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Abstract

This paper shows, from the consumer budget constraint, that the consumption spending and the different components of total wealth, i.e. financial, housing and human wealths, are cointegrated and that deviations from the common trend *cahy* is a proxy for the consumption – wealth ratio that should predict expected returns on financial assets and housing. Using U.S post–war data, we provide empirical evidence in favor of the existence of a cointegration relationship with a structural break in the mid-eighties. Moreover, we show that until the beginning of 2000, consumption spending and housing wealth were dominated by permanent shocks. The main variable that adjusts to restore the long–run trend when a deviation occurs is the financial wealth and therefore it presents the main transitory variations in total wealth. However, over the last period 2000–2009, most of transitory shocks in total wealth are associated to fluctuations in the housing component of wealth rather than financial wealth. Besides, we found that a small fraction of transitory changes in wealth is associated with movements in consumption. These conclusions are in line with our empirical results on the ability of the *cahy* to predict expected asset and housing returns. Indeed, until the beginning of 2000, the proxy of the consumption–wealth ratio predicts expected asset returns and fails to explain future fluctuations in housing returns.

Key words: Consumption–wealth ratio, Structural break, Cointegration, Cointegrated VAR, Trends and cycles, Housing returns, Asset prices, Long–run predictability.
JEL Classification: C22, E21, G12.

Résumé

A partir de la contrainte budgétaire, cet article montre que la consommation agrégée et les différentes composantes de la richesse totale sont co-intégrées et que l'écart par rapport à la tendance commune *cahy* est une approximation du ratio consommation – richesse. En utilisant des données américaines, nous montrons l'existence d'une relation de cointégration avec une rupture structurelle au milieu des années quatre-vingt. En outre, nous montrons que, jusqu'au début des années 2000, les dépenses de consommation et le patrimoine immobilier ont été dominés par les chocs permanents. La richesse financière représente la principale source des variations transitoires de la richesse totale. Cependant, au cours de la dernière période 2000 - 2009, la plupart des chocs transitoires de la richesse totale sont associés aux fluctuations de la richesse immobilière. Ces conclusions sont en adéquation avec nos résultats empiriques sur la capacité du *cahy* à prédire les rendements futurs des actifs financiers et du logement. En effet, jusqu'au début des années 2000, le ratio consommation - richesse prédit les rendements futurs des actifs financiers et ne parvient pas à expliquer les fluctuations futures du rendement du logement.

Mots clés: Ratio consommation–richesse, Rupture structurelle, Cointégration, Tendances et cycles, Rendement du logement, Prix d'actifs financiers, Prédictibilité à long–terme.
Codes JEL: C22, E21, G12.

Introduction

Since the mid-nineties, large fluctuations in asset prices have raised numerous questions about the relation between macroeconomic variables such as private consumption or economic growth and financial markets. While the stock price' boom (and burst) of the 1990's has shed light on the potential impact of the stock market fluctuations, the recent subprime crisis calls for research highlighting the specific role of housing prices. Using U.S data, we build upon the cointegration approach of Lettau and Ludvigson (2001, 2005) in order to investigate the response of aggregate consumption to non-housing and housing wealth's fluctuations.

Our contribution is twofold. First, we separate US aggregate wealth into financial (non-housing) and housing components. Thus, we are able to distinguish the US consumption's elasticity to housing wealth from elasticity to others wealth's components (financial and human wealth). Second, we take into account different critics about the stability of the cointegration relationship in Lettau and Ludvigson's model. To do so, we introduce structural shifts both in the long–term and in the short–term dynamics of aggregate consumption and wealth.

Lettau and Ludvigson's framework built up on the original work by Campbell (1993). Based on a log-linearization of the (representative) household budget constraint, Lettau and Ludvigson (2001) argue that the log-levels of consumption and components of total wealth (non–human wealth and human wealth) are cointegrated. They show that the deviation from the shared trend is a good proxy for the consumption − wealth ratio and should be a good candidate to predict future fluctuations in asset prices or/and future consumption growth. Besides, based on post war U.S. data, they show empirically that the residuals of the cointegration relationship has predictive power for future asset returns, specially at short horizons. They also present empirical results which demonstrate that most of the variation in non–human wealth, i.e. asset holdings, are transitory and induce little response in household consumption. However, their definition of asset wealth does not allow to obtain specific results for non-housing and housing wealth. Fisher, Otto and Voss (2009) and De Veirman, Dunstan (2008) apply this approach respectively to Australian and New Zealand data and find, as for US data, a cointegration relationship. Separating financial and housing wealth, they conclude that the elasticity of consumption to permanent housing wealth change was stronger than for permanent financial wealth variation. However, Fisher, Otto and Voss (2009) also find that most of the fluctuations in housing wealth are transitory and unrelated to private consumption variations. Finally they discuss the stability of the cointegration relationship and suggest that the cointegration relationship could have "disappeared" since the mid-2000 in Australia or that the cointegrating vector could have change in New-Zealand in the mid-eighties.

The stability of the cointegration relationship is indeed one of the main concerns about Lettau and Ludvigson's approach. Intuitively, it is likely that since the 1950's institutional changes have modified the way US households accumulate and consume out wealth (the development of the financial markets could be one of these changes). As Caroll, Otsuka and Slacalek (2006) noticed, long–term relationship between the log of consumption and wealth is determined by the steady–state of interest rate, productivity growth rate, etc... If one of these parameters changes, the estimation of the cointegration relationship would be biased. In particular, the cointegration hypothesis would be over–rejected by corresponding tests in the presence of structural changes in the long-term relationship's parameters (see Gregory and Hansen (1996)).

In this study, we perform statistical tests for the stability of the parameters in both cointegration relationship and Vector Error Correction Model for US consumption, financial, housing and human wealth using U.S. quarterly data over the period 1952Q1 to 2009Q1. More specifically, we follow the methodology of Seo (1998) and test the presence of a structural break in the cointegrating vector (for the system's long–term dynamic) and/or the adjustment term vector (in the short–term dynamic). We reject at the 5% level the hypothesis of (separate and joint) stability of both vectors and suggest break dates estimates for each of them. We find a shift of the cointegrating vector in the beginning of the eighties and conjecture a break in the adjustment term vector during the 2000s.

We also provide parameters' estimates for the long–term relationship between (the log of) consumption, financial, housing and human wealth and for the VECM conditional on cointegrating vector estimation. Under the stability hypothesis, we find that the consumption elasticity to permanent change in housing wealth is similar to the "financial wealth" elasticity. Under the instability hypothesis, the consumption elasticity to permanent change in human wealth rises in the last period (after 1982Q4) whereas the elasticity to asset wealth is reduced. In particular, the elasticity to permanent fluctuation in housing wealth shrinks while the elasticity to financial wealth is less affected.

Based on our cointegration work, we provide two main results.

First, we show that over the sub-period 1952–1999, consumption is dominated by permanent shocks and therefore, only permanent changes in total wealth are associated with movements in consumption. Moreover, we show that the transitory shocks in total wealth are mainly associated to fluctuations in the financial component of wealth and not the human capital nor the housing wealth. As the accumulation of wealth is mainly due to valuation of previously owned assets (see Ludvigson and Stendeil (1999) for more details), transitory innovations in financial wealth are implied by transitory movements in returns on financial. Therefore, the consumption–wealth ratio measured by the deviation from the shared trend is a good predictor of expected excess returns, specially over the sub-period 1952Q1–1999Q4. When the consumers predict an increase in future financial wealth due to an expected increase in returns, they borrow from the future to smooth their consumption, driving up the consumption–wealth ratio. On the other side, housing wealth is dominated by permanent changes, so the consumption–wealth ratio fails to predict housing returns.

Second, when the last period 1999–2009 is added to the period of estimation, things are different. Most of transitory shocks in total wealth are associated to fluctuations in the housing component of wealth rather than financial wealth and human capital. Moreover, we found that a small fraction of transitory changes in wealth is associated with movements in consumption. Therefore, there is less evidence in favor of the predictive power of consumption–wealth ratio on excess of risky assets. Besides, when the two last years are added to the period of estimation, consumption–wealth ratio explains a small fraction of the expected housing returns. Thus, our study highlights statistical results on the relation between consumption and aggregate wealth which could enrich the analysis of wealth's (and particularly housing wealth's) fluctuations for monetary policy purposes.

The paper proceeds as follows. Section 1 presents the theoretical framework that extends Lettau and Ludvigson (2001) cointegration approach by decomposing non–human wealth into non–housing and housing wealth. The cointegration test and the test of parameters stability (in the cointegrating vector) are performed in Section 2. We show in Section 3 the parameters estimates for the VECM, and discuss the stability of the whole model. We also provide cycle and trend decomposition of consumption and the different components of total wealth in order to identify the origin of transitory shocks. Finally, we test in Section 4 the ability of the *cahy* to predict both asset returns and returns on housing.

1 Theoretical Framework

This section presents the general framework linking consumption, financial wealth, housing wealth and labor income to both expected asset returns and housing returns. It generalizes the work of Lettau and Ludvigson (2001 and 2005) by decomposing non–human wealth (i.e. asset holdings) into non–housing wealth (or equivalently financial wealth) and housing wealth. We show that consumption and different components of total wealth share a common trend that presents the long run relationship between these variables. The deviation from this shared trend can be used as a measure of consumption–wealth ratio and provides a theoretical candidate to predict either returns on risky assets or housing returns. A summary of our theoretical framework is as follows[1]. We consider a representative agent economy in which all wealth (including human capital) is tradable. The accumulation equation for aggregate wealth is given by:

$$W_{t+1} = (1 + R_{w,t+1})(W_t - C_t) \tag{1}$$

when W_t denote the aggregate wealth at the beginning of the period t, C_t the aggregate consumption and $R_{w,t}$ the net return on aggregate wealth.

Following Campbell and Mankiw (1989) and Lettau and Ludvigson (2001 and 2005), we assume that the consumption–wealth ratio is stationary. Therefore, by taking the first order Taylor expansion of Equation (1) and by iterating forward, the budget constraint rewrites[2]:

$$c_t - w_t = \frac{\rho_w}{1-\rho_w} k_w + \mathbb{E}_t \sum_{i=1}^{\infty} \rho_w^i \left(r_{w,t+i} - \Delta c_{t+i} \right) \tag{2}$$

[1]More details will be provided in Appendix A.

[2]Throughout this paper, we use lower case letter to denote log variables.

where $\rho_w = \overline{\left(\frac{W-C}{W}\right)}$ and $k_w = \log(\rho_w) + \left(1 - \frac{1}{\rho_w}\right)(\rho_w - 1)$. $\mathbb{E}_t$ is the expectation operator conditional on information available at time t.

As mentioned by Lettau and Ludvigson (2001 and 2005), Equation (2) is of little use in empirical work because both aggregate total wealth and return on aggregate wealth are not observable. Therefore, total aggregate wealth is decomposed into three sub-components: human wealth L_t, financial wealth A_t and housing wealth H_t, i.e. $W_t = A_t + H_t + L_t$. Thus, the (log) aggregate wealth w_t may be approximated by:

$$w_t = \overline{w}_a a_t + \overline{w}_h h_t + \overline{w}_l l_t \tag{3}$$

where $\overline{w}_a$, $\overline{w}_h$ and $\overline{w}_l$ equal respectively the steady–state shares A/W, H/W and L/W and satisfy $\overline{w}_a + \overline{w}_h + \overline{w}_l = 1$. Because human capital is unobservable, Lettau and Ludvigson (2001 and 2005) show that the (log) human capital can be approximated as $l_t = \kappa + y_t + z_t$ where y_t is (log) aggregate labor income, z_t is a mean-zero stationary process and κ is a constant[3].

On the other side, following Campbell (1996), the return on aggregate wealth can also be decomposed into returns on the different components of total wealth:

$$1 + R_{w,t+1} = w_{a,t}(1 + R_{a,t+1}) + w_{h,1}(1 + R_{h,t+1}) + w_{l,t}(1 + R_{l,t+1}) \tag{4}$$

where $w_{a,t} = A_t/W_t$, $w_{h,t} = A_t/W_t$ and $w_{l,t} = L_t/W_t$. Assuming that the ratios $w_{a,t}$, $w_{h,t}$ and $w_{l,t}$ are stationary, Equation (4) can be approximated as follows:

$$r_{w,t+1} = \overline{w}_a r_{a,t+1} + \overline{w}_a r_{h,t+1} + \overline{w}_l r_{t+1} \tag{5}$$

Plugging Equations (3) and (5) into Expression (2), we obtain:

$$\begin{aligned} & c_t - w_a a_t - w_h h_t - (1 - w_a - w_h)\, y_t = \\ & \qquad \mathbb{E}_t \sum_{i=1}^{\infty} \rho_w^i \left(w_a r_{a,t+i} + w_h r_{h,t+i} + (1 - w_a - w_h)\, r_{l,t+i} - \Delta c_{t+i}\right) + (1 - w_a - w_h)\, z_t \end{aligned} \tag{6}$$

Equation (6) suggests that the consumption–wealth ratio, measured as the residual of the cointegration relation between (log) consumption and(log) components of total wealth, should forecast predictable changes in asset prices, housing prices or/and consumption growth. When the consumer predicts an increase in (*i*) future financial wealth, (*ii*) future housing wealth or/and (*iii*) a decrease in future consumption growth, he borrows from the future to smooth his consumption and insulate future consumption from fluctuations in expected returns on financial assets and housing, driving up the current consumption–wealth ratio.

