Housing, Home Production, and the Equity and Value Premium Puzzles

Morris A. Davis[a] and Robert F. Martin[b,*]

[a] Department of Real Estate and Urban Land Economics, University of Wisconsin-Madison

[b] Federal Reserve Board

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Abstract

We ask if a standard representative agent model with a home-production sector can resolve the equity premium or value premium puzzles. In the model, agents value market (numeraire) consumption and a home consumption good that is produced from the stock of housing, home labor, and a labor-augmenting technology shock. We construct the unobserved quantity of the home consumption good by combining observed data on numeraire consumption, hours worked in the marketplace, and rents paid on housing with restrictions of the model. We test the first-order conditions of the model using GMM. The model is rejected by the data; it cannot explain either the historical equity premium or the value premium.

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1 Introduction

A number of recent papers have documented that accounting for housing services explicitly in utility may help our understanding of the premium paid to stocks over Treasury bills, the "equity-premium puzzle," and the premium paid to value stocks over growth stocks, the "value premium puzzle." In recent papers by Lustig and Van Nieuwerburgh (2005), Piazzesi et. al. (2007), and Flavin and Nakagawa (2007), households are assumed to receive utility each period from an aggregate of market consumption and from housing services which are proportional to the stock of housing.[1] Compared to a more standard model where the marginal utility of consumption is determined exclusively by the quantity of market consumption (hereafter called "numeraire" consumption), in this relatively new literature both the quantity of numeraire consumption and the quantity of housing services affect households' marginal utility of numeraire consumption. The papers mentioned above show that once it is assumed that both numeraire consumption and housing services enter the utility function of households, it is possible to identify assumptions on the covariance of the stock of housing, numeraire consumption, and asset returns, and on the elasticity of substitution between numeraire consumption and housing services, to explain the equity premium and value premium puzzles.

The standard home-production model used by macroeconomists to study business-cycle fluctuations provides a benchmark framework to further study the contribution of housing services in accounting for the historical behavior of asset prices. In the typical home-production model, households derive utility over numeraire consumption, home consumption, and leisure, and home consumption is produced using home labor, home capital, and a labor-augmenting technology shock.[2] Viewed from the context of a home-production model, the papers mentioned in the previous paragraph have assumed that households do not value leisure and that home capital is the only input in production of the home-consumption good. As such, the theoretical approach in the earlier literature can be captured by a set of pa-

[1] Papers by Chu (2007) and Sousa (2007) also show that housing-related variables forecast the excess returns of stocks over Treasury bills and help account for differences in average returns in a cross-section of stock portfolios.

[2] See Greenwood et. al. (1995) for a review of the home production literature.

rameter restrictions on the more general home production model. In our paper, we ask if a fully unrestricted home-production model can resolve the equity premium or value premium puzzles.[3]

The analysis in the paper unfolds as follows. In section 2, we derive the full set of household first-order conditions from a neoclassical representative-agent model with a home-production sector. In section 3, we show that with two parameter restrictions the home-production model collapses to a model where the stock of housing directly enters utility, and where leisure is not valued, the "housing model" studied by Piazzesi et. al. (2007), hereafter called PST. According to our GMM test results, the housing model is rejected by the data: It can explain almost none of the historical equity premium or (tested separately) the value premium. In section 4, we relax one of these two parameter restrictions, allowing leisure to affect utility. We call this specification the "housing model with leisure." We show that the introduction of leisure in utility does not help resolve either the equity- or value- premium puzzles.

In section 5, we test the unrestricted home production model. We document how we combine observable data with two first-order conditions of the model to derive key unobserved variables: Time spent working at home, the level of home technology, and home consumption. We test the fully unrestricted home-production model and show that the over-identifying restrictions of the model are soundly rejected. The model is only capable of explaining about 33 percent of the historical quarterly equity premium in our sample and about 25 percent of the historical value premium in our sample. In addition, the parameter estimates we uncover in this exercise are qualitatively quite far from estimates used in macroeconomic models. Further, our estimates imply, counter-factually in both cases, that either very little time is spent working at home (equity premium) or most time not spent working in the market is spent working at home (value premium). We conclude that a frictionless representative agent model with a home-production sector can not match either the historical equity or value premium.

[3]Gomme et. al. (2006) ask if a standard home-production model can match fluctuations in economy-wide returns to capital. In that paper, they argue that representative agent models should not be expected to match specific financial returns; we do not address this criticism in the paper.

2 A Model of Home Production

The economy consists of a continuum of identical agents who receive per-period utility u_t from an aggregate of market (numeraire) consumption and home consumption, denoted $\hat{c}_t$, and leisure, denoted n_t. The per-period utility function is

$$u_t = \frac{\left(\hat{c}_t \; n_t^{\nu}\right)^{1-\sigma}}{1-\sigma} \; . \tag{1}$$

The consumption aggregate is a CES combination of numeraire consumption $c_{m,t}$ and home consumption $c_{h,t}$,

$$\hat{c}_t = \left[(1-\gamma)\, c_{m,t}^{\rho} + \gamma c_{h,t}^{\rho}\right]^{1/\rho} \quad \text{if} \;\; \rho \neq 0 \tag{2}$$

$$\hat{c}_t = c_{m,t}^{1-\gamma} \; c_{h,t}^{\gamma} \quad \text{if} \;\; \rho = 0 \; , \tag{3}$$

with $0 < \gamma < 1$ and $\rho < 1$.

Home consumption is produced with a Cobb-Douglas technology that combines home capital, $k_{h,t}$, time worked at home $l_{h,t}$, and labor-augmenting home technology, $z_{h,t}$, with capital share $\psi \in [0, 1]$, such that

$$c_{h,t} = k_{h,t}^{\psi} \left(z_{h,t} l_{h,t}\right)^{1-\psi} \; . \tag{4}$$

Leisure is defined as discretionary time, normalized to 1.0, less time spent working in the market and working at home,

$$n_t = 1 - l_{h,t} - l_{m,t} \; . \tag{5}$$

Each period, agents choose home work, market work, and leisure; rent home capital (at rental rate r_t); purchase numeraire consumption; and allocate their savings into one of $N+1$ assets: N financial assets, and a housing asset (with purchase price p_t) that is rented out in a central market. Agents receive labor income for their market work and receive capital income from financial assets and housing they own.

The budget constraint of agents is:

$$0 \geq \sum_{i=1}^{N} A_{i,t} R_{i,t} + \left(r_t + p_t\right) K_{h,t} + w_t \; l_{m,t} - c_{m,t} - r_t k_{h,t} - \sum_{i'=1}^{N} A_{i',t+1} - p_t K_{t+1,h} \; . \tag{6}$$

$R_{i,t}$ is the gross rate of return earned on financial asset i and $A_{i,t}R_{i,t}$ is the value of financial asset i inclusive of its period t return; $r_t K_{h,t}$ is the return earned on ownership of $K_{h,t}$ units of home capital and $p_t K_{h,t}$ is the period t value of that capital; $w_t l_{m,t}$ is labor income from market work; $c_{m,t}$ is numeraire consumption; $r_t k_{h,t}$ are current-period rental expenditures on home capital for use in period t; $A_{i',t+1}$ is the amount of financial asset i' purchased to carry forward into period $t+1$; and, $p_t K_{h,t+1}$ is the total cost of purchasing $K_{h,t+1}$ units of home capital to carry forward into $t+1$.

