Collaterality and the Housing Wealth Effect

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Abstract

The empirical literature has demonstrated that housing assets exhibit larger wealth effects than stocks (or, more broadly, financial assets), which is often interpreted as a larger MPC (Marginal Propensity of Consumption) out of housing wealth. Still, the question remains as to whether this stylized fact has anything to do with the collaterality of housing assets. We build a household consumption and portfolio choice model with two risky assets, housing and stocks, whereby housing can be used as collateral to borrow against. The optimizing agent's preference and investment opportunity set generate implications of different MPCs for groups characterized by their respective asset/debt portfolios. Under calibrated parameters from macro data, the model exhibits the highest MPC for households who simultaneously borrow against housing asset and invest in stocks. We examine the Panel Study of Income Dynamics (PSID) micro data of homeowners and find no evidence of this implied collateral effect on non-durable consumption.

1   Introduction

Empirical studies have illustrated that housing wealth has a more significant effect on consumption than financial wealth, especially equity wealth, where the wealth effect is interpreted as the consumption outlay changes induced by exogenous changes in wealth (Case, Quigley, and Shiller 2005, Bostic, Gabriel, and Painter 2008). Typical empirical specifications in the literature have taken the form

$$c_i = \beta_0 + \beta_h w_{h,i} + \beta_s w_{s,i} + \varepsilon_i \tag{1.1}$$

or its first-difference version

$$\triangle c_i = \beta_0 + \beta_h \triangle w_{h,i} + \beta_s \triangle w_{s,i} + \triangle \varepsilon_i$$

(with a host of other control variables suppressed here for ease of exposition) where c_i, $w_{h,i}$ and $w_{s,i}$ represent consumption, housing wealth, and stock wealth respectively, in level or logarithmic units. The subscript i indexes cross-section or time-series observations. The majority of the literature has found $\beta_h > \beta_s$[1]. Table 1 presents several estimates from a selected sample of studies: depending on the source of the data and the estimation methods, β_h is around 0.04 ~ 0.17, and β_s is from negligible to 0.06 (in the logarithm of variables).

This wealth effect puzzle looms large in view of the latest housing booming cycle from the second half of 1990s to the first half of 2000s in the United States. Figure 1 demonstrates the popular belief that the robustly rising consumption in recent years is associated with exuberant increases in U.S. housing prices: from 1990 q1, the ratio of consumption expenditures to disposable personal income trended upwards, until it peaked at 2005 q3, roughly mimicking the substantial appreciation of national housing prices; when real home prices

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[1]Dvornak and Kohler (2003) is an exception, in which they find little difference between wealth effects of these two.

began declining after 2006 q3, the consumption-income ratio was already declining. The connection between these two series lies in the possibility that by pledging against their home properties, homeowners were able to refinance their mortgages or tap into available home equity lines to fund their consumption that may include conspicuous and unnecessary components. Greenspan and Kennedy (2005) derive the amount of the gross extraction of equity, defined as the discretionary cashing out by homeowners against their home equity in the home mortgage market. The net equity extraction is the gross equity extraction minus the related costs. Figure 2 depicts the ratio of equity extractions to disposable personal income, alongside the real national home price index: both equity extraction ratios, despite short-term fluctuations, closely mimicked the time-series of home prices, steadily trending up over the years. The gross equity extraction ratio began at about 3 percent of personal disposable income, hiked as high as 12 percent at 2004 q3, and began a dramatic nosedive in 2006. However, another notable feature, presented by Figure 1, is that the consumption of non-durables and services (not including housing services, for instance) to DPI was flat over these years, suggesting much of the boost in consumption expenditures was steered towards durables. Consistent with this fact, both Bostic, Gabriel, and Painter (2008) and Case, Quigley, and Shiller (2005) find the larger housing wealth effect in total consumption and durable consumption measures.

However, we cannot yet discard the notion that the housing wealth effect is only contained in durable consumption. Figure 1 utilizes quarterly data and may mask otherwise discernible patterns. Moreover, labor income is an incomplete measure of permanent income; household net worth, defined as the balance of assets minus liabilities, hence taking into account of both assets and liabilities of household balance sheet, is more comprehensive than current income alone in measuring the extent of affluence that people feel, for human and non-human wealth together provide the stream of permanent income based upon which people plan their consumption. Figure 3 illustrates two household consumption measures, total

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consumption and the consumption of non-durable goods plus services, to the net worth ratio, in which we see an uptrend evident in both of the series in later years, even though its level has not terribly exceeded the historical level achieved during late 1980s or early 1990s. We observe a sharp increase in this ratio since roughly 2005, when households presumably started to reap benefits from rapid housing appreciation. This take-off in upward trends was much steeper than similar increases during the internet booming years of the late 1990s, also exemplifying the claim that the housing wealth effect is larger than the stock effect.

The prevailing literature also regards why $\beta_h > \beta_s$ as a purely empirical issue (Case, Quigley, and Shiller 2005, Carrol, Otsuka, and Slacalek 2006). To some extent, it is. However, there must be something fundamentally different between housing and financial wealth that leads consumers to view their values differently, and, we cannot gain our knowledge without a conceptual framework. Various hypotheses exist, but the collaterality of housing, as exemplified by Figure 2, is seen as one that could be used to explain the difference between the wealth effects of housing and stock assets, within the framework of rational choice. The conventional wisdom holds that, due to its collaterality, a one percentage increase in housing prices induces the expansion of the budget set more than that induced by a one percentage increase in other forms of wealth, such as stocks. Hence, this implies that an economic agent will respond more to the increase. Other distinctive features exist between housing and stocks, such as the liquidity difference, but they may indeed imply the opposite, a weaker consumption response to housing than to stock assets.

Klyuev and Mills (2007) examines macro-level time series data for the United States and other developed countries to see if the amount of home equity withdrawal (slightly different from equity extraction used in Greenspan and Kennedy (2005)) can predict the time-variations of saving rates. They fail to find any significant impacts. However, the non-existence of the macro-level evidence does not necessarily exclude such functionality on the micro-level, for probably a sizable portion of the population has not borrowed heavily

against their housing assets. To investigate such a possibility requires a decomposition of the population into those who borrow and those who do not. By the same token, Carrol, Otsuka, and Slacalek (2006) argue for the possiblity of the MPC difference for stockholders and non-stockholders, and the fact that stocks are usually held by a small, richer proportion of the population may underlie a smaller MPC for stocks.

To verify the composition hypothesis in combination with the collaterality of housing assets, we need to clarify how borrowing on housing assets would affect one's consumption decision. To accomplish this, we build a continuous-time intertemporal two risky asset allocation model in which one of the risky assets (housing) can be pledged as collateral to borrow against. We derive the quantitative implications from the model through parameterization, and examine them against the evidence from the PSID samples, which contain detailed information of the households. One of the most important implications regarding collateral effects is that agents may exhibit various MPCs, depending on whether they utilize the housing collateral to borrow funds and whether they hold stocks. In particular, the group that holds both sizable stocks and sizable debts should exhibit the highest MPC, compared to others. This quantitative implication was derived with the assistance of calibrated parameters, but it makes sense economically: those who simultaneously borrow and invest are "arbitragers" who seek to reap the profits from the risk adjusted returns, more inclined to do so than others who passively await the windfall, or who are constrained from borrowing more. Therefore, these "arbitragers" are more likely to channel part of their profits into consumption in revelation of their risk preference. Bringing household mortgage debts into the empirical quest is an improvement of this paper on the earlier literature that empirically examine the housing wealth effect. For an overview of the results, we find modest evidence supportive of the model predictions in the cross section analyses, but inconsistency is found to exist in the time-series pattern. Moreover, looking into the details of the conditional distribution of the consumption on net worth, we observe the heterogeneity of the collateral

effects between the low quantile and high quantile observations.

Other related literature includes Hurst and Stafford (2004), who find that households under liquidity constraints are more likely to refinance their home loans to tap into their home equity to smooth out the consumption stream, even when the interest rate is rising during the period. We do not zoom in on households' refinancing decisions, but instead implicitly assume that households would continuously be keen on refinancing options, given that the costs are negligible, compared to refinancing benefits. Another branch of the literature examines quantitatively the life-cycle effects of housing wealth (see Cocco (2005) and cited literature therein). As illuminating as these studies are, they choose to focus on wealth portofolio variation, not on what the most fundamental characteristics associated with housing assets are that may generate the difference in wealth effects. Moreover, the larger wealth effects of housing assets exist on the micro-level as well as on the macro-level, with or without life-cycle complications (Case, Quigley, and Shiller 2005). In contrast to these papers, we feel that a framework of an infinite horizon for the economic agent will serve to reconcile all sorts of empirical evidence with the benefit of analytical convenience.

The rest of this paper is organized as follows: Section 2 lays out the intertemporal portfolio-choice model that incorporates the collaterality of housing assets; Section 3 parameterizes the model to derive the quantitative implications for the sub-groups defined by their asset/debt portfolios, and then compares them to the estimates obtained from PSID cross section samples; Section 4 concludes by acknowledging some of the limitations of this analysis and points to possible future work.

2 Housing as Collateral

The stylized empirical finding that β_h is greater than β_s poses a challenge for the rational portfolio-choice framework initiated by Merton (1990). This framework assumes a variety of stationary investing opportunity sets plus the CRRA utility function, and the derived

consumption rule has always taken the form

$$c_t = \psi_c w_t = \psi_c(w_{h,t} + w_{s,t}) = \psi_c w_{h,t} + \psi_c w_{s,t} \qquad (2.1)$$

Apparently, as long as the individual does not distinguish different format of assets, we would always obtain that MPC, coinciding with ψ_c, is the same for housing and other assets[2].

