The Return to Wealth, Asset Pricing, and the Intertemporal Elasticity of Substitution *

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Abstract

We estimate a consumption-based asset pricing model with Epstein-Zin (1989) preferences. The intertemporal marginal rate of substitution (IMRS) depends on the return on total wealth. Rather than use the stock market as a proxy for wealth, we construct a more comprehensive return: we include the value of corporate equity and debt, durable goods (houses), and human capital. Our measure of human capital and its return is estimated jointly with the preference parameters. Our preliminary results are: the intertemporal elasticity of substitution is greater than one, the IMRS satisfies the Hansen-Jagannathan (1991) bound, and human capital comprises about 85 percent of total wealth, its return is about 6 percent per year (about 2 percentage points lower than equities) and has a Sharpe ratio that is about double that of equities.

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1 Introduction

The intertemporal elasticity of substitution (IES) is a key economic parameter for the analysis of modern dynamic macro models. Estimates of this parameter using non-durables and services have yielded, for the most part, values that are significantly less than one (e.g. Hall (1988), Campbell (2000)). More recently, Ogaki & Reinhart (1998) have shown that estimates based on durables data imply significantly larger values, although still less than one. An intuition for this is the notion that agents adjust mostly along their durables in response to changes in the risk free rate. That is, a rise in the risk free rate does not affect much agents' consumption of food, utilities etc., while there are larger responses to the purchases of durables.

In a recent paper, Bansal & Yaron (2004) show that an IES larger one is necessary to reconcile many asset prices. Bansal & Yaron (2004) use the Epstein & Zin (1989) preferences which afford separation between risk aversion and the IES (with time separable CRRA preferences the IES is restricted to be the inverse of the risk aversion parameter). In this paper we measure the IES in the presence of durables and within the Epstein & Zin (1989) class of preferences which allows for a separation between risk aversion and the IES parameter. As in Bansal & Yaron (2004) we use asset pricing restrictions to infer these parameters. These restrictions, with the Epstein & Zin (1989) preferences, require a measure of the the return on wealth. As stressed in Jagannathan & Wang (1996) appropriate measurement of this return requires measurement of the return to human capital. Consequently, we use additional macroeconomic restrictions to estimate the return to human capital. Unlike, Jagannathan & Wang (1996), Campbell (1996), Attanasio & Vissing-Jorgensen (2003) who treat the return on human capital as a function of returns on financial assets, we use a simple valuation model and data on earnings to estimate the return on human wealth.

Accounting for human capital is crucial for our estimates. First the estimates for the payout ratio of human-capital are on the order of 25. The estimated return to human capital is generally large (although a bit lower than that of equity) on the order of 6% per-annum. The striking result is that the return to human capital clearly displays the largest Sharpe ratio among the menu of assets we consider. In equilibrium, human capital is extremely important as its weight is approximately 85% of total wealth. This estimate may seem large relative to labor's share in GNP, but in our empirical work below we show that this is not inconsistent with plausible estimates of the labor share and the behavior of this return. We find that the estimated IES is generally larger than one. Although the standard errors of the IES are quite large, we find that when we

restrict the model to have no-human capital the estimates tend to be quite small and below one as commonly found in the literature. Thus the interaction between human capital and allowing for separation between the IES and risk aversion parameter seem to have important economic consequences. Finally, the time-variation in expected human capital return does not seem to be statistically significant. Our estimates human capital return is essentially uncorrelated with the stock market in contrast to the return estimated by Lustig & van Nieuwerburgh (2006) which is highly negatively correlated with stock returns.

The remainder of the paper continues as follows: Section 2 describe the model. This section introduces human capital and durables into otherwise standard Lucas economy with Epstein & Zin (1989) preferences. Section 3 describe our data construction, while section 3.1 describes the empirical findings. Section 5 provides concluding remarks.

2 Model with Durables and Human capital

Preferences are defined over non-durables and services, C_t, and durables, D_t. Details about the construction of the data series will be discussed in section 3. Intratemporal preferences are represented by a CES utility function:

$$u(C, D) = [C^{\alpha} + aD^{\alpha}]^{\frac{1}{\alpha}} \tag{1}$$

where a is a scale parameter and $\alpha < 1$ is an elasticity parameter where $\epsilon \equiv \frac{1}{1-\alpha}$ is the elasticity of substitution between non-durables and durables. We use a broad definition of durables to include housing.

Preferences are the same as in Epstein & Zin (1991) except now they are defined over sequences of (C, D) pairs and are represented recursively by an aggregator function:

$$U_t = J(u(C_t, D_t), \mu[\tilde{U}^{t+1}|I_t])$$

where J is the aggregator and $\mu[\cdot|I]$ is a certainty equivalent function conditioned on information set I. Our aggregator is CES:

$$J(u, z) = [(1-\beta)u^{1-\frac{1}{\psi}} + \beta z^{1-\frac{1}{\psi}}]^{\frac{1}{1-\frac{1}{\psi}}}$$

where ψ is the elasticity of intertemporal substitution. The certainty equivalent function

exhibits constant relative risk aversion:

$$\mu(\tilde{z}|I) = (E[\tilde{z}^{1-\gamma}|I])^{\frac{1}{1-\gamma}}$$

where γ is the coefficient of relative risk aversion.

We can write the budget constraint for the consumer in two different, but equivalent ways: the wealth-return form or the price-share form. In order to take advantage of the insights in Epstein & Zin (1991), we will use the wealth-return form, but the price-share form will be better for explaining our market structure and timing convention. We assume that markets are complete and that both durables and human capital are completely tradeable. In addition, we allow consumers to own different amounts of durable goods than they consume. For example, think of a consumer who owns a two-family house, but lives in one unit and rents out the other. The date-t purchase price of a unit of durable goods in terms of non-durable consumption, C_t, is P_t^d and the rental rate is q_t. We consider financial assets and human capital to trade ex-dividend as is standard practice. In contrast, we assume that durable goods trade cum-dividend. While this may seem odd, we consider it to be the more natural way to think about durables: when you buy a washing machine, you get to use it right away and do not have to "rent" its services from anyone. The budget constraint in price-share form is:

$$P_t^e S_t^e + P_t^d S_t^d + H_t + q_t D_t + C_t \leq q_t S_t^d + P_t^d S_{t-1}^d (1-\delta) + (P_t^e + d_t^e) S_{t-1}^e + H_t + e_t \qquad (2)$$

where S_{t+1}^e the number of shares of equity at price P_t^e and with dividends d_t^e, H_t is the value of human capital (to be discussed in section 2.3), e_t are (inelastically supplied) labor earnings, and S_t^d is the quantity of durable goods held as an asset. Durable goods depreciate at the rate δ and the stock of durables evolves according to

$$S_t^d = (1-\delta) S_{t-1}^d + d_t \qquad (3)$$

The first term on the right hand side of constraint (2), $q_t S_t^d$ is the income earned from the newly acquired stock of durables. In equilibrium with a representative agent $S_t^d = D_t$.