[3]See Appendix A for more details.

2 Cointegration

2.1 Data

Macroeconomic data used in this study are real, per capita quarterly US data from the first quarter of 1952 to the first quarter of 2009. The data[4] include (*i*) consumption, (*ii*) financial wealth, (*iii*) housing wealth, (*iv*) labor income, (*v*) total population and (*vi*) price deflator. Following Blinder and Deaton (1985), Campbell (1987) and Lettau and Ludvigson (2005), the total flow of consumption is measured as total personal consumption expenditures and housing and non–housing services, excluding shoes and clothing. Durable goods and expenditures are excluded in this definition because they are assumed to be a part of the non–human wealth. Our source is the U.S. Department of Commerce, Bureau of Economic Analysis (NIPA, Table 2.3.5). Labor income is defined as wages and salaries plus transfer payments plus other labor income minus personal contributions for social insurance minus taxes. Our source is the U.S. Department of Commerce, Bureau of Economic Analysis (NIPA, Table 2.1). Financial wealth and housing wealth are borrowed from the web site of the Board of Governors of the Federal Reserve System, Flows of Funds (household balance sheet $B100$, p.p. 102). Housing wealth is defined as the difference between real estate and home mortgage. Financial wealth is defined as the difference between the household net worth and the housing wealth. All variables are expressed in real per capita terms. Per capita variables are obtained by dividing by the total U.S population which is borrowed from the Bureau of Economic Analysis (NIPA, Table 2.1). Nominal variables are deflated by the personal consumption expenditures chain price deflator (2000=100) which is borrowed from the Bureau of Economic Analysis (NIPA, Table 2.8.4). Finally, all variables are seasonally adjusted.

Summary statistics for the consumption to total wealth ratio and for consumption, financial, housing and human wealth growth are presented in Tables 1 and 2. Besides, different unit root tests indicate that all series are integrated of order 1 (see Table 3).

2.2 Test of cointegration

We test the existence of the cointegration relationship whenever the financial wealth is split between non-housing and housing wealth, adding to the original procedure of Lettau and Ludvigson (2005) the methodology presented by Shin (1994). Lettau and Ludvigson (2005) perform Johansen's based test of cointegration (1991). However, the (residual-based) Shin's procedure appears the most appropriate for our model. First, since the model's basic assumption is the existence of one cointegration relationship between the different components of wealth and aggregate consumption, it seems more coherent to consider the cointegration as the null hypothesis. Second, we are looking for efficient estimates of the cointegrating vector, because we want to test in a second step the properties of the error-correction

[4] More details on the data can be found in Lettau and Ludvigon (2001 and 2005).

Table 1: Wealth Composition: Summary Statistics

Whole sample 1952Q1–2009Q1											
			Autocorrelations					Correlation Matrix			
	mean(%)	std(%)	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	C/W	A/W	H/W	Y/W
C/W	11.32	0.06	0.95	0.90	0.85	0.80	0.76	1.00	-0.74	0.47	0.54
A/W	58.64	0.28	0.97	0.95	0.92	0.89	0.87		1.00	-0.85	-0.68
H/W	17.21	0.18	0.98	0.96	0.93	0.90	0.87			1.00	0.25
Y/W	12.80	0.11	0.98	0.96	0.94	0.92	0.91				1.00

Note: This table reports summary statistics for the consumption–total wealth ratio C/W, financial–total wealth ratio A/W, housing–total wealth ratio H/W and labor income–total wealth ratio Y/W. Total wealth is measured as the sum of financial and housing wealths and labor income $W = A + H + Y$. The sample is quarterly and spans 1952Q1 to 2009Q1.

Table 2: Consumption and Wealth Growths: Summary Statistics

			Autocorrelations					Correlation matrix			
	mean(%)	std(%)	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	Δc	Δa	Δh	Δy
Δc	0.91	0.44	0.34	0.16	0.19	0.06	-0.07	1.00	0.21	0.30	0.45
Δa	0.89	2.56	0.07	0.04	0.05	-0.01	-0.07		1.00	0.21	0.14
Δh	0.80	1.88	0.52	0.44	0.33	0.30	0.23			1.00	0.31
Δy	0.80	1.03	-0.03	0.13	0.05	-0.01	-0.09				1.00

Note: This table reports summary statistics for consumption growth Δc, financial wealth growth Δa, housing wealth growth Δh and labor income growth Δy. The sample is quarterly and spans 1952Q1 to 2009Q1.

Table 3: Test statistics for the different unit root tests.

Test	ADF	Phillips-Perron	KPSS		ADF	Phillips-Perron	KPSS
c	-1.08	-1.49	0.39***	Δc	-10.22***	-10.43***	0.48**
a	-1.94	-2.49	0.25***	Δa	-13.29***	-13.40***	0.07
h	-2.59	-1.79	0.12*	Δh	-4.61***	-8.09***	0.16
y	-1.72	-1.79	0.33***	Δy	-15.47***	-15.49***	0.21

Note: Test equations for unit root in level (in first difference) includes trend and intercept (intercept). Rejection at the 10%, 5% and 1% level are indicated by *, ** and ***. Stationnarity is the null hypothesis in KPSS test and the alternative for ADF and PP tests.

Table 4: Test statistics for cointegration tests

	Test statistics	10% critical value
Johansen's Trace Test	40.41	44.49
Johansen's Max-Eigenvalue Test	16.92	25.12
Shin's Test	0.114	0.121

Note: Both Trace and Max-Eigenvalues tests are specified with 1 lag for differenced endogenous variable. This lag number is chosen by Akaike, Schwarz and Hannan-Quinn information criteria. Critical values are from MacKinnon, Haug and Michelis (1999) and Shin (1994). Cointegration is the null hypothesis in Shin's test contrary to both Johansen's tests.

term (called the *cahy* in reference to the studies of Lettau, Ludvigson). Estimating the cointegrating vector in (6), Lettau and Ludvigson perform Dynamic Least Square in order to eliminate the effects of regressors endogeneity on the distribution of the least squares estimator (see Saikonen (1991) and Stock and Watson (1993) for details on the efficient estimation of the cointegrating vector). We argue it is more consistent to incorporate in the cointegration test the DLS procedure, such that the residuals of the equation (6) used in the cointegration test and the error correction model estimation are coherent.

We obtain mixed evidences concerning the existence of cointegration among (log of) consumption, financial, housing and human wealth. Both Trace and max-Eigenvalue's tests from Johansen (1991) cannot reject the no-cointegration hypothesis. On the other hand, following the methodology of Shin[5] (1994), we are not able to reject the hypothesis of cointegration at the 10% level (see Table 4). Finally, we estimate the corresponding cointegrating vector in equation (7) by Dynamic Least Square as Lettau and Ludvigson (2001,2005).

$$c_t = \delta_1 + \beta_1 [a_t \quad h_t \quad y_t]' + \sum_{i=-K}^{K} \pi_i \Delta [a_t \quad h_t \quad y_t]' + \varepsilon_t \tag{7}$$

for $t = 1...T$ and $\beta_1 = [\beta_{1a} \quad \beta_{1h} \quad \beta_{1l}]$.

The estimates of the coefficients are presented in Table 5.

Section 1 and Appendix A discuss the analytical determinants of the cointegrating vector's coefficients. Analytically, each wealth components' coefficient should be related to the average share of the corresponding element in total wealth. We obtain a long–term consumption elasticity to housing wealth β_{1h} of 18% which is not statistically different from the financial elasticity β_{1a}. These estimates correspond to a Marginal Propensity to Consume (MPC) out of additional financial and housing wealth at 0.042 and 0.118 respectively. Caroll, Otsuka and Slacalek (2006) estimate on a somewhat smaller sample

[5]Following Lettau and Ludvigson (2001 and 2005), we took 8 leads and lags in the cointegration test and the DLS estimation procedure. We also test for 4 leads and lags, as recommended by Shin (1994) or Fisher, Otto and Voss (2009), without finding significant changes. Standard-errors in Table 5 are based on the Newey–West estimator (Newey and West, 1987) with eight lags.

Table 5: No-break in the cointegrating vector

δ_1	β_{1a}	β_{1h}	β_{1l}
-1.20	0.21	0.17	0.69
[-39.24]	[10.07]	[6.36]	[17.42]

Note: Newey-West based's t-stats are in parentheses.

(1960Q1-2004Q3) long run MPC out of stock wealth at 0.04 and MPC out of housing wealth at 0.09 for the US. Our findings are broadly in line with these results. The β coefficients estimated are also similar to the ones found in applications of the same procedure to Australia and New Zealand (see Fisher, Otto and Voss (2009) and De Veirman, Dunstan (2008)) [6].

However, through β estimation, we measure the effect of a permanent change in wealth on consumption. As highlighted by Lettau and Ludvigson (2005), if wealth is also affected by quantitatively important transitory shocks, β may be not appropriate to evaluate properly the size of the consumption response to wealth changes. We go more in depth into this subject in Section 3 where we distinguish in wealth movements what is related to permanent or transitory shocks.

We interpret the mixed evidence concerning the existence of cointegration relationship as the possible consequence of unstable cointegrating vector coefficients. The existence of this cointegration relation has been tested in numerous studies since the original work of Lettau and Ludvigson (2001) but is still under discussion, both for theoretical and empirical reasons (see Rudd, Whelan (2006) or Carroll, Otsuka and Slacalek (2006)). In particular, the stability of the error correction model is one of the main concern about the cointegration approach, as stressed by Carroll, Otsuka and Slacalek (2006). We formally test the stability of the cointegration relationship in the following section.

2.3 Test of the stability of the cointegration relationship

Many countries, in particular the United States have undergone significant changes in their financial and labor markets since the 50's and we suspect this could lead to structural changes in the cointegrating vector or the adjustment term vector. For instance, Lettau and Ludvigson (2005) admit that including data from the last half of the 1990's might create instability. In the same study, they obtain mixed result testing the stability of the cointegration vector's coefficients trough SupF, MeanF and L_c test (see Hansen (1992)). Fisher, Otto and Voss (2009), in a replication of the Lettau and Ludvigson's model to Australian data provides evidences for shifts in the cointegrating vector since the mid-2000's (their estimates differs significantly whether the period 2004–2008 is included in the sample or not). Using Andrews (1993) and Andrews, Ploberger (1994) AveF test and SupF test, De

[6]Our estimates are higher than Lettau Ludvigson who estimates a coefficient of 0.30 for aggregated asset wealth.

Veirman and Dunstant (2008) also test the stability of the cointegration relationship on New-Zealand data and concludes there were evidences for instability in the mid-eighties.

In the following part of the section, we present formal test of instability of the cointegrating vector for US data, using a method developed by Seo (1998) in a multivariate framework. In the second part of the section, we also provide efficient estimates of the long-run elasticities and interpret the results.

The observed data are $X_t = (X_{1t}, X_{2t})$ where $X_{1t} = c_t$ is the consumption and $X_{2t} = (a_t, h_t, y_t)$ is a 3-dimensional vector of wealth components. It is also useful to define the dummy variable

$$\varphi_{t\tau} = \begin{cases} 0 & \text{if} \quad t \leq [\tau T] \\ 1 & \text{if} \quad t > [\tau T] \end{cases}$$

where $[s]$ denotes the largest integer not exceeding s. The tested hypothesis are:

$$X_t = \alpha_1 \begin{pmatrix} 1 \\ \beta_1' + \varphi_{t\tau}\beta_2' \end{pmatrix} X_{t-1} + \Gamma \Delta X_{t-1} + \eta_t$$

where $\beta_i = [\beta_{ia} \ \beta_{ih} \ \beta_{il}]$ with $i = 1, 2$ and $\alpha_1 = [\alpha_{1a} \ \alpha_{1h} \ \alpha_{1y}]$

We test the stability of β: $H_\beta^0 : \beta_2 = 0$ and $H_\beta^a : \beta_2 \neq 0$. To do so, we apply the three LM tests proposed by Seo (1998)[7]

$$Ave - LM^\beta = \frac{1}{T\tau_u - T\tau_l} \sum_{\tau = T\tau_l}^{T\tau_u} LM^\beta(\tau)$$

$$Exp - LM^\beta = \log\left(\frac{1}{T\tau_u - T\tau_l} \sum_{\tau = T\tau_l}^{T\tau_u} \exp\left(\frac{LM^\beta(\tau)}{2} \right) \right)$$

$$Sup - LM^\beta = \max_{\tau \in [\tau_l, \tau_u]} LM^\beta(\tau)$$

The result of these tests are provided in Table 6.