Before dismissing this framework as an appropriate one to interpret the large body of empirical estimates, we need to bring the single most important feature often mentioned regarding the distinction between housing and other forms of financial wealth: that the house can be used as collateral to borrow funds. Even though other financial assets may also be able to be used as collateral, a housing asset is more likely. We set forth to isolate how this feature will affect the consumption rule (2.1). In doing so, we essentially treat housing as another asset with the same liquidity and the transaction costs as stocks. Houses are freely bought and sold, and one can always obtain her/his desired house in a market, with the desired footage, structure, and location. When the only wealth form held by an agent is housing, s/he can downsize it to any desirable level, or take an equity loan to squeeze cash out to finance her/his consumption, at no additional transaction cost. This is, of course, highly hypothetical. However, we reiterate that including any such frictions in the housing market would diminish the appeal of owning housing assets, thus, it is only reaffirming, rather than enlightening, the housing wealth effect puzzle. We assume a competitive rent market in this paper. Any psychological factors or utility that an economic agent may derive from merely owning a house is excluded here, to concentrate on the collaterality feature of housing. We will discuss some of the limitations arising from these idealized assumptions

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[2]Strictly speaking, the MPC interpretation of β only applies when variables such as c and w's are measured in levels. β should be interpreted as the elasticity of consumption to wealth, when those variables are measured instead in logarithm units. In the latter case, however, β is supposed to conincide with the wealth ratio of each asset. In the empirical results, using the log of the variables, β is far less than the wealth ratio for each asset, which only lends an explanation to error-ridden issues and will thus be less interesting.

in the concluding section.

The collaterality of housing does not immediately lend itself to a higher MPC, even if it is intuitively appealing. When an agent takes out a loan against appreciated housing, her/his increased budget set endows her/him for more current consumption; on the other hand, s/he has to aside a portion of the budget, to pay back the loan in the future. This would offset the incentive of more current consumption. The tradeoff of these two forces can be not be explicitly characterized without an intertemporal choice model. Fleming and Zariphopoulou (1991) solve the optimal portofolio-choice problem in the environment of one risky asset, plus one riskless asset, where the risky asset can be pledged as the collateral for borrowing. We extend their analysis to an environment of two-risky assets, plus one riskless asset, where one of those risky assets, housing, can be served as collateral. None of these three assets can be sold short, and the consumer/investor has to maintain her/his net worth to be positive at any point in time.

Let D_t be the outstanding debt level that the agent can establish by borrowing in continuous-time at the borrowing interest rate R, which is greater than the risk-free rate of return, r_f. We highlight the borrowing constraint imposed by the collateral feature of housing assets by the requirement that the outstanding debt level, at any instantanenous point in time, cannot exceed the current housing value

$$D_t \leq w_{h,t} \tag{2.2}$$

This immediately implies w_t, the net worth of the agent, is also non-negative

$$w_t = w_{b,t} + w_{h,t} + w_{s,t} - D_t \geq 0 \tag{2.3}$$

where $w_{b,t}$ is the amount of wealth the agent will allocate to the riskless saving deposits. The collateral constraint (2.2) also implies, even though the borrowing rate R is constant, that

the agent can freely choose how much more to borrow, or how much to pay back, as long as the outstanding debt will always be lower than current housing wealth. This assumption is consistent with the prepayment and refinancing activities widely existing in mortgage borrowing. The constraint rules out the possibility of defaulting, and empirically, we only focus on those households who are not defaulting or are not experiencing foreclosure during the period. We assume that the price of housing and of stocks evolve according to the stochastic differential equations

$$dP_{j,t} = \mu_j P_{j,t} dt + \sigma_j P_{j,t} dz_{j,t} \qquad (j = h, s) \tag{2.4}$$

where $z_{j,t}$ are standard, independent Brownian motion processes. The long-run correlation of housing real returns and stock real returns is extremely low, about 0.01 (Piazzesi, Schneider, and Tuzel 2007), even though introducing the inter-correlations of the housing and stock risks is conceptually straightforward[3]. The wealth accumulation equation becomes

$$dw_t = r_f w_t dt + [(\mu_h - r_f)w_{h,t} + (\mu_s - r_f)w_{s,t} - (R - r_f)D_t]dt - c_t dt$$
$$+ \sigma_h w_{h,t} dz_{h,t} + \sigma_s w_{s,t} dz_{s,t} \tag{2.5}$$

Assume the agent possesses the value function

$$J(w) = \int_0^{+\infty} e^{-\beta t} u(c_t) dt \tag{2.6}$$

given initial endowment w and $u(c_t) = \frac{c_t^{1-\gamma}}{1-\gamma}$ where γ is the reciprocal of the elasticity of intertemporal substitution, non-distinguishable from the coefficient of constant relative risk

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[3]If income is introduced into the model, Cocco (2005) finds that aggregate income shocks are strongly positively correlated with housing returns, but uncorrelated with stock returns. However, the mere introduction of income in the model will not change the formula, such as (2.1), in which coefficients before housing and stock assets will be the same. A model incorporating labor income risk and housing consumption is available upon request, in which we illustrate that MPC is affected by the composition of human wealth, defined as present value of future income stream, and non-human wealth.

aversion[4]. This CRRA utility function enables us to derive the consumption rules that are dependent on preference parameters, but are independent of the wealth level. The optimization problem, thus, is to maximize (2.6) subject to (2.5), (2.2), (2.3) and $w_{b,t}, w_{h,t}, w_{s,t}, D_t \geq 0$. It follows that the value function $J(w)$ should solve the Hamilton-Jacobi-Bellman (HJB) equation

$$\beta J(w) = \sup_{c, w_h, w_s, D} [u(c) + \mathcal{D}^c J(w)] \tag{2.7}$$

where

$$
\begin{aligned}
\mathcal{D}^c J(w) = &\left[r_f w + (\mu_h - r_f) w_h + (\mu_s - r_f) w_s - (R - r_f)D - c \right] J_w(w) \\
&+ \frac{1}{2}(w_h^2 \sigma_h^2 + w_s^2 \sigma_s^2) J_{ww}(w)
\end{aligned} \tag{2.8}
$$

We conjecture $J(w) = K \frac{w^{1-\gamma}}{1-\gamma}$. Therefore $J_w(w) = Kw^{-\gamma}$, $J_{ww}(w) = K(-\gamma)w^{-\gamma-1}$. Given $\gamma > 0$, $J_w(w) > 0$ and $J_{ww}(w) < 0$.

The solution to this dynamic optimization problem can be tackled through a transformation into a static optimization problem, at the core of which is to characterize the combined budget constraint by (2.2) and (2.3). Following Fleming and Zariphopoulou's (1991) analysis, we introduce the following claim before characterizing the solution.

Claim 1. *Given $r_f < R < \mu_h < \mu_s$, define*

$$g(p, q, w_h, w_s, D) = \frac{1}{2}\sigma_h^2 w_h^2 q + \frac{1}{2}\sigma_s^2 w_s^2 q + (\mu_h - r_f)w_h p + (\mu_s - r_f)w_s p - (R - r_f)Dp \tag{2.9}$$

where $p > 0$, $q < 0$ and $(w_h, w_s, D) \in \triangle(w)$ defined as

$$\triangle(w) = \{(w_h, w_s, D) : w_h \geq 0, w_s \geq 0, D \geq 0, w_h \geq D, w - w_h - w_s + D \geq 0\} \tag{2.10}$$

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[4]For our purposes, we have chosen not to incorporate the recursive utility specification as in Epstein and Zin (1991) that separates the parameters governing the elasticity of intertemporal substitution from the risk aversion.

Let

$$\overline{w}_{kD} = \frac{(\mu_k - R)p}{-\sigma_k^2 q}, \quad \overline{w}_{kf} = \frac{(\mu_k - r_f)p}{-\sigma_k^2 q}, \quad (k = h, s)$$

and assume that

$$\overline{w}_{sD} \leq \overline{w}_{hD}, \quad \overline{w}_{sD} + \overline{w}_{hD} \leq \overline{w}_{hf} \tag{2.11}$$

the maximization solution to (2.9) subject to (2.10) and (2.11) can be characterized as (w_h^*, w_s^*, D^*) such that

1. *when $w < \overline{w}_{sD}$: $D^* = \overline{w}_{hD} - w (> 0)$, $w_s^* = 0$, $w_h^* = \overline{w}_{hD}$;*

2. *when $\overline{w}_{sD} \leq w < \overline{w}_{hD} + \overline{w}_{sD}$: $D^* = \overline{w}_{hD} + \overline{w}_{sD} - w (> 0)$, $w_s^* = \overline{w}_{sD}$, $w_h^* = \overline{w}_{hD}$;*

3. *when $\overline{w}_{hD} + \overline{w}_{sD} \leq w < \overline{w}_{hf}$: $D^* = 0$, $w_s^* = 0$, $w_h^* = w$;*

4. *when $\overline{w}_{hf} \leq w < \overline{w}_{hf} + \overline{w}_{sf}$: $D^* = 0$, $w_s^* = 0$, $w_h^* = \overline{w}_{hf}$;*

5. *when $w \geq \overline{w}_{hf} + \overline{w}_{sf}$: $D^* = 0$, $w_s^* = \overline{w}_{sf}$, $w_h^* = \overline{w}_{hf}$.*

Proof. See Appendix. ∎

$r_f < R < \mu_h < \mu_s$ is needed in our infinite-horizon context, but may not be necessary for finite life-cycle models. For a graphical understanding of what the constraint set looks like, refer to Figure 5. Figure 5 visualizes the surface of $\{D : D = w_h\}$ and $\{D : D = w_h + w_s - w\}$ for $w = 2$. The constraint set $\triangle(w)$ requires (w_h, w_s, D) in the space below $\{D : D = w_h\}$ and above $\{D : D = w_h + w_s - w\}$. However, the minus sign before the term with D in (2.9) indicates that, for the optimal solution, D is to be small as possible, which in turn suggests optimal candidate points for D should be on the surface $\{D : D = w_h + w_s - w\}$, and that $D \leq w_h$ should not be binding except those intersecting with $\{D : D = w_h + w_s - w\}$ (Figure 6). To browse some numerical examples: Point $A(3, 2, 3)$ is a candidate for the optimal solution; however, points such as $(3, 3, 4)$ would be violating the collateral constraint, even though the net worth identity is satisfied; Point $B(3, 0, 1)$ is also a candidate for the optimal

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solution, but points such as $(3, 0, 2)$ would be violating the net worth identity, even though the collateral constraint is satisfied. The restrictions in (2.11) are imposed in light of our data only including homeowners. Given these relationships between the risk profiles of the housing and stock assets, agents would always begin with accumulating housing assets, i.e., a renter who would rather buy stocks than a house is ruled out in this model. Our parameter values to be chosen in next section are also consistent with these restrictions. The solution without these restrictions in place would be far more practically complicated, for it would involve more corner solution comparisons.