There are two features of the housing sector in this model worth mentioning. First, agents in our model pay no adjustment or moving costs if they change the amount of housing they own or rent. This is a standard assumption in macroeconomic studies of residential investment (see Davis and Heathcote 2005, for example). Second, rather than specify all households as owner-occupiers, we assume that households rent their home capital each period from a decentralized market. This renting-owning distinction is without loss of generality, it allows us to derive an explicit rental price r_t for housing, and the accounting is consistent with treatment of housing expenditure data in the National Income and Product Accounts (NIPA), data we use in estimation.[4]

Agents solve the following problem

$$\max_{\{c_{m,t},\ l_{m,t},\ l_{h,t},\ k_{h,t},\ A_{i',t+1},\ K_{h,t+1}\}} \sum_{s=0}^{\infty} \beta^s E_t \left[u_{t+s} \right] \ , \tag{7}$$

subject to the budget constraint (6) holding each period.

Denote the period t Lagrange multiplier on the budget constraint as λ_t. The optimal

[4]Obviously, in a representative agent framework, in equilibrium the amount of housing the agent rents each period, $k_{h,t}$, will equal the amount of housing the agent owns, $K_{h,t}$, and all rental expenditures paid each period, $r_t k_{h,t}$ will each all rental income collected, $r_t K_{h,t}$.

first-order conditions for households are as follows:

$$c_{m,t}: \quad \lambda_t \; c_{m,t} \;=\; \left(\hat{c}_t n_t^{\nu}\right)^{1-\sigma} \; \hat{c}_t^{-\rho} \; (1-\gamma) \; c_{m,t}^{\rho} \tag{8}$$

$$l_{m,t}: \quad \lambda_t \; w_t n_t \;=\; \left(\hat{c}_t n_t^{\nu}\right)^{1-\sigma} \; \nu \tag{9}$$

$$l_{h,t}: \quad \lambda_t \; w_t \; l_{h,t} \;=\; \left(\hat{c}_t n_t^{\nu}\right)^{1-\sigma} \; \hat{c}_t^{-\rho} \; \gamma \; (1-\psi) \; c_{h,t}^{\rho} \tag{10}$$

$$k_{h,t}: \quad \lambda_t \; r_t \; k_{h,t} \;=\; \left(\hat{c}_t n_t^{\nu}\right)^{1-\sigma} \; \hat{c}_t^{-\rho} \; \gamma \; \psi \; c_{h,t}^{\rho} \tag{11}$$

$$A_{i',t+1}, \; i' = 1, \ldots, N: \quad 1 \;=\; \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \; R_{i',t+1} \right] \tag{12}$$

$$K_{h,t+1}: \quad 1 \;=\; \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left(\frac{r_{t+1} + p_{t+1}}{p_t} \right) \right] . \tag{13}$$

Notice that equations (12) and (13) are equivalent, in the sense that all assets must pay the same risk-adjusted rate of return: The total return to owned housing is $\left(r_{t+1} + p_{t+1}\right)/p_t$.

Our main focus is to test if the model can explain the historical premium paid to a portfolio of stocks over 3-month Treasury Bills (the "equity premium") and the premium paid to a portfolio of small-cap value stocks over a portfolio of large-cap growth stocks (the "value premium.") We test the model three times. First, we study a "housing model", identical to that of PST, by setting $\nu = 0$ and $\psi = 1$ (implying inelastically supplied market labor), so home consumption is linearly proportional to the stock of home capital. This eliminates equations (9) and (10) from the above system. Second, we allow households to enjoy leisure, our "housing model with leisure," such that $\nu > 0$, thus re-introducing equation (9) as a first-order condition, but keeping ψ fixed at 1. Finally, we test the unrestricted home production model.

3 Housing Model: $\nu = 0$ and $\psi = 1$

We start by considering the model of PST, in which households receive utility from numeraire consumption and from the real quantity of housing. This is exactly the model of the previous section with the parameter restrictions $\nu = 0$ and $\psi = 1$. After manipulation, the first order conditions collapse to:

$$c_{m,t}: \quad \lambda_t = (1-\gamma)\ c_{m,t}^{\rho-1}\ \hat{c}_t^{1-\sigma-\rho} \tag{14}$$

$$k_{h,t}: \quad 0 = \frac{r_t k_{h,t}}{c_{m,t}} - \left(\frac{\gamma}{1-\gamma}\right)\left(\frac{k_{h,t}}{c_{m,t}}\right)^{\rho} \tag{15}$$

$$A_{i',t+1},\ i'=1,\ldots,N: \quad 0 = 1 - \beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\ R_{i',t+1}\right] \tag{16}$$

$$K_{h,t+1}: \quad 0 = 1 - \beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{r_{t+1}+p_{t+1}}{p_t}\right)\right]. \tag{17}$$

Define the ratio of rental expenditures on housing to numeraire consumption as $x_t = r_t k_{h,t}/c_{m,t}$. We assume that the observed value of x_t, call it x_t^o, is equal to the true value of x_t plus classical measurement error, i.e. $x_t^o = x_t + e_{x,t}$. Also define $e_{i',t+1}$ as β times the difference of the expected and realized value of the term in brackets in equation (16) and $e_{k,t+1}$ as β times the difference of the expected and realized value of the term in brackets in equation (17). Given this notation, and assuming we use equation (14) to substitute for λ_t, the first-order conditions of the model can be written as

$$e_{x,t} = x_t^o - \left(\frac{\gamma}{1-\gamma}\right)\left(\frac{k_{h,t}}{c_{m,t}}\right)^{\rho} \tag{18}$$

$$e_{i',t+1} = 1 - \beta\left(\frac{\lambda_{t+1}}{\lambda_t}\right) R_{i',t+1} \tag{19}$$

$$e_{k,t+1} = 1 - \beta\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\left(\frac{r_{t+1}+p_{t+1}}{p_t}\right). \tag{20}$$

We estimate the parameters of the model using GMM on the moment conditions implied by (18) and (19). We omit the first-order condition for the amount of housing to own from estimation, equation (20), because we are concerned that available estimates of the dividend yield to housing, r_{t+1}/p_t, may be systematically mismeasured (Lebow and Rudd 2003).

We estimate and test the model twice. First, we consider a portfolio of stocks and the 3-month Treasury bill as the two financial assets for equation (19), testing to see if the model can help resolve the equity premium puzzle. Second, and separately, we test if the model can help resolve the value-premium puzzle by considering portfolios of small-cap value stocks and large-cap growth stocks as the two financial assets for equation (19). We perform two separate tests to learn if the model enhances our understanding about either the equity-premium or value-premium puzzles, even if the model is incapable of simultaneously pricing all financial assets. In both tests, moment conditions based on equation (18) are included.

Data: The data we use in estimation are drawn from a number of sources. For nominal stock returns, we use the monthly data (aggregated to quarterly) on the "6 Portfolios Formed on Size and Book-to-Market" available on Professor Kenneth French's web site.[5] We construct the return on a portfolio of stocks for use in tests of the equity premium as an equal-weighted average of the returns of these six portfolios. Our data on returns of small-cap value stocks and large-cap growth stocks for use in tests of the value premium are also taken directly from this web site. For nominal returns on 3-month Treasury bills, we use the quarterly average of the historical data available on the Federal Reserve Board's web site.[6]

Define $p^c_{m,t}$ as the price index for numeraire consumption, with index value $p^c_{m,t} = 1$ in some arbitrary base year. We compute $x_t = \left(p^c_{m,t} r_t k_{h,t}\right) / \left(p^c_{m,t} c_{m,t}\right)$ using data from the National Income and Product Accounts (NIPA): The numerator is the sum of nominal expenditures on housing services (tenant rental payments and imputed rental payments of homeowners) and expenditures on household operation (utilities) and the denominator is equal to nominal total personal consumption expenditures less nominal expenditures on housing services and household operation. We compute real aggregate numeraire consumption as its nominal value divided by the appropriately calculated price index, $p^c_{m,t}$;[7] note that we use quarterly changes in $p^c_{m,t}$ to convert all nominal financial returns into real returns. We compute the real aggregate stock of home capital as the Davis and Heathcote (2007) estimate of the nominal market value of all housing units, divided by the Davis and Heathcote price index for the stock of housing.[8] This estimate of the real stock of housing includes both physical structures and land in residential use. The Davis and Heathcote data start in 1975:1, explaining the sample range of our GMM tests. In our empirical work, real numeraire consumption and housing are expressed in per-capita terms, consistent with the

[5]http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

[6]http://www.federalreserve.gov/releases/h15/data/Monthly/H15_TB_M3.txt.