Now, to rewrite the budget constraint in wealth-return form. First we must define wealth:

$$W_t \equiv P_t^d S_{t-1}^d (1-\delta) + (P_t^e + d_t^e) S_{t-1}^e + H_t + e_t. \qquad (4)$$

In other words, wealth at the start of date-t is the sum of depreciated durables, equities including dividends, and human capital including current labor income. The budget

constraint becomes

$$(P_t^d - q_t)S_t^d + P_t^e S_t^e + H_t \leq W_t - C_t - q_t D_t. \tag{5}$$

Multiplying both sides by W_{t+1} and rearranging yields:

$$W_{t+1} = \frac{P_{t+1}^d S_t^d (1-\delta) + S_t^e (P_{t+1}^e + d_{t+1}^e) + H_{t+1} + e_{t+1}}{(P_t^d - q_t)S_t^d + P_t^e S_t^e + H_t}(W_t - C_t - q_t D_t) \tag{6}$$

where the first term on the right hand side is the return on wealth from date-t to date-$t+1$, $R_{w,t+1}$. We can decompose the return on wealth into contributions from equities, durables, and human capital:

$$R_{w,t+1} = \omega_t^e R_{t+1}^e + \omega_t^d R_{t+1}^d + \omega_t^h R_{t+1}^h \tag{7}$$

where the returns and their respective weights are defined as follows:

$$\omega_t^e \equiv \frac{S_{t+1}^e P_t^e}{S_{t+1}^e P_t^e + H_t + (P_t^d - q_t)S_t^d} \tag{8}$$

$$R_{t+1}^e = \frac{P_{t+1}^e + d_{t+1}^e}{P_t^e} \tag{9}$$

$$\omega_t^h \equiv \frac{H_t}{S_{t+1} P_t^e + H_t + (P_t^d - q_t)S_t^d} \tag{10}$$

$$R_{t+1}^h \equiv \frac{H_{t+1} + e_{t+1}}{H_t} \tag{11}$$

$$\omega_t^d \equiv \frac{P_t D_t}{S_{t+1} P_t^e + H_t + (P_t^d - q_t)S_t^d} \tag{12}$$

$$R_{t+1}^d \equiv \frac{P_{t+1}^d (1-\delta)}{P_t^d - q_t} \tag{13}$$

We can now write the consumer's problem as a dynamic program with the following value function:

$$V(W_t, I_t) = \max_{C_t, D_t, \boldsymbol{\omega_t}} \left\{ (1-\beta)\left[(C_t^\alpha + a D_t^\alpha)^{\frac{1}{\alpha}} \right]^{\frac{1-\gamma}{\theta}} + \beta (E_t V_{t+1}^{1-\gamma})^{\frac{1}{\theta}} \right\}^{\frac{\theta}{1-\gamma}} \tag{14}$$

where $\boldsymbol{\omega_t}$ is the vector of returns on equities, durables, and human capital which must sum to one and $\theta = \frac{1-\gamma}{1-\frac{1}{\psi}}$. Following Epstein & Zin (1991), the intertemporal marginal rate

of substitution (IMRS) can be written exclusively in terms of observable variables as:

$$M_{t,t+1} = \beta^{\theta}(\frac{A_{t+1}}{A_t})^{\theta(1-\alpha-\frac{1}{\psi})}(\frac{C_{t+1}}{C_t})^{\theta(\alpha-1)}R_{w,t+1}^{-(1-\theta)} \tag{15}$$

where $A_t \equiv (C_t^{\alpha} + aD_t^{\alpha})^{\frac{1}{\alpha}}$.

2.1 Some Special Cases

When $\theta = 1$ (i.e., $\gamma = \frac{1}{\psi}$), the model collapses to the standard CRRA case of expected utility, but now with two goods. The IMRS is:

$$M_{t,t+1} = \beta(\frac{A_{t+1}}{A_t})^{1-\alpha-\frac{1}{\psi}}(\frac{C_{t+1}}{C_t})^{\alpha-1} \tag{16}$$

which coincides with the IMRS in Ogaki & Reinhart (1998). In addition, if we set $a = 0$, the IMRS reduces further to the standard one good CRRA IMRS:

$$M_{t,t+1} = \beta(\frac{C_{t+1}}{C_t})^{-\frac{1}{\psi}}. \tag{17}$$

Finally, if we allow $\gamma \neq \frac{1}{\psi}$ and maintain $a = 0$, we get the Epstein & Zin (1991) IMRS:

$$M_{t+1,t} = \beta^{\theta}(\frac{C_{t+1}}{C_t})^{-\frac{\theta}{\psi}}R_{w,t+1}^{\theta-1}. \tag{18}$$

2.2 Pricing Durable Goods

Our timing convention for durable goods is unconventional, at least from an asset pricing perspective. Consequently, we will now show that our definition of R_{t+1}^d in (13) is consistent with standard practice for valuing streams of cash flows. While it is usually more convenient to think of the consumer's problem as the dynamic program in (14) now it is easier to think of it as a Lagrangian with a recursive objective function, U_t. The IMRS that we derive in this context ($\frac{\partial U_t}{C_{t+1}}/\frac{\partial U_t}{C_t}$) corresponds to (15) after using the homogeneity properties of the value function as in Epstein & Zin (1991) (see appendix for details). If we let λ_t be the multiplier on the date-t price-share budget constraint (2) the first order conditions for equity and durable holdings are:

$$\lambda_t P_t^e = E_t[\lambda_{t+1}(P_{t+1}^e + d_{t+1}^e)] \tag{19}$$

$$\lambda_t(P_t^d - q_t) = E_t[\lambda_{t+1}P_{t+1}^d(1-\delta)]. \tag{20}$$

Noting that $M_{t+1,t} = \lambda_{t+1}/\lambda_t$ we can rewrite these first order constraints as

$$E_t\left[M_{t+1,t}\left(\frac{P^e_{t+1} + d^e_{t+1}}{P^e_t}\right)\right] = 1 \tag{21}$$

$$E_t\left[M_{t+1,t}\left(\frac{P^d_{t+1}(1-\delta)}{P^d_t - q_t}\right)\right] = 1. \tag{22}$$

Equation (21) is standard and (22) matches our definition of the return to owning (not using) durable goods in (13).

2.3 A Human Capital Model

In this section we propose a simple human capital model. We then proceed to discuss various macroeconomic restrictions such a model should satisfy.

For simplicity we assume that human capital, H_t, is proportional to labor earnings. That is

$$H_t = \phi e_t.$$

In this case it is simple to show that the return to human capital is

$$R^H_{t+1} = \frac{\phi e_{t+1} + e_{t+1}}{\phi e_t} = \frac{(\phi+1)}{\phi} g_{e,t+1}$$

where $g_{e,t+1}$ is the growth rate of labor earnings. A more sophisticated model should allow the human capital to earnings ratio to be state dependent and thus $\phi_t = \phi_0 + \phi_1'\omega_t$ for some mean zero stationary predictive variables ω_t. In our empirical section we try several candidates for ω_t. In that case the return to human capital becomes $R^H_{t+1} = \frac{(\phi_{t+1}+1)}{\phi_t} g_{e,t+1}$.