Conditioning on the existence of cointegration, the tests reject at 5% the hypothesis of stability on the whole. For robustness check, we also test whether the hypothesis of cointegration remains whenever a break occurs in the cointegrating vector. We perform (residual-based) test of cointegration with structural break, with the cointegration being the null hypothesis (Arai, Kurozumi (2005)) or the alternative (Gregory, Hansen (1996)). Results in Table 7 show that both tests accept the hypothesis of cointegration at a 5% (for Arai, Kurozumi and the ADF* test of Gregory, Hansen) or 10% (for the Z_t and Z_α test of GH). Interestingly, the breakdate estimated by Gregory-Hansen procedure[8] is very

[7]Note that the power of the Ave-LM test is concentrated on the null hypothesis while the power of Exp-LM and sup-LM is concentrated on the alternative.

[8]The break point estimates is the point in the sample for which the smallest value of the test statistic is obtained

Table 6: Test statistics for the instability in the cointegrating vector

	$Ave-LM^{\beta}$	$Exp-LM^{\beta}$	$Sup-LM^{\beta}$
β	5.35*	5.27**	18.57**

Note: Significance at the level 10%, 5% and 1% is indicated by *, ** and ***.

Table 7: Test of cointegration with structural break

	Arai, Kurozumi	ADF^*	Z_t^*	Z_α^*
Test Statistic	0.0372	-6.21	-6.07	-66.12
10% CV	0.0543	-5.75	-5.75	-63.42
5% CV	0.0676	-6.00	-6.00	-68.94

Note: Cointegration is the null hypothesis in Arai and Kurozumi test and the alternative in ADF^*,Z_t^* and Z_α^* tests.

close to the one which minimizes the sum of squared residuals. In the next subsection, we provide the estimates for the breakdate and the associated cointegrating vector's coefficients.

2.4 Estimation of the breakdate in the cointegrating vector

To estimate the date of a possible shift in the cointegrating vector, we follow Arai, Kurozumi (2005) (and numerous studies on structural breaks) and find the date of break τ which minimizes the sum of squared residuals in the equation (8).

$$c_{1t} = \delta_1 + \varphi_{t\tau}\delta_2 + (\beta_1 + \varphi_{t\tau}\beta_2)\,[a_t \quad h_t \quad y_t] + \sum_{i=-K}^{K} \pi_i \Delta[a_{t-1} \quad h_{t-1} \quad y_{t-1}] + \varepsilon_t \tag{8}$$

for $t = 1...T$ and $\beta_i = [\beta_{ia}\ \beta_{ih}\ \beta_{il}]$ with $i = 1, 2$

The plot of the sum of squared residuals for each date of break is presented in Figure 1. Allowing a break in the beginning of the eighties seems to reduce substantially the size of errors in (8), with a minimum for τ in 1982Q4. The eighties are frequently highlighted as the starting point of a new regime in the economic history of the developed countries, in particular in the US. In the macroeconomic literature, the eighties are related, among others things, to the development of financial markets and the acceleration of financial innovations, to a new monetary policy regime and to a less volatile economic growth (the so-called "Great Moderation"). Moreover, the eighties are also characterized by the start of the downward trend of the US personal saving ratio. Interestingly, Lustig, Van Nieuwerburgh and Verdelhan (2009) also find a clear change in the dynamic of the US household's wealth and

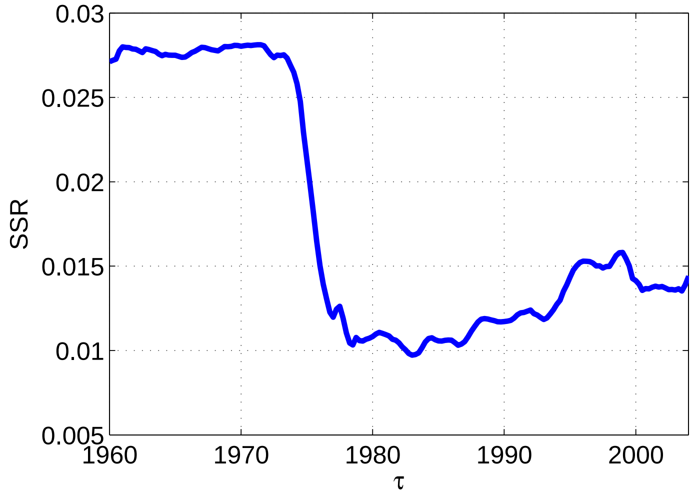

Figure 1: Sum of squared residuals for different breakdates τ in the cointegrating vector β

Table 8: Break in $\tau = 0.45$ (1982Q4) in the cointegrating vector

δ_1	β_{1a}	β_{1h}	β_{1l}
-1.22	0.25	0.21	0.61
$[-14.88]$	[7.11]	[13.51]	[14.07]
δ_2	β_{2a}	β_{2h}	β_{2l}
0.51	-0.04	-0.18	0.18
[3.20]	$[-1.65]$	$[-7.65]$	[4.00]

Note: Newey-West based's t-stats are in parentheses.

log wealth-to-consumption ratio at that time[9].

The corresponding estimates[10] of the coefficients, with a break in 1982Q4 are presented in Table 8.

The most striking feature of the estimates with break is the decrease in the elasticity of consumption to the (permanent change in) financial components of wealth relative to the human component in the second period. The estimates of the human wealth elasticity after 1982Q4 is higher than results of the existing literature (Lettau and Ludvigson (2005) which estimate it at 0.6. Nonetheless, we argue that these estimates are consistent with recent results of Lustig, Van Nieuwerburgh and Verdelhan (2009) which show that on average, 90% of total wealth is human wealth.

Another interesting feature in our estimates is the difference in changes between housing and non-

[9] see figure 6 and 9 in Lustig, Van Nieuwerburgh and Verdelhan (2009)

[10] Following Lettau and Ludvigson (2001 and 2005), we took 8 leads and lags in the DLS estimation procedure. We also test for 4 leads and lags, as recommended by Shin (1994), without finding significant changes. Standard-errors are based on the Newey–West estimator (Newey and West, 1987) with eight lags.

housing wealth. The drop in consumption elasticity to housing wealth is in contradiction with several studies, which argue that the housing wealth effect would have increased in recent period due to financial innovations (see for instance Mishkin (2007)). However, empirically, there are mixed evidences concerning the US mortgage market's sophistication (Muellbauer (2007)): on the whole, this sophistication has not undoubtedly increased before the years 2000. Besides, whether the housing wealth effect exists at the aggregate level is unclear theoretically (Buiter (2008)). Finally, as noticed by Carroll, Otsuka and Slacalek (2006), there are no theoretical presumptions about whether there should be larger wealth effect for stocks or houses. On the one hand, compared to housing wealth, stock wealth may be concentrated on a smaller share of population (the richest) with a lower marginal propensity to consume out of wealth. Therefore, on the aggregate, an increase in housing wealth may produce a larger boost on consumption than an increase in stock wealth. On the other hand, more liquid assets are more likely to be used to smooth consumption, and consequently, consumption should respond more strongly to shocks to liquid assets.

The corresponding long run Marginal Propensity to Consume out wealth are estimated at 0.049 for financial wealth and at 0.141 for housing wealth before $1982Q4$. After the break these MPCs fall at 0.041 and 0.02 for financial and housing wealth respectively. One intuition for such drops in MPC is the larger volatility of wealth components since the eighties: the volatility of financial and housing wealth's growth is about twice as large after $1982Q4$ contrary to the volatility of consumption growth which halves after the break (see Table 18 in Appendix B.). In practice, the larger wealth fluctuations do not seem to have translated in consumption fluctuations of the same magnitude, so the coefficients are estimated to be smaller.

Finally, the positive shift in the constant term of the equation (8) can be explained by numerous factors, in particular by an higher wealth to consumption ratio $\overline{(\frac{W-C}{W})}$[11], or by higher returns on average on wealth components (which is the case for financial returns).

3 Vector Error Correction Models

3.1 On the estimation in the adjustment term vector

Having determined the existence of a break in the cointegration relationship, we look for a break in the adjustment vector term in the error-correction model. From a modeling point of view:

$$X_t = (\alpha_1 + \varphi_{t\tau,\alpha}\alpha_2)\begin{pmatrix} 1 \\ \beta_1' + \varphi_{t\tau,\beta}\beta_2' \end{pmatrix} X_{t-1} + \Gamma\Delta X_{t-1} + \eta_t \quad (9)$$

where

$$\varphi_{t\tau,\beta} = \begin{cases} 0 & \text{if} \quad t \leq 1982Q4 \\ 1 & \text{if} \quad t > 1982Q4 \end{cases}$$

[11] note that in Lustig, Van Nieuwerburgh and Verdelhan (2009), the trend of the log wealth to consumption ratio reverse at the beginning of the eighties (from downward to upward), see figure 6 in LNV.

Table 9: Test statistics for the instability in the adjustment term vector

	$Ave-LM^{\alpha}$	$Exp-LM^{\alpha}$	$Sup-LM^{\alpha}$
α	6.06	7.13***	21.66***

Note: Significance at the level 10%, 5% and 1% is indicated by *, ** and ***.

Assuming no-break in the cointegrating vector, i.e conditioning on $\beta_2 = 0$, the methodology of Seo presented in Section 2.3 seems to find a break in the adjustment term vector α (see Table 9). However this procedure does not allow to test for a break in the adjustment term vector, conditioning on a structural break in the cointegrating vector β. To gain some hindsights, we apply the same methodology as for the cointegrating vector in order to approximate the date of the break in the adjustment term vector α: we look at the break date τ which minimizes the sum of standardized squared residuals in the error correction model (9) $\sum_j \sum_{t=1}^{T} \frac{\eta_{t,j}^2}{\sigma_j}$ across all series (j =consumption, financial, housing and human wealth). This preliminary procedure showed us that the model's fit improves when we introduce a break after 1995, with an optimum break in 2004Q1. To deal more properly with such instability in α, we perform several estimations of the error-correction model (9) for different subsamples. The results are presented and discussed in the following subsection.

3.2 Cointegrated VAR

In this section, we estimate the Vector Error Correction Model (VECM) of our system $X_t = [c_t\ a_t\ h_t\ y_t]'$:

$$\Delta X_t = \overline{\Delta X} + \gamma\hat{\beta}X_{t-1} + \Gamma(L)\Delta x_{t-1} + \nu_t \tag{10}$$

where ΔX_t is the vector of log first differences and $\hat{\beta}X_{t-1}$ the estimated[12] residuals of the cointegration relation linking consumption and different components of total wealth. The vector γ is the adjustment vector that identifies which variables restore the common trend when a deviation occurs. Therefore, if the variables $X_t = [c_t\ a_t\ h_t\ y_t]'$ are cointegrated, at least one of the components of the adjustment vector must be non zero.

As developed in Section 2, the estimated residuals of cointegration relation $cahy_t$ take into account the break that occurs at the date 1982Q4. However, we are not able to check the existence of a break in the adjustment vector taking as given the break in the cointegration vector. Therefore, the cointegrated VAR model is estimated over (i) the whole sample that covers the entire available period and spans 1952–2009 and (ii) a selection of restricted sub–samples in order to detect eventually the existence of some variations in the short run behavior of consumption, financial wealth, housing wealth and labor income. Table 10 presents the estimates from a cointegrated VAR over the whole sample

[12] Throughout this paper, hats denote the estimated values of parameters.

Table 10: Estimates from a Cointegrated VAR – Whole sample

$\Delta X_t = \alpha\hat{\beta}X_{t-1} + \Gamma\Delta X_{t-1} + e_t$				
	Δc	Δa	Δh	Δy
Δc_{t-1}	0.19	0.13	0.45	0.46
	[2.76***]	[0.30]	[1.68*]	[2.68***]
Δa_{t-1}	0.03	0.09	0.07	0.05
	[3.30***]	[1.42]	[1.65*]	[2.05**]
Δh_{t-1}	0.02	0.26	0.59	0.02
	[1.49]	[2.66***]	[9.64***]	[0.62]
Δy_{t-1}	0.077	-0.20	-0.282	-0.13
	[2.61**]	[-1.10]	[-2.42**]	[-1.90]
$cahy_{t-1}$	0.001	**0.15**	0.05	**0.06**
	[0.13]	[2.46**]	[1.44]	[2.37**]
$\overline{R}^2$	0.21	0.06	0.36	0.08

Note: The table reports the estimated coefficients from cointegrated vector autoregressions of the column variable on the row variable. t–statistics are in parentheses. Significance at the level 10%, 5% and 1% is indicated by *, ** and ***. The sample,spans the fourth quarter of 1952 to the first quarter of 2003.

1952Q1–2009Q1. Based on Akaike and Schwarz criteria, the lag length in model 10 is limited to order 1, i.e. $\Gamma(L) = \Gamma$. Two main results emerge. First, in line with Lettau and Ludvigson (2005), the financial wealth is predictable by the lagged cointegrating residual *cahy*. The corresponding adjustment coefficient $\alpha_{\Delta c}$ is about 0.15 and it is statisticaaly significant at the level 5%. Second, in contrast with Lettau and Ludvigson (2005), labor income is also predictable by the lagged consumption–wealth ratio *cahy*. The cointegrated coefficient is small, about 0.06 but statistically significant at the level 5%. In accordance with Table 10, the consumers adjust their consumption–wealth ratio to expected transitory shocks in labor and financial wealth to match the smoothness in consumption.