[7]This is the price index for: Total personal consumption expenditures less expenditures on housing services and household operation.

[8]The Davis and Heathcote (2007) estimates of the nominal market value of all housing units are similar to estimates that can be derived from the Flow of Funds Accounts of the United States. A discussion of differences of the two series is available in the Appendix of the Davis and Heathcote paper.

specification of the model; our population estimates are taken from the web site of the U.S. Census Bureau.[9]

Our real numeraire consumption and real housing stock data are not quite standard, and deserve more discussion. Our measure of numeraire consumption includes spending on durable goods, which has typically been excluded by other authors from numeraire consumption (PST, for example). We include expenditures on durable goods in our measure of numeraire consumption to be consistent with the specification that the only durable good used by households to produce home consumption is the stock of housing. With respect to housing, a more commonly used measure of the stock of housing (see Greenwood et. al. 1995, for example) is an estimate of the stock of "Residential Fixed Assets" that is produced by the Bureau of Economic Analysis (BEA).[10] This BEA estimate includes only the replacement cost of physical structures and does not include the stock of land in residential use. We use the Davis and Heathcote data specifically because it includes land, and thus is conceptually consistent with the NIPA data on consumption of housing services.[11]

Table 1 compares our measures of growth in per-capita numeraire consumption and in the per-capita real stock of housing ("measure 1") to growth in the more commonly used measures ("measure 2"). There are a few differences. Our measure of numeraire consumption (column 1) increases more rapidly and is more volatile than the measure excluding durables (column 2), and our measure of housing (column 3) increases at a less rapid rate and is less volatile than the measure of housing structures that excludes land (column 4). However, the correlation of the two measures of numeraire consumption growth and the two measures of growth of the housing stock is high, 0.80 for numeraire consumption and 0.99 for the housing stock. Although some parameter estimates change, almost all of our analysis and conclusions do not depend on the measure of numeraire consumption or housing we use in the analysis, and thus in the text that follows we focus on results from our preferred measures.[12]

[9] We convert the annual population estimates reported by the Census Bureau to quarterly by interpolation.

[10] These BEA data are available at http://www.bea.gov/national/FA2004/index.asp.

[11] The NIPA estimates total rental payments on housing, inclusive of payments to both structures and land.

[12] As an important caveat to our results, we should note that a fairly common assumption in macroeconomic studies of home-production models (see Greenwood et. al. 1995, for example) is that the stock of home capital

Results: Table 2 lists the optimal GMM estimation results for the moment conditions of the housing model over the 1975:2 - 2007:1 sample period. The top panel shows results when the two financial assets in consideration are a portfolio of stocks and the 3-month T-bill (the equity premium) and the bottom panel shows the results when the two financial assets in consideration are small-cap value and large-gap growth stocks (the value premium). In both panels, the first four columns show the parameter estimates with standard errors in parentheses[13] and the middle two columns show the minimized value of the objective function and the p-value of the chi-squared test of the over-identifying restrictions. In the top panel, the rightmost two columns show 100 times the average of the error of equation (19) for the portfolio of stocks, $\bar{e}_{st}$, and for the 3-month T-Bill, $\bar{e}_{tb}$. In the bottom panel, the rightmost two columns show 100 times the average value of the error of equation (19) for small-cap value stocks, $\bar{e}_{sh}$, and for large-cap growth stocks, $\bar{e}_{bl}$.

In both the top and bottom panels, we use 2 instruments for equation (18), a constant and a time trend, and use 3 instruments for each of the financial returns, a constant and one lag of each of the two financial returns. For each panel this yields 8 moment conditions with 4 over-identifying restrictions. Our use of lagged returns as instruments for equation (19) is standard. We use a time trend as an instrument for equation (18) to ensure that our predicted values of $r_t k_{h,t}/c_{m,t}$ do not display a pronounced and counterfactual upward or downward trend over time, even though the fitted sample average value of $r_t k_{h,t}/c_{m,t}$ may be correct.[14] This moment condition helps to ensure that potential changes or extensions in our sample period do not, by necessity, impact our estimate of ρ.[15]

For computing the objective function, the weighted sum of squares of the moments, we estimate the variance-covariance matrix of the moments (the inverse of the optimal weighing

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includes both the stock of housing and the stock of durable goods. We do not test this measure of home capital because implicit rents on the stock of durable goods are not observed, and knowledge of rental expenditures on home capital is critical to some of our identification procedures. We discuss issues related to identification later in the text.

[13]We compute standard errors using the procedure described on page 415 of Hamilton (1994).

[14]In Figure 1, discussed later, we graph the actual and fitted values of $r_t k_{h,t}/c_{m,t}$.

[15]In practice, this moment condition has the effect of eliminating values of ρ that are less than -1 from consideration.

matrix) using the Newey-West estimator described in Hamilton (1994).[16] We use the Nelder-Meade algorithm to estimate the parameters that minimize the objective function. In the estimation algorithm, we impose the following restrictions: $\beta \in [0.95, 0.999]$, $\sigma \in [1.0, 15.0]$, $\rho < 1.0$ and $\gamma \in [0.01, 0.99]$. To ensure we are reporting parameters that truly minimize the objective function, we begin the Nelder-Meade algorithm at 90 different starting sets of parameters: At $\beta = \{0.97, 0.98, 0.99\}$, $\sigma = \{1.5, 3.5\}$, $\rho = \{0.5, -0.5, -1.5\}$, and $\gamma = \{0.1, 0.3, 0.5, 0.7, 0.9\}$. At every set of parameters, we estimate the optimal weighing matrix in order to compute the objective function.[17] We discard any parameter combinations in which the optimal weighing matrix can not be computed (i.e. where the determinant of the matrix to be inverted is zero). Table 2 reports the parameter estimates that, conditional on the procedure just described, minimize the objective function.

Equity Premium: We start our analysis with the estimates for the equity-premium shown in the top panel of Table 2. We draw three conclusions from this panel. First, based on the ratio of standard errors to point estimates, β and γ are more tightly identified identified than σ or ρ. Second, at the reported parameters, the model seems to more closely fit T-Bill returns (with average error of 0.79 percentage points) than stock returns (with average error of -1.79 percentage points). Third, the reported p-value shows that the over-identifying restrictions of the model are soundly rejected.[18] The model is rejected because it can not come close to matching both the realized returns to stocks and T-bills. In fact, based on the reported values of $\bar{e}_{st}$ and $\bar{e}_{tb}$, a case can be made that the housing model adds nothing to our understanding of the equity premium puzzle: The difference in the average errors of the stock and T-bill returns of 2.58 percentage points ($= -1.79 - 0.79$) is almost exactly as large as the quarterly equity premium over this period, 2.64 percentage points.

Value Premium: The bottom panel of Table 2 shows the results when the two financial

[16] We use a bandwidth parameter (q) of 4 based on our sample size: See page 414 of Hamilton (1994).

[17] Hansen et. al. (1996) document some finite sample properties of this kind of estimator, which they describe as a “continuous-updating” estimator; and, Pakes and Pollard (1989) document the conditions required for consistency of this estimator.