2.4 Macroeconomic Restrictions

We follow Ogaki & Reinhart (1998) and exploit the intratemporal relationship between C and D to pin down the elasticity of substitution between them. First we know that the cum dividend purchase price of durables is just the expected discounted present value of the rental income:

$$P^d_t = E_t\left[\sum_{j=0}^{\infty}\left(\Pi^j_{i=0} M_{t+i,t+i-1}\right)(1-\delta)^j q_{t+j}\right]. \tag{23}$$

We also know from the intratemporal first order conditions that

$$q_t = a\left(\frac{C_t}{D_t}\right)^{1/\epsilon}. \tag{24}$$

Substituting for q in (23) and simplifying produces the recursive analog of Eq (9) from Ogaki & Reinhart (1998):

$$P_t^d = E_t \left[\sum_{j=0}^{\infty} \left(\frac{A_{t+j}}{A_t} \right)^{\theta(1/\epsilon - 1/\psi)} \left(\frac{C_{t+j}}{C_t} \right)^{\theta(-1/\epsilon)} \left(\Pi_{i=1}^{j} R_{w,t+i+}^{\theta-1} \right) (1-\delta)^j \left(\frac{C_{t+j}}{D_{t+j}} \right)^{1/\epsilon} \right]. \quad (25)$$

Following Ogaki & Reinhart (1998), we can multiply both sides of the previous equation by $(d_t/C_t)^{1/\epsilon}$ and take advantage of the stationarity of the terms on the right hand side to estimate ϵ as the cointegrating coefficient for $\log(P_t^d)$ and $\log(C_t/d_t)$. We can estimate $\hat{\epsilon}$ first, and then use our point estimate while estimating the other parameters of the model. Since estimators for cointegration coefficients are super consistent, we do not have to correct for the sampling error of $\hat{\epsilon}$ in the second stage.

Finally the share parameter a that appears in the CES felicity function can also be estimated using some additional moments relating Tobin's q and its market measure Q to the relative prices of durables and non-durables. However, the data on Tobin's q is problematic for housing and we chose to calibrate a to 0.2 as implied by measures of the share of housing services of total consumption from NIPA.

3 Annual Data

We use annual data from 1929 through 2002. The flow data is from the Bureau of Economic Analysis National Income and Product Accounts and the stock data is from the BEA's Fixed Asset files. Because these data are chain weighted, we have to be careful when combining real series. Following Whelan (2002) and Landefeld, Moulton, & Vojtech (2003) we re-chain aggregate the disaggregated series we use to create the series we use. In other words, when aggregating two chained series, we use the chained levels and the implicit price deflators to create new chain weighted series for the quantities and the price level.

Our measure of the population is derived from the aggregate and per capita measures of GDP. Our measure of the stock of durable goods (D) is residential structures from the Fixed Asset accounts. Our measure of C is a combination of non-durables and services less expenditures on housing services.[1] Our measure of earnings is the sum of nominal employee compensation and two thirds of proprietors income (with inventory valuation and capital consumption adjustments) deflated by the price index we computed for our

[1]We compute this last series in two steps. First, we extract housing services from the consumption services series by re-aggregating services and the negative of housing services. We then aggregate this series with non-durable consumption.

measure of non-durable consumption.

We use the 90-day treasury bill return as a short interest rate. For the return on equity, we use the NYSE/AMEX/NASDAQ return along with the corresponding market capitalization series. The previous series are from CRSP. We use data from the Federal Reserve's Flow of Funds accounts to measure the value of non-financial corporate debt and we use a corresponding return series on long-term corporate bond total returns from SBBI. Unfortunately, the data on corporate debt only goes back as far as 1945, so we construct synthetic values for 1929-1944 by computing the average debt-equity ratio from 1945-1954 and multiplying that by the market value of equity for the earlier period.[2]

3.1 Estimation Results

Before presenting the asset pricing results we first use the cointegration relationship motivated by the intratemporal equation (24) to estimate ϵ. We use dynamic least squares techniques as detailed in Stock & Watson (1993). The parameter ϵ is estimated to be 0.4 via the slope coefficient from regressing log consumption minus log of durables onto the relative price of durables to consumption, and one lead and lag of this log price.[3] Table 2 presents the estimate for ϵ, its standard errors, as well as the overall fit the regression. The estimate for ϵ is quite stable with respect to other time periods as indicated by the rest of the rows in Table 2. Figure 1 plots the two cointegrated series. It is apparent that they both are trending at slightly differently slopes which is consistent with the smaller than one estimate for ϵ. The standard errors indicate the estimate are significantly different from zero and one – indicating the elasticity is significantly different than Cobb-Douglas and Leontief preferences. The reason the estimate for ϵ is about 0.4, while Ogaki and Reinhart's estimate is around 1 is due to the fact that our consumption measure excludes housing services while the measure for consumer durable goods is residential structures. Using our data, and Ogaki and Reinhart's definitions of C and d we estimate ϵ to be one.

3.2 Asset Pricing

Given the calibrated parameters $\{\delta, a\}$ and the estimated parameter ϵ, we estimate the rest of the structural parameters $\Psi = \{\beta, \gamma, \psi, \phi_0, \phi_1\}$, using moment condition

$$E[(M_{t,t+1}(\Psi)R_{i,t+1} - 1) \times Z_{i,t}] = 0$$

[2]something about how this lines up with the 1975-1990 period as well - 1955-1975 and 1990-2002 are lower

[3]This choice is motivated by the Akaike criterion. Our results are broadly robust to the inclusion of longer leads and lags.

where M is the pricing kernel defined in equation (15), Z are lagged instruments, and $R_i = \{R_s, R_f, R_h, R_b, R_d\}$ and the entries respectively denote the Value Weighted Return on CRSP, the risk free rate, and the return to human capital defined in equation (11). We use different specifications with different subsets of returns and instruments. In all specification we include the return to human capital. Recall that the return to human capital, R_h, is already included in M via the return on wealth. It is however, important that the constructed pricing kernel prices R_h itself and thus it is also one of the returns to be priced.

3.2.1 Constant Human-Capital Earnings Ratio, $\phi_1 = 0$

We start out by setting a constant price of human capital (H) to labor earnings e ratio (that is we set $\phi_1 = 0$). We use GMM to estimate the parameters of interest. In applying GMM we utilize the first stage estimates with an Identity matrix. As is well known these first stage estimates are often more robust. We experimented with two-stage estimators as well as the continuously updated GMM estimator as described in Hansen, Heaton, & Yaron (1996). In many cases these estimators tend to concentrate on the moment condition corresponding to the risk-free rate which can lead to implausible estimates. For consistency and comparability across various return and instrument sets we resorted to the robust first stage estimates. The results are given in Table 3. The first column describes the set of returns being priced (other than the return to human capital), and the corresponding instruments used in the estimation. The first set of columns provide the point estimates for the structural parameters. For the most part, risk aversion is between 2-6 with large standard errors. The IES is estimated to be larger than one in all cases and around 1.2. The standard errors are somewhat large and just about include zero. Figure 2 plots the value of the GMM criterion against ψ holding the other parameters at their minimizing values. ψ (the IES) against the J-test based on estimating the rest of the parameters. The figure clearly demonstrates that $\psi > 1$ is the global maximum.