To utilize the results in Claim 1, let $p = J_w(w)$ and $q = J_{ww}(w)$. Employing the standard guess-and-verify procedure used in the continuous-time finance literature, we proceed to obtain the solutions corresponding to each case of Claim 1, summarized as Theorem 1 below:

Theorem 1. *Let* $p \equiv J_w(w)$, $q \equiv J_{ww}(w)$, $\frac{p}{q} \equiv \frac{w}{-\gamma}$, $c^* = K^{-\frac{1}{\gamma}}w$, *and*

$$\overline{\psi}_{kD} = \frac{\overline{w}_{kD}}{w} = \frac{\mu_k - R}{\sigma_k^2 \gamma}, \quad \overline{\psi}_{kf} = \frac{\overline{w}_{kf}}{w} = \frac{\mu_k - r_f}{\sigma_k^2 \gamma}, \quad k = h, s$$

and

$$\overline{\psi}_{sD} \le \overline{\psi}_{hD} \quad , \quad \overline{\psi}_{sD} + \overline{\psi}_{hD} \le \overline{\psi}_{hf} \tag{2.12}$$

1. *when* $\overline{\psi}_{sD} > 1$: $D^* = (\overline{\psi}_{hD} - 1)w$, $w_s^* = 0$, $w_h^* = \overline{\psi}_{hD}w$,

$$c^* = \left[\frac{\beta}{\gamma} - \frac{1-\gamma}{\gamma}[R + (\mu_h - R)\overline{\psi}_{hD}] + \frac{1-\gamma}{2}\overline{\psi}_{hD}^2 \sigma_h^2 \right] w \equiv \alpha_1 w$$

2. *when* $\overline{\psi}_{sD} \le 1 < \overline{\psi}_{hD} + \overline{\psi}_{sD}$: $D^* = (\overline{\psi}_{hD} + \overline{\psi}_{sD} - 1)w$, $w_s^* = \overline{\psi}_{sD}w$, $w_h^* = \overline{\psi}_{hD}w$,

$$c^* = \left[\frac{\beta}{\gamma} - \frac{1-\gamma}{\gamma}[R + (\mu_h - R)\overline{\psi}_{hD} + (\mu_s - R)\overline{\psi}_{sD}] + \frac{1-\gamma}{2}(\overline{\psi}_{hD}^2 \sigma_h^2 + \overline{\psi}_{sD}^2 \sigma_s^2) \right] w \equiv \alpha_2 w$$

3. *when* $\overline{\psi}_{hD} + \overline{\psi}_{sD} \leq 1 < \overline{\psi}_{hf}$: $D^* = 0$, $w_s^* = 0$, $w_h^* = w$,

$$c^* = \left[\frac{\beta}{\gamma} - \frac{1-\gamma}{\gamma}\mu_h + \frac{1-\gamma}{2}\sigma_h^2\right]w \equiv \alpha_3 w$$

4. *when* $\overline{\psi}_{hf} \leq 1 < \overline{\psi}_{hf} + \overline{\psi}_{sf}$: $D^* = 0$, $w_s^* = 0$, $w_h^* = \overline{\psi}_{hf}w$,

$$c^* = \left[\frac{\beta}{\gamma} - \frac{1-\gamma}{\gamma}[r_f + (\mu_h - r_f)\overline{\psi}_{hf}] + \frac{1-\gamma}{2}\overline{\psi}_{hf}^2\sigma_h^2\right]w \equiv \alpha_4 w$$

5. *when* $1 \geq \overline{\psi}_{hf} + \overline{\psi}_{sf}$: $D^* = 0$, $w_s^* = \overline{\psi}_{sf}w$, $w_h^* = \overline{\psi}_{hf}w$,

$$c^* = \left[\frac{\beta}{\gamma} - \frac{1-\gamma}{\gamma}[r_f + (\mu_h - r_f)\overline{\psi}_{hf} + (\mu_s - r_f)\overline{\psi}_{sf}] + \frac{1-\gamma}{2}(\overline{\psi}_{hf}^2\sigma_h^2 + \overline{\psi}_{sf}^2\sigma_s^2)\right]w \equiv \alpha_5 w$$

$c^* = K^{-\frac{1}{\gamma}}w$ is obtained from the maximization of c on the right-hand side of (2.7). The imposed constraint (2.12) is the counterpart of (2.11) in Claim 1. The demarcation of these five groups depends upon the risk-return parameter values of the housing and stock portfolio of the individuals, relative to their degree of risk aversion, γ, which may be heterogeneous across the population. Moreover, Case and Shiller (1989) argue that the housing markets may be largely inefficient, resulting in heterogeneity in the risk-return profiles of houses. We will explore the impacts of these concerns on the calibration results.

Theorem 1 informs us that the agents can be classified into several cases, according to their portfolio composition of debts, housing and stock assets. The consumption rule out of the net worth for each case may be different, depending on the specific parameter values. More specifically, letting α denote the MPC of consumption rule derived in Theorem 1 for each case, we can identify four groups according to their wealth holdings (see Table 2). Notice that the Benchmark group includes two cases, for these two cases are identical in terms of net worth compositions. The MPC for each group would be a weighted average of MPC for the cases in Theorem 1 that are included in the particular group. We turn to the

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empirical part related to this model in the next section.

3   Some Empiricals

Apparently, it will be difficult to analytically compare the relative magnitudes of MPC for each case in Theorem 1. Putting the complexity of the formulas aside, each case corresponds to a different segment of values for $\overline{\psi}$'s, e.g., $\overline{\psi}_{sD}$ is greater than 1 in Case 1, but less than 1 in Case 2. If the only heterogeneity source is from γ, this would imply γ in Case 1 is greater than γ in Case 2, which would complicate the comparison of MPCs for Case 1 with Case 2. We instead resort to the computation of the range of MPCs, by looking at the reasonable values for these primitive parameters to gauge the effects[5].

3.1   Calibration

To offer an idea of the returns and volatilities for the various assets, Figure 4 depicts the upward trends of the various asset levels in last three decades, when 1991q1 is normalized at 100. Stocks exhibited the most significant upturn trend during this period, albeit with the most volatility. Housing appreciation accelarated since the beginning of 2000s, and its volatility appeared to be much less than stocks. The difference in volatility in housing and stocks may have contributed to their wealth effect difference.

We use the standard procedure (see, e.g., Hull (2008, Chapter 13)) to estimate the expected return and volatility corresponding to the Brownian motion processes (2.4) for the housing and stock markets. To be consistent with the time span of micro data on households, and the general perception that the run-up in housing prices fuels the equity leverage ratio, we choose quarterly data on housing and stock prices from 1996 to 2007 to obtain annualized estimates. The annual expected housing price appreciation for single homes from 1996

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[5]We also tried for other sets of parameter values, estimated from various periods and indices; to the extent that these parameter values satisfied the presumptions in Theorem 1, the calibrated results were qualitatively similar to what we present next.

to 2007, according to S&P/Case-Shiller U.S. National Home Price Index, is 6.3%, with a volatility per annum of 3.3%. This is in sharp contrast to its much lower, long-run mean of about 2% (Campbell and Cocco 2003, Piazzesi, Schneider, and Tuzel 2007). For stocks, we calculate from CRSP NYSE/AMEX/NASDAQ stock index data (including distributions) that the expected annual return of stocks is 10.3%, and the corresponding volatility is 17.2% per annum for the same period. The average one-year treasury bond yield for the same period is about 4.4%. The expected annual mortgage rate, measured by the 30-year fixed mortgage rate, seems higher than the expected housing return for the period. However, mortgage payments are tax-deductible in the United States, therefore, we discount the mortgage rate by 25%, roughly the average personal income tax rate, before calculating the effective mortgage rate. After this adjustment is adjusted, the expected annual mortgage rate is approximately 5%. These parameter values, taken together, are consistent with the setup of our model that an infinitely-living agent is willing to borrow, but unwilling to default. We summarize the parameters for the calibration in Table 3.

Recall that in Table 2, we classify agents into four different groups based on their portfolios of stock holdings and debt levels, for stock holdings and debts are what we can observe from an actual data set. Figure 7 plots the MPC associated with the agents endowed with heterogeneous degrees of risk aversion, but with the same risk-return profiles of financial assets. The heterogeneity in risk aversions alone generates observations for all of these four groups. One substantial feature of the plot is that the MPC for the Group DS (people who both borrow and hold stocks) is distinguishingly higher than two of the other three groups that do not carry debt. Intuitively, the fact that some households are able to borrow implies that they are not liquidity constrained; the fact that they choose to invest in stocks implies their elasticity of intertemporal substitution is low, hence consumption will not tend to change drastically in response to any exogenous change of rates of return. These two factors together generate a higher propensity for them to consume out of their net worth.

Agents must be at the high end of the elasticity of intertemporal substitution if they borrow, but do not invest, and their MPCs are not unambiguously higher or lower than those who both borrow and invest.

Case and Shiller (1989) argue that, due to the inefficiency of the housing market, there may exist heterogeneity in σ_h cross-sectionally. We now experiment with heterogeneity in σ_h, the volatility of housing returns. Instead of a single value, we set σ_h to vary over the range from 0.01 to 0.08. Figure 8 illustrate the change of group composition over the range of σ_h for different values of γ. Uniformly, when σ_h increases, which means more variation in future housing price appreciation, the MPC decreases, because agents become more precautionary in consumption. For the same range of σ_h, a larger γ phases out groups with outstanding debts and phases in groups with more savings. Again, the MPC for Group DS, as long as it exists in the population, is greater than the two other groups without debts.