[18] Under the null hypothesis, the sample size (128) times the minimized objective function is distributed as a chi-squared random variable with $m - r$ degrees of freedom, where m is the number of moments (8 in our case) and r is the number of parameters (4).

instruments we consider in equation (19) are small-cap value stocks and large-cap growth stocks. The parameter estimates in this bottom panel appear to be more imprecisely estimated than in the top panel. Compared to the equity-premium estimate, the value-premium estimate of β is quite low, 0.970 compared to 0.999. At the reported parameter estimates, the model more closely fits small-cap value returns (with average error of -0.64 percentage points per quarter) at the expense of the fit of large-cap growth returns (with average error of 1.4 percentage points per quarter). The reported p-value, 0.04, shows that the over-identifying restrictions of the model are rejected at the 5 percent level. The difference of the average errors of the small-cap value and large-cap growth returns is 2.05 percentage points ($= -0.64 - 1.41$), almost exactly the same as the average historical difference in returns over our sample period, 2.12 percentage points per quarter. Thus, like the results for the equity premium, our view is that the housing model does not have much to say about the source of the value premium.

One final side note is that the two sets of estimates match historical variation in $r_t k_{h,t}/c_{m,t}$ a bit differently. In Figure 1, we plot the observed (solid line) and predicted (dotted and dashed lines) ratio of housing expenditures to numeraire consumption expenditures, x_t. In the equity premium case, the dotted red line, the model matches the long (but relatively small) decline in x_t starting at about 1982.[19] In the case of the value premium, the long-dashed green line, the predicted expenditure ratio is just about flat. Given that the ratio of $k_{h,t}/c_{m,t}$ is declining over this period (not shown), the estimation algorithm fits the historical data on x_t by setting ρ to be positive and close to zero (equity-premium) or statistically indistinguishable from zero (value-premium). Our estimates of a small but positive value for ρ are consistent with the findings of PST, and also accord with recent micro-based evidence from Davis and Ortalo-Magné (2007) who find that, at the median, renting households approximately spend 24 percent of their income on rent, regardless of MSA of residence, rental price, and time period of consideration.

[19]Note that over the 1960-2007 period, not shown, x_t is relatively stable: The decline in x_t starting in 1982 is not indicative of longer-run trends.

4 Housing Model with Leisure: $\nu > 0$ and $\psi = 1$

Next, we add leisure to the model. This model is identical to the housing model without leisure, except that $\nu > 0$ and an additional first-order condition determines the optimal time spent working in the market. The full set of first order conditions for this model are:

$$c_{m,t}: \quad \lambda_t = (1-\gamma)\ c_{m,t}^{\rho-1}\ \hat{c}_t^{1-\sigma-\rho}\ n_t^{\nu(1-\sigma)} \tag{21}$$

$$l_{m,t}: \quad 0 = \frac{c_{m,t}}{w_t n_t} - \left(\frac{1-\gamma}{\nu}\right)\left(\frac{c_{m,t}}{\hat{c}_t}\right)^{\rho} \tag{22}$$

$$k_{h,t}: \quad 0 = x_t - \left(\frac{\gamma}{1-\gamma}\right)\left(\frac{k_{h,t}}{c_{m,t}}\right)^{\rho} \tag{23}$$

$$A_{i',t+1},\ i'=1,\ldots,N: \quad 0 = 1 - \beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\ R_{i',t+1}\right] \tag{24}$$

$$K_{h,t+1}: \quad 0 = 1 - \beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{r_{t+1}+p_{t+1}}{p_t}\right)\right]. \tag{25}$$

Define y_t as the ratio of numeraire consumption to the value of leisure, $c_{m,t}/w_t n_t$. If y_t is measured with error such that the observed value of y_t, denoted y_t^o, is equal to y_t plus error $e_{y,t}$, then the first-order conditions of the model can be written as:

$$l_{m,t}: \quad e_{y,t} = y_t^o - \left(\frac{1-\gamma}{\nu}\right)\left(\frac{c_{m,t}}{\hat{c}_t}\right)^{\rho} \tag{26}$$

$$k_{h,t}: \quad e_{x,t} = x_t^o - \left(\frac{\gamma}{1-\gamma}\right)\left(\frac{k_{h,t}}{c_{m,t}}\right)^{\rho} \tag{27}$$

$$A_{i',t+1},\ i'=1,\ldots,N: \quad e_{i',t+1} = 1 - \beta\left(\frac{\lambda_{t+1}}{\lambda_t}\right) R_{i',t+1} \tag{28}$$

$$K_{h,t+1}: \quad e_{k,t+1} = 1 - \beta\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\left(\frac{r_{t+1}+p_{t+1}}{p_t}\right), \tag{29}$$

where λ_t is given by equation (21).

We use GMM to estimate the model parameters based on the moment conditions implied by equations (26) - (28); as before, we exclude moment conditions based on equation (29). We estimate the parameters of the model twice, once for two financial assets in equation (28) corresponding to the equity premium case, a portfolio of stocks and 3-month Treasury Bills, and once for the two financial assets of the value premium case, portfolios of small-cap value and large-cap growth stocks.

Data: The numeraire consumption, housing stock, and T-Bill data are the same as in the housing model without leisure. We derive market hours worked as a fraction of total discretionary time, $l_{m,t}$, using data from the U.S. Department of Labor, Bureau of Labor Statistics (BLS).[20] Specifically, $l_{m,t}$ is computed as aggregate hours worked per week divided by aggregate discretionary hours. Aggregate weekly discretionary hours is computed as the BLS estimate of the labor force times an assumed value of 15 hours per day discretionary time times 7 days per week. We compute aggregate weekly hours of market work as total private employees times private hours worked per week, both from the BLS, plus the BLS estimate of total government employees times an assumed government work week of 35 hours per week. The BLS data on employees and hours worked per week are monthly; we derive quarterly estimates of hours worked per week and number of employees as the average of the monthly estimates. Leisure is computed as $n_t = 1.0 - l_{m,t}$

We assume a 35 hour work week for government employees to try to best align our estimate of aggregate hours worked with the (annual) estimate of hours worked in domestic industries that is published in the NIPA.[21] Figure 2 compares our annualized estimate, the solid line, with the NIPA estimate, the dotted line. Figure 2 shows that the two series track each other over time. Also, not shown, the cyclical movements of the two series are almost identical. In both cases, the standard deviation of the logged and HP-filtered series is 2.1 percent, and the correlation of the two logged and HP-filtered series is 0.98.[22] On average throughout our sample, we find that market work accounts for about 28-1/2 percent of total discretionary time (not shown), close to the estimate reported by Gomme and Rupert (2007) of 25-1/2 percent.

To compute the nominal wage rate per unit of market work, call it $p^c_{m,t}w_t$, which is an estimate of nominal total wages paid per worker if workers spend all their discretionary time working, we start by assuming that GDP is produced as a Cobb-Douglas aggregate of market capital and market labor. Given this assumption, we calculate the nominal aggregate wage bill paid to market labor as the Gomme and Rupert (2006) estimate of labor's share of income, 0.717, multiplied by nominal GDP less nominal consumption expenditures on housing rents and household operation. We then compute $p^c_{m,t}w_t$ as the nominal aggregate

[20] All the BLS data referred to in this section can be downloaded from http://data.bls.gov/PDQ/outside.jsp?survey=ce.

[21] These estimates are available in NIPA tables 6.9B, C, and D.

[22] We use a smoothing parameter for the HP filter on the annual data of 100.

wage bill paid to market labor divided by the population, and divided again by hours worked as as fraction of total discretionary time, $l_{m,t}$.

In summary, y_t^o is computed as nominal per-capita numeraire consumption, $p_{m,t}^c c_{m,t}$ divided by the product of the nominal wage rate per unit of discretionary time and the fraction of discretionary time spent on leisure, $p_{m,t}^c w_t n_t$.

