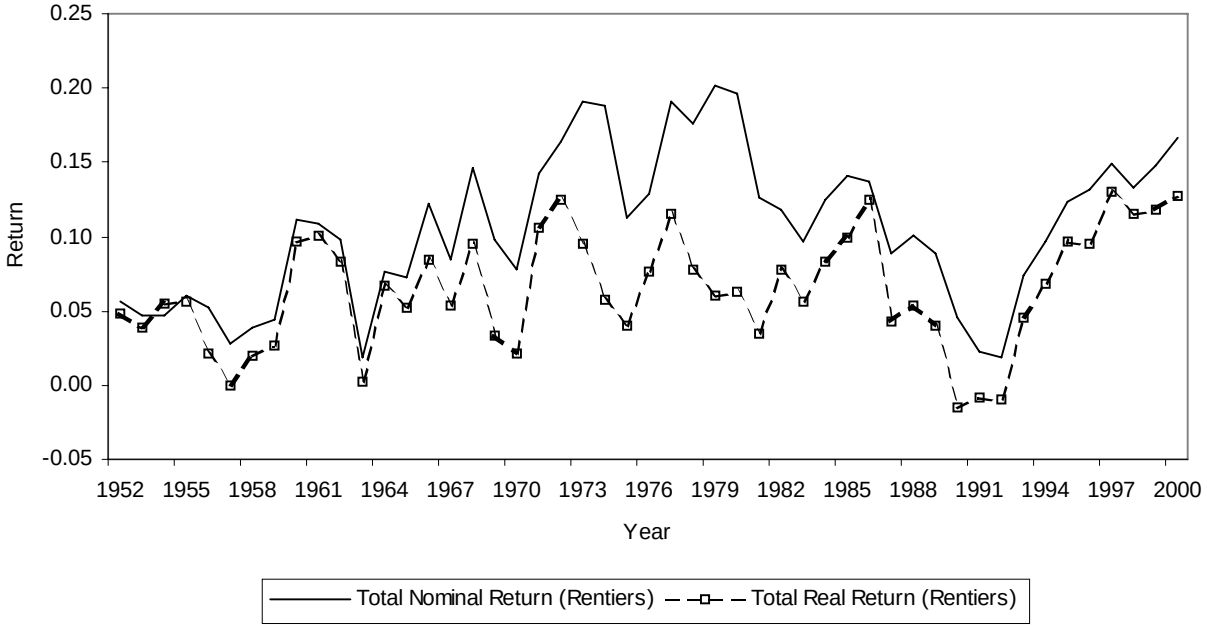


Table 6. Correlation Coefficient Matrix for Nominal Returns on Housing
(1952:I-2000:IV, quarterly series)

	Total Return (Owners)	*Total Return (Rentiers)*	*Total Income Return*	*Total Capital Gain Return*	*Total Return*	*Inflation*
Total Return (Owners)	1.0000					
Total Return (Rentiers)	0.6432	1.0000				
Total Income Return	-0.1866	-0.1992	1.0000			
Total Capital Gain Return	0.9680	0.7918	-0.3169	1.0000		
Total Return	0.9761	0.7929	-0.2084	0.9937	1.0000	
Inflation	0.3682	0.4263	-0.4380	0.4537	0.4160	1.0000

Table 7. Correlation Coefficient Matrix for Nominal Returns on Housing
(1952-2000, annual series)

	Total Return (Owners)	*Total Return (Rentiers)*	*Total Income Return*	*Total Capital Gain Return*	*Total Return*	*Inflation*
Total Return (Owners)	1.0000					
Total Return (Rentiers)	0.7599	1.0000				
Total Income Return	-0.2092	-0.2073	1.0000			
Total Capital Gain Return	0.9728	0.8621	-0.3466	1.0000		
Total Return	0.9823	0.8675	-0.2227	0.9917	1.0000	
Inflation	0.5281	0.6100	-0.4720	0.6205	0.5800	1.0000

C. Comparison with Other Measures of Residential Housing Returns

In this subsection, we compare our computed measure of return on residential real estate with that in the literature. We use the following data for alternative measures of return: (i) average sales price of new single-family homes sold in the US published by the Census Bureau available for 1963-2000, (ii) Freddie Mac's repeat sales national single-family home price index dated from 1970 to 2000, (iii) total returns on residential housing computed by Ibbotson and Siegel (1984) for 1947-1982 period, and (iv) residential structures of owners produced by the BEA for 1952-2000. Using the price data from the Census Bureau and the index data from the Freddie Mac, we compute the capital gain return on housing as changes in the prices or index values. Since our measure is return on equity rather than on assets, we re-compute the return on residential housing assets. Further, we use the owners' housing assets to compute the capital gain

return to owners for comparison with the house price changes and use the total return to owners for comparison with the Ibbotson and Siegel's total return measure.

We plot quarterly returns in Figures 8 and 9, and Table 8 presents the descriptive statistics. It is evident from Figure 8 that the change in the average price of new single-family homes sold in the US is more volatile than our capital gain return on owners' assets. The autocorrelation of the series is close to zero, and the correlation coefficient is low at 0.35. However, the means for the Census Bureau's house price change and our measure are almost identical, 1.63% versus 1.5%, respectively. However, the change in house prices as a measure of the capital gain return has many shortcomings due to ignoring, for instance, quality change through time and characteristics of homes sold during the period. Thus, we examine the repeat sales house price index published by the Freddie Mac. This is a better measure of the appreciation returns to housing, accounting for drawbacks associated with the changes in the home prices.[3]

Figure 9 plots the changes in the Freddie Mac's house price index. Interestingly, this measure resembles our capital gain return measure on owners' assets, especially after 1975. The correlation coefficient is 0.56. The standard deviations are almost identical, and the means do not differ much, though the autocorrelation for the Freddie Mac's series is lower, 0.17 versus 0.53. The appraisal bias may not be present in our series as the Freddie Mac's index uses transaction data. The return series for the annual data are, however, more comparable to one another. Figures 10 and 11 and Table 9 present the data. Figure 10 presents the annual data for the above-mentioned series. By and large, the series follow one another more closely. The correlation coefficient of our measure with the Census Bureau's house price change is 0.65, whereas with the Freddie Mac's house price index change is higher at 0.78. Note also a high correlation of

[3] For a discussion of repeat sales indexes, see Case and Shiller (1987).

Figure 8. Comparison of Quarterly Returns on Housing (1963:II-2000:IV):
Census Bureau's Change in Average Sales Price vs. Change in Owners' Residential Assets

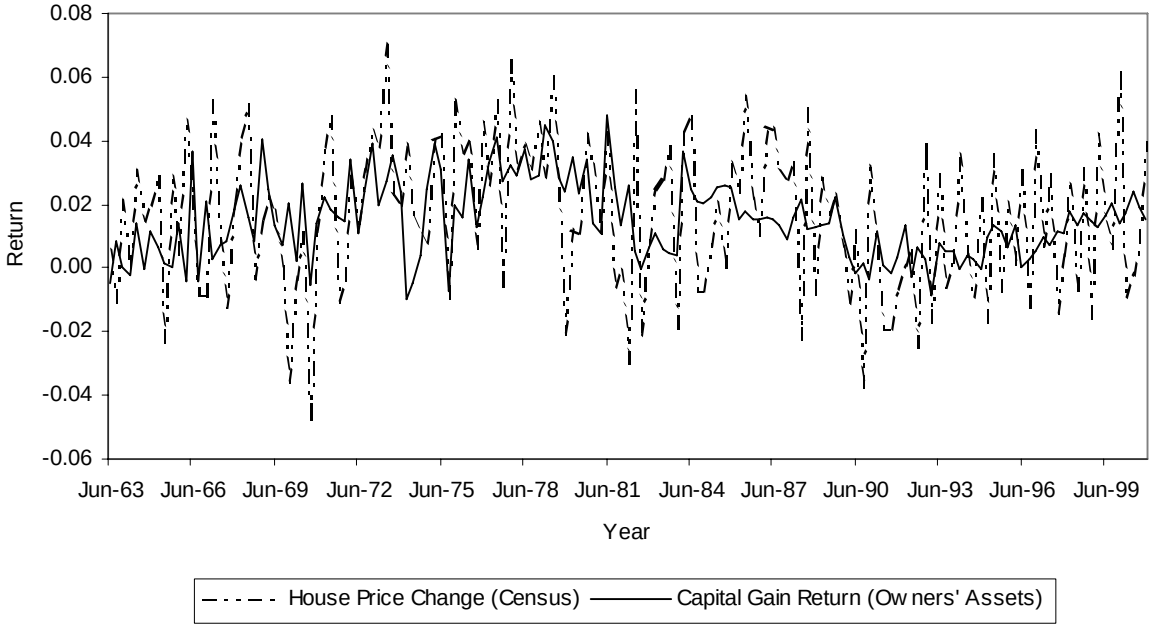


Figure 9. Comparison of Quarterly Returns on Housing (1970:II-2000:IV):
Freddie Mac's Change in House Price Index vs. Change in Owners' Residential Assets