How would this exercise add to our understanding of the discrepancy of MPCs between housing and stock wealth? If the population consists of all the five groups encompassed by Theorem 1, the cross-section regression of consumption on housing and stock wealth will be their weighted average

$$
\begin{aligned}
E(c \mid w_h, w_s) &= \sum_{j=1}^{5} p_j E(c_j \mid w_{h,j}, w_{s,j}) \\
&= p_1 \alpha_1 (w_{h,1} - D_1) + p_2 \alpha_2 (w_{h,2} + w_{s,2} - D_2) + p_3 \alpha_3 w_{h,3} + p_4 \alpha_4 w_{h,4} + p_5 \alpha_5 (w_{h,5} + w_{s,5})
\end{aligned}
$$

(3.1)

where p_j $(j = 1, \cdots, 5)$ is the proportion of observations of each group in the population. This defies the interpretation of a typical specification (1.1) which implicitly assumes the homogenous composition of a population. Without the decomposition into separate groups

for the population, this regression becomes

$$E(c \mid w_h, w_s) = \sum_{j=1}^{5}(p_j\alpha_j)w_h + (p_2\alpha_2 + p_5\alpha_5)w_s - (p_1\alpha_1 + p_2\alpha_2)D \qquad (3.2)$$

from which it is no wonder why the coefficient before w_h is greater than that before w_s. This also applies to the time-series data, if observations belonging to different cases in Theorem 1 shifted in and out in the time-series, which would affect the aggregate macro data, if the parameter values are time-varying. A decomposition based upon the observations' asset/debt portfolio, which allows us to examine the behavior of the groups before being aggregated, as in (3.1), is necessary to examine this possibility. We turn to this point in the next subsection.

3.2 Evidence from PSID sample

We choose Panel Study of Income Dynamics (PSID) data set, a representative panel of the United States current population starting from 1968, for our analysis of households on the micro level. PSID collects respondents' financial information every five years up to 1999, and every two years thereafter. The limitation of PSID data is that it does not provide consumption expenditure data as detailed as in the Consumer Expenditure Survey (CEX). On the other hand, CEX has much less information concerning households' balance sheets. However, PSID has collected expenditure information on a few essential items, from which we can extrapolate useful aggregate measure of non-durable consumption by Skinner's (1987) method.

We extract five cross-section samples from PSID 1994 survey and successive biennial surveys from 1999 to 2005, corresponding to the period for which we adopt the parameter values in last section. For each cross-section sample, we restrict our attention to households who own a primary residence unit, have not moved in the year, and have positive household head labor income. These waves of PSID surveys provide self-assessed values on the house

and stock holdings. Cocco (2005) provides evidence that the PSID self reported housing values follow relatively well with the Conventional Mortgage Home Price Index (CMHPI) constructed by Freddie Mac and Freddie Mae, and the Housing Price Index contructed by the Office of Federal Housing Enterprise Overnight (OFHEO). We leave out all households who had no idea how much their house was worth at the time, as well as those whose net worth (home equity included) were negative. After all these restrictions, we are left with cross-section sample sizes varying from 2531 to 3819 for the period.

For the consumption measure, we adopt two kinds of measurements: the simple sum of food, utility and transportation from the PSID, and the predicted total consumption of non-durable goods and services from these components. To obtain the predicted consumption measure, we use the coefficients of the regressions of all non-durable goods and service expenditures on these components from the Consumer Expenditure Survey (CEX) of comparable years. This prediction approach was first advocated by Skinner (1987). We use the assembled CEX data from Anguiar and Hurst (2009) to obtain the prediction coefficients pertaining to 1994-2005. The R^2's for these prediction equations are more than 80 percent. Table 4 presents the summary statistics for the four groups during this period, depending on their asset/debt profile. The coefficients from regressions are similar in magnitude to those in Bostic, Gabriel, and Painter (2008). The predicted consumption measure appears to be more reasonable than the other simple sum measure, which is, at times, extremely skewed by outlier observations. The households who had stock holdings, but no mortgage debts, though a small proportion of the sample, are older and richer than those who had outstanding mortgage debt only, which consists of the largest proportion of the sample (except for 1994). This is consistent with the crowding-out effect of housing assets on other financial assets in the literature (Cocco 2005). It can also be observed off Table 4 that the average mortgage debts have been increasing during this period.

Our model claims that the wealth effect of housing and stocks ought to be the same, after

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properly taking into account their risk/return characteristics, and the difference in the MPC stems only from the collaterality of the housing asset, which suggests the decomposition into four groups by their asset/debt profiles. We restrict the coefficients before housing and stocks to be equal, and examine the difference in MPC of their net worth for these four groups. These four groups are constructed according to their definitions in our model: a household is classified into Group DS if it had a mortgage balance outstanding, and held a positive amount of stocks in non-retirement accounts for the reference year; Group D includes those who owed an outstanding mortgage balance, yet, had not owned a positive ammount of stocks for the reference year; Group S and Benchmark Group are defined accordingly. For our purposes, it will be the most illuminating to compare the MPC of Group DS with that of Group D, for the calibrated prediction of the model is the sharpest between these two. This is illustrated in Figures 7 and 8 that demonstrate that the MPC of Group DS is adjacent to those of Group D and the Benchmark Group. Any misclassification of observations among these three groups will blur the real difference in their MPCs. In all regressions, we control for labor income, family size, and household age, although their coefficients are not the focus of this paper. Table 5 contains detailed information of all the estimates of the MPCs.

Figure 9 presents all of the regression estimates for Group DS and Group S, based upon the predicted non-durable goods and services consumption measure. For the weighted OLS regressions, in three of the five survey years, the MPC of Group DS is dominating that of Group S, and is consistent with our model prediction, and these two series co-move with each other. Moreover, the coefficients before the net worth for Group S are mostly insignificant. However, in year 2005, presumably the period when the activity of home equity extraction peaked, these two MPCs switched their relative signs, and the MPC of Group S dominated Group DS. This is also contradicting the pattern we observe from Figure 3, in which both total consumption and non-durable consumption rise since 2005.

There also exists a difference in MPC when breaking down the conditional distribution

of consumption. Here, the same pattern between the MPC of Group DS and MPC of Group S can be replicated in the first quartile regressions. Yet, in the median regressions and third quartile regressions, the opposite occurs: the MPC of Group S is greater than the MPC of Group DS. Quantile regressions are less sensitive to outlier observations, and the fact that OLS results are consistent with the lower quantile results suggests that the greater magnitude of MPC for Group DS in OLS estimates is largely driven by the observations of lower quantiles in consumption. Note that our regressions are not breaking the observations of each cross-section sample down into quantiles based on net worth; instead, all quantile regressions are conditional on the net worth for all observations. This may hint that the collateral effect matters more for those households whose consumption is less than the average, for possible unobserved idiosyncratic reasons that may include, for instance, the uncertainty of future economic conditions. Moreover, F-tests for $\beta_{DS} > \beta_S$ are insignificant in all cases, whereas those significant ones pertain to cases where $\beta_S > \beta_{DS}$ (Table 5). This is contradictory to the collateral impact implied from macro data, or at the very least, it suggest the effect is largely absent from the consumption of non-durable components.

4   Concluding Remarks

This paper sets up the collaterality of housing assets as the null hypothesis, and attempts to gauge its effect on MPC. The evidence from the PSID data supporting this hypothesis is contradictory to calibrated predictions from macro data based upon the same model. With sylized assumptions in place, any effect would be deemed as the upper bound of the wealth effect that can possibly be attributed to collaterality. In particular, the fact that we fail to find any substantial support for the cross-section sample of year 2005 is curious, belying the belief that the consumption boost in recent years was largely fueled by the easy credit pledged against homeowners' equity. However, due to the limitations in PSID data, our consumption measure is the aggregate of non-durable goods and services; whether and how

consumers tap into their home equity to finance durable goods and services expenditures, such as health care or education, or other investments other than housing, stocks, and bank deposits, is unexamined in this paper. In fact, all these analyses echo the hint from Figure 1 that the boost in consumption due to the housing collateral booming may take place in durable goods and services consumption.

We intentionally choose not to state precisely what possible alternative hypotheses are. These alternative hypotheses may zoom in on consumers' psychological factors – e.g., people do not treat different forms of wealth all the same (Thaler 1990), or on intrinsic preferences – people simply prefer living in their own houses rather than renting, or on the complementarity of housing anc consumption – people simply consume more if they are living in a bigger house, as more lights will be needed or more gas will be burnt for heating. However, these possibilities exist regardless of the collaterality of the house. Our attempt is to isolate the collateral effect to investigate. These alternative hypotheses are unlikely to generate the same predictions on the differences in the MPCs as ours, when the population is devided into sub-groups by their asset/debt portfolios. Nonethless, incorporating elements of these alternative hypotheses to bring up fresh insights will be worthwhile extensions of our model.

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A   Tables and Figures

	Data dimension	Data source	Log of housing wealth	Log of financial wealth
Bostic et al. (2008)	Cross-section	CEX matched with SCF	0.042~0.06 (for housing value) 0.076~0.247 (for home equity)	0.018~0.024 (for financial wealth) 0.009~0.065 (for financial net worth)
Case et al. (2005)	Panel (long time series)	International country-level data U.S. state-level data	0.10~0.17 0.03~0.10	N/A~0.02 (for stock wealth) N/A~0.06 (for stock wealth)[a]
			Level of housing wealth	Level of financial wealth
Dvornak & Kohler (2003)	Panel (long time series)	aggregate level of five states in Australia	0.024~0.036[b]	0.06~0.12
Klyuev & Mills (2007)[b]	Time series	U.S., Australia, Canada, U.K., country-level	0.02	-0.009[c]
Levin (1998)				

Note: (a) Testing of housing wealth effect equal to stock wealth effect is unambiguously rejected in each specification; (b) all variables are measured as a ratio to disposable income; (c) coefficient not significant at 10 percent.