The human-capital to earnings ratio is estimated to be around 26. Note that this valuation ratio is larger than the average price-dividend ratio for the Value Weighted return on NYSE. This is due to the fact the human capital offers a less volatile stream of cashflows (as the volatility of earnings growth is lower than that of dividend growth). Figure 3 displays the time series of realized returns. It clear that the return to human capital is substantially less volatile than the volatility of the market return and displays a more pronounced persistence and business cycle fluctuations. In fact the return to human capital seem to be more in line with that of housing. Further, the return to human capital seems to be particularly large after the later 1970s which corresponds with the well

documented rise in the return to schooling in the 1980s. The average return to human capital is estimated to be 6.5%. Worth noting is the fact the Sharpe ratio on this return is larger than any other Sharpe ratio. This Sharpe ratio greatly affects the Sharpe ratio of the return to overall wealth, as human capital's weight in the return to total wealth is estimated to be about 88%. Figure 4 displays the estimated time series for the wealth shares. It is pretty clear that human capital dominates the rest of the financial returns. The wealth share of human capital is quite stable over time except in the late 1990s where it seem to have decline at the expense of a rise in the wealth share of the market return.

Intuition may suggest that this ratio is too large due to the fact that the labor income share is about 66%. This is a misconception and this ratio should be this large. First, the relevant share to compare is based on national income and not GDP as the latter includes components such as indirect business taxes and consumption of fixed capital not reflecting the endowment economy we describe in the model. Labor income to national income share is about 73% on average. The remaining difference (between 88% to 73%) is due to the fact that labor income is less risky than capital income and thus one would expect that in terms of wealth share the portfolio shares for human capital would be 'biased' upward. In other words, human capital is less risky and thus its market valuation is higher, which is what our estimates imply. This implies the rate of discount on human capital is lower than comparable capital and that leads human capital to have a larger share of total wealth of the private sector.

3.2.2 Time Varying Human-Capital Earnings Ratio

In Table 5 we present the results for the case in which ϕ is time varying. The various rows in the table correspond to different ω_t used in $\phi_0 + \phi_1 \, \omega_t$. In the first five rows of this table we consider a single variable for ω_t. The structural parameters seem to accord well with those estimated for the case of constant human-capital earnings ratio depicted in Table 3. In particular, again the IES is larger than one while the unconditional mean of the human-capital earnings ratio is about 26. In all cases the over-identifying restrictions of the model are not rejected statistically. The intriguing aspect of this table is the fact that none of the candidate variables for generating time variation in the human-capital earnings ratio (consumption growth, earnings growth, and the stock,bond and risk free returns) seem to be statistically significant (see the standard errors under the column (ϕ_1). As seen by the last several rows of this table, the lack of evidence for time-variation in the human capital valuation ratio prevails even when the vector applied to ϕ_1 is extended to two state variables.

It is worth noting that with $\phi_1 \neq 0$ the general structure of return and wealth weights

remain similar to that in Table 3. However, the Sharpe Ratio of the return to human capital is somewhat increased and consequently also the role of the human capital in the wealth return (as its share rises to about 89%).

3.3 Human Capital and the IES

Bansal & Yaron (2004) demonstrate that an IES greater than one is critical to explain certain asset pricing properties observed in the data. The literature has mixed evidence on this crucial parameter. The finding thus far show that human capital is greatly affects the estimated IES. To ascertain our finding regarding the IES, Table 6 shows that standard estimation of the IES parameter without accounting explicitly for human capital tend to generate a substantial downward bias in the estimates. The table provides the IES estimates when we constrain the return to wealth to be solely a function of the market return – that is we set the human capital share to be zero. This is the common practice in addressing the CAPM and its various variants and in particular corresponds to the estimation conducted in Epstein & Zin (1991). Our results clearly show that the IES is substantially below one, regardless of the set of instruments used. Although not shown this phenomena is robust to alternative values of the parameter a. This result also holds when we use the more standard consumption measure of non-durable goods and services (including housing services) as the only argument in our utility function.

3.4 Long Run Risks as Predictive Variables

To be added

4 Quarterly Data

In this section we conduct the exercises of the previous section but with a different data set. Now, instead of annual data going back to the Great Depression era, we use quarterly data from the last three decades that makes use of information in the Federal Reserve's Flow of Funds accounts as well as the data set constructed by Davis & Heathcote (2006). This allows us to include residential land in our measure of home value where our annual data only incorporated the value of residential structures.

To be completed.

5 Conclusion

This paper presents a consumption-based model of asset prices. We assume preferences of the Epstein & Zin (1989) class. Estimation of this class of models requires the specification of the return on wealth. Standard practice in this literature has been to use the return on equities as a proxy for the return on wealth. Here, we construct a more comprehensive measure of wealth that includes, among other things, a measure of the return to human capital. We estimate the value of human capital simultaneously with the preference parameters. Our results so far indicate that the inclusion of human capital in the wealth return is important for the estimation of the intertemporal elasticity of substitution. In particular, without human capital, the estimates of the IES are typically well below unity and statistically insignificant. When human capital is included, the point estimates of the IES are greater than one.

To be completed.

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Table 1 *Data: Summary Statistics*

	g_c	g_d	g_e	R_s	R_b
mean:	3.15	2.52	3.48	8.35	2.86
std. dev.:	2.42	1.37	5.05	19.70	9.90
AR(1):	0.39	0.87	0.52	-0.07	0.20
Sharpe ratio:	–	–	–	0.37	0.24

The entries correspond to the mean, standard deviation, and first autocorrelation of the following variables: consumption growth of non-durables and services minus the services of housing g_c, growth rate of housing durables g_d, labor earnings growth g_e, the Value Weighted return on NYSE,the return to debt (based on Ibbotson corporate debt return), and the return on housing durables assuming $\epsilon = .4$, $a = .2$, and $\delta = .015$. The sample is 1931–2002. See data appendix for more detail description of the data sources and construction.

Table 2 *Cointegration Tests for Consumption and Durables*

Sample	K	ϵ	adj. R^2	DF-Test
1931-2001	1	0.40	0.80	.04
		(0.09)	–	

The table provides the point estimates for the cointegration parameter ϵ based on the following projection:

$$\log(C_t/D_t) = a_0 + \epsilon \log(P_{d,t}) + a_1 DM_{depression} + \sum_{j=1}^{K} [a_{-j} \Delta \log(P_{d,t-j}) + \sum_{j=1}^{K} a_j \Delta \log(P_{d,t+j})] + u_t$$

where C_t is consumption of non-durables and services excluding housing services, D_t denotes the stock of housing durables, and $P_{d,t}$ is the relative price of housing and consumption, $DM_{depression}$ denotes a time dummy for the great depression period and the a_j's are the dynamic lead-lag coefficients following Stock & Watson (1993). The sample is 1931-2001.