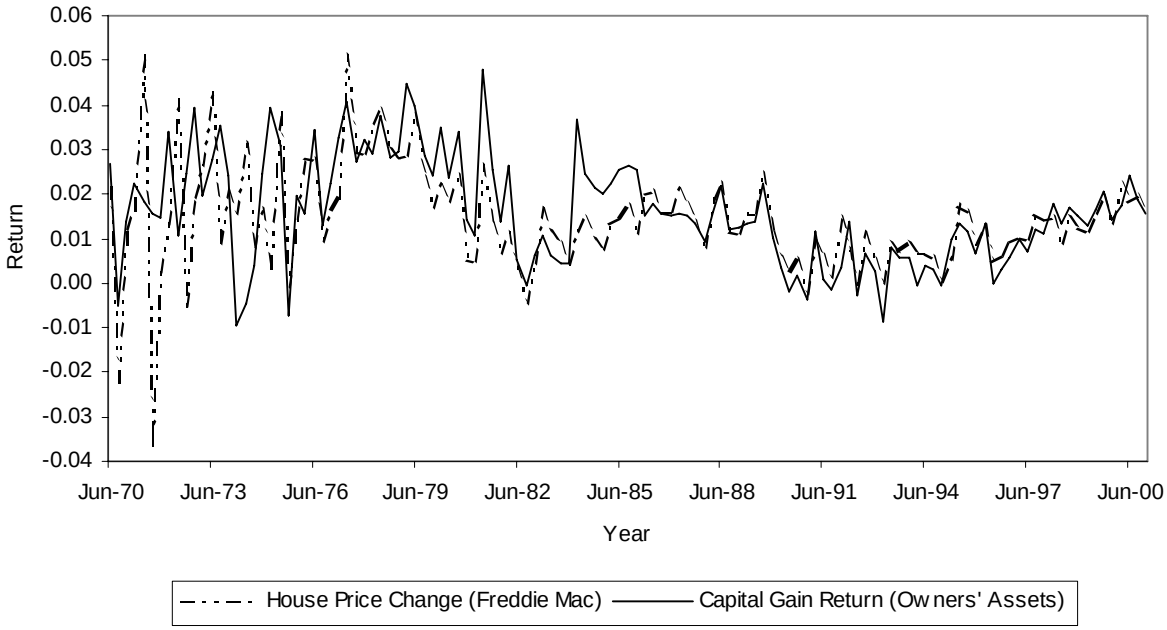
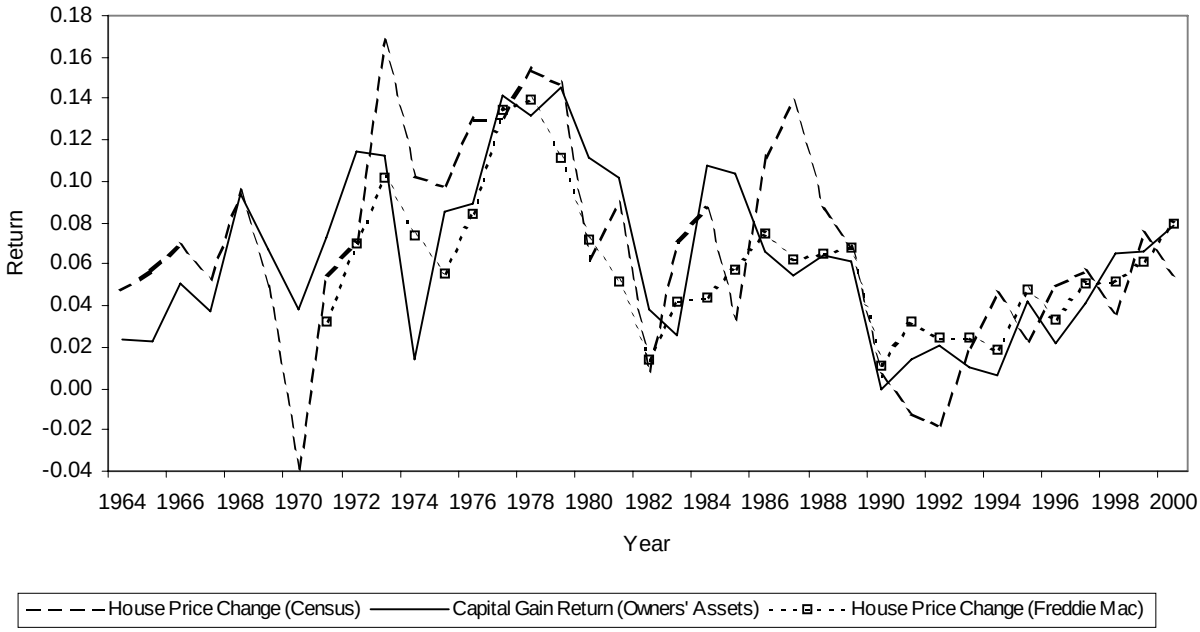


Table 8. Descriptive Statistics and Correlation Matrix for Quarterly Returns on Housing

	House Price Change		*Capital Gain Return (Owners' Assets)*	
	Census	Freddie Mac		
	1963:II-2000:IV	1970:II-2000:IV	1963:II-2000:IV	1970:II-2000:IV
Mean	0.0163	0.0143	0.0150	0.0160
Standard Deviation	0.0237	0.0120	0.0122	0.0122
Minimum	-0.0476	-0.0363	-0.0096	-0.0096
Maximum	0.0701	0.0511	0.0478	0.0478
Autocorrelation	-0.0635	0.1728	0.4279	0.5316

	House Price Change		*Capital Gain Return*
	Census	Freddie Mac	*(Owners' Assets)*
Census	1.0000		
Freddie Mac	0.4691	1.0000	
CG Rate (Owners)	0.3526	0.5640	1.0000

Figure 10. Comparison of Annual Returns on Housing:
House Price Change (Census and Freddie Mac) vs. Owners' Assets



0.81 between the Freddie Mac's and the Census Bureau's series. In addition, autocorrelation of the annual series is more pronounced and high at 0.54 for the Census data and 0.58 for the owners' assets data during 1964-2000 period, and 0.69 for the Freddie Mac's data and 0.62 for the owners' assets data during 1971-2000. The means and standard deviations do not differ much

from one another for the annual data. The series are much smoother with almost the same mean return. Another feature of the series is that the minimum of our series is quite larger than that of the Census Bureau's and the Freddie Mac's series for the quarterly data. The annual data exhibits larger minimum for the Freddie Mac's series, which is even positive. The Census Bureau's minimum is the smallest at –3.88%. The maximum returns are more comparable for all series.

We also present the total return series obtained from Ibbotson and Siegel (1984) and compare them to the total returns on owners' assets. From Figure 11, the returns in 1952-1966 period are closer together and have less volatility than in the later years. The correlation between the total return series is 0.56. The mean of Ibbotson and Siegel's (1984) returns is lower at 7.55% versus 8.58%, though other statistics are almost identical. The difference in means is due to our accounting for the tax subsidies for the owners. The correlation between the Ibbotson and

Figure 11. Comparison of Annual Returns on Housing (1952-1982):
Ibbotson and Siegel's Total Returns vs. Total Returns on Owners' Assets

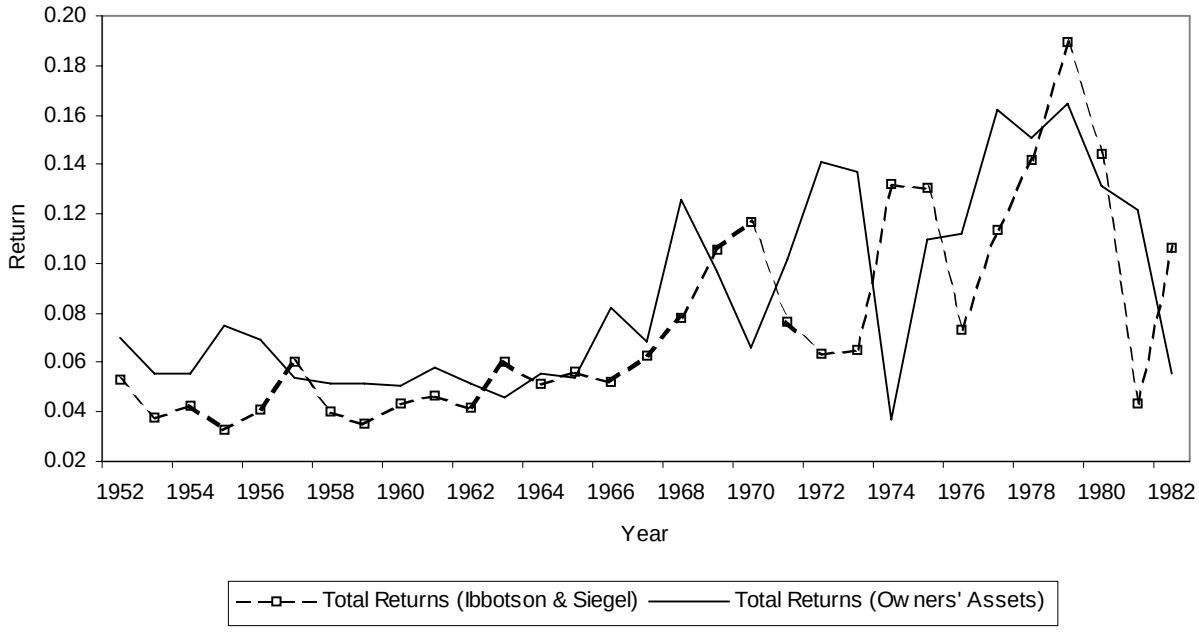


Table 9. Descriptive Statistics and Correlation Matrix for Annual Returns on Housing

	House Price Change		*Total Return*	*Capital Gain Return*		*Total Return*
	Census	Freddie Mac	(Ibbotson&Siegel)	*(Owners' Assets)*		*(Owners' Assets)*
	1964-2000	1971-2000	1952-1982	1964-2000	1971-2000	1952-1982
Mean	0.0669	0.0597	0.0755	0.0633	0.0669	0.0858
Standard Deviation	0.0482	0.0321	0.0402	0.0404	0.0426	0.0387
Minimum	-0.0388	0.0108	0.0329	-0.0003	-0.0003	0.0370
Maximum	0.1671	0.1397	0.1892	0.1457	0.1457	0.1644
Autocorrelation	0.5369	0.6870	0.6554	0.5841	0.6168	0.6262

	House Price Change		*Total Return*	*Capital Gain Return*	*Total Return*
	Census	Freddie Mac	(Ibbotson&Siegel)	*(Owners' Assets)*	*(Owners' Assets)*
Census	1.0000				
Freddie Mac	0.8130	1.0000			
Ibbotson&Siegel	0.2069	0.3672	1.0000		
CG Rate (Owners)	0.6527	0.7807	0.5992	1.0000	
Total Rate (Owners)	0.6459	0.7742	0.5577	0.9852	1.0000

Siegel's (1984) data and the Freddie Mac's series is 0.37 and with the Census Bureau's data is even lower at 0.21. Different data sources most likely account for these differences in correlation.

Lastly, we compare our capital gain return on owners' assets with the capital gain return computed from the changes in the owners' residential structures produced by the BEA. In computing the capital gain return from the BEA's residential structures data, we account for the new construction and improvements during the period taken from the Census Bureau. Figures 12 and 13 with Table 10 show the results. Note that the difference in annual series is rather small. The correlation coefficient is 0.75. However, the mean return for our capital gain measure is higher at 5.43% as compared to 3.38% for the measure from the BEA's series. The capital gain return from the BEA's data also exhibits a higher autocorrelation.