Table 1: Selected estimates of wealth effects in literature

	Wealth Portfolio	Corresponding to Theorem 1	Group MPC
Group D	$D^*>0$, $W^*_s=0$	Case 1	α_1
Group S	$D^*=0$, $W^*_s>0$	Case 5	α_5
Group DS	$D^*>0$, $W^*_s>0$	Case 2	α_2
Benchmark Group	$D^*=0$, $W^*_s=0$	Case 3, 4	α_3 , α_4

Notes: $W^*_h>0$ for all groups. The Group MPC column indicates that the MPC for each group will be a weighted average of MPCs of cases in Theorem 1 included in the group.

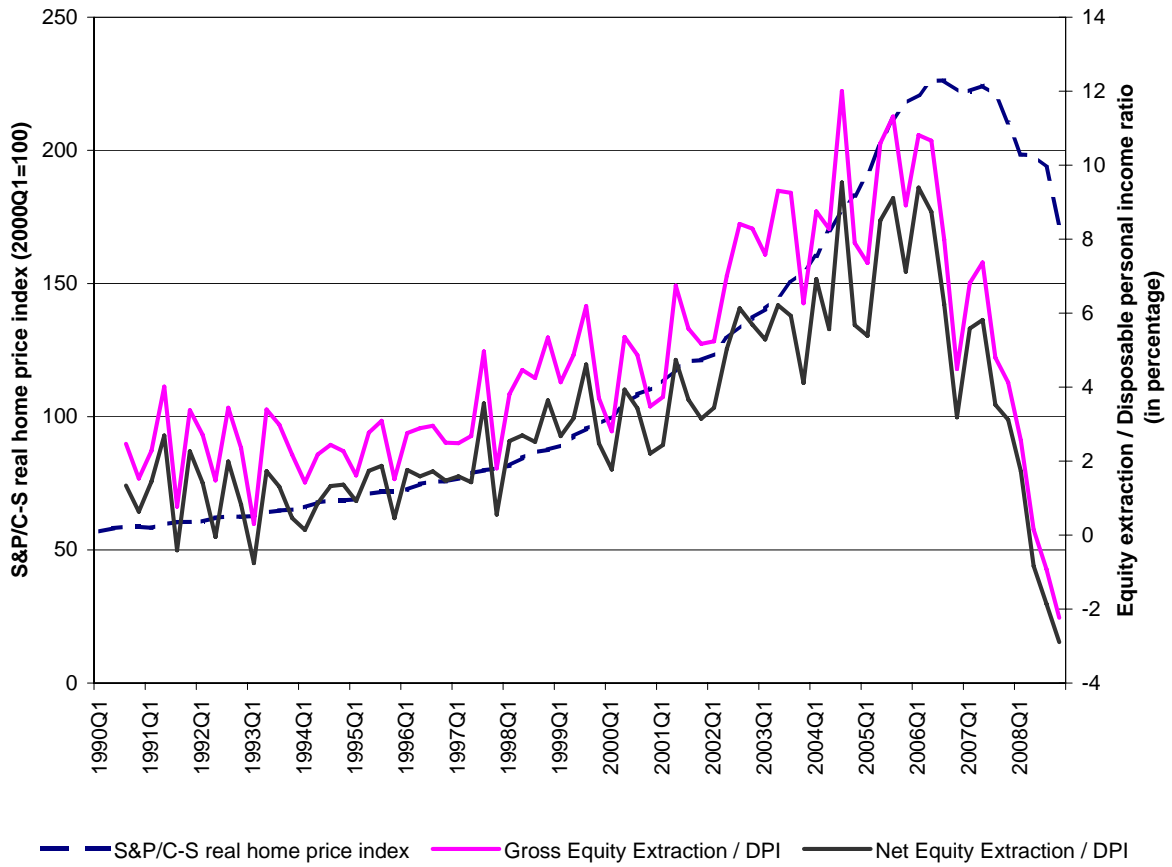Table 2: Classification of four groups by asset/debt portfolio

Home Price and Consumption/Income Ratio
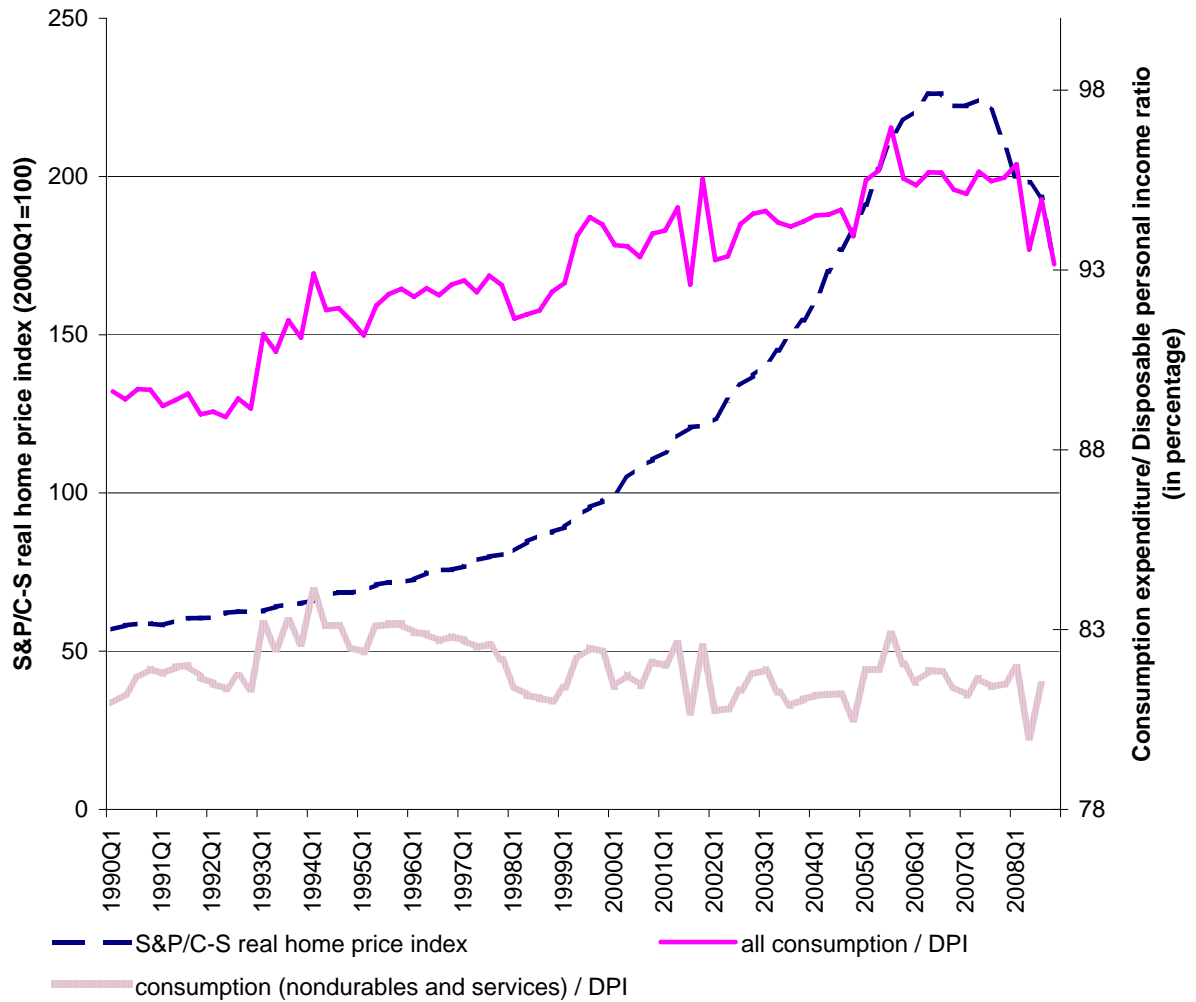
Source: Standard & Poors & Fiserv; Bureau of Economic Analysis; Bureau of Labor Statistics.

Figure 1: U.S. real home price index and consumption/income Ratio: 1990 Q1 – 2008 Q4
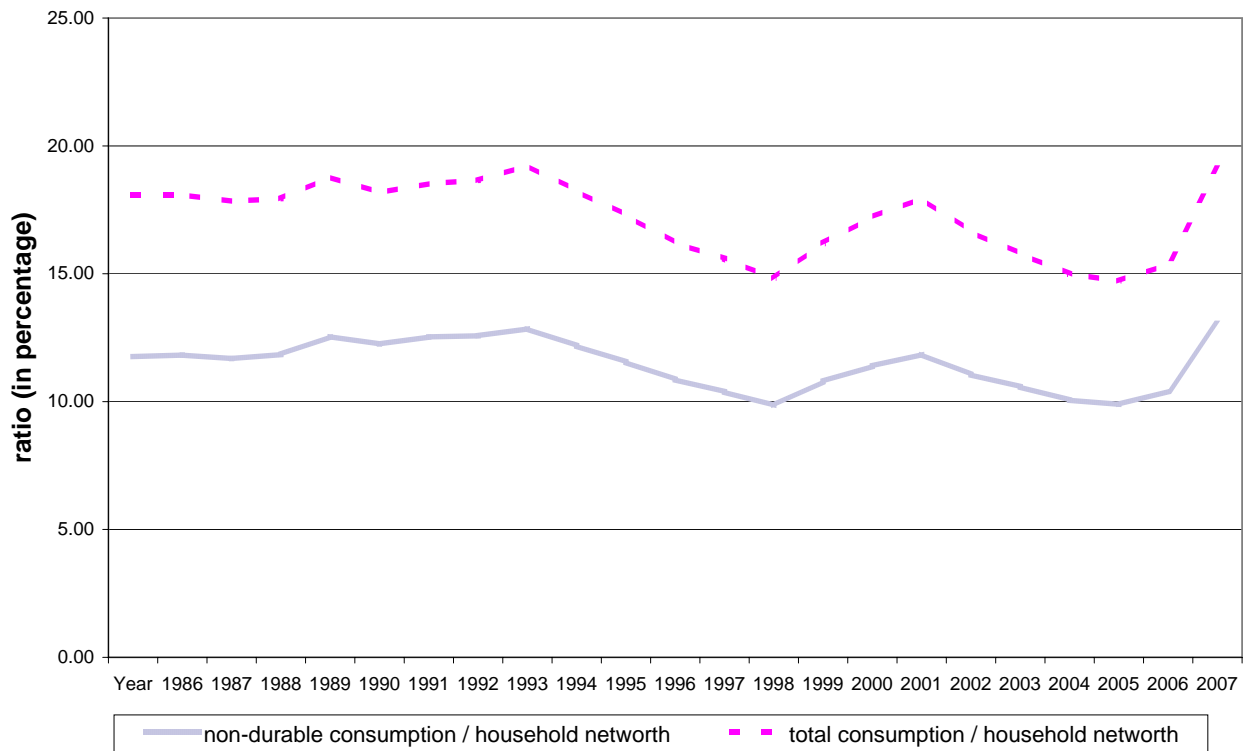
Home Price and Equity Extraction Ratio

Source: Standard & Poors & Fiserv; Bureau of Economic Analysis; Greenspan and Kennedy (2005).