Table 11 presents the estimates from a cointegrated VAR over a selection of sub–periods. Only the estimated adjustment parameters and their corresponding t–statistics are reported.

Several findings stand out from Table 11. The first raw of Table 11 reports results of the restricted sub–period 1952Q1–1982Q3. In line with the results of Table 10, both financial wealth and labor income growths are predictable by the lagged consumption–wealth ratio. However, compared to the whole sample, the coefficients of adjustment $\hat{\alpha}_{\Delta a}$ and $\hat{\alpha}_{\Delta y}$ are higher over the first sub–period 1952Q1–1982Q3, about 0.52 and 0.16 respectively. Panel A of Table 11 investigates the impact of the last period 2000–2009. To do this, we first estimate our model 9 over the sub–period 1952Q1–1999Q4 and then we add more observations to the end of period and re–estimate the model. In addition, the adjustment coefficients of labor income $\hat{\alpha}_{\Delta a}$ are remarkably stable over the different sub-periods, about 0.05 – 0.06. However, the consumption–wealth ratio losses his predictive power on future labor income over the sub–periods 1952Q1–2002Q4, 1952Q1–2003Q4, 1952Q1–2004Q4. Second, the adjustment coefficients of financial wealth is statistically significant whatever the restricted sub–period but it decreases when the last period 2000-2009 is added. For instance, $\hat{\alpha}_{\Delta a}$ is about 0.33 over the sub–period 1952–1999 and shifts to 0.15 over the whole sample. Third, the adjustment coefficient of housing wealth is statistically significant over the sub–period 1952Q1–2004Q4 and 1952Q1–2005Q4 but the sign is wrong. Indeed, with negative adjustment coefficient, the variations of housing wealth accentuates the remoteness from the common trend when a deviation occurs. The main conclusion to be retained from Tables 10 and 11 is that the consumers adjust their consumption–wealth ratio to expected transitory shocks in labor and financial wealth to match the smoothness in consumption. The adjustment of the consumption–to–wealth ratio is slower during the last period, specially for financial wealth (the adjustment coefficient $\hat{\alpha}_{\Delta a}$ decreases from 0.52 to 0.15). Finally, years 2000–2004 were characterized by a transitory phase which may be implied by the dramatically increase in housing wealth during this period (see Figure 3 in Appendix B). These conclusions are in line with results of panels B and C of Table 11.

Table 11: Estimates from a Cointegrated VAR

$$\Delta X_t = \alpha\hat{\beta}X_{t-1} + \Gamma\Delta X_{t-1} + e_t$$

	Adjustement vector			
Sub–period	$\hat{\alpha}_{\Delta c}$	$\hat{\alpha}_{\Delta a}$	$\hat{\alpha}_{\Delta y}$	$\hat{\alpha}_{\Delta y}$
Panel A				
$1952Q1 - 1982Q3$	0.01	**0.52**	0.04	**0.12**
	[0.26]	[4.11***]	[0.43]	[1.98**]
$1952Q1 - 1999Q4$	-0.01	**0.33**	-0.03	**0.06**
	[-0.99]	[3.78***]	[-0.66]	[1.78*]
$1952Q1 - 2001Q4$	-0.01	**0.38**	-0.06	**0.06**
	[-0.97]	[4.23***]	[-1.25]	[1.67*]
$1952Q1 - 2002Q4$	-0.01	**0.42**	-0.07	0.05
	[-0.78]	[4.60***]	[-1.35]	[1.37]
$1952Q1 - 2004Q4$	-0.01	**0.32**	**-0.10**	0.05
	[-0.72]	[3.66***]	[-2.06**]	[1.48]
$1952Q1 - 2005Q4$	-0.01	**0.25**	**-0.11**	**0.06**
	[-0.46]	[3.17***]	[-2.49**]	[2.19**]
$1952Q1 - 2006Q4$	-0.002	**0.16**	-0.04	**0.05**
	[-0.25]	[2.42**]	[-1.11]	[2.10**]
$1952Q1 - 2007Q4$	0.002	**0.15**	0.052	**0.05**
	[0.18]	[2.41**]	[1.33]	[2.31**]
$1952Q1 - 2009Q1$	0.001	**0.15**	0.05	**0.05**
	[0.13]	[2.46**]	[1.44]	[2.37**]
Panel B				
$1982Q4 - 2009Q1$	0.001	0.10	**0.07**	**0.04**
	[0.11]	[1.27]	[2.21**]	[1.66*]
$1975Q1 - 2009Q1$	0.001	0.10	**0.07**	**0.05**
	[0.14]	[1.36]	[1.90*]	[1.86*]
$1970Q1 - 2009Q1$	0.003	**0.13**	**0.08**	**0.05**
	[0.33]	[1.93*]	[2.11**]	[2.02**]
Panel C				
$1970Q1 - 2000Q1$	-0.002	**0.37**	-0.004	**0.08**
	[-0.14]	[3.66***]	[-0.07]	[2.00**]
$1975Q1 - 2000Q1$	-0.015	**0.27**	-0.06	**0.10**
	[-0.81]	[2.25**]	[-0.95]	[1.96**]

Note: The table reports the estimated adjustment vector from cointegrated vector autoregressions. t–statistics are in parentheses. Significance at the level 10%, 5% and 1% is indicated by *, ** and ***.

3.3 Cycle and Trend Analysis

In this section, we identify permanent and transitory components of consumption, financial wealth, housing wealth and labor income. A summary of this methodology is as follows[13]. Gonzalo and Granger (2001) propose a framework for analyzing the dynamics effects of permanent and transitory shocks in a system of n first–difference stationary economic variables X_t that share r common trends or equivalently r cointegrating relations $\alpha' X_t$. The estimation of the cointegrated VAR (Eq. 10), described in the previous section 3.1, provides the estimated adjustment parameters $\hat{\gamma}$. Based on the estimation of the cointegrating coefficients $\hat{\alpha}$ and the estimated adjustment parameters $\hat{\gamma}$, the permanent–transitory decomposition is achieved in two steps. First, based on the Wold moving–average representation of a first-difference stationary process $\Delta X_t = \overline{\Delta x} + C(L)e_t$ that can be derived from the estimated cointegrated VAR, Gonzalo and Granger (2001) show that the innovations shocks e_t can be decomposed into $(n-r)$ permanent shocks and r transitory shocks by multiplying the initial shocks e_t by the following matrix:

$$G = \begin{bmatrix} \gamma_{\perp} \\ \alpha \end{bmatrix}$$

Therefore, the Wold representation can be rewritten $\Delta X_t = \overline{\Delta x} + C(L)G^{-1}Ge_t = \overline{\Delta x} + D(L)\nu_t$ where $D(L) = C(L)G^{-1}$ and $\nu_t = Ge_t$. At this stage, the initial shocks are decomposed into a function of three permanent shocks (the three first elements of the vector ν_t) and a transitory shock (the last element of the vector ν_t). The second step is a transformation of the permanent and transitory shocks into serially and mutually uncorrelated permanent and transitory shocks with unit variance. The orthogonalized permanent and transitory shocks $P1$, $P2$, $P3$ and T are obtained as follows:

$$\begin{bmatrix} P1_t \\ P2_t \\ P3_t \\ T_t \end{bmatrix} = H^{-1}\nu_t$$

where the matrix H is the lower triangular Choleski decomposition of the covariance–variance matrix of ν_t.

The Gonzalo and Granger (2001) procedure is used to decomposed any of our variables into "trend" and "cyclical" components. Using this procedure, Impulse–response functions are plotted and variance decomposition are reported to evaluate the "permanent–transitory" decomposition. Note that our results are based on orthogonalized permanent and transitory shocks.

First of all, we consider the first sub–period 1952–1982. Both cases are reported: (i) the adjustment coefficients that are not statistically significant are set to zero and (ii) all the adjustment coefficient are set to their estimates values. We will show above that the results of these cases are remarkably similar. Variance decompositions are reported in Tables 12 and 13. Impulse–response functions are represented in Figures 4 and 5 in Appendix D.

[13] See Gonzalo and Granger (2001) and Lettau and Ludvigson (2005) for more details.

Based on the sub–sample 1952Q1–1982Q3, Table 12 displays the fraction of h–step ahead forecast error of consumption, financial wealth, housing wealth and labor income growths that are attributable to (i) the permanent ($P1$, $P2$ and $P3$) shocks combined[14] and (ii) the single transitory shock T. Several results emerge. First, consumption and housing wealth are mainly driven by permanent shocks. For instance, less than 3% of the variation of consumption is due to transitory variations. More than 98% of the variations of housing wealth are explained by permanent shocks. Transitory shock is more related to variations in financial assets and labor income. Indeed, it explains about 69% and 25% of the variance of expected financial wealth and expected labor income respectively at horizon 1–quarter. It is worth noting that those conclusions remain stable when the VECM is estimated over the sub–period 1952Q1 – 1999Q4, as shown in Table 13. The corresponding Impulse–response functions, represented in Figures 6 and 7 are also similar to those corresponding to the sub–period 1952Q1–1982Q3 (See Figures 4, 5, 6 and 7 in Appendix D).

We now consider the whole sample that covers the period 1952Q1–2009Q1. In line with results of the estimation of VECM model presented in the previous section, we note that the housing wealth presents more transitory movements. Indeed, as shown in Table 14, the transitory shock explains about of 67% of the variation of expected housing wealth at 1-quarter horizon. Moreover, only 22% of the variation of financial wealth is attributable to transitory shock. This is in line with the reduction of the predictive power of (lagged) consumption–wealth ratio on financial wealth during the last ten years 1999–2009. The variations of consumption remain mainly permanent and results corresponding to labor income remain remarkably stable over different sub–periods. Moreover, the transitory shock over the last period is more persistent as shown in Figures 8 and 9, reported in Appendix D.

[14] The fraction of h–step ahead forecast error of consumption, financial wealth, housing wealth and labor income growths that are attributable to each permanent shock and the single transitory shock are reported in Appendix C.

Table 12: Variance Decomposition – Sub–Period 1952Q1–1982Q3

	$\alpha_c = \alpha_h = 0$							
	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$		$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$		$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$		$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$	
horizon h	P	T	P	T	P	T	P	T
1	1.00	0.00	0.301	0.699	1.00	0.00	0.788	0.212
2	0.981	0.019	0.343	0.657	0.992	0.018	0.811	0.189
3	0.974	0.026	0.396	0.604	0.987	0.013	0.823	0.177
4	0.974	0.026	0.452	0.548	0.987	0.013	0.839	0.161
8	0.984	0.016	0.647	0.353	0.991	0.019	0.894	0.106
40	0.997	0.003	0.929	0.071	0.998	0.002	0.975	0.025
	α_c and α_h are estimated							
	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$		$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$		$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$		$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$	
horizon h	P	T	P	T	P	T	P	T
1	0.969	0.031	0.161	0.839	0.975	0.024	0.746	0.254
2	0.925	0.075	0.206	0.794	0.948	0.052	0.738	0.262
3	0.917	0.083	0.268	0.732	0.939	0.061	0.744	0.256
4	0.922	0.078	0.336	0.664	0.941	0.059	0.762	0.238
8	0.953	0.047	0.575	0.425	0.959	0.041	0.841	0.159
40	0.991	0.009	0.913	0.087	0.989	0.011	0.962	0.038

Note: The table reports the fraction of h–step ahead forecast error of consumption, financial wealth, housing wealth and labor income growths (respectively Δc, Δa, Δh ans Δy) that are attributable to innovations in the permanent shocks P and the transitory shock T. Horizosn h are in quarters. The VECM model is estimated over the sub–period 1952Q1–1982Q3.

Table 13: Variance Decomposition – Sub–Period 1952Q1 – 1999Q4

	$\alpha_c = \alpha_a = 0$							
	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$		$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$		$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$		$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$	
horizon h	P	T	P	T	P	T	P	T
1	1.000	0.000	0.398	0.602	1.000	0.000	0.795	0.205
2	0.962	0.038	0.449	0.551	0.996	0.007	0.789	0.211
3	0.951	0.049	0.482	0.519	0.993	0.007	0.786	0.214
4	0.949	0.051	0.506	0.494	0.992	0.008	0.791	0.209
8	0.957	0.043	0.592	0.408	0.993	0.007	0.825	0.176
40	0.989	0.011	0.880	0.120	0.998	0.002	0.947	0.053
100	0.995	0.005	0.951	0.049	0.999	0.001	0.978	0.022
	α_c and α_a are estimated							
	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$		$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$		$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$		$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$	
horizon h	P	T	P	T	P	T	P	T
1	0.941	0.059	0.587	0.413	0.969	0.031	0.859	0.141
2	0.978	0.022	0.633	0.367	0.981	0.019	0.879	0.121
3	0.987	0.013	0.659	0.341	0.987	0.013	0.887	0.113
4	0.991	0.009	0.678	0.322	0.990	0.010	0.894	0.106
8	0.995	0.005	0.736	0.264	0.995	0.005	0.917	0.083
40	0.999	0.001	0.921	0.079	0.999	0.001	0.975	0.025
100	0.999	0.000	0.968	0.032	0.999	0.001	0.989	0.011

Note: The table reports the fraction of h–step ahead forecast error of consumption, financial wealth, housing wealth and labor income growths (respectively Δc, Δa, Δh ans Δy) that are attributable to innovations in the permanent shocks P and the transitory shock T. Horizosn h are in quarters. The VECM model is estimated over the sub–period 1952Q1–1999Q4.