The above presentation suggests the following conclusions. For the annual series, mean return, standard deviation, and autocorrelation do not differ much from one another, and the correlations among the capital gain series are high. For the quarterly data, we observe higher

Figure 12. Comparison of Quarterly Returns on Housing:
Owners' Structures (BEA) vs. Owners' Assets (FFA)

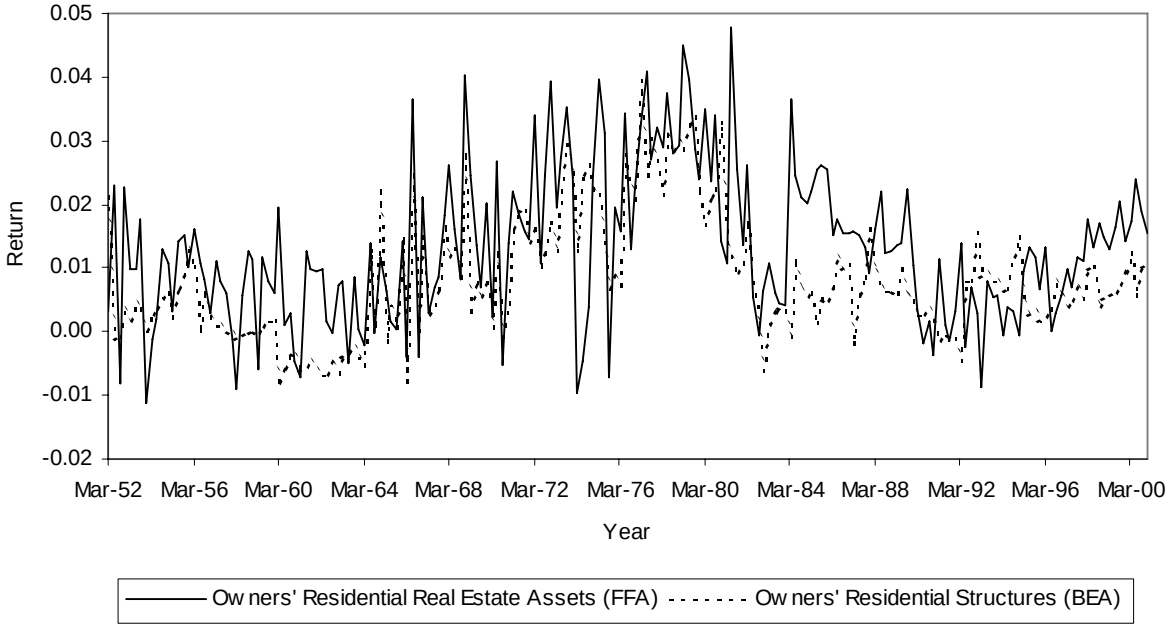


Figure 13. Comparison of Annual Returns on Housing:
Owners' Structures (BEA) vs. Owners' Assets (FFA)

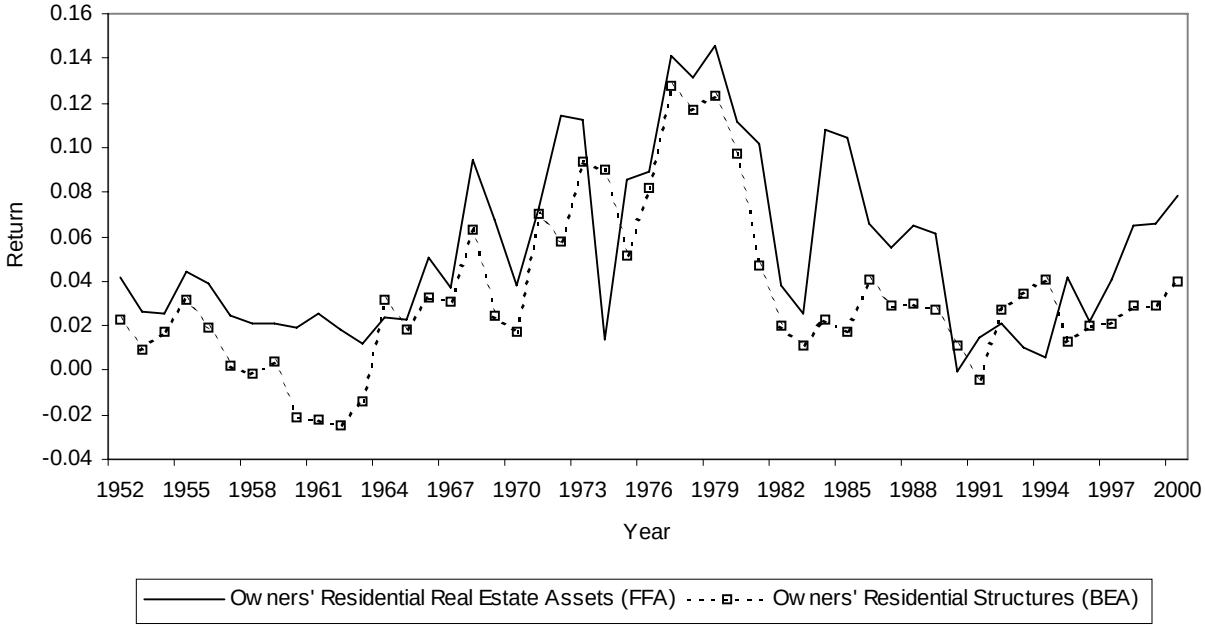


Table 10. Descriptive Statistics for Returns on Housing:
Owners' Structures (BEA) vs. Owners' Assets (FFA)

	Capital Gain Return			
	Owners' Real Estate Assets	Owners' Residential Structures	Owners' Real Estate Assets	Owners' Residential Structures
	1952:I-2000:IV	1952:I-2000:IV	1952-2000	1952-2000
Mean	0.0131	0.0081	0.0543	0.0338
Standard Deviation	0.0119	0.0096	0.0387	0.0357
Minimum	-0.0112	-0.0082	-0.0003	-0.0249
Maximum	0.0478	0.0392	0.1457	0.1281
Autocorrelation	0.4264	0.6955	0.6646	0.8103

correlation between the Freddie Mac's series and our series as well as lower volatility and higher autocorrelation than for the Census Bureau's series. The mean returns are also similar. Our capital gain measure resembles the Freddie Mac's series suggesting the viability of our return data. Though the data sets used in each series are different, the return statistics suggest more similarities than differences. Our measure of return on housing is a useful addition to the return measurement literature, accounting for tax subsidies in the rental income and for taxes in the return computations as well as providing longer time series, return data for owners and rentiers, capital gain and rental income return components, and return on equity rather than market value.

IV. Returns on Residential Real Estate and Other Assets

In this section, we compare the performance of the residential real estate to that of Treasury bills (T-bills), Treasury notes (T-notes), Treasury bonds (T-bonds), money (M2), municipal bonds, corporate bonds, and common stocks (S&P 500). We use both quarterly and annual data. The data sources are described in the Appendix. It is important to keep in mind that the financial assets are traded on the exchange markets and thus their characteristics differ from those of the residential real estate. For instance, liquidity and market value measurement may affect the return statistics, and in turn, the comparison results may not be completely accurate.

Nevertheless, such a comparison may still be useful for illustrating the performance of housing versus other assets.

Several studies analyzed the relationship between the returns on residential real estate and returns on other assets. Zerbst and Cambon (1984), Sirmans and Sirmans (1987), and Benjamin, Sirmans, and Zietz (2001) provide good summaries on this topic for both commercial and residential real estates. Ibbotson and Fall (1979), Ibbotson and Siegel (1984), and Goetzmann and Ibbotson (1990) using residential real estate returns, indicate that residential real estate earns higher return and exhibits lower volatility than long-term bonds. Common stocks, in contrast, earn a higher return but also have a larger volatility. In addition, a lot of studies conclude that the real estate is a good diversification asset as its correlation with other assets is low.

Our comparison experiment reinforces the results of other researchers. The findings are presented in Tables 11 and 12, and plots for the annual data are shown in the Appendix. Among all the assets, T-bills and money exhibit low standard deviation in their return. Yet the coefficient of variation of the housing return is as low as that on the T-bills and money rate. That is, the standard deviation per unit return of the residential real estate is almost identical to that of the T-bills and money. However, housing provides much higher return than either T-bills or money. From the tables, it is also evident that the residential housing performs better than any of the bonds, including T-notes, and has lower volatility and yet higher mean return. The return on stocks is slightly higher than that on housing but its standard deviation is quite larger as well. In contrast to housing, the financial assets except for T-bills and money also have wide range, with negative large minimum and positive large maximum.

The returns on financial assets except for T-bills and money have very low, almost zero, autocorrelation. The high autocorrelation of the housing series (0.49, quarterly) can partially be explained by the autocorrelation of inflation (0.67, quarterly) after observing that the Fisher real

housing returns are much less autocorrelated (0.28, quarterly, Table 1). Likewise, high autocorrelation of the T-bills and money rates can be explained by the autocorrelation in the inflation rate. In addition, we observe that the correlation of the returns on residential real estate with those on other assets is low except with the T-bill return (0.48, annual) and the money rate (0.41, annual). Thus, the residential real estate can provide diversification benefits in the household portfolio. Housing can also be a possible inflation hedge as indicated by the correlation between housing and inflation, which is 0.42 for the quarterly and 0.58 for the annual data. The correlation of inflation with T-bills and money is even higher, which also explains a high correlation between T-bills and money with residential housing. The correlation of inflation with other assets is negative, and for instance, with stocks is –0.22 for the quarterly and –0.32 for the annual data, which suggests that stocks may not be a good hedge against inflation.

Table 11. Descriptive Statistics and Correlation Matrix for the Quarterly Returns (1952:I-2000:IV)

	Mean	Standard Deviation	Minimum	Maximum	Autocorrelation
Residential Housing	0.0274	0.0153	-0.0037	0.0681	0.4928
T-bills	0.0131	0.0069	0.0019	0.0381	0.9508
T-notes	0.0162	0.0290	-0.0618	0.1634	-0.0004
T-bonds	0.0163	0.0499	-0.1420	0.2412	-0.0333
Money	0.0090	0.0049	0.0016	0.0245	0.9796
Municipal Bonds	0.0128	0.0470	-0.1523	0.1755	0.0250
Corporate Bonds	0.0166	0.0456	-0.1288	0.2385	0.0124
Stocks	0.0329	0.0753	-0.2494	0.2277	0.0779
Inflation	0.0097	0.0085	-0.0075	0.0443	0.6701

	Residential Housing	T-bills	T-notes	T-bonds	Money	Municipal Bonds	Corporate Bonds	Stocks	Inflation
Residential Housing	1.0000								
T-bills	0.3752	1.0000							
T-notes	-0.0518	0.2453	1.0000						
T-bonds	-0.0712	0.1316	0.9281	1.0000					
Money	0.3266	0.9409	0.2598	0.1598	1.0000				
Municipal Bonds	-0.0766	0.0265	0.8015	0.8048	0.0942	1.0000			
Corporate Bonds	-0.0796	0.1042	0.9177	0.9415	0.1557	0.8505	1.0000		
Stocks	-0.0263	-0.1068	0.1755	0.2527	-0.0363	0.3084	0.3223	1.0000	
Inflation	0.4160	0.6549	-0.0586	-0.1692	0.5463	-0.2316	-0.1924	-0.2236	1.0000

Table 12. Descriptive Statistics and Correlation Matrix for Annual Returns (1952-2000)

	Mean	Standard Deviation	Minimum	Maximum	Autocorrelation
Residential Housing	0.1130	0.0524	0.0264	0.2300	0.7253
T-bills	0.0536	0.0286	0.0086	0.1472	0.8421
T-notes	0.0668	0.0649	-0.0501	0.2879	0.0763
T-bonds	0.0671	0.1088	-0.0906	0.3979	-0.0671
Money	0.0368	0.0201	0.0073	0.0946	0.9159
Municipal Bonds	0.0538	0.1150	-0.1733	0.4010	0.0313
Corporate Bonds	0.0684	0.1017	-0.0792	0.4195	0.0319
Stocks	0.1381	0.1670	-0.2626	0.5214	-0.1389
Inflation	0.0396	0.0314	-0.0074	0.1329	0.7750

	Residential Housing	T-bills	T-notes	T-bonds	Money	Municipal Bonds	Corporate Bonds	Stocks	Inflation
Residential Housing	1.0000								
T-bills	0.4843	1.0000							
T-notes	0.0666	0.4510	1.0000						
T-bonds	-0.0064	0.2232	0.9285	1.0000					
Money	0.4126	0.9487	0.5235	0.3166	1.0000				
Municipal Bonds	-0.0424	0.0638	0.8238	0.8619	0.2009	1.0000			
Corporate Bonds	-0.0373	0.2047	0.9253	0.9557	0.3295	0.9164	1.0000		
Stocks	-0.0717	-0.1437	0.0952	0.1900	-0.0407	0.2449	0.2851	1.0000	
Inflation	0.5800	0.7368	0.0475	-0.1586	0.6082	-0.2939	-0.1936	-0.3164	1.0000

V. Efficient Frontier Analysis

Since residential housing is a major asset in the portfolios of many households, it is natural to include it in the efficient frontier analysis. Even before undertaking the analysis, we observe that housing asset, with its high average return, low standard deviation, and low correlation with other assets, should account for a significant portion of the household portfolio. As expected, efficient frontier with all assets illustrates that housing accounts for most of the optimal portfolio for reasonable coefficients of relative risk aversion. We also find that stocks have a large allocation in the optimal portfolio.