Table 3 *Estimation Results: Constant ϕ*

Instruments	β	γ	ψ	ϕ_0	J	$E(R_h)$	SR_h	$E(R_w)$	SR_w	SR_s	SR_b	w_s	w_b	w_h
R1, I1	0.968	5.584	1.258	20.915	0.764	0.063	0.770	0.057	0.758	0.075	0.084	0.038	0.072	0.869
	(0.011)	(8.363)	(0.614)	(4.913)	0.382									
R1, I2	0.969	5.544	1.257	21.193	0.623	0.062	0.763	0.057	0.751	0.075	0.084	0.037	0.071	0.870
	(0.011)	(8.242)	(0.606)	(5.030)	0.430									
R1, I3	0.969	5.259	1.236	21.033	0.516	0.063	0.767	0.057	0.755	0.075	0.084	0.038	0.072	0.869
	(0.010)	(5.043)	(0.232)	(6.513)	0.481									
R2, I1	0.968	3.516	1.128	20.014	2.471	0.065	0.796	0.059	0.782	0.075	0.084	0.039	0.075	0.864
	(0.011)	(7.093)	(0.419)	(4.973)	0.116									

The table provides parameter estimates of the model in equation (15) for the case in which the price-human capital ratio, ϕ, is constant. The depreciation parameter, $\delta = 0.015$, the share parameter $a = 0.2$ are calibrated (see discussion in text), and $\epsilon = 0.4$ is estimated in Table 2. R1=$[R_s, R_s, R_d, R_b]$, R2=$[R_s, R_s, R_d, R_s]$, R3=$[R_s, R_s, R_d, R_s]$, I1=$[g_{c,lag}, R_{s,lag}, 1, 1]$, I2=$[R_{s,lag}, 1, 1, 1]$, I3=$[R_{s,lag}, 1, 1, g_{c,lag}]$;

Table 4 *Asset return moments*

	Mean	Std. dev.	R_s	R_d	R_b	R_f	R_h
R_s	8.3465	19.6994	1.0000	0.1818	0.2279	0.0373	-0.0539
R_d	1.3503	3.5109	0.1818	1.0000	-0.0203	-0.0831	-0.0849
R_b	2.8649	9.8967	0.2279	-0.0203	1.0000	0.5354	-0.2180
R_f	0.8558	4.4231	0.0373	-0.0831	0.5354	1.0000	-0.4317
R_h	7.1601	5.2381	-0.0539	-0.0849	-0.2180	-0.4317	1.0000

The table provides the means, standard deviations, and correlations of the returns on stocks, durables (housing), debt, the risk-free asset, and human capital. The first four are from the data and the last is determined during estimation. Model: constant ϕ, R1I1.

Table 5 *Estimation Results: Time Varying ϕ*

Instruments	β	γ	ψ	ϕ_0	ϕ_1	ϕ_2	J	$E(R_h)$	SR_h	$E(R_w)$	SR_w	SR_s	SR_b	w_s	w_b	w_h
R1,I1,HZ1	0.969	5.591	1.262	21.226	-0.002	—	0.260	0.062	0.762	0.057	0.750	0.075	0.084	0.037	0.071	0.870
	(0.020)	(18.731)	(1.272)	(7.149)	(20.710)	—	0.610									
R1,I1,HZ2	0.967	2.835	1.100	18.457	3.998	—	2.356	0.070	0.813	0.063	0.797	0.075	0.084	0.042	0.080	0.854
	(0.013)	(9.384)	(0.568)	(6.292)	(4.907)	—	0.125									
R1,I1,HZ3	0.970	9.424	2.228	30.012	1.738	—	0.011	0.048	0.613	0.046	0.607	0.075	0.084	0.027	0.052	0.905
	(0.013)	(11.889)	(5.615)	(16.371)	(4.103)	—	0.915									
R1,I1,HZ4	0.969	5.530	1.260	21.232	-0.003	—	0.798	0.062	0.761	0.057	0.750	0.075	0.084	0.037	0.071	0.870
	(0.011)	(7.320)	(0.542)	(5.244)	(0.757)	—	0.372									
R1,I1,HZ5	0.969	5.656	1.268	21.254	-0.006	—	0.534	0.062	0.761	0.057	0.750	0.075	0.084	0.037	0.071	0.871
	(0.011)	(8.261)	(0.610)	(5.083)	(8.186)	—	0.465									
R1,I1,HZ6	0.969	5.470	1.252	21.165	-0.003	—	1.496	0.062	0.763	0.057	0.752	0.075	0.084	0.037	0.071	0.870
	(0.012)	(11.567)	(0.932)	(5.317)	(69.092)	—	0.221									
R1,I1,HZ7																
R1,I1,HZ8	0.970	9.487	2.275	30.214	0.043	1.790	0.011	0.048	0.611	0.045	0.604	0.075	0.084	0.027	0.052	0.905
	(0.010)	(8.247)	(5.637)	(24.800)	(21.021)	(6.035)	0.916									
R1,I1,HZ9	0.968	5.654	1.270	21.289	-0.003	0.027	0.344	0.062	0.760	0.057	0.749	0.075	0.084	0.037	0.071	0.871
	(0.019)	(16.583)	(1.131)	(7.777)	(21.009)	(1.135)	0.557									
R1,I1,HZ10	0.968	5.673	1.271	21.285	0.002	-0.078	0.255	0.062	0.760	0.057	0.749	0.075	0.084	0.037	0.071	0.871
	(0.019)	(17.727)	(1.190)	(7.418)	(21.986)	(9.401)	0.614									
R1,I1,HZ11	0.972	0.755	0.987	22.072	7.545	0.352	7.5e10	0.061	0.725	0.056	0.716	0.075	0.084	0.036	0.069	0.875
	(0.022)	(7.767)	(0.396)	(16.573)	(34.949)	(17.161)	0.000									
R1,I1,HZ12	0.963	3.738	1.187	19.858	-0.003	—	1.149	0.066	0.801	0.059	0.786	0.075	0.084	0.039	0.075	0.863
	(0.014)	(9.117)	(0.763)	(3.805)	(3.477)	—	0.284									
R1, I1	0.968	5.584	1.258	20.915	—	—	0.764	0.063	0.770	0.057	0.758	0.075	0.084	0.038	0.072	0.869
	(0.011)	(8.363)	(0.614)	(4.913)	—	—	0.382									