Table 14: Variance Decomposition – Sub–Period 1952Q1 – 2009Q1

	$\alpha_c = \alpha_a = 0$							
	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$		$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$		$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$		$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$	
horizon h	P	T	P	T	P	T	P	T
1	1.000	0.000	1.000	0.000	0.168	0.832	0.532	0.468
2	0.972	0.028	0.998	0.002	0.242	0.751	0.538	0.462
3	0.949	0.051	0.985	0.015	0.276	0.724	0.537	0.463
4	0.921	0.079	0.969	0.031	0.297	0.703	0.538	0.462
8	0.824	0.176	0.894	0.106	0.354	0.646	0.557	0.443
40	0.858	0.142	0.869	0.131	0.644	0.356	0.863	0.137
100	0.926	0.074	0.928	0.072	0.769	0.231	0.943	0.057
	α_c and α_a are estimated							
	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$		$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$		$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$		$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$	
horizon h	P	T	P	T	P	T	P	T
1	0.998	0.002	0.778	0.222	0.327	0.673	0.621	0.379
2	0.935	0.065	0.774	0.226	0.399	0.601	0.600	0.340
3	0.900	0.100	0.741	0.259	0.429	0.571	0.597	0.403
4	0.867	0.133	0.714	0.284	0.452	0.548	0.598	0.402
8	0.793	0.207	0.651	0.349	0.522	0.478	0.631	0.369
40	0.887	0.113	0.794	0.206	0.783	0.217	0.891	0.109
100	0.945	0.055	0.897	0.103	0.872	0.128	0.955	0.046

Note: The table reports the fraction of h–step ahead forecast error of consumption, financial wealth, housing wealth and labor income growths (respectively Δc, Δa, Δh ans Δy) that are attributable to innovations in the permanent shocks P and the transitory shock T. Horizosn h are in quarters. The VECM model is estimated over the sub–period 1952Q1–2009Q1.

4 Long Horizon Predictability

This section studies the role of fluctuations in consumption–wealth ratio *cahy* for predicting real returns on risky assets and housing.

Assets returns are quarterly and include (i) the real U.S three–month treasury bill as proxy for the risk–free rate and (ii) the real value weighted returns on CRSP index (which includes the NYSE, AMEX and NASSAQ) as a proxy for the market return. Nominal data are borrowed from the data library of Kenneth. R. French. Excess returns are delated with the Consumer Price Index (CPI) described in Section 2.1.

Following Flavin and Yamashita (2002) and Piazzesi, Schneider and Tuzal (2007), the nominal housing returns are computed as follows:

$$R^H_{t+1} = \frac{P^H_{t+1}H_{t+1} + q_{t+1}S_{t+1}}{P^H_t H_t}\left(\frac{P^H_t H_t}{P^H_{t+1}H_{t+1}}\right)\left(\frac{P^H_{t+1}}{P^H_t}\right) - \frac{\delta}{4} - \frac{(1-0.33)0.025}{4} \tag{11}$$

where $P^H_t H_t$ denotes the aggregate value of residential stock, $q_{t+1}S_{t+1}$ the rent payments and P^H_t the price per unit of housing quantity. The parameter δ denotes the depreciation rate of the residential stock. At annual frequency, Malpezzi, Ozanne and Thibodeau (1987) estimate the annual depreciation δ at the value of 4.3%. The term $(1-0.33)0.025$ corresponds to the net property tax payment, evaluated at annual frequency. More details on the definition of housing returns (11) can be found in Appendix E. Additionally, nominal returns on housing are deflated using the same Consumer Price Index (CPI) described above.

The current value of the residential stock $P^H_t H_t$ is borrowed from the Flows of Funds, Federal Reserve Board, household balance sheet ($B100$, $p102$). The sample is quarterly and spans 1951Q4 to 2009Q1. Housing services $q_{t+1}S_{t+1}$ are borrowed from the Bureau of Economic Analysis (BEA) and are available for the period 1951Q4 to 2009Q1. There are several sources for the change in housing prices P^H. The most used price index is the S&P Case–Shiller housing price index. It is the reference price index for the futures market on real estate that trades in the Chicago Mercantile Exchange Group. However, at quarterly frequency, the Case–Shiller price index starts at date 1987. Alternative price indexes can be used such as the price index constructed by the Census Bureau and the price index for private investment in residential structures, borrowed from the the Bureau of Economic Analysis (BEA). These alternative price indexes are available respectively for the periods 1963Q1 to 2009Q1 and 1952Q1 to 2009Q1.

Figure 2 presents the developments of real returns on aggregate housing computed with different housing price indexes. Table 10 reports corresponding summary statistics.

As we can see in Table 15, both returns on housing based on Census Bureau index price and NIPA index price are characterized by unrealistic levels. Indeed, their corresponding unconditional means are around 6.76% and 6.74% at quarterly frequency, or equivalently 27.04% and 26.96% at annual frequency! Moreover, in contrast with the housing returns based on S&P case–shiller price index,

Table 15: Housing Returns – Summary Statistics

			Auto–correlation function					Correlation matrix		
	mean(%)	std(%)	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	R^H_{NIPA}	R^H_{Census}	R^H_{CS}
r^H_{NIPA}	6.76	1.47	0.61	0.55	0.65	0.54	0.54	1.00	0.66	0.62
r^H_{Census}	6.74	2.09	0.14	0.37	0.35	0.28	0.37		1.00	0.57
r^H_{CS}	2.71	2.35	0.72	0.59	0.65	0.67	0.54			1.00

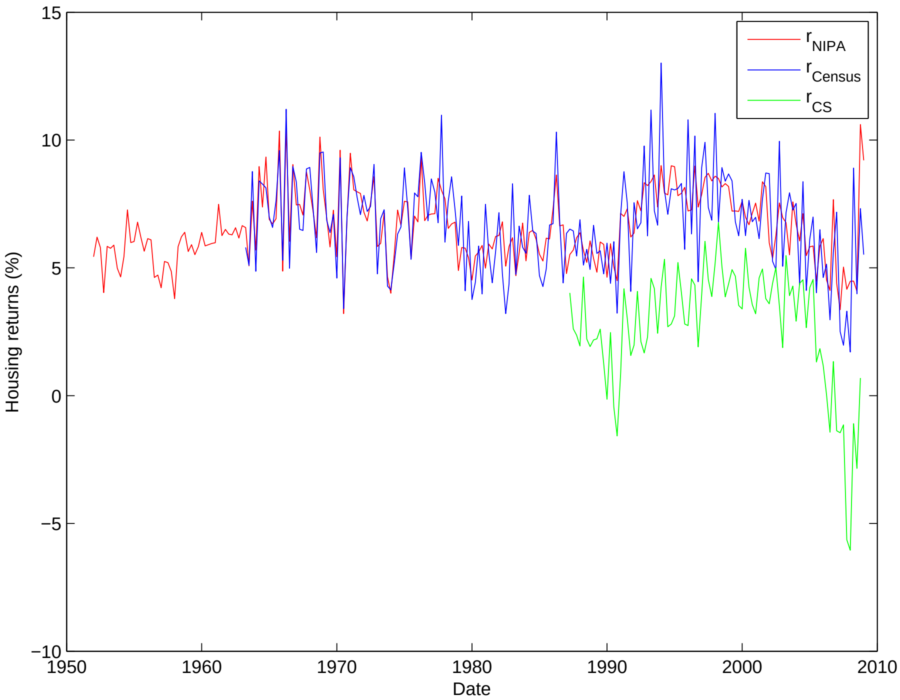

Figure 2: Quarterly Real Housing Returns

Figure 2 presents real quarterly returns to housing computed with different price indexes: (i) r_{NIPA} is computed using the index from investments in residential structures from NIPA, (ii) r_{Census} is computed using the price index constructed by the Census Bureau and (iii) r_{CS} is computed using the Case–Shiller price index. The housing returns r_{NIPA}, r_{Census} and r_{CS} start respectively from the first quarter of 1952, the second quarter of 1963 and the second quarter of 1987, until the first quarter of 2009.

the alternative returns do not take into account the dramatic fall in housing prices during the sub–prime crisis. Consequently, our empirical investigation will be based on housing returns based on S&P case–shiller price index, even if the sample is the smallest.

4.1 Long Horizon Regressions

A common way to investigate the predictive power of the consumption–wealth ratio *cahy* at different horizons is to run regressions for the compounded (log) returns $r_{t,t+k}$ on $cahy_t$ at several lags k:

$$r_{t,t+k} = \alpha_k + \beta_k cahy_t + e_{t,t+k} \tag{12}$$

where $e_{t,t+k}$ is drawn from a Gaussian distribution with mean zero and constant standard deviation. Ordinary Least Squares (OLS) methodology is used to estimate Equation (12).

Table 16 reports the results of univariate horizon regressions of excess returns on risky assets on $cahy_t$. For each horizon k, Table 16 reports (i) the OLS estimates of the regressor, (ii) the Newey–West t–statistics associated to the null of the absence of predictability t_{NW}, (iii) the modified t–statistics $t/\sqrt(T)$ proposed by Valkanov (2003) and (iv) the coefficient of determination R^2. The first panel of Table 16 reports estimated results from the whole sample 1952Q1–2009Q1. The estimated $\hat{\beta}_k$ have positive sign as in Lettau and Ludvigson (2001a). Furthermore, the coefficients of determination R^2 increase with horizons. For instance, at 2–year horizon, the $cahy_t$ accounts for 27% of the variability of excess returns. Based on the Newey–West t–statistics, the consumption–wealth ratio is statistically significant at any horizon. However, the modified t–statistics $t/\sqrt{T}$ proposed by Valkanov (2003) suggests that the consumption–wealth ratio is statistically insignificant.

The second panel reports results over the sub–sample 1952Q1–1982Q3. Based on the Newey–West and Valkanov t–statistics, the consumption–wealth ratio is remarkably statistically significant. Moreover, the estimated coefficients slopes $\hat{\beta}_k$ have the right sign according to the economic intuition. Higher consumption to wealth ratio can predict higher future excess returns. Additionally, the coefficient of determination increases with horizon to achieve 50% at 2–year horizon. In line with Lettau and Ludvigson (2001a), the consumption to wealth ratio is a strong predictor of excess returns on risky assets over the sub–period 1952Q1–1982Q2. Panels 3 and 4 of Table 16 show that macroeconomic indicator *cahy* loses part of his predictive power at the period following the break date 1982 specially over the last five years. Indeed, over the sub–period 1982Q4–2009Q1, the consumption–wealth ratio is not statistically significant at 1 and 2–quarter horizons when we consider the Newey–West t–statistics. Using Valkanov t–statistics, the regressor is never significant at any horizon. The coefficient of determination increases with horizon but remains smaller specially at short horizons.

The last panel reports results over the sub–sample 1982Q4–2004Q1. Even if the t–statistics $t/\sqrt(T)$ proposed by Valkanov (2003) remain statistically insignificant at any horizon, the Newey–West t–statistics are higher that those corresponding to the sub–period 1982Q4–2009Q1. Moreover, the coefficient of determination is larger at any horizon. This result confirms that the last five years were marked by a particular phase of the evolution of stock markets, weakening the predictability of stock markets.

Table 17 reports the results of univariate horizon regressions of housing returns on $cahy_t$. Several sub–periods are tested: sub–period 1987–2004, 1987–2007, 1987–2008 and 1987–2009. The starting date 1987 is related to the fact that the selected housing returns starts at date 1978, as explained above. Besides, last period was characterized by a deep crisis characterized by dramatically changes in the evolution of housing prices, financial markets and the real economy.

The first panel of Table 17 provides little evidence in favor of the existence of housing prices predictability. Even if the modified Valbanov (2003) t–statistic is statistically insignificant at any horizon, the Newey–West t statistic is significant from 3–quarter horizon. Moreover, the coefficient of determination is small at short horizons to reach 34% at 2–year horizon. However, these results are not stable. Indeed, the predictive power of the *cahy* is lost when the sample ends in 2004. The coefficient of determination is almost close to 0 and the estimates slopes are statistically insignificant at any horizon. Panels 3 and 4 present intermediate conclusions. The main conclusion to be retained from Table 17 is that the consumption–wealth ratio has no predictive power on housing returns when the sample data is ended at date 2003. Last years were characterized by a deep crisis, driving a dramatically fall in both housing prices and consumption –wealth ratio. Is it a transitory period or a structural break ? We do not have enough data for better analysis and we leave this question for future research.