Before discussing the results, first we present the algorithm of constructing the efficient frontier, which follows Flavin and Yamashita (1998). The problem is as follows:

$$\text{min. } w'Vw \quad \text{subject to} \quad i'w = 1,\ r'w = \mu, \text{ and } w \geq 0, \tag{8}$$

where w is a vector of portfolio shares of n assets; V is the variance-covariance matrix of the assets; i is a vector of ones; r is a vector of expected returns, and μ is a desired level of portfolio return. Thus, the objective is to minimize the portfolio variance with the following constraints: (i) shares must add to one; (ii) expected portfolio return must equal a desired return (μ), and (iii) there are no short sales. Solving the problem, we obtain an optimal solution, $w(\mu)$, as a function of μ:

$$w^*(\mu) = \lambda V^{-1} i + \gamma V^{-1} r + V^{-1}\omega, \tag{9}$$

where λ, γ, and ω are Lagrange multipliers associated with the above constraints, respectively. Then, the optimal portfolio variance is:

$$\sigma^2(\mu) = w^{*\prime} V w^* \tag{10}$$

Expected utility maximizers choose an optimal portfolio where the slope of their indifference curve is equal to the slope of the efficient frontier, that is, the marginal rate of substitution (MRS) equals the marginal rate of transformation (MRT). The slope of the efficient frontier is:

$$\text{MRT} = \frac{d\mu}{d\sigma} = \frac{2D\sigma}{2A\mu - 2B - (Ar' - Bi')V^{-1}\omega}, \tag{11}$$

where

$$A = i'V^{-1}i,\ B = i'V^{-1}r = r'V^{-1}i, \text{ and } D = AC - B^2 \text{ with } C = r'V^{-1}r \tag{12}$$

Assuming that the portfolio returns are normally distributed with mean μ and variance σ^2 and that the utility function is of the constant relative risk aversion form, $U(W) = \frac{1}{1-\rho} W^{1-\rho}$, where W is the end-of-period wealth and ρ is the coefficient of relative risk aversion (CRRA), then the indifference curves of the expected utility maximizer can be approximated locally as follows (Blake 1996):

$$\mu = EU + \frac{1}{2}\rho\sigma^2, \tag{13}$$

where EU is an expected utility index. Then, the slope of the indifference curves is:

$$\text{MRS} = \frac{d\mu}{d\sigma} = \rho\sigma \tag{14}$$

Equating MRT with MRS, we obtain:

$$\rho = \frac{2D}{2A\mu - 2B - (Ar' - Bi')V^{-1}\omega} \tag{15}$$

The computation is performed using the quadratic programming routine in MATLAB, and the data used to obtain variance-covariance matrix and means are quarterly observations for net real rates spanning the 1952-2000 period.

Figure 14 illustrates the frontier with and without a housing asset. Note that the frontier is expanded as housing is included in the portfolio. Another feature to note is that the return on housing, with much lower standard deviation, is almost identical to return on stocks. This is due to the tax exemptions for homeowners as well as definition of the return on housing as that on equity. Table 13 below shows that the optimal portfolio consists of housing and stocks. Money

Table 13. Optimal Asset Shares (1952:I-2000:IV)

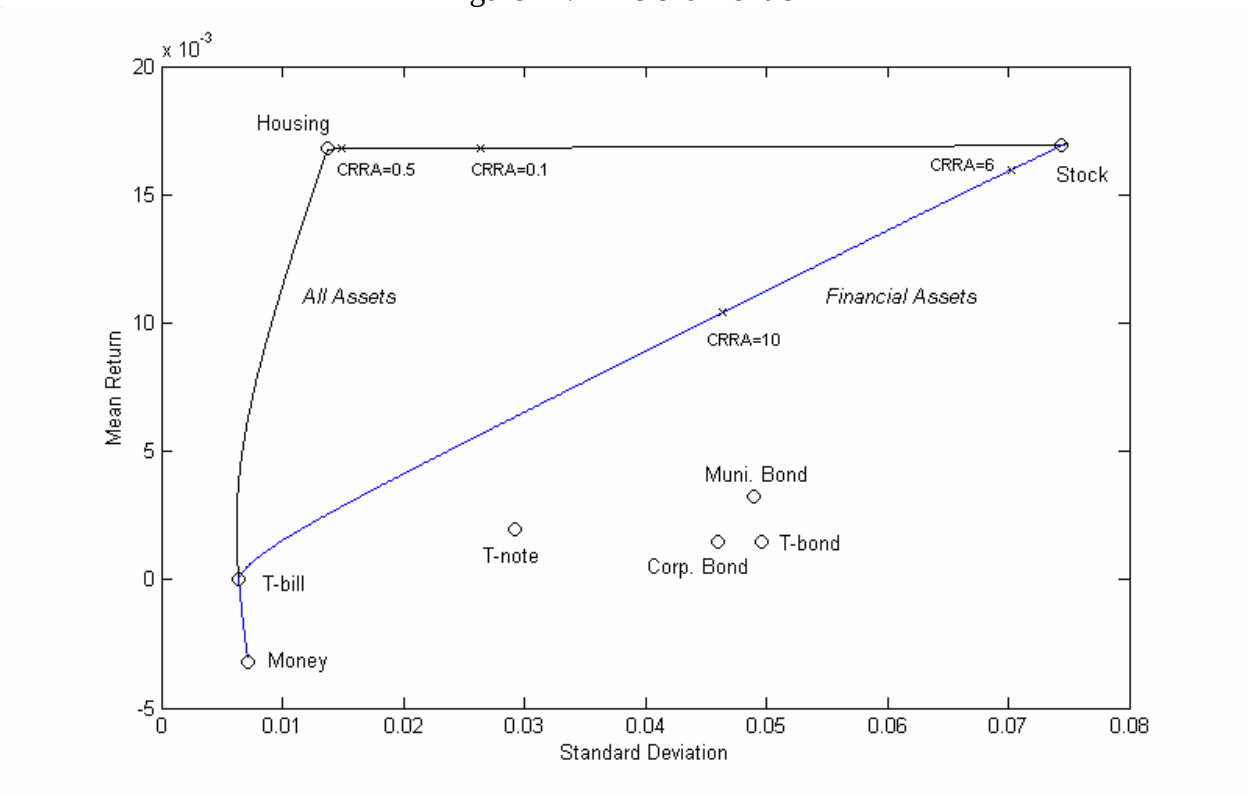
All Assets

CRRA	T-bill	T-note	T-bond	Muni. bond	Corp. bond	Stock	Money	Housing
0.5	0.000	0.000	0.000	0.000	0.000	0.091	0.000	0.909
0.1	0.000	0.000	0.000	0.000	0.000	0.316	0.000	0.684

Financial Assets

CRRA	T-bill	T-note	T-bond	Muni. bond	Corp. bond	Stock	Money
10	0.270	0.130	0.000	0.000	0.000	0.600	0.000
9	0.180	0.152	0.000	0.000	0.000	0.668	0.000
8	0.069	0.179	0.000	0.000	0.000	0.753	0.000
7	0.000	0.142	0.000	0.000	0.000	0.858	0.000
6	0.000	0.062	0.000	0.000	0.000	0.938	0.000

Figure 14. Efficient Frontier



and bond assets are not part of this optimal portfolio. However, they are part of the portfolio on the steeper side of the frontier corresponding to very high and unreasonable relative risk aversion coefficients. The efficient frontier without housing indicates that, for CRRA below 10, stocks amount to a significant portion of the optimal portfolio. In constructing efficient frontier with all assets, it is important to keep in mind that housing, with its peculiar market characteristics, differs from other financial assets. A household cannot invest in a national housing asset, and thus, the standard deviation of metropolitan area housing may actually be quite higher. Higher standard deviation will change the shape of the frontier. However, increasing standard deviation of housing and its covariance with other assets, thus keeping correlation coefficient constant, by three-fold does not change the results. Though the steep part of the frontier becomes flatter, the corresponding coefficients of relative risk aversion are well above 20, considered too high by economists. Again, portfolio funds are divided between housing and stocks.

In the above analysis, we consider return on housing equity; that is, the return incorporates the actual share of debt. Households do not have a choice of borrowing at a mortgage rate and then investing in a housing asset. As in Flavin and Yamashita's (1998) paper, we incorporate this choice into our analysis. We use the 30-year conventional mortgage rate obtained from the FRED database from the St. Louis Federal Reserve Bank's website. Since the data range from the 2nd quarter of 1971, we use the same time period for other assets in consideration. We compute the net real mortgage rate accounting for tax advantages of mortgage interest payment deductions:

$$r_m^{nr} = \frac{1+(1-t)r_m^n}{1+\pi} - 1, \tag{16}$$

where superscripts nr and n refer to the net real and nominal rates, respectively, while t and π stand for the income tax rate and inflation rate, respectively. We also compute the return on the housing asset for owners excluding mortgage tax subsidy. In computing the efficient frontier, two constraints are imposed such that (i) the household cannot borrow more than the value of the housing asset (the mortgage share cannot exceed the housing share, $x'w \geq 0$, where x is a vector of ones for housing and mortgage shares and zeros for other shares) and (ii) the mortgage share cannot be positive. These constraints modify the original MRT in equation (11) and thus the computation of CRRA in equation (15). Incorporating these constraints, equation (15) becomes:

$$\rho = \frac{2D}{2A\mu - 2B - (Ar' - Bi')(V^{-1}\omega + V^{-1}\eta) - \kappa(AF - BE)}, \tag{17}$$

where κ and η are Lagrange multipliers corresponding to constraints (i) and (ii) above, respectively; $E = i'V^{-1}x = x'V^{-1}i$, and $F = r'V^{-1}x = x'V^{-1}r$.