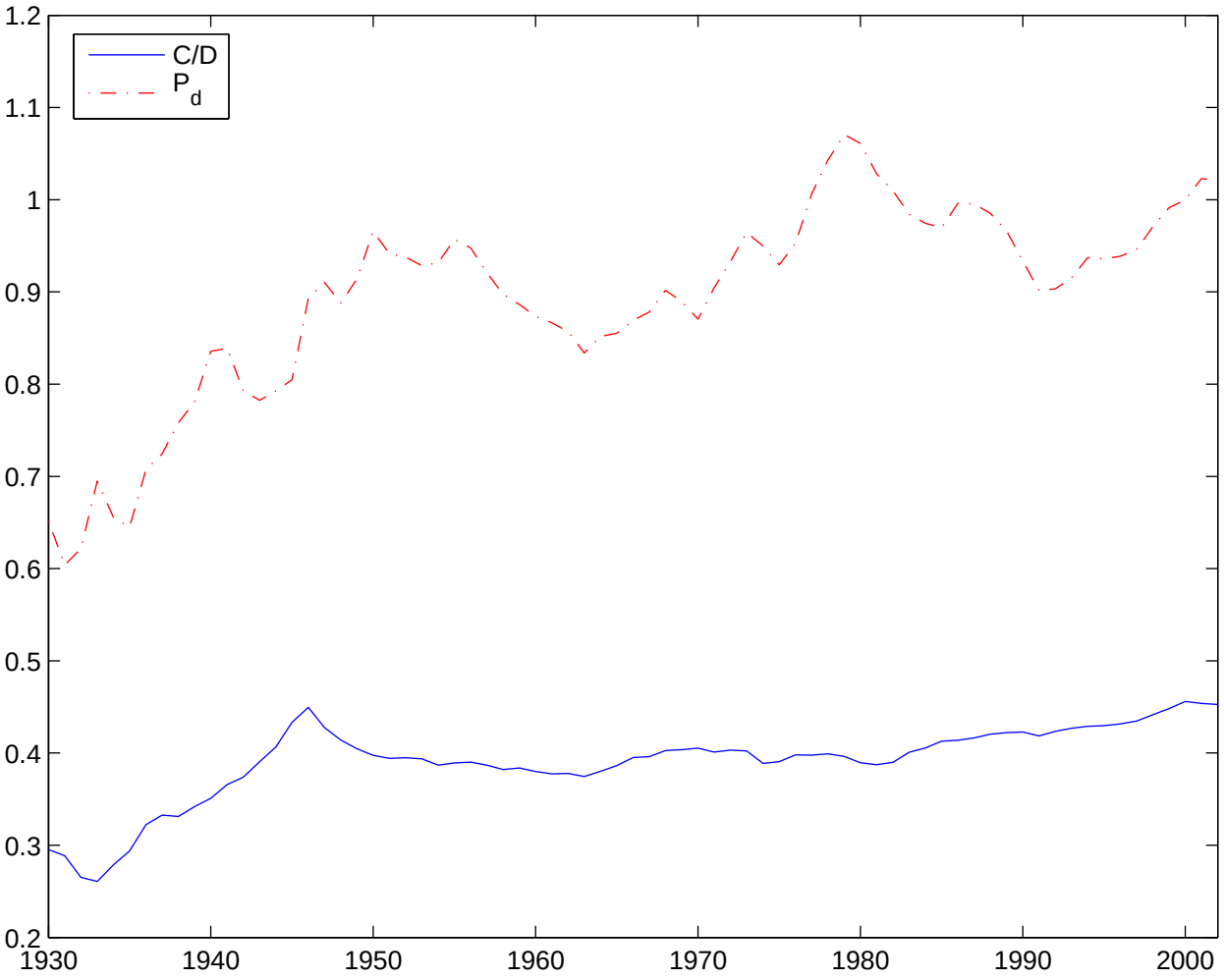
The table provides parameter estimates of the model in equation (15) for the case in which the price-human capital ratio, ϕ, is constant. The depreciation parameter, $\delta = 0.015$, the share parameter $a = 0.2$ are calibrated (see discussion in text), and $\epsilon = 0.4$ is estimated in Table 2. R1=$[R_s, R_s, R_d, R_b]$, I1=$[R_{s,lag}, 1, 1, 1]$, I2=$[R_{s,lag}, 1, 1, g_{c,lag}]$, I3=$[g_{c,lag}, R_{s,lag}, 1, 1]$; HZ denotes the instruments for the time-varying component for ϕ. $HZ(i) = \{[g_c], [g_e], [R_s], [R_b], [R_f], [g_{c,long}], [p-d]\}$ for $i = 1, 2, ..., 7$ respectively, and $HZ(i) = \{[g_c, R_s], [g_c, R_b], [g_c, R_f], [g_c, g_e]\}$, $i = 8, 9, 10, 11,$, respectively, and $i = 12$ is the dummy variable.

Table 6 *Estimation Results (No Human Capital)*

Instruments	β	γ	ψ	J
R1, I1	0.999	0.000	0.439	0.296
	(0.068)	(2.430)	(0.640)	0.587
R1, I2	0.988	0.403	0.556	0.314
	(0.063)	(2.173)	(0.959)	0.575
R1, I3	0.977	0.787	0.769	0.388
	(0.045)	(1.550)	(1.342)	0.534
R2, I1	0.968	1.211	1.344	1.772
	(0.034)	(1.420)	(3.066)	0.183

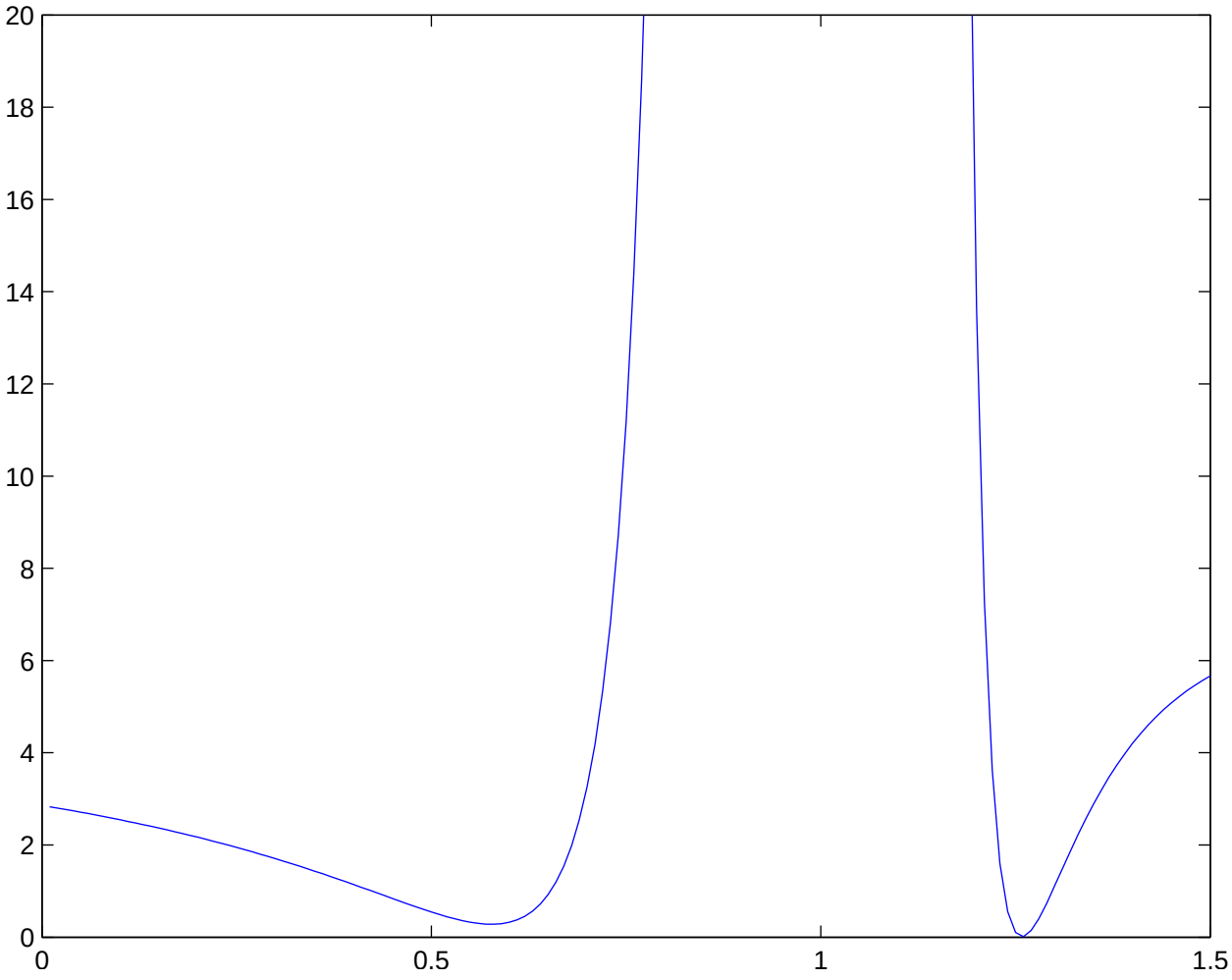
The table provides parameter estimates of the model in equation (15) for the case in which the wealth share of human capital is set to zero. The depreciation parameter, $\delta = 0.015$, the share parameter $a = 0.2$ are calibrated (see discussion in text), and $\epsilon = 0.4$ is estimated in Table 2. R1=$[R_s, R_s, R_d, R_b]$, I1=$[R_{s,lag}, 1, 1, 1]$, I2=$[R_{s,lag}, 1, 1, g_{c,lag}]$, I3=$[g_{c,lag}, R_{s,lag}, 1, 1]$;