Results: Table 3 lists the optimal GMM estimation results for the housing model with leisure over the 1975:2 - 2007:1 sample period. The layout of Table 3 is identical to Table 2, with the exception that in Table 3 we estimate an additional parameter, ν. The moment conditions and instruments for equations (27) and (28) are the same as in the housing model. In addition, we add equation (26) with a constant as an instrument as a moment condition. Thus, we estimate 5 parameters using 9 moment conditions. Our procedure to estimate the parameters of this model is identical to the procedure we use in the housing model without leisure, except we start the Nelder-Meade algorithm at 270 different starting sets of parameters: The 90 combinations of parameters from the housing model, all of them evaluated at $\nu = \{1.0, 3.0, 5.0\}$.

Equity Premium and Value Premium: The addition of leisure to the housing model does not appear to significantly change any of the parameter estimates, nor does it help explain the equity- or value- premium puzzles. A quick comparison of all of the estimates and reported results in Tables 2 with those in Table 3 shows that they are very nearly identical. An intuitive explanation for these similarities is as follows. The two moment conditions for equation (27) basically pin down values for ρ and γ. Given ρ and γ, equation (26) pins down ν. In Figure 3, we plot the actual (solid line) and predicted values (dotted and dashed lines) of $c_{m,t}/\left(w_t l_{m,t}\right)$. The two series of predicted values nearly overlap. From this, we infer that the estimation algorithm fits the remaining moment conditions involving asset returns by choosing among combinations of β and σ. Apparently, there are no combinations of β and σ that enable the model to match the equity or value premiums, even though the marginal utility of numeraire consumption in the housing model with leisure includes an additional term, $n_t^{\nu(1-\sigma)}$, that is absent in the housing model without leisure.

5 Home Production Model: $\nu > 0$ and $0 < \psi < 1$

To test the unrestricted home production model, we must first identify time spent working at home, $l_{h,t}$, and home productivity, $z_{h,t}$, neither of which is observed. To identify these data, we proceed as if two of the first-order conditions of the model exactly hold every period, enabling us to identify $z_{h,t}$ and $l_{h,t}$ every period.[23]

Specifically, we assume there is no gap between the predicted and actual ratio of rental expenditures to numeraire consumption. We divide equation (11) by equation (8) to yield

$$\frac{r_t k_{h,t}}{c_{m,t}} = \frac{\gamma\psi}{1-\gamma}\left(\frac{c_{h,t}}{c_{m,t}}\right)^{\rho} . \tag{30}$$

Equation (30) shows that at any combination of values of γ, ψ, and ρ, and given data on $x_t = r_t k_{h,t}/c_{m,t}$, we can determine the value of $c_{h,t}$ such that equation (30) exactly holds. With data on $c_{h,t}$ and $c_{m,t}$, $\hat{c}_t$ is determined via the CES-aggregator for home and numeraire consumption, equation (2).[24]

We also divide the first-order condition for home hours, equation (10), by the first-order condition for market hours, equation (9) to uncover the following relationship between home hours worked, $l_{h,t}$, and leisure, n_t:

$$\frac{l_{h,t}}{n_t} = \frac{\gamma\left(1-\psi\right)}{\nu}\left(\frac{c_{h,t}}{\hat{c}_t}\right)^{\rho} . \tag{31}$$

Equation (31) shows that given values of γ, ψ, and ρ, and given $c_{h,t}$ and thus $\hat{c}_t$ based on equation (30), we can determine $l_{h,t}/n_t$. Since $n_t = 1 - l_{m,t} - l_{h,t}$, we can use equation (31) to solve directly for $l_{h,t}$. Finally, given $l_{h,t}$ and $c_{h,t}$, and given an estimate of ψ, we can solve for $z_{h,t}$ based on the production function for home consumption, equation (4).

The remaining first-order conditions we can use in estimation and testing of the model

[23] Ingram et. al. (1997) also use the first-order conditions of a home-production model to identify time-series changes in home hours and home productivity.

[24] Note that the variation in the ratio of rental expenditures to numeraire consumption necessarily implies that $\rho \neq 0$.

are

$$l_{m,t}: \quad 0 \;=\; \frac{c_{m,t}}{w_t n_t} \;-\; \left(\frac{1-\gamma}{\nu}\right)\;\left(\frac{c_{m,t}}{\hat{c}_t}\right)^{\rho} \tag{32}$$

$$A_{i',t+1},\; i'=1,\ldots,N: \quad 0 \;=\; 1 \;-\; \beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\; R_{i',t+1}\right] \tag{33}$$

$$K_{h,t+1}: \quad 0 \;=\; 1 \;-\; \beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{r_{t+1}+p_{t+1}}{p_t}\right)\right]\;, \tag{34}$$

where

$$\lambda_t \;=\; (1-\gamma)\; c_{m,t}^{\rho-1}\;\hat{c}_t^{1-\sigma-\rho}\; n_t^{\nu(1-\sigma)}\;, \tag{35}$$

and $\hat{c}_t$ and $l_{h,t}$ are defined implicitly by equations (30) and (31).

As with the previous GMM systems, we will not use equation (34) to estimate any model parameters. This leaves us with equations (32) and (33) to use in estimation. Using the same notation as earlier, we use moment conditions based on

$$l_{m,t}: \quad e_{y,t} \;=\; y_t^o \;-\; \left(\frac{1-\gamma}{\nu}\right)\;\left(\frac{c_{m,t}}{\hat{c}_t}\right)^{\rho} \tag{36}$$

$$A_{i',t+1},\; i'=1,\ldots,N: \quad e_{i',t+1} \;=\; 1 \;-\; \beta\frac{\lambda_{t+1}}{\lambda_t}\; R_{i',t+1}\;, \tag{37}$$

to estimate all model parameters.

In summary, in the housing-model tests of the two previous sections, we use the gap between the observed and predicted value of x_t as a moment condition to estimate parameters and test the model. In this home-production application, we assume the actual and predicted values of x_t always align, such that we can use x_t to infer the missing data on home hours and home productivity.

Before we review our results, we note that our direct use of the expenditure data in estimation implies that the parameter γ is not identified. To see this, define the variable χ_t as

$$\chi_t \;=\; \frac{\gamma}{1-\gamma}\left(\frac{c_{h,t}}{c_{m,t}}\right)^{\rho}\;. \tag{38}$$

Given a value for ψ, equation (30) shows that χ_t is directly measurable from NIPA data as

$$\chi_t \;=\; \frac{1}{\psi}\left(\frac{r_t k_{h,t}}{c_{m,t}}\right)\;. \tag{39}$$

With χ_t defined as in equation (38), the ratio of home labor to leisure has the simple expression

$$\frac{l_{h,t}}{n_t} = \left(\frac{1-\psi}{\nu}\right)\left(\frac{\chi_t}{1+\chi_t}\right) . \tag{40}$$

Further, $\hat{c}_t$ can be expressed as (see equation 2)

$$\hat{c}_t = (1-\gamma)^{\frac{1}{\rho}} \; c_{m,t} \; (1+\chi_t)^{\frac{1}{\rho}} . \tag{41}$$

So, why is γ unidentified? The marginal utility of numeraire consumption, λ_t, reduces to

$$\lambda_t = (1-\gamma)^{\frac{1-\sigma}{\rho}} \; c_{m,t}^{-\sigma} \; (1+\chi_t)^{\frac{1-\sigma-\rho}{\rho}} \; n_t^{\nu(1-\sigma)} , \tag{42}$$

and thus the pricing kernel for assets to be used in tests of equation (37) can be constructed as

$$\beta\left(\frac{\lambda_{t+1}}{\lambda_t}\right) = \beta \; \left(\frac{c_{m,t+1}}{c_{m,t}}\right)^{-\sigma} \; \left(\frac{1+\chi_{t+1}}{1+\chi_t}\right)^{\frac{1-\sigma-\rho}{\rho}} \; \left(\frac{n_{t+1}}{n_t}\right)^{\nu(1-\sigma)} , \tag{43}$$

which does not include γ anywhere. Further, given the definition of χ_t, $c_{m,t}/\left(w_t n_t\right)$ reduces to

$$\frac{c_{m,t}}{w_t n_t} = \left(\frac{1}{\nu}\right)\left(\frac{1}{1+\chi_t}\right) \tag{44}$$

and equation (36) can be rewritten as

$$l_{m,t}: \qquad e_{y,t} = y_t^o - \left(\tfrac{1}{\nu}\right)\left(\tfrac{1}{1+\chi_t}\right) . \tag{45}$$

which also does not include γ anywhere. Thus, γ is unidentified because it does not appear in any of the moment conditions that we use to estimate the parameters of the model.