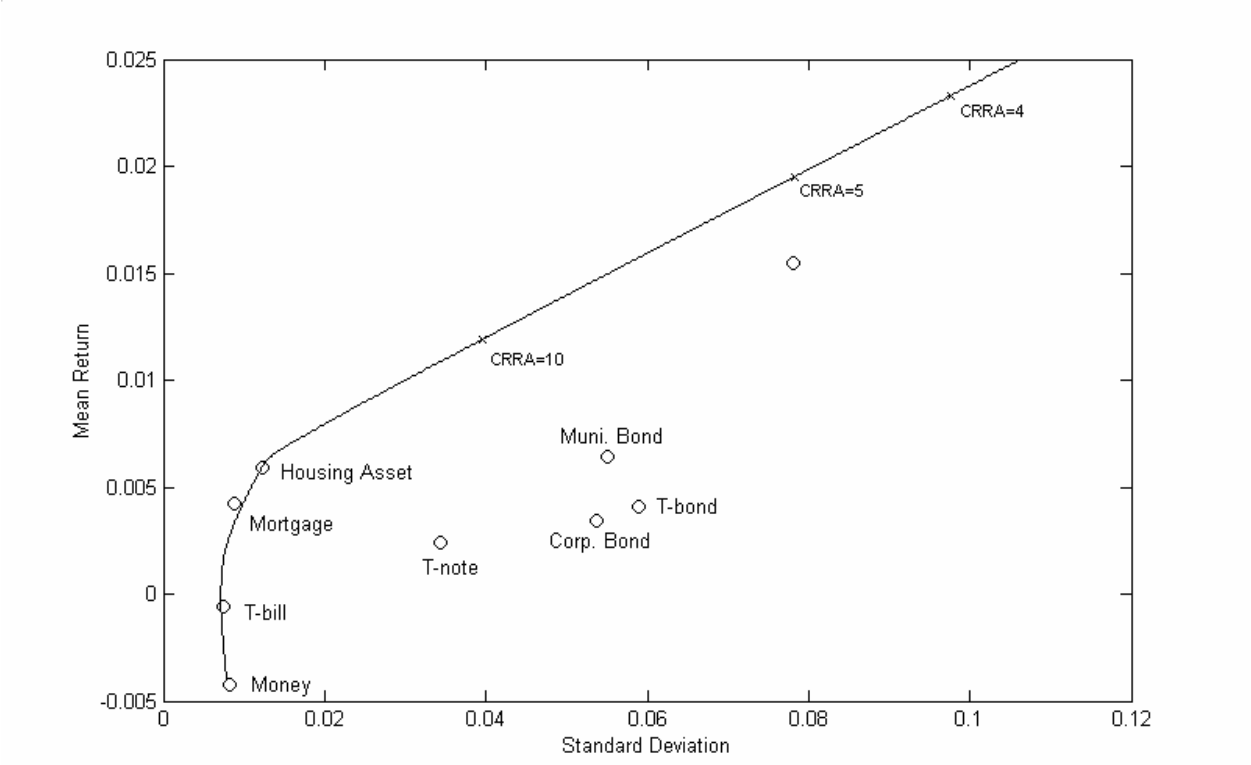
Figure 15 and Table 14 illustrate the above computations. Municipal bonds account for a small part of the portfolio, and stocks and housing are dominant assets. As expected, the share of

stocks increases as CRRA falls, but in addition, interestingly, the value of housing asset and amount borrowed increases as well. Another feature to note is that the optimal share of housing equity (asset value less mortgage) becomes zero at CRRA of three. Thus, it is optimal for less risk-averse individuals to have higher valued housing and completely finance the purchase through borrowing. It seems rational that with the mortgage rate lower than the housing asset

Table 14. Optimal Asset Shares (1971:II-2000:IV)

All Assets, Borrow at Mortgage Rate/Invest in Housing									
CRRA	T-bill	T-note	T-bond	Muni	C-bond	Stock	Money	Housing	Mortgage
10	0.000	0.000	0.000	0.001	0.000	0.338	0.000	2.262	-1.601
6	0.000	0.000	0.000	0.036	0.000	0.576	0.000	3.602	-3.214
5	0.000	0.000	0.000	0.053	0.000	0.696	0.000	4.279	-4.029
4	0.000	0.000	0.000	0.080	0.000	0.875	0.000	5.288	-5.243
3	0.000	0.000	0.000	0.000	0.000	1.000	0.000	6.178	-6.178
2	0.000	0.000	0.000	0.000	0.000	1.000	0.000	7.233	-7.233
1	0.000	0.000	0.000	0.000	0.000	1.000	0.000	10.485	-10.485

Figure 15. Efficient Frontier (Borrow at Mortgage Rate/Invest in Housing)



return, less risk-averse individuals would borrow more and thus earn more. An interesting implication is that households who are less risk-averse should hold no equity in their houses to maximize their portfolio return. In essence, borrowing against the house makes housing a more liquid asset.

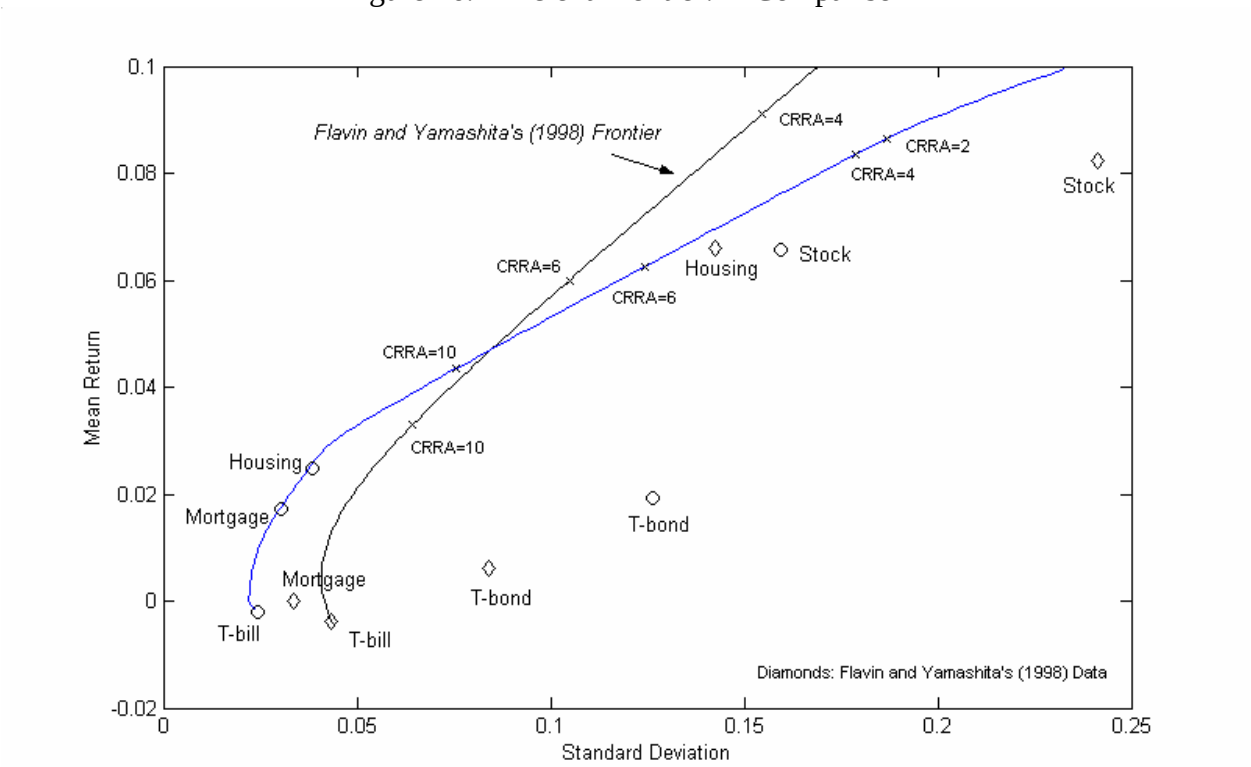
The last experiment we conduct compares our results with those of Flavin and Yamashita (1998). Data used are annual, and assets in consideration are T-bills, T-bonds, stocks, housing, and mortgage. A comparison is presented in Figure 16 and Table 15. First, note that the asset mean returns and variance-covariance matrices differ in two analyses mainly due to the different time periods used in their computation. As a result, the efficient frontiers do not resemble one another, and for similar CRRA, the optimal portfolios differ, though at CRRA of one, the optimal portfolios are closer to one another. We still observe that, in our analysis, stocks and

Table 15. Optimal Asset Shares

Flavin and Yamashita's (1998) Data, Annual					
CRRA	T-bill	T-bond	Stock	Housing	Mortgage
10	0.5061	0.0000	0.1441	0.3498	0.0000
6	0.0196	0.1429	0.2443	0.5932	0.0000
5	0.0000	0.2320	0.2954	0.7020	-0.2295
4	0.0000	0.3824	0.3772	0.8744	-0.6341
3	0.0000	0.4840	0.5160	1.1772	-1.1772
2	0.0000	0.2073	0.7927	1.8124	-1.8124
1	0.0000	0.0000	1.0000	6.3369	-6.3369

Our Data, Annual, 1971-2000					
CRRA	T-bill	T-bond	Stock	Housing	Mortgage
10	0.0000	0.0000	0.3580	1.1478	-0.5057
6	0.0000	0.0000	0.6589	1.7056	-1.3645
5	0.0000	0.0000	0.8015	1.9699	-1.7713
4	0.0000	0.0000	0.9915	2.3222	-2.3137
3	0.0000	0.0000	1.0000	2.5254	-2.5254
2	0.0000	0.0000	1.0000	2.6534	-2.6534
1	0.0000	0.0000	1.0000	3.4214	-3.4214

Figure 16. Efficient Frontier: A Comparison



housing dominate bonds for CRRA below 10. In addition, as relative risk aversion falls, the share of stock increases to one, while housing investment is completely financed by borrowing (for instance, at CRRA equal to 3). In Flavin and Yamashita's (1998) analysis, at CRRA of two and higher, the optimal portfolio contains a sizable amount of bonds; however, as CRRA falls below two, the optimal portfolio consists of stocks and housing, as in our case.

What is the correspondence of the optimal portfolio as generated by the efficient frontier analysis to the actual portfolio held by the representative household? For the period of 1952:I-2000:IV, the average asset shares in the portfolio are as follows: money – 21.75%, T-bills – 0.13%, T-notes – 1.65%, T-bonds – 1.02%, corporate bonds – 5.85%, municipal bonds – 2.5%, stocks – 27.66%, and housing equity – 39.44%.[4] Thus, money and bonds account for 32.9% of the total portfolio. The efficient frontier analysis shows that to justify these shares, CRRA must be high, especially if housing is included. From the figures, it is evident that housing is a good

[4] The average asset shares for the period of 1971:II-2000:IV are almost identical to the above shares.

asset to hold, and stocks offer the highest return, yet with the highest standard deviation. Consequently, for reasonable degrees of relative risk aversion, the wealth is allocated between housing and stocks. In contrast, the Flavin and Yamashita's (1998) optimal portfolio includes bonds at reasonable CRRA. However, the mix of assets still differs from the observed mix. Different time periods and different housing returns used are key factors why our optimal portfolio differs from that of Flavin and Yamashita (1998). The use of right data becomes crucial. Yet both results indicate that housing and stocks are major components of the household portfolio.