Notes: data of equity extraction / disposable income after 2005 Q1 is generously shared by James Kennedy.

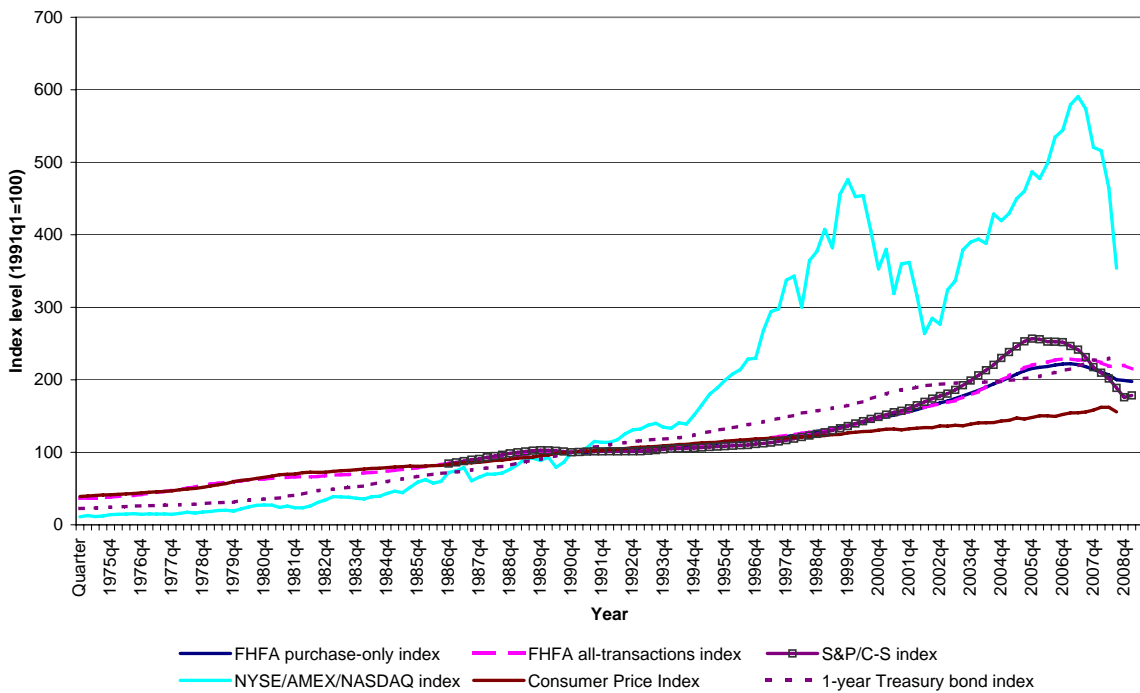Figure 2: U.S. real home price index and equity extraction/income Ratio: 1990 Q1 – 2005 Q1

household consumption-to-networth ratio

Source: Bureau of Economic Analysis; Federal Reserve Bank.

Figure 3: Ratio of household consumption to net worth

Financial and housing assets index levels

Source: CRSP; Federal Reserve Bank.

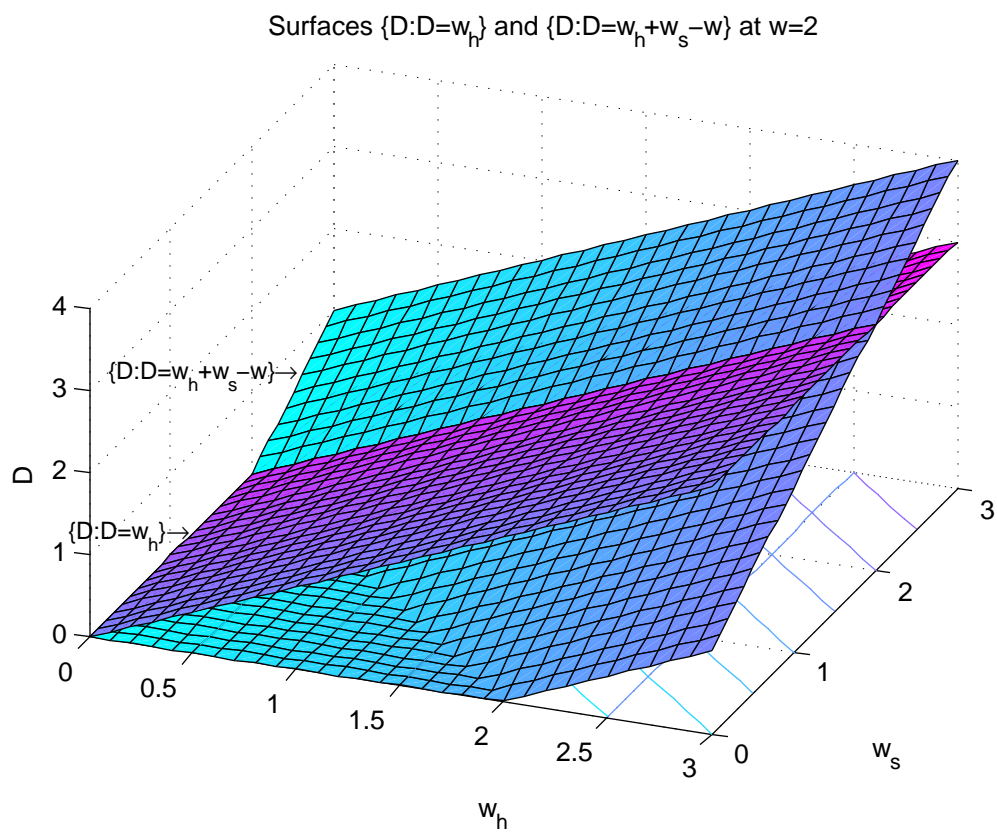Figure 4: Financial and housing market indice (1991q1=100)

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Figure 5: Plot of constraints in $\triangle(w)$
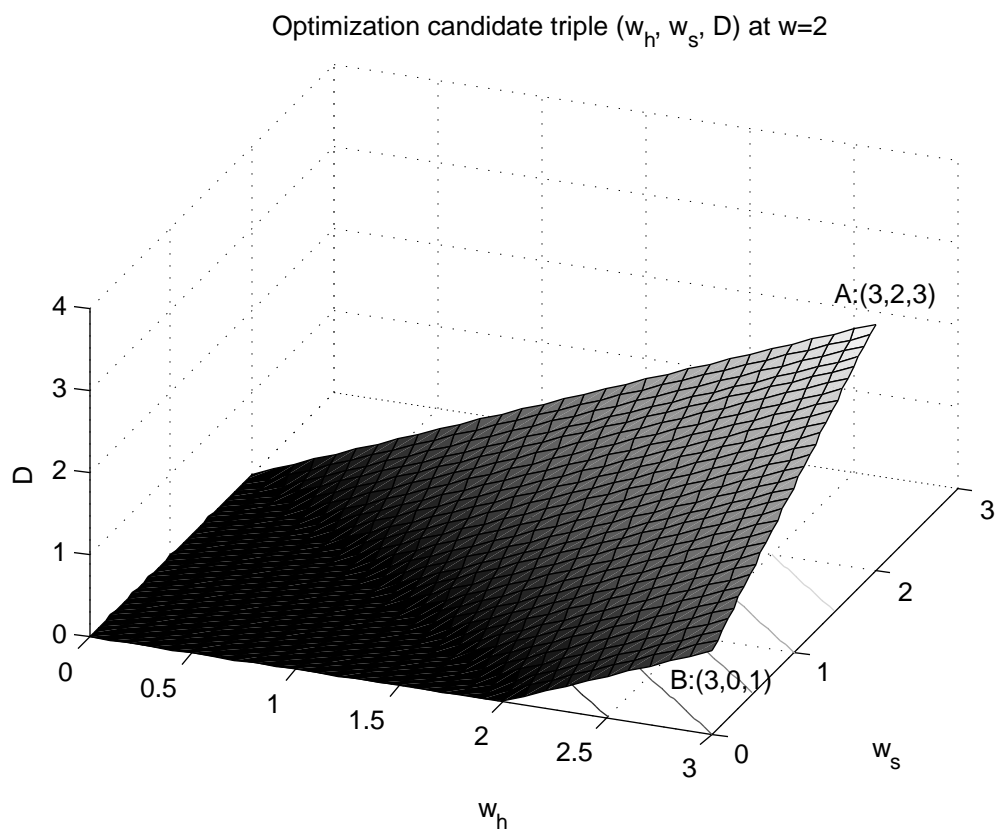
Figure 6: Plot of optimal candidate set for (w_h, w_s, D)

Baseline Parameter Values		
Description	*Parameter*	*Value*
Degree of risk aversion	γ	3
Discount rate	β	0.05
Risk-free interest rate	r_f	0.044
Borrowing premium	$R-r_f$	0.007
Housing return premium	μ_h-r_f	0.02
Housing return volatility	σ_h	0.033
Stock return premium	μ_s-r_f	0.059
Stock return volatility	σ_s	0.172
Notes: all parameter values are in annual terms.		