As an aside, note that our use of χ_t in constructing the pricing kernel in equation (43) is almost identical to the use of the simulated expenditure-ratio data in the construction of the pricing kernel of PST,[25] with two exceptions. First, χ_t is not exactly the ratio of rental-expenditures to numeraire consumption. Rather, it is equal to that ratio dividend by capital's share of home production, which is 1.0 in the case of PST. Second, the last term in our pricing kernel, equation (43), is related to changes in leisure; this term reduces to 1.0 if

[25] See equation (9) of PST.

$\nu = 0$. Thus, one can view our results in this section as GMM-based tests of an unrestricted version of the PST procedure.

Results: Table 4 lists the optimal GMM estimation results for the full home production model over the 1975:2 - 2007:1 sample period. Our procedure to estimate the parameters of this model is similar to the procedure used for the housing model with leisure, with four exceptions. First, as mentioned, we do not estimate γ because it is not identified, but instead estimate ψ, capital's share of home production. Second, we start the Nelder-Meade algorithm at 108 different starting sets of parameters: The 54 combinations of starting values of β, σ, ρ, and ν from the housing model with leisure, all evaluated at $\psi = \{0.25, 0.75\}$. Third, we reduce the bandwidth parameter in the estimation of the inverse of the optimal weighing matrix from 4 to 1; at the original bandwidth parameter of 4, our estimator produces parameter estimates that are "odd."[26] Fourth , for computational reasons we do not consider estimates of ρ less than 0.1 in absolute value.[27]

Equity Premium and Value Premium: The layout of Table 4 is essentially identical to that of the previous tables, with the exception that estimates and standard errors of ψ replace those of γ in the fourth column. In both the top and bottom panels, we estimate the parameters of the model using 7 moment conditions for equations (36) and (37), the same moment conditions as with equations (26) and (28) in the housing model with leisure.[28]

From both panels of this table, we draw four main conclusions. First, based on the magnitude of the standard errors, all of the parameters are imprecisely estimated. Second, most (if not all) of the reported parameter estimates are, qualitatively speaking, not close to the typical calibrated estimates from home production models used in macroeconomic studies. For example, Gomme et. al. (2006) use estimates of $\beta = 0.99$, $\sigma = 1.0$, and $\psi = 0.31$;

[26] At a bandwidth parameter of 4 (the same as we use in the housing model with and without leisure), 100 times the values of $\bar{e}_{st}$ and $\bar{e}_{tb}$ are both greater than 5 in absolute value at the optimal estimates. We believe this occurs because the optimal weighing matrix places negative and equal weights on some of the moments. Note that almost all of the results we have reported for the housing model with and without leisure do not change if we switch from a bandwidth parameter of 4 to a bandwidth parameter of 1.

[27] For example, when $\sigma = 15$ and $\rho = -0.1$, the expenditure-ratio variable in the pricing kernel (43) is raised to the power -141.

[28] Note that if we exclude the 1 moment condition based on equation (36), our parameter estimates change a bit, but our main conclusions are unaffected.

they also use $\rho = 0.40$ (taken from a study by McGrattan et. al. 1997) and set $\nu = 0.75$, which (conditional on other model parameters) pins down average fraction of discretionary time spent working at home.[29]

Third, based on the reported p-value, the over-identifying restrictions of the model are soundly rejected. Thus, the model cannot simultaneously price stocks and 3-month Treasury bills, nor can it simultaneously price small-cap value and large-cap growth stocks. The model is rejected despite the fact that it has been afforded some flexibility in fitting financial returns: That is, we do not add any discipline on time spent working at home as a fraction of total discretionary time, which Gomme and Rupert (2007) report to be 0.24.[30] At the reported parameter estimates, in the equity-premium case (top panel), 4.1 percent of discretionary time is spent doing home work; at the value-premium estimates (bottom panel), 70.5 percent of time is spent doing home work.

Fourth, even despite all these caveats, it seems that the home production model might be capable of providing some insight as to some of the source of the historical equity- and value- premiums. In the case of the equity premium, the sum of 100 times the average stock and t-bill errors, 1.78 percent per quarter ($= 1.69 + 0.09$) is about one percentage point less than the equity premium itself, 2.64 percentage points per quarter. For the value premium, the sum of 100 times the average stock and t-bill errors is 1.61 percent per quarter, ($= 1.28 + 0.33$), about 1/2 percentage point less than the historical value premium over this sample, 2.12 percentage points per quarter. Thus, the model, although soundly rejected, can account for about 1/3 of the historical equity premium ($= 1 - 1.78/2.64$) and 1/4 of the value premium ($= 1 - 1.61/2.12$), albeit at different parameter estimates.

As a final note, we consider the implications of $\rho = 0$, such that the per-period utility function of the representative agent collapses to

$$u_t = \frac{\left(c_{m,t}^{1-\gamma} \; (z_{h,t} l_{h,t})^{\gamma(1-\psi)} \; k_{h,t}^{\gamma\psi} \; (1 - l_{m,t} - l_{h,t})^{\nu} \right)^{1-\sigma}}{1-\sigma} . \tag{46}$$

With $\rho = 0$, the model predicts

$$\frac{r_t k_{h,t}}{c_{m,t}} = \frac{\gamma\psi}{1-\gamma} , \tag{47}$$

[29]We discuss the issue of time spent working at home later in the text.

[30]The estimate of Gomme and Rupert is based on data reported in Juster and Stafford (1985).

(see equation 30), and thus the model treats variation in the data of this ratio as measurement error. Even though hours worked at home can be identified from equation (31) as,

$$\frac{l_{h,t}}{n_t} = \frac{\gamma(1-\psi)}{\nu}, \tag{48}$$

there is no way the shock to home productivity z_t can be identified using only intra-temporal first order conditions. The intuitive reason for this result is that equation (46) can be rewritten as

$$u_t = Z_t \frac{\left(c_{m,t}^{1-\gamma} \; l_{h,t}^{\gamma(1-\psi)} \; k_{h,t}^{\gamma\psi} \; (1 - l_{m,t} - l_{h,t})^{\nu}\right)^{1-\sigma}}{1-\sigma}, \tag{49}$$

where $Z_t = z_{h,t}^{\gamma(1-\psi)(1-\sigma)}/(1-\sigma)$. Thus, when $\rho = 0$, the home productivity shock shifts utility around over time, but serves no other role. Since we cannot identify Z_t from available data, we do not pursue further tests of the equity- and value- premium puzzles under the restriction that $\rho = 0$.