The discrepancy between the computed optimal portfolio and the actual portfolio can be accounted in a couple of ways. First, as noted in the above discussion, is the data. Using different asset mean returns and variance-covariance matrices produces rather different results. Thus, it is important to use the best available data. Second is, of course, the use of a simplistic one-period model of household investment behavior. Other motives for investment behavior may be present such as life-cycle effects and bequest motive. Further, households may care about something more than return and risk as measured by standard deviation. Households may value liquidity defined as how fast the asset can be converted into cash without incurring large capital loss. This definition of liquidity incorporates an additional notion besides the thickness of the market. For instance, housing asset is relatively illiquid; however, a house could be sold relatively quickly if one is willing to suffer a large capital loss. Thus, if households value liquidity, for instance, money may be present in the optimal portfolio with reasonable CRRA, and the shares of housing and stocks may fall. This issue is beyond the scope of this paper, and we pursue it separately.

VI. Conclusion

This paper uses the National Income and Product Accounts and Flow of Funds Accounts tables to compute an aggregate measure of return on residential real estate. We compute the return to owners and rentiers, capital gain and income components of the total return as well as the Fisher real and net real rates. Both quarterly and annual data over 1952-2000 period are used in the analysis. To our knowledge, this is one of the most comprehensive calculations of the returns on housing. We find that the returns on housing provide a high average return and low volatility, have low correlation with other assets such as bonds and stocks, and exhibit high correlation with inflation. The efficient frontier analysis indicates that the residential housing providing diversification should be an important part of the household portfolio.

The housing asset with its tax exemptions earns an average net real return of 6.77% as compared to 7.05% that stocks earn. Note a much bigger difference between Fisher real rates, 7.07% for housing and 9.72% for stocks. It becomes evident that tax subsidies and taxes on returns have a significant effect on the level of the average return on housing. Thus, another implication of our return series is that if the average return is important in the analysis, taxes cannot be ignored.

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Appendix

A. Data Sources for Financial Assets

The nominal returns on T-bills, T-notes (intermediate-term government bonds with maturity of five years), T-bonds (long-term government bonds with maturity of twenty years), corporate bonds (high-grade long-term bond index with approximate maturity of twenty years), stocks (S&P 500) are taken from Ibbotson's *Stocks, Bonds, Bills, and Inflation, 2001 Yearbook*. The 1959-2000 nominal returns for money are M2 own rate (weighted-average of returns from assets included in M2) taken from the FRED database, St. Louis Federal Reserve Bank. The 1952-1958 returns are estimated using the linear regression of the T-bill yield on M2 own rate for 1959-2000.

The return on municipal bonds is computed using the yield data (mixed quality Bond Buyer Index, 1953-2000) from "H.15 Selected Interest Rates" published by the Federal Reserve Board (the yield data for 1952 is available from the National Bureau of Economic Research (NBER) historical series). The monthly income returns are monthly yields. The capital gain return is calculated using the Ibbotson's (2001) methodology. 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. The total return is the sum of the income and capital gain returns.

B. Data

Table A1. Total Nominal Return on Residential Housing and Its Components

Year	Return to Owners	Return to Proprietors	Total Income Return	Total Capital Gain Return	Total Return
Mar-52	0.0124	0.0311	0.0072	0.0120	0.0192
Jun-52	0.0368	0.0089	0.0073	0.0192	0.0266
Sep-52	-0.0018	0.0069	0.0073	-0.0060	0.0013
Dec-52	0.0370	0.0091	0.0075	0.0195	0.0270
Mar-53	0.0211	0.0172	0.0080	0.0118	0.0197
Jun-53	0.0211	0.0107	0.0080	0.0095	0.0175
Sep-53	0.0312	0.0118	0.0080	0.0164	0.0244
Dec-53	-0.0051	0.0064	0.0080	-0.0092	-0.0012
Mar-54	0.0078	0.0146	0.0083	0.0019	0.0101
Jun-54	0.0121	0.0103	0.0084	0.0032	0.0115
Sep-54	0.0262	0.0099	0.0084	0.0122	0.0206
Dec-54	0.0232	0.0114	0.0084	0.0107	0.0192
Mar-55	0.0140	0.0175	0.0085	0.0066	0.0152
Jun-55	0.0279	0.0125	0.0085	0.0142	0.0227
Sep-55	0.0291	0.0110	0.0085	0.0146	0.0230
Dec-55	0.0227	0.0181	0.0084	0.0128	0.0212
Mar-56	0.0310	0.0236	0.0085	0.0201	0.0286
Jun-56	0.0239	0.0093	0.0084	0.0107	0.0191
Sep-56	0.0203	0.0103	0.0084	0.0086	0.0171
Dec-56	0.0132	0.0081	0.0084	0.0032	0.0116
Mar-57	0.0242	0.0112	0.0086	0.0114	0.0200
Jun-57	0.0200	0.0059	0.0086	0.0069	0.0155
Sep-57	0.0178	0.0047	0.0086	0.0051	0.0137
Dec-57	0.0082	0.0061	0.0087	-0.0011	0.0075
Mar-58	-0.0022	0.0138	0.0090	-0.0062	0.0028
Jun-58	0.0179	0.0094	0.0092	0.0060	0.0152
Sep-58	0.0274	0.0060	0.0092	0.0116	0.0207
Dec-58	0.0254	0.0091	0.0091	0.0112	0.0204
Mar-59	0.0023	0.0188	0.0094	-0.0021	0.0073
Jun-59	0.0269	0.0123	0.0097	0.0127	0.0224
Sep-59	0.0218	0.0051	0.0098	0.0069	0.0167
Dec-59	0.0191	0.0079	0.0098	0.0059	0.0158
Mar-60	0.0379	0.0443	0.0100	0.0298	0.0398
Jun-60	0.0121	0.0253	0.0098	0.0063	0.0160
Sep-60	0.0151	0.0188	0.0098	0.0064	0.0162
Dec-60	0.0046	0.0199	0.0099	-0.0007	0.0092
Mar-61	0.0012	0.0332	0.0100	0.0009	0.0109
Jun-61	0.0294	0.0243	0.0101	0.0177	0.0279
Sep-61	0.0252	0.0209	0.0101	0.0137	0.0238
Dec-61	0.0250	0.0273	0.0102	0.0155	0.0257
Mar-62	0.0253	0.0315	0.0101	0.0171	0.0272

Jun-62	0.0139	0.0255	0.0101	0.0074	0.0175
Sep-62	0.0113	0.0168	0.0102	0.0028	0.0130
Dec-62	0.0222	0.0218	0.0103	0.0118	0.0221
Mar-63	0.0234	0.0115	0.0104	0.0092	0.0196
Jun-63	0.0049	0.0046	0.0105	-0.0056	0.0048
Sep-63	0.0250	-0.0032	0.0107	0.0054	0.0161
Dec-63	0.0130	0.0063	0.0107	0.0002	0.0109
Mar-64	0.0087	0.0174	0.0105	0.0009	0.0114
Jun-64	0.0330	0.0256	0.0105	0.0202	0.0307
Sep-64	0.0117	0.0033	0.0104	-0.0014	0.0090
Dec-64	0.0301	0.0295	0.0105	0.0194	0.0299
Mar-65	0.0213	0.0196	0.0102	0.0105	0.0207
Jun-65	0.0141	0.0162	0.0102	0.0045	0.0148
Sep-65	0.0126	0.0055	0.0104	-0.0001	0.0103
Dec-65	0.0343	0.0300	0.0105	0.0225	0.0329
Mar-66	0.0060	0.0142	0.0105	-0.0019	0.0086
Jun-66	0.0701	0.0639	0.0106	0.0575	0.0681
Sep-66	0.0060	0.0064	0.0102	-0.0041	0.0061
Dec-66	0.0455	0.0351	0.0104	0.0318	0.0421
Mar-67	0.0167	0.0221	0.0103	0.0081	0.0184
Jun-67	0.0231	0.0174	0.0103	0.0109	0.0213
Sep-67	0.0251	0.0159	0.0103	0.0118	0.0221
Dec-67	0.0404	0.0282	0.0102	0.0263	0.0365
Mar-68	0.0524	0.0432	0.0102	0.0393	0.0495
Jun-68	0.0363	0.0304	0.0099	0.0245	0.0344
Sep-68	0.0241	0.0177	0.0098	0.0123	0.0221
Dec-68	0.0731	0.0494	0.0097	0.0559	0.0656
Mar-69	0.0484	0.0335	0.0095	0.0343	0.0438
Jun-69	0.0312	0.0192	0.0093	0.0182	0.0274
Sep-69	0.0212	0.0158	0.0092	0.0103	0.0196
Dec-69	0.0414	0.0272	0.0092	0.0278	0.0370
Mar-70	0.0137	0.0215	0.0089	0.0072	0.0161
Jun-70	0.0505	0.0274	0.0087	0.0345	0.0432
Sep-70	0.0024	0.0051	0.0087	-0.0055	0.0032
Dec-70	0.0309	0.0207	0.0089	0.0189	0.0278
Mar-71	0.0433	0.0421	0.0087	0.0343	0.0430
Jun-71	0.0376	0.0343	0.0086	0.0280	0.0366
Sep-71	0.0333	0.0295	0.0085	0.0236	0.0321
Dec-71	0.0316	0.0316	0.0085	0.0231	0.0316
Mar-72	0.0605	0.0526	0.0084	0.0497	0.0581
Jun-72	0.0247	0.0286	0.0075	0.0184	0.0259
Sep-72	0.0458	0.0289	0.0083	0.0324	0.0407
Dec-72	0.0675	0.0466	0.0083	0.0529	0.0612
Mar-73	0.0375	0.0437	0.0076	0.0318	0.0394
Jun-73	0.0490	0.0423	0.0075	0.0395	0.0470
Sep-73	0.0601	0.0467	0.0073	0.0489	0.0561
Dec-73	0.0436	0.0463	0.0072	0.0372	0.0444
Mar-74	-0.0056	0.0409	0.0068	0.0018	0.0085