Figure 1 *Non-durables-to-Durables ratio and relative price*



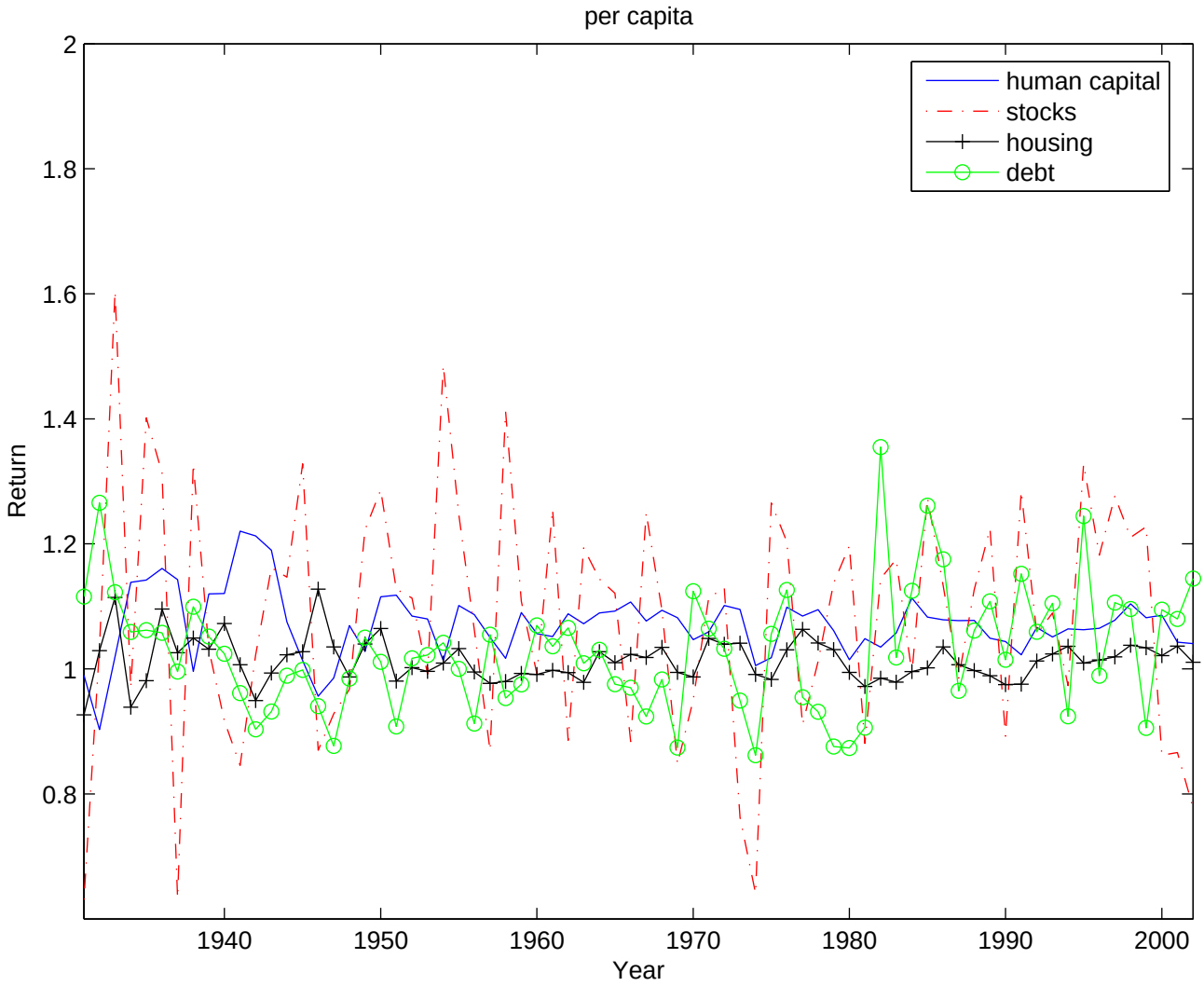
Time series plots of the ratio of C/D, the ratio of non-durables and services (less housing services) consumption to durable housing and P_d, the relative price of durable housing.