Table 3: Baseline parameter values used for calibration

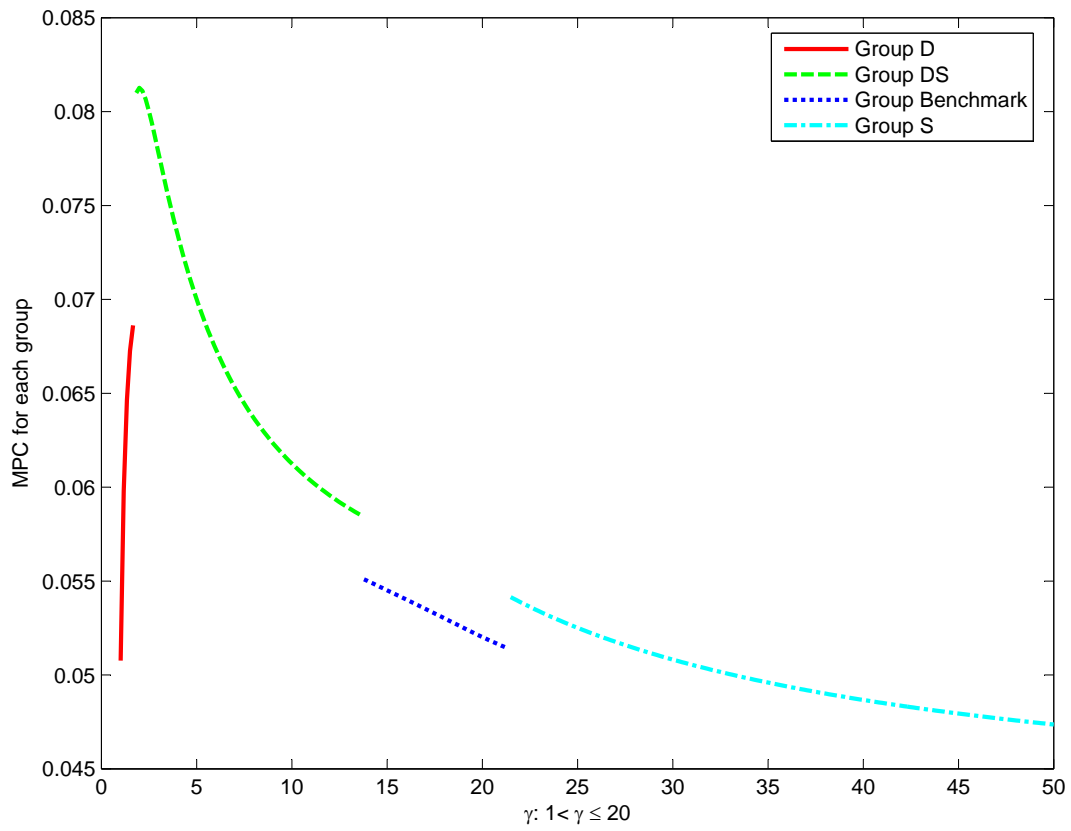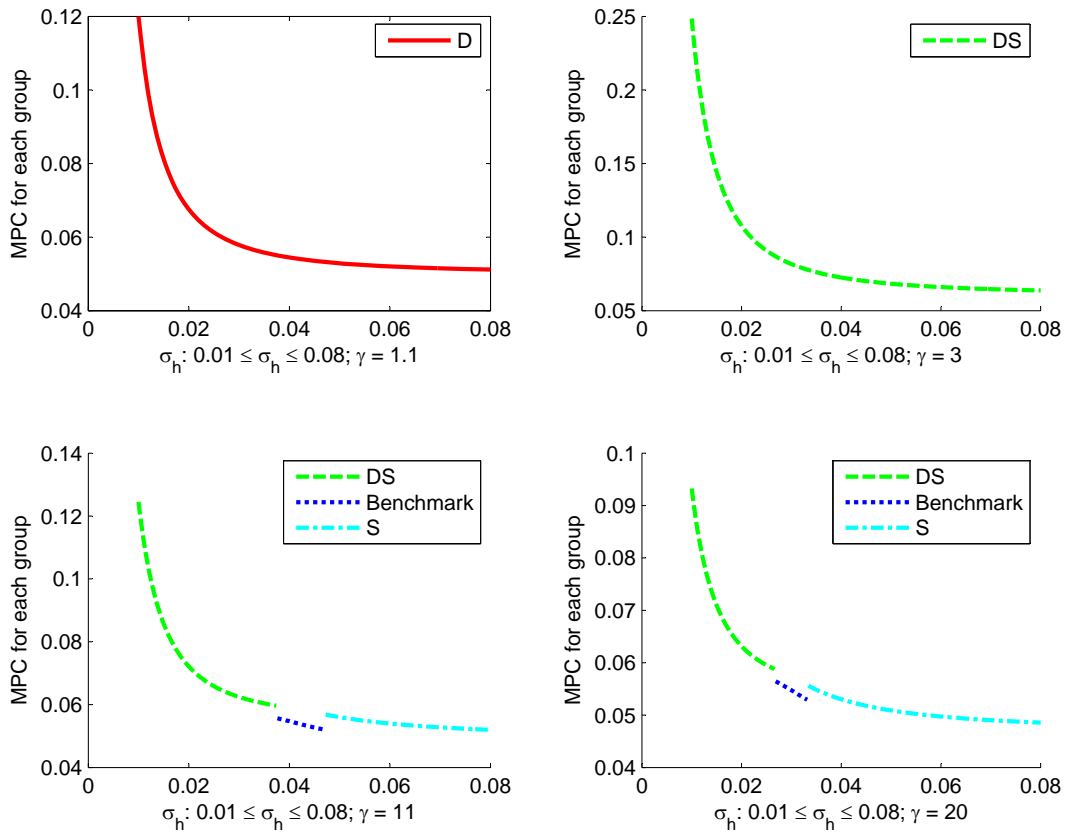Figure 7: MPC for different groups based on baseline parameter values: heterogeneity in γ

Figure 8: MPC for different groups based on baseline parameter values: heterogeneity in σ_h

Survey Year	Variable	Group D				Group DS				S				Benchmark			
		Obs.	Median	Mean	Std. Dev.	Obs.	Median	Mean	Std. Dev.	Obs.	Median	Mean	Std. Dev.	Obs.	Median	Mean	Std. Dev.
1994	House value	1194	72000	91610.05	74300.3	1427	110000	133532.8	96951.21	618	68000	107455.6	411036.2	580	43450	52090.85	47332.36
	Mortgage debt	1194	40000	57067.22	291347	1427	58000	71299.78	63437.86	618	0	0	0	580	0	0	0
	Net worth	1194	47556	89407.05	196960.9	1427	132000	264246.2	545555.5	618	254000	521946.8	1084504	580	59750	115880.4	233988.1
	Labor income	1194	40999	44798.76	31580.14	1427	80998	7158118	1.06E+07	618	2.30E+07	1.32E+07	1.14E+07	580	22134	26511.08	22793.89
	Consumption (simple sum)[a]	1194	5273	5669.831	2975.547	1427	6240	6701.528	3618.037	618	4940	8554.01	56625.65	580	4160	4515.575	2825.305
	Consumption (predicted)[b]	1194	18012.3	18840.13	8638.593	1427	20822.9	21751.85	10175.95	618	17028.35	23149.5	91847.33	580	14686.1	15340.88	8543.186
	Family size	1194	3	3.31	1.40	1427	3	3.35	1.46	618	3	3.07	1.66	580	3	2.85	1.44
	Household head age	1194	41	42.2	9.78	1427	43	44.2	10.63	618	53	53.3	14.6	580	44	46.3	14.7
1999	House value	1374	90000	113863.6	84728.69	584	160000	194419.2	133233.9	164	122500	175393.3	185389.1	390	60000	81593.33	122439.5
	Mortgage debt	1374	55000	65394.09	55656.36	584	82000	100984.9	74987.11	164	0	0	0	390	0	0	0
	Net worth	1374	61135	142073.7	469057.7	584	214500	448898.6	1296164	164	455500	1011580	2136910	390	84700	225044.1	726741
	Labor income	1374	50000	55627.96	34741.05	584	80000	100261.2	108565.8	164	50500	64930.91	72311.5	390	30000	34337.34	25181.09
	Consumption (simple sum)[a]	1374	6400	7228.819	3660.707	584	7268	8321.365	4666.121	164	6388	7706.457	4837.663	390	6058	6738.621	3503.756
	Consumption (predicted)[b]	1374	7752.95	8143.86	3971.774	584	8980.23	9747.808	4547.594	164	7460.572	8290.098	4366.042	390	6567.25	6855.885	3962.121
	Family size	1374	3	3.29	1.41	584	3	3.12	1.30	164	2	2.43	1.10	390	3	2.94	1.58
	Household head age	1374	43	43.5	9.64	584	45	45.0	9.33	164	55	55.1	11.7	390	49	49.5	13.6
2001	House value	1486	105000	133119.9	107746.8	637	180000	227357.4	218488.3	148	147500	201152	193745.1	398	60000	87034.17	114745.9
	Mortgage debt	1486	62000	74854.34	64564.96	637	90000	107163.1	91382.34	148	0	0	0	398	0	0	0
	Net worth	1486	63500	139547.8	300882.2	637	255000	452380	1383818	148	473000	1174615	3782206	398	97200	239195.3	563392.2
	Labor income	1486	54000	62109.21	52526.54	637	82500	104199.3	103971.1	148	54603	70081.03	79808.25	398	33000	44377.75	54966.98
	Consumption (simple sum)[a]	1486	7702	8876.579	5467.088	637	8448	9918.906	5784.664	148	7450	8644.27	4805.724	398	6610	7702.726	5177.155
	Consumption (predicted)[b]	1486	8754.61	9310.469	4701.342	637	10428.5	11118.23	5084.234	148	8277.071	9035.564	5040.575	398	7318.34	7601.086	5020.012
	Family size	1486	3	3.20	1.43	637	3	3.21	1.41	148	2	2.51	1.24	398	2	2.84	1.46
	Household head age	1486	44	44.0	10.2	637	46	45.6	9.30	148	54	55.3	11.1	398	50	49.5	12.5
2003	House value	1485	125000	159005	125890.5	604	225000	280579.5	269774.6	177	150000	231875.7	241079	397	65000	89063.98	99080.97
	Mortgage debt	1485	71000	87481.52	68194.62	604	101500	128784.4	121156	177	0	0	0	397	0	0	0
	Net worth	1485	77500	172298.8	442681.6	604	273000	499943.5	881457.5	177	488600	1201596	3287664	397	96000	198173.2	383565
	Labor income	1485	56160	66592.58	56612.93	604	80000	104849.5	164599.4	177	47500	72491.21	157538.2	397	35000	41632.68	33584.53
	Consumption (simple sum)[a]	1485	8040	9394.512	5809.877	604	8880	11212.3	9589.329	177	8116	10323.45	7932.715	397	6880	8328.058	5779.338
	Consumption (predicted)[b]	1485	9899.23	10388.36	4969.235	604	10984.5	12226.18	6195.988	177	9147.866	10513.91	5948.071	397	8160.14	8526.71	5592.806
	Family size	1485	3	3.22	1.42	604	3	2.99	1.27	177	2	2.39	1.06	397	2	2.73	1.33
	Household head age	1485	45	44.9	10.0	604	47	46.8	10.1	177	56	56.5	11.0	397	49	50.3	11.6
2005	House value	1525	150000	201228.4	175288.8	584	270000	353920	359794.8	171	180000	312751.5	341408.5	400	80000	114306.8	133415.5
	Mortgage debt	1525	80000	101159.6	83101.47	584	122500	152688.7	139271	171	0	0	0	400	0	0	0
	Net worth	1525	97000	224139.4	587995.8	584	338750	691354	2049987	171	805300	1425382	3428565	400	124000	256538.1	507319.1
	Labor income	1525	62500	71745.1	54359.19	584	90326.5	121436.8	217818.9	171	57000	79039.54	107555.1	400	33205	43583.25	38534.15
	Consumption (simple sum)[a]	1525	10662	12225.49	7459.789	584	11474.5	13704.96	8668.048	171	10272	13294.68	11932.08	400	8758	10685.47	7217.169
	Consumption (predicted)[b]	1525	11570.6	12357.51	6034.918	584	13018	14491.98	7023.233	171	10573.7	12357.34	7026.547	400	9790.52	9949.335	5704.335
	Family size	1525	3	3.14	1.43	584	3	3.02	1.23	171	2	2.25	0.96	400	2	2.72	1.38
	Household head age	1525	46	45.7	10.1	584	47	47.4	10.2	171	56	56.9	10.5	400	52	52.3	12.1