Jun-74	0.0017	0.0462	0.0068	0.0090	0.0159
Sep-74	0.0145	0.0456	0.0070	0.0178	0.0247
Dec-74	0.0465	0.0460	0.0070	0.0393	0.0463
Mar-75	0.0685	0.0484	0.0067	0.0549	0.0616
Jun-75	0.0545	0.0268	0.0064	0.0388	0.0452
Sep-75	-0.0024	0.0117	0.0062	-0.0039	0.0022
Dec-75	0.0372	0.0223	0.0062	0.0260	0.0322
Mar-76	0.0315	0.0247	0.0062	0.0231	0.0292
Jun-76	0.0593	0.0391	0.0061	0.0465	0.0526
Sep-76	0.0271	0.0274	0.0059	0.0212	0.0272
Dec-76	0.0411	0.0340	0.0060	0.0328	0.0388
Mar-77	0.0559	0.0653	0.0060	0.0530	0.0590
Jun-77	0.0675	0.0355	0.0057	0.0513	0.0570
Sep-77	0.0466	0.0375	0.0055	0.0381	0.0436
Dec-77	0.0543	0.0421	0.0055	0.0449	0.0504
Mar-78	0.0494	0.0480	0.0054	0.0436	0.0490
Jun-78	0.0616	0.0427	0.0053	0.0503	0.0556
Sep-78	0.0477	0.0340	0.0054	0.0380	0.0434
Dec-78	0.0499	0.0420	0.0054	0.0420	0.0474
Mar-79	0.0729	0.0556	0.0055	0.0620	0.0675
Jun-79	0.0644	0.0493	0.0052	0.0546	0.0597
Sep-79	0.0478	0.0471	0.0051	0.0426	0.0476
Dec-79	0.0415	0.0381	0.0054	0.0350	0.0404
Mar-80	0.0582	0.0486	0.0061	0.0492	0.0552
Jun-80	0.0416	0.0415	0.0058	0.0357	0.0416
Sep-80	0.0564	0.0404	0.0056	0.0459	0.0515
Dec-80	0.0274	0.0560	0.0058	0.0302	0.0361
Mar-81	0.0227	0.0430	0.0063	0.0227	0.0290
Jun-81	0.0771	0.0279	0.0062	0.0555	0.0617
Sep-81	0.0443	0.0231	0.0063	0.0315	0.0378
Dec-81	0.0267	0.0284	0.0063	0.0209	0.0272
Mar-82	0.0440	0.0576	0.0061	0.0420	0.0481
Jun-82	0.0139	0.0345	0.0059	0.0142	0.0201
Sep-82	0.0053	0.0168	0.0058	0.0030	0.0088
Dec-82	0.0149	0.0069	0.0057	0.0068	0.0125
Mar-83	0.0209	0.0296	0.0055	0.0180	0.0235
Jun-83	0.0141	0.0187	0.0054	0.0100	0.0154
Sep-83	0.0120	0.0201	0.0055	0.0089	0.0144
Dec-83	0.0119	0.0276	0.0057	0.0108	0.0165
Mar-84	0.0589	0.0330	0.0056	0.0458	0.0513
Jun-84	0.0409	0.0315	0.0055	0.0327	0.0382
Sep-84	0.0363	0.0281	0.0057	0.0283	0.0340
Dec-84	0.0347	0.0314	0.0058	0.0281	0.0338
Mar-85	0.0371	0.0463	0.0057	0.0339	0.0396
Jun-85	0.0423	0.0225	0.0056	0.0314	0.0370
Sep-85	0.0430	0.0298	0.0054	0.0342	0.0396
Dec-85	0.0419	0.0406	0.0053	0.0363	0.0416
Mar-86	0.0268	0.0407	0.0054	0.0249	0.0304

Jun-86	0.0305	0.0315	0.0053	0.0254	0.0308
Sep-86	0.0275	0.0270	0.0051	0.0223	0.0274
Dec-86	0.0272	0.0351	0.0049	0.0243	0.0292
Mar-87	0.0280	0.0234	0.0050	0.0218	0.0268
Jun-87	0.0272	0.0169	0.0049	0.0197	0.0246
Sep-87	0.0247	0.0162	0.0052	0.0174	0.0226
Dec-87	0.0189	0.0316	0.0054	0.0166	0.0220
Mar-88	0.0290	0.0387	0.0052	0.0262	0.0314
Jun-88	0.0377	0.0200	0.0050	0.0283	0.0333
Sep-88	0.0231	0.0159	0.0050	0.0164	0.0214
Dec-88	0.0241	0.0247	0.0054	0.0188	0.0242
Mar-89	0.0256	0.0322	0.0053	0.0219	0.0272
Jun-89	0.0261	0.0224	0.0053	0.0200	0.0252
Sep-89	0.0388	0.0130	0.0050	0.0277	0.0327
Dec-89	0.0205	0.0197	0.0047	0.0156	0.0203
Mar-90	0.0104	0.0173	0.0052	0.0068	0.0120
Jun-90	0.0025	0.0138	0.0053	-0.0001	0.0052
Sep-90	0.0083	0.0099	0.0056	0.0031	0.0087
Dec-90	-0.0004	0.0036	0.0058	-0.0052	0.0006
Mar-91	0.0244	0.0062	0.0060	0.0139	0.0199
Jun-91	0.0073	0.0032	0.0060	0.0003	0.0063
Sep-91	0.0035	0.0171	0.0061	0.0007	0.0068
Dec-91	0.0112	-0.0043	0.0060	0.0014	0.0074
Mar-92	0.0285	0.0104	0.0063	0.0177	0.0241
Jun-92	0.0014	-0.0055	0.0064	-0.0066	-0.0002
Sep-92	0.0167	0.0018	0.0060	0.0072	0.0132
Dec-92	0.0104	0.0125	0.0067	0.0042	0.0109
Mar-93	-0.0073	0.0079	0.0076	-0.0112	-0.0037
Jun-93	0.0207	0.0260	0.0078	0.0142	0.0220
Sep-93	0.0168	0.0175	0.0076	0.0093	0.0170
Dec-93	0.0170	0.0211	0.0078	0.0102	0.0180
Mar-94	0.0070	0.0355	0.0078	0.0062	0.0140
Jun-94	0.0150	0.0308	0.0083	0.0107	0.0190
Sep-94	0.0138	0.0087	0.0085	0.0039	0.0125
Dec-94	0.0075	0.0194	0.0086	0.0019	0.0105
Mar-95	0.0253	0.0189	0.0092	0.0145	0.0237
Jun-95	0.0317	0.0417	0.0090	0.0252	0.0342
Sep-95	0.0284	0.0226	0.0088	0.0181	0.0269
Dec-95	0.0196	0.0382	0.0089	0.0154	0.0243
Mar-96	0.0318	0.0330	0.0090	0.0231	0.0321
Jun-96	0.0087	0.0349	0.0090	0.0064	0.0154
Sep-96	0.0139	0.0313	0.0090	0.0094	0.0184
Dec-96	0.0187	0.0295	0.0091	0.0124	0.0215
Mar-97	0.0263	0.0397	0.0089	0.0210	0.0298
Jun-97	0.0212	0.0414	0.0088	0.0178	0.0266
Sep-97	0.0297	0.0274	0.0088	0.0203	0.0291
Dec-97	0.0285	0.0358	0.0088	0.0217	0.0305
Mar-98	0.0402	0.0283	0.0085	0.0285	0.0370

Jun-98	0.0327	0.0345	0.0088	0.0244	0.0332
Sep-98	0.0392	0.0356	0.0090	0.0292	0.0382
Dec-98	0.0356	0.0326	0.0089	0.0259	0.0348
Mar-99	0.0320	0.0390	0.0088	0.0250	0.0338
Jun-99	0.0385	0.0348	0.0088	0.0287	0.0376
Sep-99	0.0455	0.0345	0.0086	0.0340	0.0426
Dec-99	0.0340	0.0373	0.0087	0.0262	0.0349
Mar-00	0.0396	0.0411	0.0084	0.0316	0.0400
Jun-00	0.0510	0.0513	0.0082	0.0428	0.0511
Sep-00	0.0416	0.0347	0.0080	0.0318	0.0398
Dec-00	0.0356	0.0341	0.0079	0.0273	0.0352

C. Comparison of Residential Housing Returns with Returns on Other Assets in Figures

Figure A1. Total Nominal Return on Residential Housing and T-bills (1952-2000)

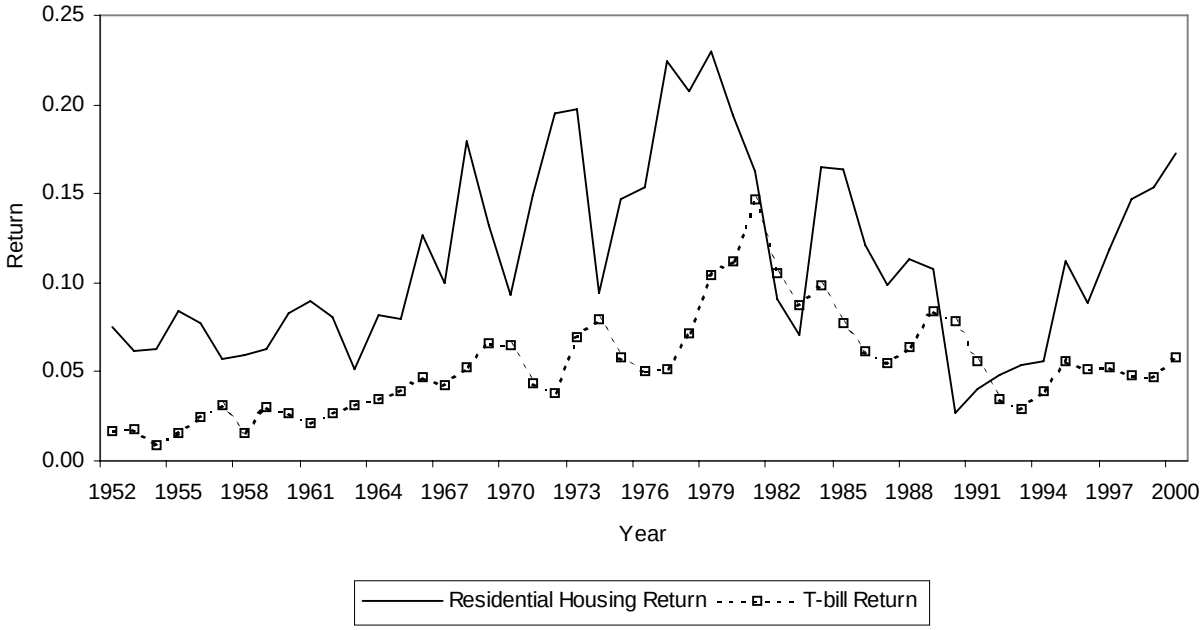

Figure A2. Total Nominal Return on Residential Housing and T-notes (1952-2000)

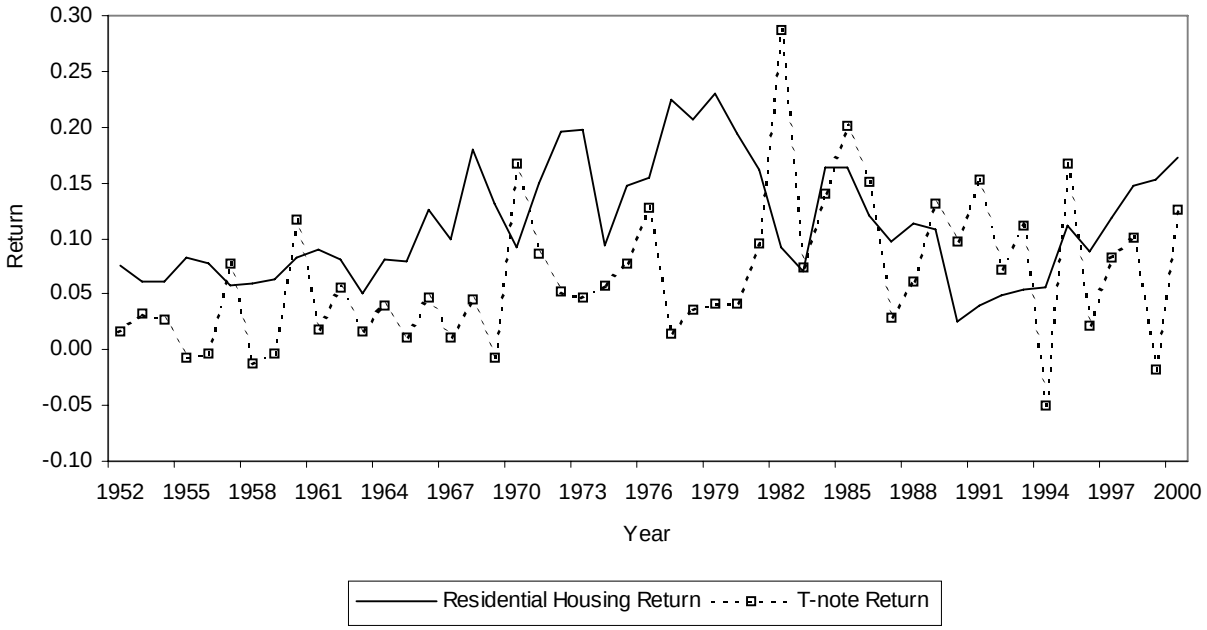

Figure A3. Total Nominal Return on Residential Housing and T-bonds (1952-2000)