Concluding Remarks

This paper investigates the cointegration relationship between consumption and the different components of total wealth (i) to identify the origins of transitory shocks that affect consumption growth and (ii) to study the role of consumption–wealth ratio in predicting excess returns on risky assets and housing. Using U.S data, we provide empirical evidence in favor of the existence of a cointegration relationship with a structural break in the mid-eighties. According to trend and cycle decomposition, we conclude that over the sub-period 1952–1999, consumption is dominated by permanent shocks and therefore, only permanent changes in total wealth are associated with movements in consumption. Moreover, we show that the transitory shocks in total wealth are mainly associated to fluctuations in the financial component of wealth. Over the last period 1999–2009, we found that a small fraction of transitory changes in wealth is associated with movements in consumption. Besides, we show that most of transitory shocks in total wealth are associated to fluctuations in the housing component of wealth rather than financial wealth. Additionally, we show empirically that the consumption–wealth ratio is a good predictor of excess returns on risky assets at short horizons but it fails to predict housing returns.

Table 16: Univariate Long–Horizon Regressions – Excess Returns

$er_{t+k} = \alpha_k + \beta_k cahy_t + e_{t+k}$						
Whole sample 1952Q1 – 2009Q1						
k(quarter)	1	2	3	4	8	12
β_k	0.65	1.43	2.12	2.86	4.78	6.48
t_{NW}	2.01**	2.25**	2.37**	2.53**	2.90***	3.74***
$t/\sqrt{T}$	0.13	0.14	0.15	0.16	0.19	0.24
R^2	0.04	0.09	0.14	0.19	0.27	0.30
Sub-sample 1952Q1 – 1982Q3						
k(quarter)	1	2	3	4	8	12
β_k	2.01	4.32	6.28	7.93	10.23	8.60
t_{NW}	6.28***	8.93***	10.56***	10.54***	5.54***	3.82***
$t/\sqrt{T}$	0.56**	0.80***	0.95***	0.95***	0.50**	0.34
R^2	0.14	0.28	0.38	0.45	0.38	0.21
Sub-sample 1982Q3–2009Q1						
k(quarter)	1	2	3	4	8	12
β_k	0.30	0.67	1.17	1.68	3.68	5.81
t_{NW}	1.24	1.64	2.11**	2.35**	3.14***	3.84***
$t/\sqrt{T}$	0.12	0.15	0.20	0.22	0.30	0.37
R^2	0.01	0.04	0.08	0.13	0.18	0.50
Sub-sample 1952Q1 – 2004Q1						
k(quarter)	1	2	3	4	8	12
β_k	1.32	2.71	3.94	5.05	8.01	9.29
t_{NW}	4.42***	4.53***	4.62***	4.83***	5.79***	6.37***
$t/\sqrt{T}$	0.30	0.31	0.32	0.33	0.40*	0.44*
R^2	0.10	0.19	0.26	0.33	0.43	0.41

Note: Significance at the level 10%, 5% and 1% is indicated by *, ** and ***.

Table 17: Univariate Long–Horizon Regressions – Housing Returns

$r^H_{t+k} = \alpha_k + \beta_k cahy_t + e_{t+k}$						
Sub-sample 1987Q1 – 2009Q1						
k(quarter)	1	2	3	4	8	12
β_k	0.13	0.36	0.65	0.99	2.11	3.11
t_{NW}	1.37	1.66	1.91**	2.10**	2.55**	2.71***
$t/\sqrt{T}$	0.14	0.17	0.20	0.22	0.27	0.29
R^2	0.05	0.10	0.16	0.22	0.34	0.38
Sub-sample 1987Q1 – 2004Q1						
k(quarter)	1	2	3	4	8	12
β_k	-0.11	-0.16	-0.14	-0.09	0.30	1.21
t_{NW}	-1.30	-0.99	-0.61	-0.27	0.33	0.75
$t/\sqrt{T}$	-0.16	-0.12	-0.07	-0.03	0.04	0.09
R^2	0.03	0.02	0.01	0.00	0.00	0.05
Sub-sample 1987Q1 – 2007Q1						
k(quarter)	1	2	3	4	8	12
β_k	0.05	0.12	0.20	0.26	0.46	0.94
t_{NW}	0.58	0.76	0.92	0.98	0.90	0.92
$t/\sqrt{T}$	0.06	0.08	0.10	0.11	0.10	0.10
R^2	0.01	0.02	0.03	0.03	0.02	0.04
Sub-sample 1987Q1 – 2008Q1						
k(quarter)	1	2	3	4	8	12
β_k	0.11	0.25	0.39	0.53	1.04	1.49
t_{NW}	1.16	1.30	1.47	1.59	1.75*	1.60
$t/\sqrt{T}$	0.12	0.14	0.16	0.17	0.19	0.17
R^2	0.06	0.09	0.11	0.12	0.13	0.11

Note: Significance at the level 10%, 5% and 1% is indicated by *, ** and ***.

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A. Theoretical Framework

- The accumulation equation for aggregate wealth is given by:

$$W_{t+1} = (1 + R_{w,t+1})(W_t - C_t) \tag{13}$$

By taking the first order Taylor expansion of Equation (13), the budget constraint rewrites:

$$\Delta w_{t+1} = r_{w,t+1} + k_w + \left(1 - \frac{1}{\rho_w}\right)(c_t - w_t) \tag{14}$$

where $\rho_w = \overline{\left(\frac{W-C}{W}\right)}$ and $k_w = \log(\rho_w) + \left(1 - \frac{1}{\rho_w}\right)(\rho_w - 1)$.

Iterating forward and imposing the following tranversality condition $\lim_{i\to\infty} \rho_w^i (c_{t+i} - w_{t+i}) = 0$, we obtain:

$$c_t - w_t = \frac{\rho_w}{1-\rho_w} k_w + \mathbb{E}_t \sum_{i=1}^{\infty} \rho_w^i (r_{w,t+i} - \Delta c_{t+i}) \tag{15}$$

where $\mathbb{E}_t$ is the expectation operator conditional on information available at time t.

- Total aggregate wealth is decomposed in three sub-components: human wealth L_t, financial wealth A_t and housing wealth H_t, i.e. $W_t = A_t + H_t + L_t$. Let $NL_t = A_t + H_t$ denote the non-human capital. Therefore,

$$w_t = \log(NL_t + L_t) \tag{16}$$

$$= nl_t + \log(1 + \exp(l_t)) \tag{17}$$

$$\simeq \overline{\left(\frac{NL}{W}\right)} nl_t + \overline{\left(\frac{L}{W}\right)} l_t + \kappa \tag{18}$$

where $\kappa = \log\left(1 + \overline{\left(\frac{L}{NL}\right)}\right) - \overline{\left(\frac{L}{NL}\right)}\,\overline{\left(\frac{L}{W}\right)}$. Equivalently, the non–human capital is decomposed into two components: financial wealth A_t and housing wealth H_t. It follows that:

$$nl_t = (A_t + H_t) \tag{19}$$

$$=\simeq \overline{\left(\frac{A}{NL}\right)} a_t + \overline{\left(\frac{H}{NL}\right)} h_t + \nu \tag{20}$$

where $\nu = \log\left(1 + \overline{\frac{H}{A}}\right) - \overline{\left(\frac{H}{A}\right)}\,\overline{\left(\frac{H}{NL}\right)}$. Plugging Eq. (20) into Eq. (18), we get:

$$w_t = w_a a_t + \overline{w}_h h_t + \overline{w}_l l_t + \epsilon \tag{21}$$

where $\epsilon = \overline{\frac{A+H}{W}}\left(\log\left(1 + \overline{\frac{H}{A}}\right) - \overline{\frac{H}{A}}\,\overline{\left(\frac{H}{A+H}\right)}\right) + \log\left(1 + \overline{\frac{L}{A+H}}\right) - \overline{\frac{L}{W}}\,\overline{\left(\frac{L}{A+H}\right)}$.
The parameters w_a, $\overline{w}_h$ and $\overline{w}_l$ equal respectively the average shares of financial, housing and human wealth in total wealth. Therefore, the (log) consumption–wealth ratio can be approximated as follows:

$$c_t - w_t = c_t - w_a a_t - \overline{w}_h h_t - \overline{w}_l l_t - \epsilon \tag{22}$$

Because (log) human capital l_t is unobservable, Eq. (22) is of little use in empirical work. Following Campbell (1996) and Jagannathan and Wang (1996), the human capital L_t is approximated by a function of labor income and a stationarity component. Indeed, the labor income Y_t is described as the annuity value of human capital. Il follows that the return on the human capital $R_{l,t+1}$ is defined as follows:

$$R_{l,t+1} = \frac{L_{t+1} + Y_{t+1}}{L_t} \tag{23}$$

therefore:

$$\begin{aligned} r_{l,t+1} &= \Delta y_{t+1} + (y_t - l_t) + \log\left(\frac{L_{t+1}}{Y_{t+1}} + 1\right) && (24) \\ &\simeq \rho_y\left(l_{t+1} - y_{t+1}\right) + \Delta y_{t+1} + (y_t - l_t) + k_y && (25) \end{aligned}$$

where $\rho_y = \overline{\frac{L}{Y+L}}$ and $k_y = \frac{1}{\rho_y} - 1 - \rho_y \log\left(\frac{1}{\rho_y} - 1\right)$. Iterating forward and imposing the transversality condition $\lim_{i\to\infty} \rho_y^i (h_{t+i} - l_{t+i}) = 0$, we obtain:

$$l_t \simeq y_t + z_t \tag{26}$$

where $z_t = \sum_{i=1}^{\infty} \rho_y^{i-1}\left(\Delta y_{t+i} - r_{l,t+i}\right) + \frac{k_y}{1-\rho_y}$. The labor income y_t and the process z_t are respectively the permanent and the transitory components of the (log) human capital wealth.

- The return on aggregate wealth is decomposed into the returns on the different components of total wealth:

$$R_{w,t+1} = w_{a,t}R_{a,t+1} + w_{h,t}R_{h,t+1} + w_{l,t}R_{l,t+1} \tag{27}$$

where $w_{a,t} = A_t/W_t$, $w_{h,t} = A_t/W_t$ and $w_{l,t} = L_t/W_t$ and verify $w_{a,t} + w_{l,t} + w_{h,t} = 1$. Imposing the approximation $r_{t+1} \simeq R_{t+1} - 1$, we obtain:

$$r_{w,t+1} \simeq w_{a,t}r_{a,t+1} + w_{h,t}r_{h,t+1} + (1 - w_a - \overline{w}_h)r_{l,t+1}$$

Assuming that $w_{a,t}$, $w_{h,t}$, $r_{a,t}$, $r_{h,t}$ and $r_{l,t}$ are stationary, we linearize around $\overline{w}_a$, $\overline{w}_h$, $\overline{r}_a$, $\overline{r}_h$ and $\overline{r}_l$ as in Campbell (1996). It follows that:

$$r_{w,t+1} \simeq \overline{w}_a r_{a,t+1} + \overline{w}_h r_{h,t+1} + (1 - \overline{w}_a - \overline{w}_h)r_{l,t+1} + \underbrace{(\overline{r}_a - \overline{r}_l)(w_{a,t} - \overline{w}_a) + (\overline{r}_h - \overline{r}_l)(w_{h,t} - \overline{w}_h)}_{\text{set to 0 by assuming that } \overline{r}_a \simeq \overline{r}_l \simeq \overline{r}_h} \tag{28}$$

Plugging Eq. (22), (26) and (28) into Expression (15), we obtain:

$$\begin{aligned} c_t - \overline{w}_a a_t - \overline{w}_h h_t - (1 - \overline{w}_a - \overline{w}_h)\, y_t = \epsilon + \frac{\rho_w}{1-\rho_w} k_w + (1 - \overline{w}_a - \overline{w}_h)\, z_t \\ + \mathbb{E}_t \sum_{i=1}^{\infty} \rho_w^i \left(\overline{w}_a r_{a,t+i} + \overline{w}_h r_{h,t+i} + (1 - \overline{w}_a - \overline{w}_h)\, r_{l,t+i} - \Delta c_{t+i}\right) \end{aligned} \tag{29}$$

Note that Eq. (29) can be rewritten as follows:

$$c_t - \overline{w}_a a_t - \overline{w}_h h_t - (1 - \overline{w}_a - \overline{w}_h)\, y_t = \overline{\xi} + \xi_t \tag{30}$$

where

$$\begin{cases} \overline{\xi} = \epsilon + \frac{\rho_w}{1-\rho_w}\left(k_w + \overline{w}_a \overline{r}_a + \overline{w}_h \overline{r}_h + (1 - \overline{w}_a - \overline{w}_h)\overline{r}_l - \overline{\Delta c}\right) + \frac{k_y}{(1-\rho_y)^2}(1 - \overline{w}_a - \overline{w}_h)(\overline{\Delta y} - \overline{r}_l) \\ \mathbb{E}\left(\xi_t\right) = 0 \end{cases}$$

Table 18: Wealth Composition: Summary Statistics

Panel A: Sub–period 1952Q1–1982Q3											
			Autocorrelations					Correlation Matrix			
	mean(%)	std(%)	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	C/W	A/W	H/W	L/W
C/W	11.28	0.55	0.96	0.91	0.87	0.84	0.81	1.00	-0.86	0.64	0.79
A/W	58.02	2.37	0.97	0.95	0.92	0.90	0.88		1.00	-0.92	-0.69
H/W	17.10	1.60	0.98	0.96	0.95	0.93	0.91			1.00	0.39
L/W	13.58	0.57	0.94	0.89	0.84	0.80	0.75				1.00
Panel B: Sub–period 1982Q3–2009Q1											
			Autocorrelations					Correlation Matrix			
	mean(%)	std(%)	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	C/W	A/W	H/W	L/W
C/W	11.36	0.64	0.94	0.89	0.83	0.76	0.70	1.00	-0.71	0.33	0.95
A/W	59.40	3.20	0.97	0.95	0.92	0.88	0.85		1.00	-0.89	-0.82
H/W	17.35	2.17	0.98	0.96	0.92	0.88	0.84			1.00	0.47
L/W	11.87	0.98	0.97	0.94	0.90	0.86	0.82				1.00

Note: This table reports summary statistics for the consumption to total wealth ratio C/W, financial to total wealth ratio A/W, houisng to total wealth ratio H/W and labor inocme to total wealth ratio L/W. Total wealth is measured as the sum of financial and houisng wealths and labor income $W = A + H + L$.