6 Concluding Remarks

In this paper, we have derived the household first-order conditions for a frictionless representative-agent home-production model. Using GMM, we have tested if the home production model can explain either the premium paid to a portfolio of stocks over a 3-month Treasury bill, or the premium paid to small-cap value stocks over large-cap growth stocks. We have tested the model assuming that the labor share in home production is zero (the "housing model," with and without leisure), a case in which all data are directly observable, and we have tested the model allowing the labor share in home production to be greater than zero (the "home production" model), in which we use NIPA data on the ratio of rental expenditures to numeraire consumption and assume two first-order conditions of the model hold with equality in order to infer time spent working at home and home productivity. In all our tests and procedures, we reject the over-identifying restrictions of the model. In the case of the housing model with and without leisure, we find that the model cannot explain any of the equity or value premium. In the full home production model, the model can explain about 1/4 to 1/3 of the historical value and equity premium. However, the estimated parameters are far from those typically used in macroeconomic models with a home-production sector, and at our parameter estimates, the predicted fraction of discretionary time spent working at home is very different from estimates in the literature based on time-use surveys. Taken together, we conclude that the representative-agent home production model has little to say about the source or nature of the equity- or value- premium puzzles.

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Figure 1

Actual and Predicted ratio of Housing Expenditures to Consumption Expenditures (x_t)

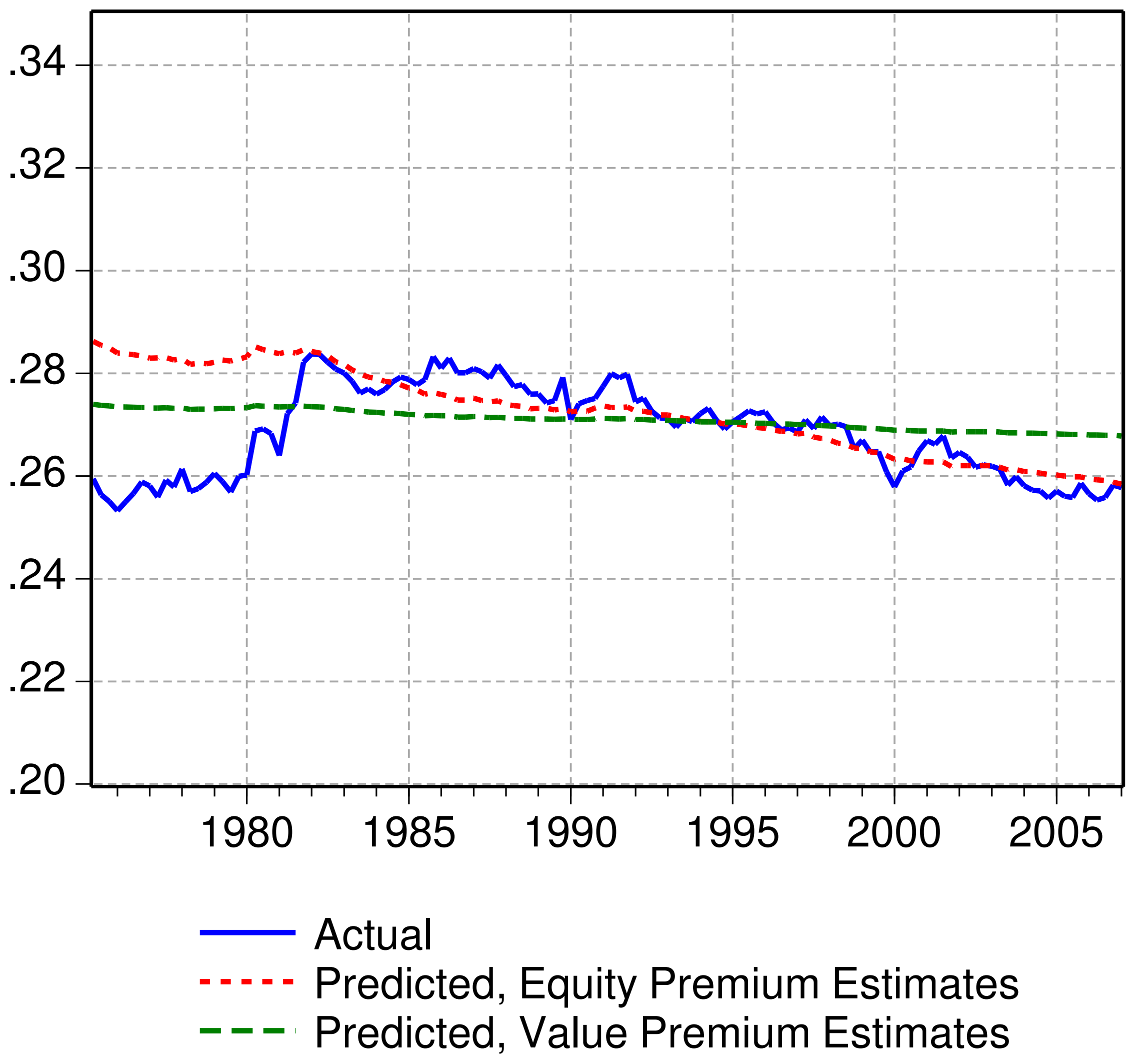

Figure 2

BLS-Based and NIPA Estimate of Aggregate Hours Worked, $l_{m,t}$, Log Scale:

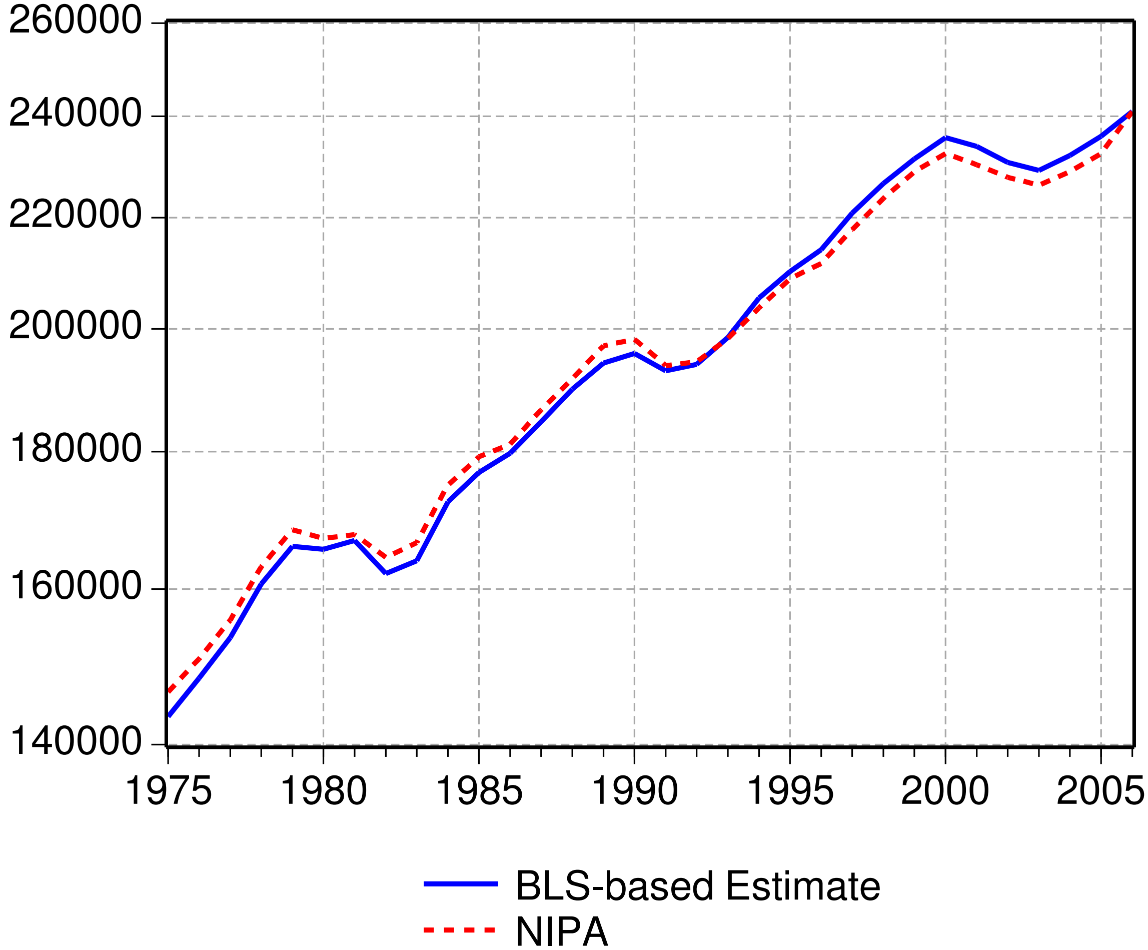

Figure 3

Actual and Predicted ratio of Market Consumption to the Value of Leisure (y_t)