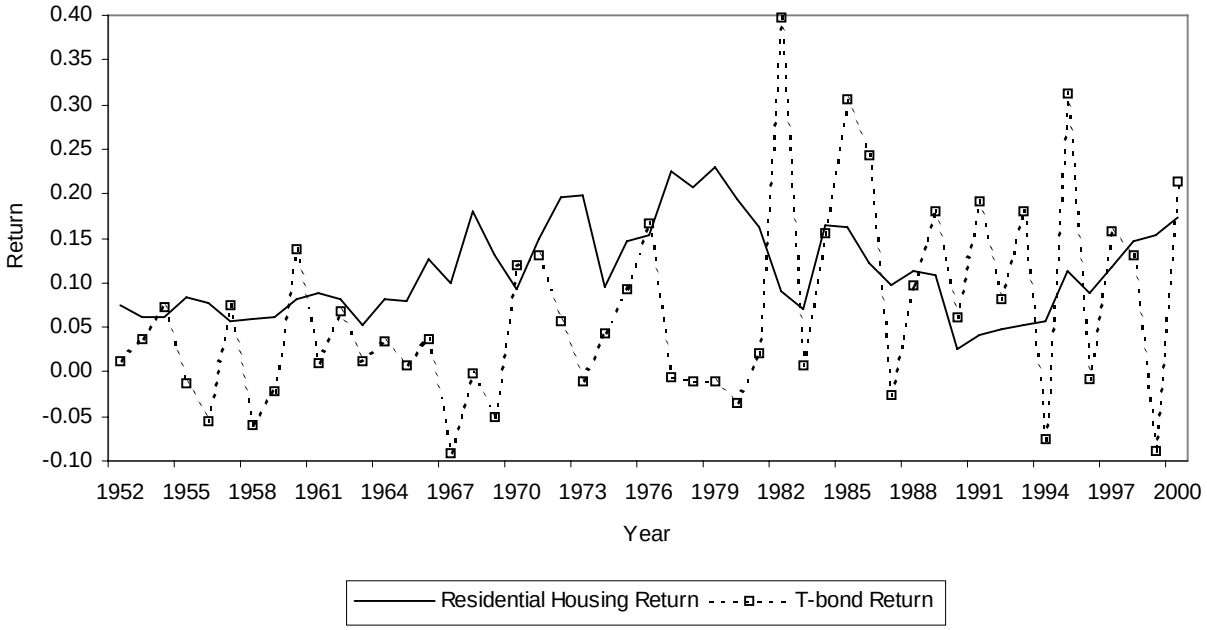

Figure A4. Total Nominal Return on Residential Housing and Money (1952-2000)

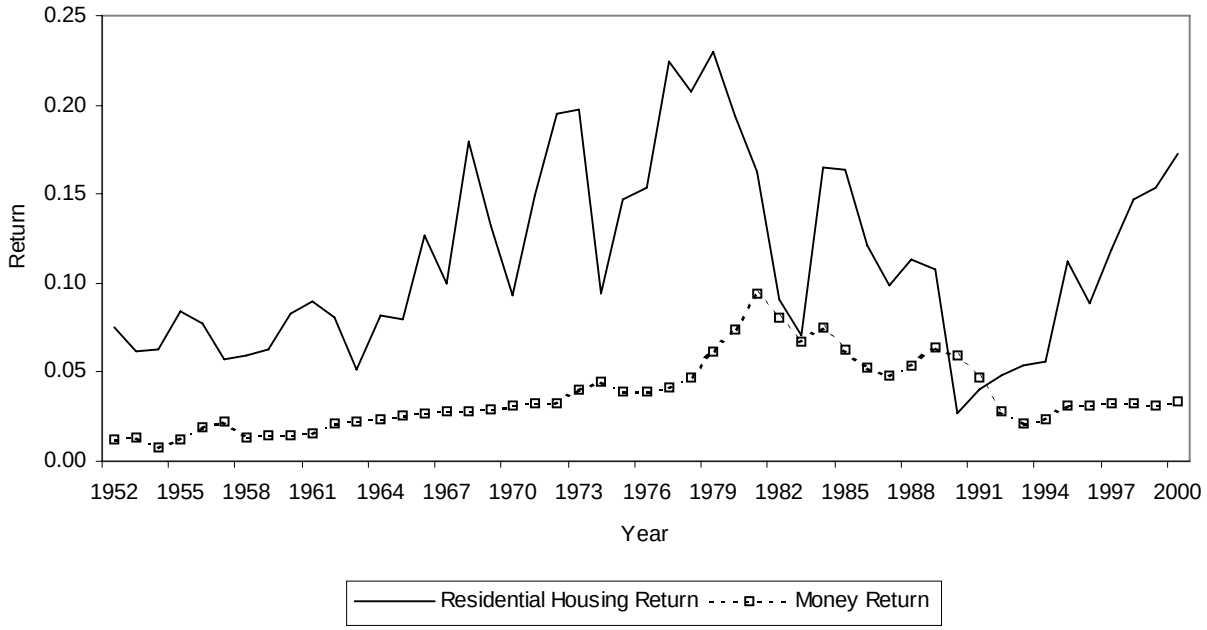

Figure A5. Total Nominal Return on Residential Housing and Municipal Bonds (1952-2000)

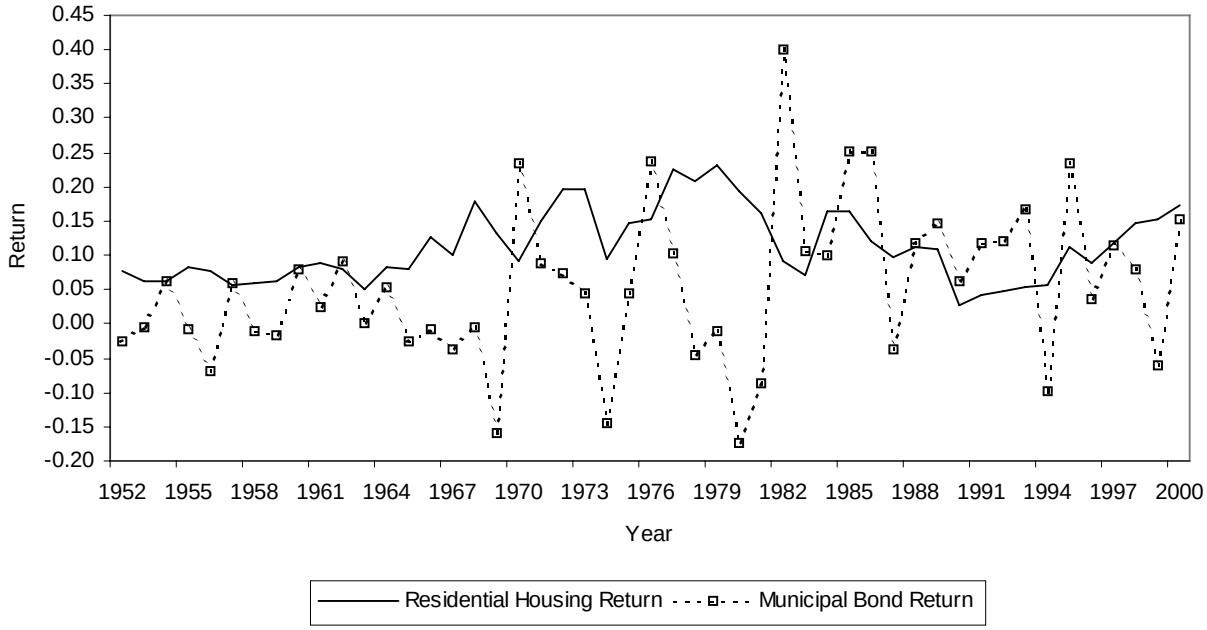

Figure A6. Total Nominal Return on Residential Housing and Corporate Bonds (1952-2000)

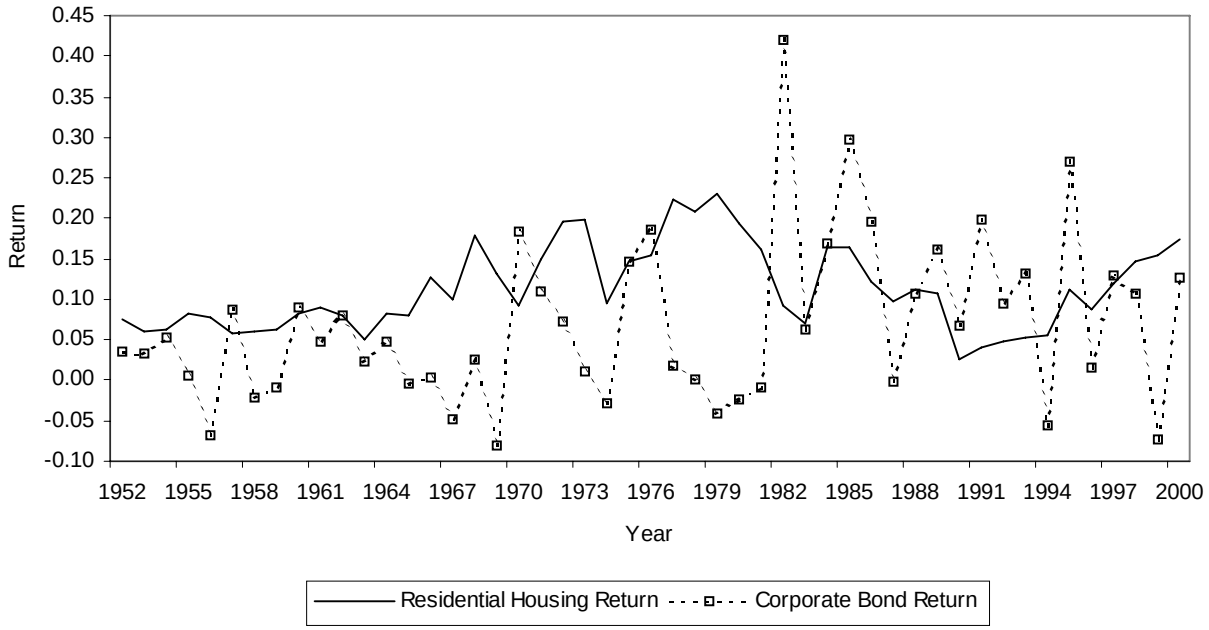

Figure A7. Total Nominal Return on Residential Housing and Stocks (1952-2000)