B. Wealth Composition – Summary Statistics

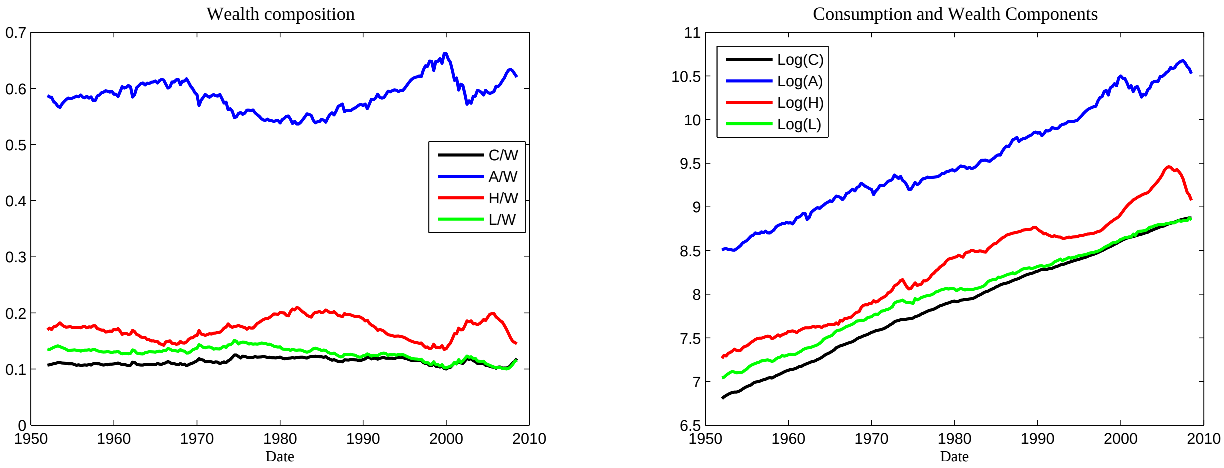

Figure 3: Wealth Composition

C. Variance Decomposition

Table 19: Variance Decomposition Sub–period 1952Q1–1982Q3

	α_c=α_h=0							
horizon h	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$				$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	1.000	0.000	0.000	0.000	0.085	0.013	0.202	0.699
2	0.978	0.000	0.001	0.019	0.071	0.014	0.257	0.656
3	0.972	0.001	0.000	0.025	0.064	0.010	0.321	0.603
4	0.972	0.001	0.000	0.025	0.057	0.016	0.377	0.548
8	0.981	0.001	0.000	0.016	0.037	0.114	0.495	0.352
40	0.985	0.011	0.000	0.003	0.007	0.376	0.544	0.071
horizon h	$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$				$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	0.056	0.943	0.000	0.000	0.278	0.027	0.483	0.211
2	0.104	0.880	0.007	0.007	0.403	0.052	0.355	0.188
3	0.123	0.853	0.010	0.011	0.467	0.048	0.307	0.176
4	0.134	0.840	0.012	0.012	0.508	0.042	0.288	0.160
8	0.152	0.821	0.018	0.008	0.592	0.025	0.276	0.106
40	0.172	0.800	0.025	0.002	0.661	0.029	0.283	0.025
	α_c and α_h are estimated							
horizon h	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$				$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	0.960	0.007	0.002	0.030	0.010	0.039	0.111	0.838
2	0.919	0.004	0.000	0.074	0.006	0.053	0.145	0.793
3	0.911	0.005	0.001	0.082	0.004	0.051	0.212	0.731
4	0.915	0.004	0.002	0.077	0.004	0.043	0.289	0.663
8	0.938	0.002	0.011	0.047	0.002	0.030	0.543	0.424
40	0.952	0.007	0.031	0.009	0.000	0.047	0.864	0.087
horizon h	$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$				$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	0.026	0.746	0.202	0.024	0.247	0.042	0.456	0.253
2	0.055	0.751	0.141	0.051	0.350	0.018	0.368	0.261
3	0.068	0.751	0.119	0.060	0.411	0.012	0.320	0.255
4	0.077	0.757	0.106	0.058	0.458	0.011	0.292	0.237
8	0.097	0.780	0.081	0.040	0.578	0.032	0.231	0.158
40	0.131	0.810	0.047	0.010	0.719	0.114	0.128	0.037

Note: The table reports the fraction of h–step ahead forecast error of consumption, financial wealth, housing wealth and labor income growths (respectively Δc, Δa, Δh ans Δy) that are attributable to innovations in the permanent shocks P and the transitory shock T. Horizons h are in quarters. The VECM model is estimated over the sub–period 1952Q1–1982Q3.

Table 20: Variance Decomposition Sub–period 1952Q1–1999Q4

	α_c=α_h=**0**							
horizon h	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$				$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	1.000	0.000	0.000	0.000	0.026	0.038	0.333	0.601
2	0.953	0.006	0.001	0.038	0.030	0.041	0.378	0.550
3	0.939	0.010	0.000	0.049	0.032	0.035	0.412	0.519
4	0.936	0.011	0.001	0.051	0.034	0.029	0.442	0.493
8	0.948	0.008	0.000	0.043	0.039	0.022	0.530	0.407
40	0.980	0.008	0.000	0.010	0.038	0.224	0.616	0.120
100	0.982	0.012	0.000	0.004	0.035	0.316	0.599	0.048
horizon h	$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$				$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	0.036	0.963	0.000	0.000	0.065	0.119	0.610	0.205
2	0.062	0.911	0.022	0.003	0.140	0.147	0.501	0.211
3	0.073	0.889	0.030	0.006	0.180	0.153	0.452	0.214
4	0.079	0.878	0.035	0.007	0.206	0.151	0.431	0.209
8	0.089	0.861	0.042	0.006	0.266	0.124	0.434	0.174
40	0.106	0.841	0.050	0.001	0.358	0.036	0.551	0.053
100	0.110	0.836	0.052	0.000	0.375	0.017	0.584	0.022
	α_c **and** α_h **are estimated**							
horizon h	$\Delta c_{t+h} - \mathbb{E}_t \Delta c_{t+h}$				$\Delta a_{t+h} - \mathbb{E}_t \Delta a_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	0.065	0.001	0.873	0.059	0.001	0.493	0.092	0.413
2	0.127	0.006	0.843	0.021	0.000	0.538	0.093	0.367
3	0.150	0.013	0.823	0.012	0.001	0.558	0.098	0.341
4	0.160	0.017	0.813	0.009	0.005	0.568	0.104	0.322
8	0.169	0.023	0.802	0.004	0.047	0.563	0.125	0.264
40	0.160	0.022	0.816	0.000	0.439	0.318	0.162	0.079
100	0.575	0.421	0.003	0.000	0.584	0.218	0.164	0.031
horizon h	$\Delta h_{t+h} - \mathbb{E}_t \Delta h_{t+h}$				$\Delta y_{t+h} - \mathbb{E}_t \Delta y_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	0.729	0.231	0.0093	0.030	0.635	0.193	0.030	0.141
2	0.639	0.336	0.0042	0.019	0.667	0.130	0.081	0.120
3	0.612	0.370	0.0036	0.013	0.673	0.104	0.109	0.113
4	0.599	0.386	0.0035	0.010	0.672	0.093	0.128	0.106
8	0.583	0.407	0.0036	0.005	0.648	0.098	0.169	0.083
40	0.575	0.420	0.0034	0.001	0.474	0.251	0.249	0.025
100	0.575	0.421	0.0033	0.000	0.401	0.316	0.270	0.010

Note: The table reports the fraction of h–step ahead forecast error of consumption, financial wealth, housing wealth and labor income growths (respectively Δc, Δa, Δh ans Δy) that are attributable to innovations in the permanent shocks P and the transitory shock T. Horizons h are in quarters. The VECM model is estimated over the sub–period 1952Q1–1999Q4.

Table 21: Variance Decomposition Sub–period 1952Q1–2009Q1

α_c=α_h=0

horizon h	$\Delta c_{t+h}-\mathbb{E}_t\Delta c_{t+h}$				$\Delta a_{t+h}-\mathbb{E}_t\Delta a_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	1.000	0.000	0.000	0.000	0.044	0.955	0.000	0.000
2	0.949	0.021	0.001	0.028	0.065	0.925	0.007	0.001
3	0.912	0.034	0.002	0.050	0.082	0.890	0.013	0.014
4	0.874	0.039	0.006	0.079	0.093	0.853	0.022	0.030
8	0.747	0.035	0.039	0.176	0.120	0.707	0.066	0.105
40	0.722	0.024	0.110	0.142	0.180	0.488	0.200	0.130
100	0.820	0.021	0.083	0.074	0.194	0.545	0.188	0.072
horizon h	$\Delta h_{t+h}-\mathbb{E}_t\Delta h_{t+h}$				$\Delta y_{t+h}-\mathbb{E}_t\Delta y_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	0.026	0.009	0.132	0.832	0.090	0.012	0.428	0.468
2	0.034	0.009	0.204	0.751	0.108	0.009	0.419	0.4627
3	0.042	0.007	0.225	0.724	0.120	0.007	0.409	0.4631
4	0.048	0.006	0.242	0.703	0.129	0.006	0.402	0.4626
8	0.061	0.002	0.289	0.646	0.150	0.011	0.394	0.4436
40	0.059	0.166	0.417	0.356	0.081	0.093	0.687	0.1370
100	0.047	0.281	0.439	0.231	0.063	0.088	0.790	0.0573

α_c and α_h are estimated

horizon h	$\Delta c_{t+h}-\mathbb{E}_t\Delta c_{t+h}$				$\Delta a_{t+h}-\mathbb{E}_t\Delta a_{t+h}$			
	P1	P2	P3	T	P1	P2	P3	T
1	0.000	0.997	0.000	0.002	0.639	0.039	0.099	0.222
2	0.000	0.932	0.002	0.064	0.651	0.059	0.063	0.225
3	0.003	0.894	0.002	0.099	0.620	0.077	0.043	0.259
4	0.003	0.857	0.006	0.132	0.593	0.089	0.031	0.285
8	0.002	0.740	0.050	0.206	0.503	0.122	0.025	0.348
40	0.001	0.753	0.132	0.112	0.566	0.179	0.048	0.205
100	0.001	0.845	0.098	0.054	0.692	0.177	0.027	0.102
horizon h	$\Delta h_{t+h}-\mathbb{E}_t\Delta h_{t+h}$				$\Delta y_{t+h}-\mathbb{E}_t\Delta y_{t+h}$			
1	0.021	0.018	0.287	0.673	0.406	0.064	0.150	0.3788
2	0.009	0.026	0.363	0.600	0.362	0.080	0.157	0.3998
3	0.007	0.034	0.387	0.570	0.354	0.090	0.152	0.4025
4	0.006	0.039	0.405	0.547	0.349	0.098	0.149	0.4022
8	0.006	0.053	0.462	0.477	0.369	0.118	0.142	0.3695
40	0.028	0.068	0.685	0.217	0.405	0.073	0.412	0.1085
100	0.041	0.067	0.763	0.127	0.400	0.058	0.496	0.0446

Note: The table reports the fraction of h–step ahead forecast error of consumption, financial wealth, housing wealth and labor income growths (respectively Δc, Δa, Δh ans Δy) that are attributable to innovations in the permanent shocks P and the transitory shock T. Horizons h are in quarters. The VECM model is estimated over the sub–period 1952Q1–2009Q1.