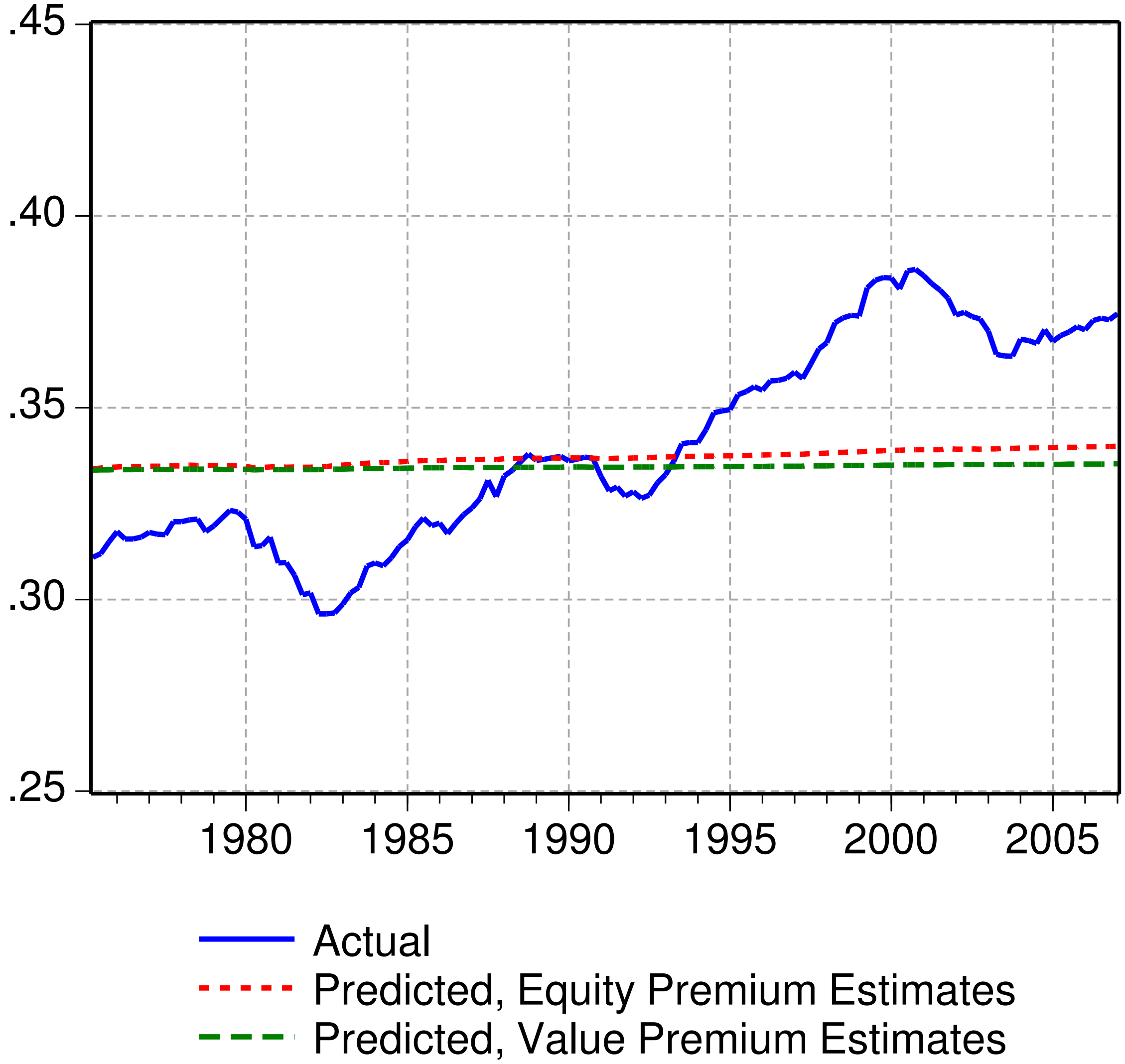

Table 1

Summary of statistical properties

of our quarterly measures of c_{t+1}/c_t and h_{t+1}/h_t to more common measures

1975:2 - 2007:1

	$c_{m,t+1}/c_{m,t}$		$k_{h,t+1}/h_{h,t}$	
	measure 1: w/ durables	measure 2: xcl durables	measure 1: land + struct.	measure 2: only struct.
mean	1.0062	1.0052	1.0021	1.0038
std. dev.	0.0073	0.0044	0.0016	0.0024
correlation	0.79		0.98	

Table 2

GMM Results, Housing Model, 1975:2 - 2007:1

Standard Errors in Parentheses

GMM Estimates, Equity Premium

Parameter Estimates				Minimized		100 times	
β	σ	ρ	γ	Obj. Function	p-value	$\bar{e}_{st}$	$\bar{e}_{tb}$
0.999	2.19	0.198	0.179	0.135	0.002	-1.79	0.79
(0.006)	(1.04)	(0.057)	(0.009)				

GMM Estimates, Value Premium

Parameter Estimates				Minimized		100 times	
β	σ	ρ	γ	Obj. Function	p-value	$\bar{e}_{sh}$	$\bar{e}_{bl}$
0.970	1.09	0.044	0.205	0.079	0.037	-0.64	1.41
(0.025)	(4.78)	(0.051)	(0.009)				

Table 3

GMM Results, Housing Model with Leisure, 1975:2 - 2007:1

Standard Errors in Parentheses

GMM Estimates, Equity Premium

Parameter Estimates					Minimized		100 times	
β	σ	ρ	γ	ν	Obj. Function	p-value	$\bar{e}_{st}$	$\bar{e}_{tb}$
0.999	2.03	0.159	0.185	2.334	0.122	0.004	-1.92	0.67
(0.005)	(0.83)	(0.056)	(0.009)	(0.030)				

GMM Estimates, Value Premium

Parameter Estimates					Minimized		100 times	
β	σ	ρ	γ	ν	Obj. Function	p-value	$\bar{e}_{sh}$	$\bar{e}_{bl}$
0.970	1.09	0.044	0.205	2.352	0.080	0.037	-0.64	1.41
(0.156)	(32.58)	(0.050)	(0.009)	(0.031)				

Table 4

GMM Results, Full Home Production Model, 1975:2 - 2007:1

Standard Errors in Parentheses

GMM Estimates, Equity Premium

Parameter Estimates					Minimized		100 times	
β	σ	ρ	ψ	ν	Obj. Function	p-value	$\bar{e}_{st}$	$\bar{e}_{tb}$
0.950	14.91	-0.100	0.614	1.923	0.077	0.007	-0.09	1.69
(0.225)	(19.79)	(0.852)	(5.512)	(8.004)				

GMM Estimates, Value Premium

Parameter Estimates					Minimized		100 times	
β	σ	ρ	ψ	ν	Obj. Function	p-value	$\bar{e}_{sh}$	$\bar{e}_{bl}$
0.999	14.91	0.245	0.085	0.008	0.070	0.010	-0.33	1.28
(0.441)	(80.58)	(1.009)	(2.408)	(14.622)				