Notes: Group DS includes households who owe positive mortgage debts and own positive stockholdings in the reference year; Group D includes households who owe positive mortgage debts but do not own positive stockholdings in the reference year; Group S includes households who do not owe positive mortgage debts but own positive stockholdings in the reference year; all financial variables are in current dollars of the year. (a) the measure of simple sum of food, utilities and transportation expenditures; (b) predicted non-durable goods and service expenditure by the same three components (see Skinner (1987) and text for detail).

Table 4: Summary statistics for four groups in PSID samples
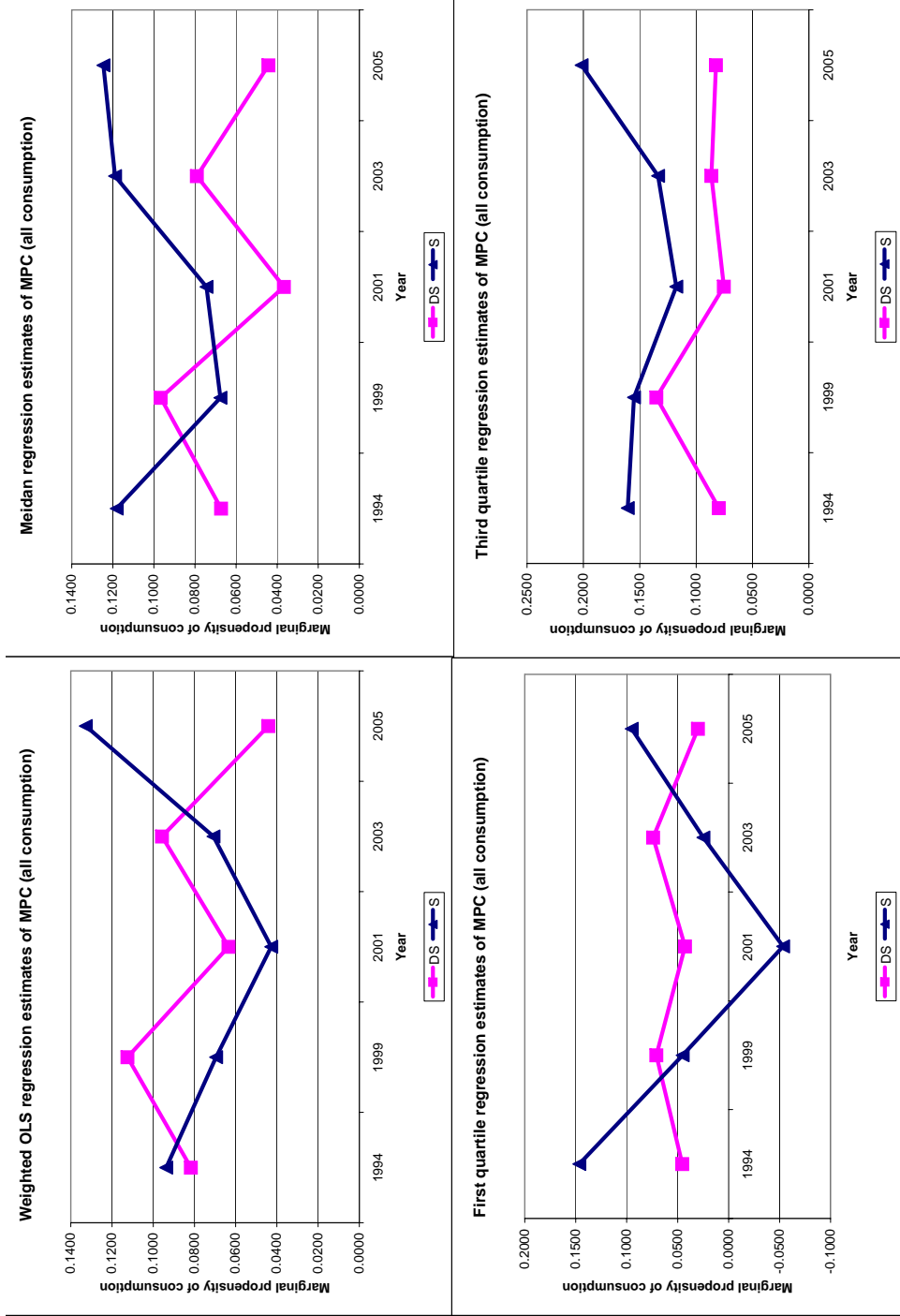
Figure 9: Predicted consumption (non-durable goods and services) regression estimates of MPC for four groups in PSID samples

Table 5: Cross section regression results for four groups in PSID samples

YEAR	OLS D	OLS DS	OLS S	OLS Benchmark	First Quartile D	First Quartile DS	First Quartile S	First Quartile Benchmark	Median D	Median DS	Median S	Median Benchmark	Third Quartile D	Third Quartile DS	Third Quartile S	Third Quartile Benchmark
Consumption: predicted from food, utility, and transportation expenditure																
1994	0.0991	**0.0817**	**0.0937**	0.4175	0.0562	**0.0455**	**0.1465**	0.1518	0.0756	**0.0673**	**0.1181**	0.1021	0.0773	**0.0798**	**0.1606**	0.0777
p-value	0.001	0.000	0.169	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$H_0: \beta_{DS}=\beta_S$?			0.944				0.006				0.060				0.413	
1999	0.1574	**0.1125**	**0.0695**	0.2452	0.0800	**0.0709**	**0.0451**	0.1985	0.0397	**0.0967**	**0.0676**	0.1481	0.0499	**0.1352**	**0.1551**	0.1347
p-value	0.004	0.000	0.220	0.000	0.000	0.000	0.168	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000
$H_0: \beta_{DS}=\beta_S$?			0.573				0.777				0.241				0.662	
2001	0.0479	**0.0635**	**0.0428**	0.0778	0.0417	**0.0428**	**-0.0534**	0.0701	0.0418	**0.0367**	**0.0744**	0.0671	0.0621	**0.0754**	**0.1176**	0.0873
p-value	0.014	0.005	0.444	0.093	0.001	0.035	0.322	0.088	0.000	0.077	0.076	0.000	0.000	0.001	0.003	0.000
$H_0: \beta_{DS}=\beta_S$?			0.613				0.130				0.723				0.628	
2003	0.0736	**0.0958**	**0.0708**	0.1820	0.0374	**0.0740**	**0.0248**	0.1521	0.0459	**0.0791**	**0.1189**	0.1137	0.0662	**0.0865**	**0.1338**	0.1239
p-value	0.000	0.000	0.131	0.006	0.001	0.000	0.498	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.000
$H_0: \beta_{DS}=\beta_S$?			0.740				0.063				0.368				0.023	
2005	0.0531	**0.0442**	**0.1327**	0.1850	0.0240	**0.0301**	**0.0951**	0.1880	0.0340	**0.0442**	**0.1246**	0.1222	0.0363	**0.0824**	**0.2016**	0.1167
p-value	0.009	0.024	0.013	0.000	0.010	0.087	0.007	0.000	0.000	0.009	0.002	0.002	0.002	0.000	0.000	0.000
$H_0: \beta_{DS}=\beta_S$?			0.187				0.176				0.071				0.002	