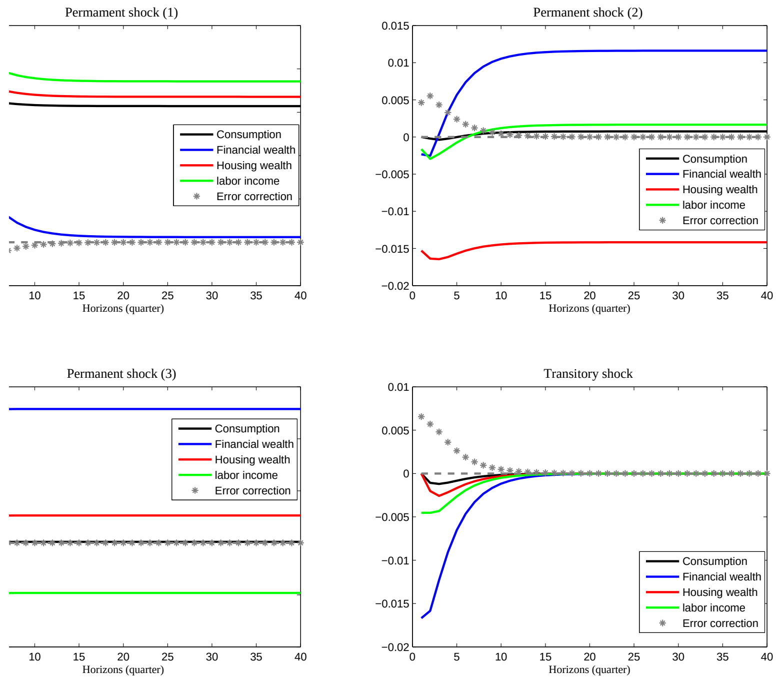

Figure 4: Impulse Response Functions (1) – Sub–period 1952Q1–1982Q3

Figure 4 reports impulse response functions to a one–standard deviation of each permanent shock $P1$, $P2$, $P3$ and transitory shock T. the VECM model is estimated the sub–period 1952Q1–1982Q3. Adjustment coefficients that are not statistically significant are set to zero $\alpha_c = \alpha_h = 0$.

D. Impulse Response Functions

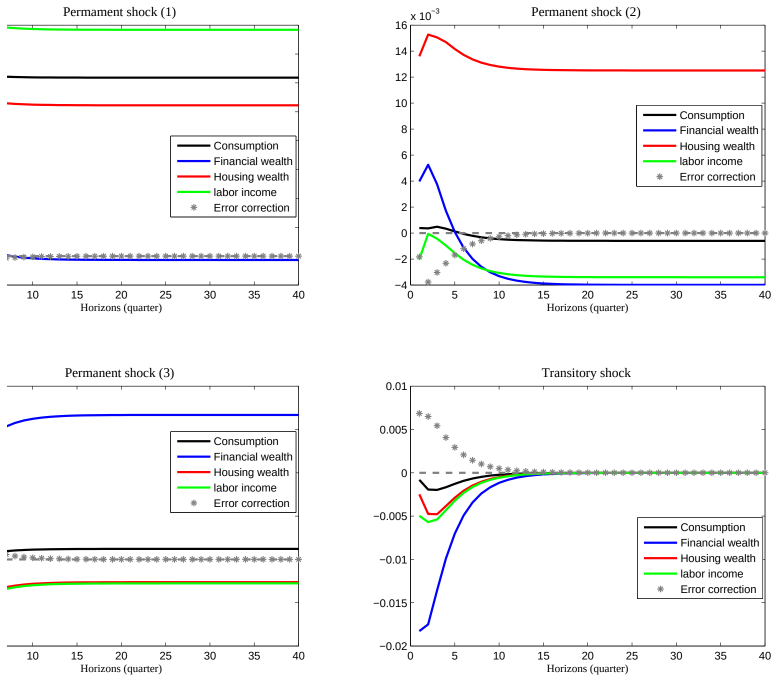

Figure 5: Impulse Response Functions (2) – Sub–period 1952Q1–1982Q3

Figure 5 reports impulse response functions to a one–standard deviation of each permanent shock $P1$, $P2$, $P3$ and transitory shock T. the VECM model is estimated the sub–period 1952Q1–1982Q3. Adjustment coefficients set to their estimated values.

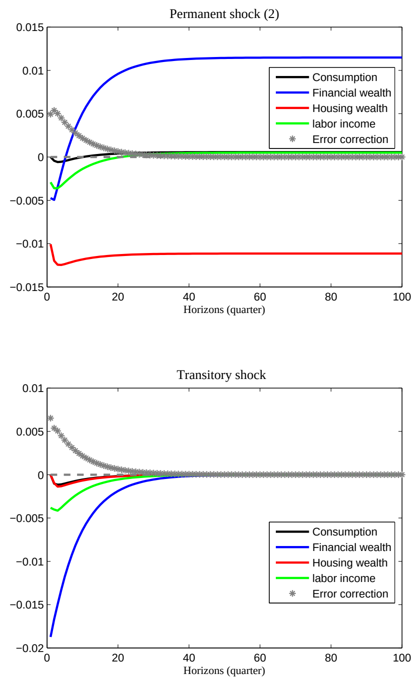

Figure 6: Impulse Response Functions (1) – Sub–period 1952Q1–1999Q4

Figure 6 reports impulse response functions to a one–standard deviation of each permanent shock $P1$, $P2$, $P3$ and transitory shock T. the VECM model is estimated the sub–period 1952Q1–1999Q4. Adjustment coefficients that are not statistically significant are set to zero $\alpha_c = \alpha_h = 0$.

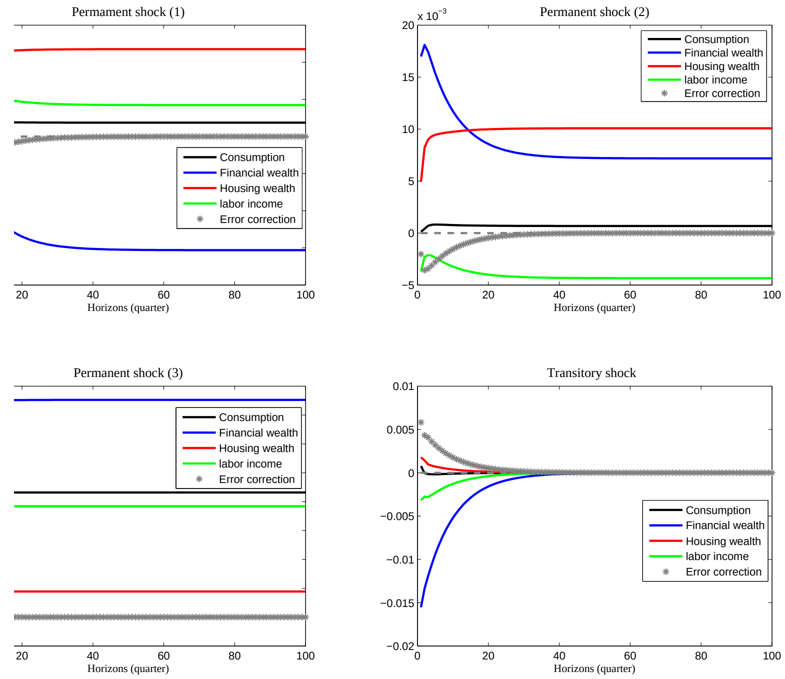

Figure 7: Impulse Response Functions (2) – Sub–period 1952Q1–1999Q4

Figure 7 reports impulse response functions to a one–standard deviation of each permanent shock $P1$, $P2$, $P3$ and transitory shock T. the VECM model is estimated the sub–period 1952Q1–1999Q4. Adjustment coefficients are set to their estimated values.

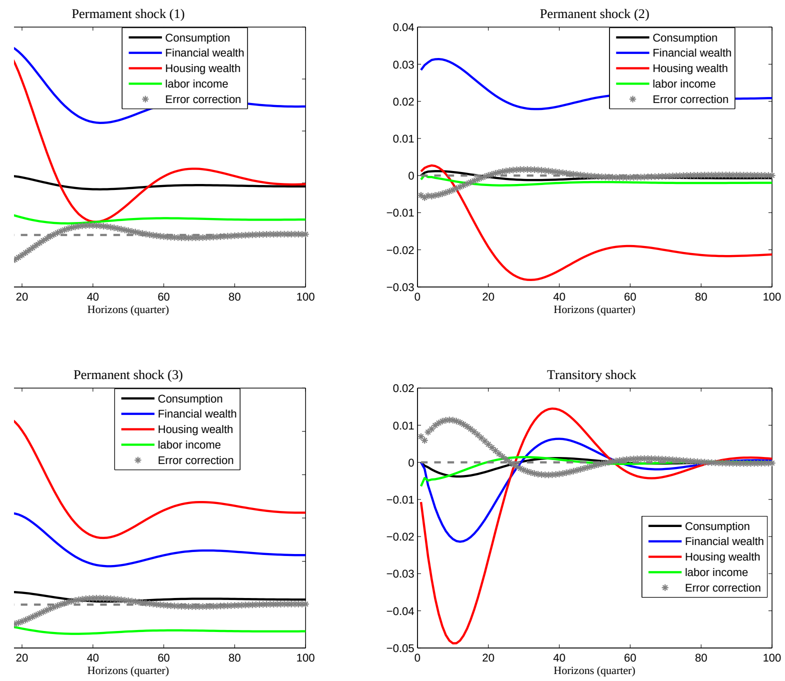

Figure 8: Impulse Response Functions (1) – Sub–period 1952Q1–2009Q1

Figure 8 reports impulse response functions to a one–standard deviation of each permanent shock $P1$, $P2$, $P3$ and transitory shock T. the VECM model is estimated the sub–period 1952Q1–2009Q1. Adjustment coefficients that are not statistically significant are set to zero $\alpha_c = \alpha_h = 0$.

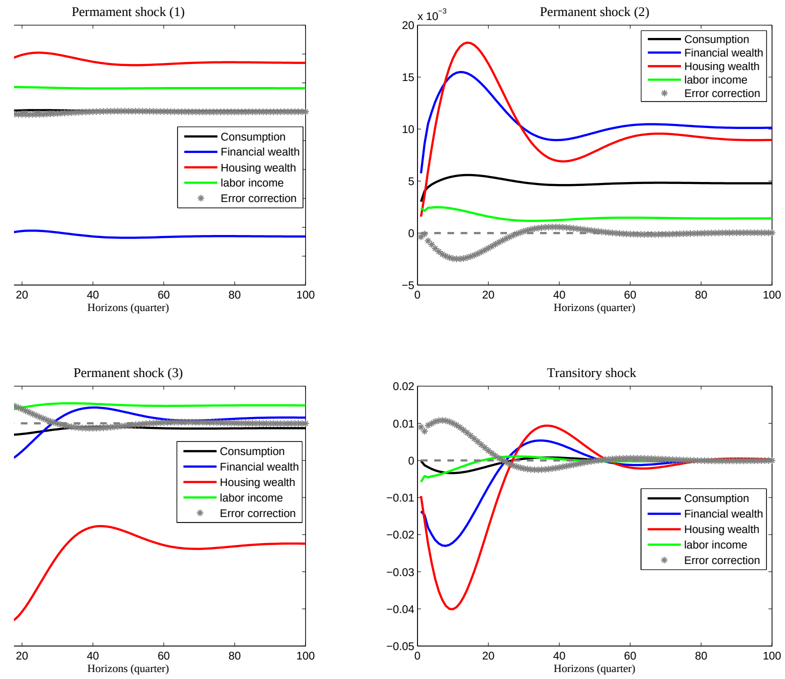

Figure 9: Impulse Response Functions (2) – Sub–period 1952Q1–2009Q1

Figure 9 reports impulse response functions to a one–standard deviation of each permanent shock $P1$, $P2$, $P3$ and transitory shock T. the VECM model is estimated the sub–period 1952Q1–2009Q3. Adjustment coefficients set to their estimated values

E. Housing Returns

Following Flavin and Yamashita (2002), housing returns R^H is defined as follows:

$$R^H_{t+1} = \frac{P^H_{t+1} + D^H_{t+1} - COM^H_{t+1}}{P^H_t}$$

where P^H_t is the price per unit of housing quantity and D^H_{t+1} the dividends on housing. The term COM^H_{t+1} denotes the cost of ownership and maintenance, including the net property tax payment. Flavin and Yamashita (2002) assume that the maintenance is roughly equal to depreciation, estimated as a fixed share δ of the current price of the residential wealth P^H_t. The marginal tax rate is assumed to be 33% (28% federal rate and 5% state rate) and the property tax rate is assumed to be 2.5%. Therefore, we need to subtract the net property tax payment $(1 - 33\%)2.5\% P^H_t$ from dividends. The real housing returns is thus

$$R^H_{t+1} = \frac{P^H_{t+1} + D^H_{t+1}}{P^H_t} - \delta - (1 - 0.33) * 0.025 \tag{31}$$

The housing returns rewrites

$$R^H_{t+1} = \frac{P^H_{t+1} H_{t+1} + q_{t+1} S_{t+1}}{P^H_t H_t} \left(\frac{H_t}{H_{t+1}} \right) - \delta - (1 - 0.33) * 0.025 \tag{32}$$

or equivalently

$$R^H_{t+1} = \frac{P^H_{t+1} H_{t+1} + q_{t+1} S_{t+1}}{P^H_t H_t} \left(\frac{P^H_t H_t}{P^H_{t+1} H_{t+1}} \right) \left(\frac{P^H_{t+1}}{P^H_t} \right) - \delta - (1 - 0.33) * 0.025 \tag{33}$$

where H_t is the physical quantity held of housing and the dividends on housing are rent payments $q_{t+1} S_{t+1}$.

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