Figure 2 *IES and the GMM Criterion Function*



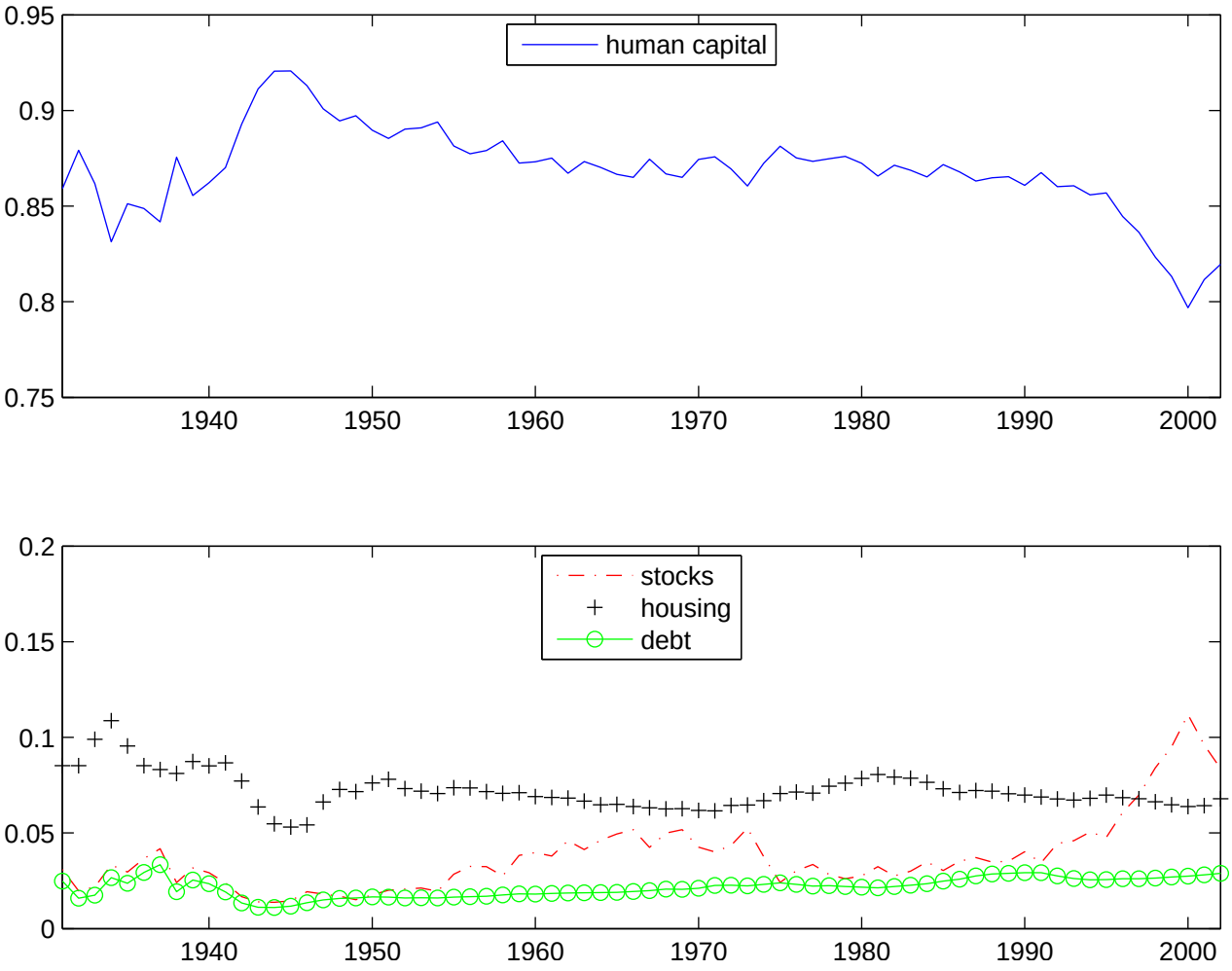
This plot depicts the GMM criterion function for alternative IES (ψ) values (R1, I1)

Figure 3 *Asset returns*



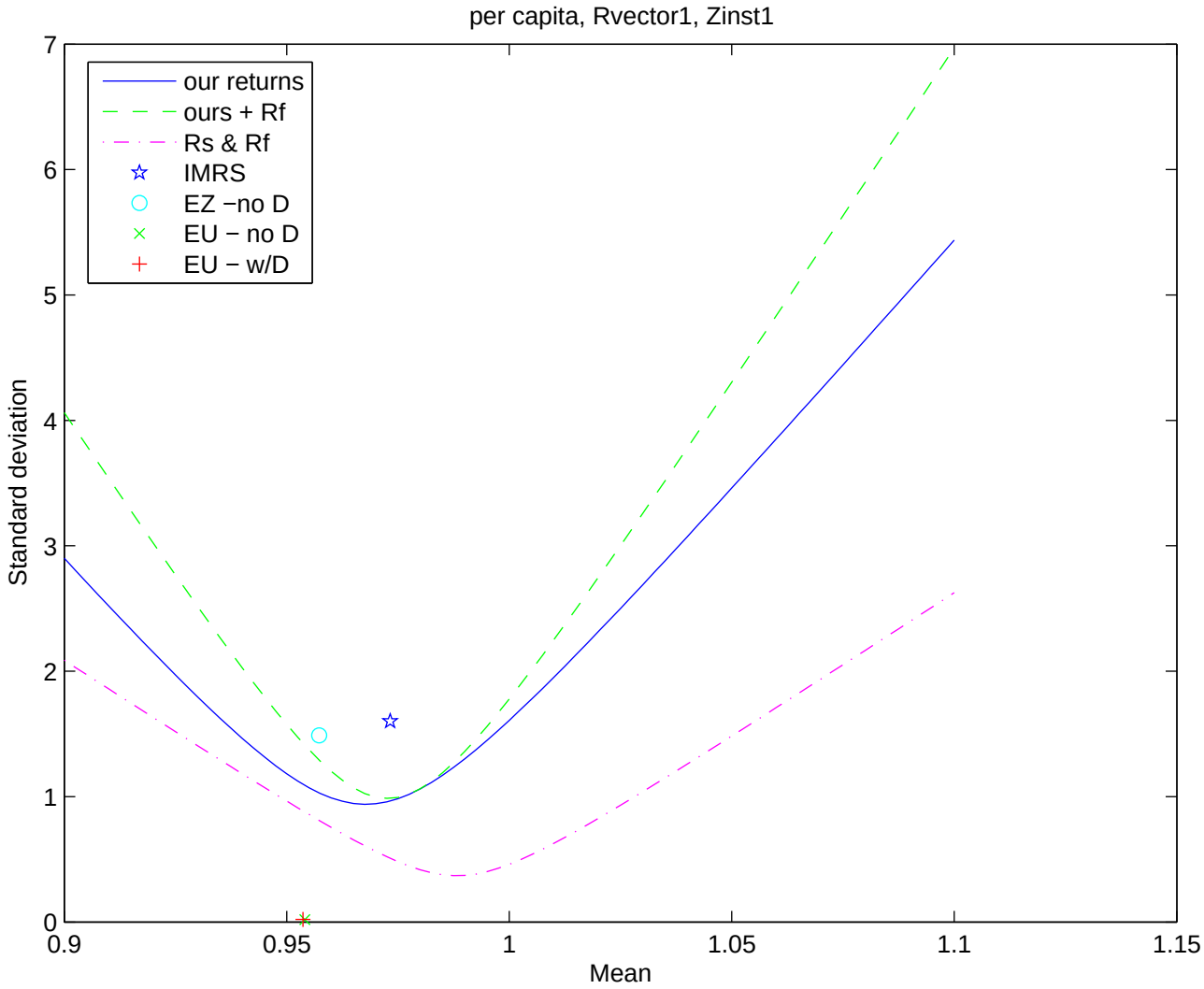
Time series plots of the returns to human capital (estimated), equities, housing (estimated), and debt.[R1, I1]

Figure 4 *Wealth shares*



Time series plots of the share of wealth held in human capital, equities, housing, and debt.[R1, I1]

Figure 5 *Hansen-Jagannathan bounds, constant ϕ*



Hansen-Jagannathan bounds.[R1, I1]