VECM and Variance Decomposition: An Application to the Consumption-Wealth Ratio

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Abstract

This study uses a variance decomposition technique, which doesn't rely on the underlying economic theory, in order to implement a permanent-transitory variance decomposition of the consumption-wealth ratio. We break down the wealth variable into financial assets, tangible assets, and human assets. Using quarterly data over the last six decades, we rely on cointegration analysis as the framework for the study, in order to assess the long-term interrelation between consumption shocks, and those from each of the above mentioned wealth components. Our results indicate that wealth components tend to exhibit permanent shocks, while consumption shocks appear to be transitory. Moreover, the results also indicate a low contemporaneous correlation between shocks in consumption and the ones from financial assets, and also between shocks in consumption and the ones from tangible assets. In addition, the variance decomposition of consumption shocks seems to indicate that, over the time a significantly increasing proportion of consumption shocks is explained by financial assets.

Keywords: cointegration, error correction model, variance decomposition, consumption-wealth ratio

1. Introduction

In this study, we implement a variance decomposition technique on a system of time-series variables, in order to determine which ones tend to exhibit long term permanent shocks, and which ones tend to have transitory shocks in the long run. One particularity of the technique we use in order to achieve this variance decomposition, is that it doesn't rely on any specific underlying economic theory. Our system of variables derives from the consumption-wealth ratio, from which we break down the wealth variable component into financial assets, tangible assets, and human assets, in order to obtain along with the consumption variable, a system of four time-series variables to work with. The study relies extensively on vector autoregression analysis VAR, and more specifically on error correction models ECM, to achieve the permanent-transitory variance decomposition between the variables in the model. Gonzalo and Granger (1995), suggest a way of using error correction model to implement a permanent-transitory variance decomposition in a system of two variables, and Gonzalo and Ng (2001), use the error correction model to implement a permanent – transitory decomposition in a multivariate context with a system of three variables, in such a way that the outcome doesn't rely on the underlying economic theory.

The main results of this study appear to indicate that over the past six decades covered by our data, all wealth components exhibit permanent shocks while consumption shocks are transitory. Moreover, the results indicate that there's a low contemporaneous correlation between innovations in consumption and the ones from financial assets, and also between innovations in consumption and the ones from tangible assets. In addition, the variance decomposition of consumption shocks indicates that over the time, a significantly increasing proportion of consumption shocks is explained by financial assets. A fact that seem to suggest that the consumption-wealth linkage apparently manifest itself essentially through financial assets.

The rest of the paper is structured as follows: In the next section (section 2) we present a review of previous studies related to this topic, then in section 3 we present the theoretical framework of our work, and in section 4 we present our empirical framework. The main results, as well as the main implications of our findings are presented in section 5, and finally the conclusion is presented in section 6.

2. Literature History

Several other studies explore issues related to those considered here. Anthony Garratt, Donald Robertson, and Stephen Wright (2004), suggest a multivariate version of the Beveridge-Nelson Permanent-Transitory decomposition, as a tool to assess what are the economic mechanisms that pull a given variable towards its trend. They show that transitory components can be related directly to the underlying stationary process that drives the system. Campbell and Mankiw (1987); in Permanent-Transitory Components and Economics Fluctuations, fail to reject the hypothesis that fluctuations in real GNP appear to represent only deviations from the deterministic trend. However, they also consider the possibility that this finding might be due to the failure to distinguish the business cycle from other fluctuations in real GNP. Gonzalo and Granger (1995), propose a new way of estimating common long memory components of large cointegrated systems. John Cochrane (1994) in "Permanent and Transitory Components of GNP and Stock Prices", uses a two-variable vector autoregression framework, to characterize transitory components in GNP and stock prices. He finds that shocks to GNP holding consumption constant, are almost entirely transitory, and account for large fractions of the variance of GNP growth. He finds also in the same study that shocks to prices holding dividends constants, are almost entirely transitory. Gonzalo and Ng (2001), propose a systematic framework for analyzing the dynamic effects of permanent and transitory shocks, on a system of n variables, using a two-step orthogonalization of the residuals of a VECM with r cointegrating vectors. Martin Lettau and Sydney Ludvigson (2003), in "Understanding Trend and Cycle in Asset Values: Reevaluating the Wealth Effect on Consumption", investigate the wealth-consumption linkage, in an attempt to explain why there are movements in asset values that often seem to be disassociated with important movements in consumer spending. They find enough evidence to support that only a small fraction of the variation in household net worth is related to variation in aggregate consumer spending, with the precision, they continue, that this does not mean that wealth has no effect on consumer spending, but rather, that only permanent changes in wealth are associated with movements in consumption. More recently, Francis X. Diebold and Kamil Yilmaz (2011), in "On The Network Topology of Variance Decomposition", combine VAR variance decomposition theory and network topology theory, to provide a way to assess measures of the connectedness among financial asset returns and volatilities.

Our current study, partly follows on these steps of Lettau and Ludvigson (2003), in assessing the wealth-consumption linkage, but by decomposing the wealth element into three components: financial assets, tangible assets, and human assets, while relying on the variance decomposition framework developed by Gonzalo and Granger (1995), and Gonzalo and Ng (2001).

3. Consumption-Wealth Ratio and Wealth Decomposition.

The methodology we use in this study is that of a representative agent economy in which all wealth, including human capital, is tradable. The theoretical framework is based on the simple accumulation equation for aggregate wealth, written as:

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

Where $R_{w,t+1}$ is the net return on aggregate wealth.

We use an adaptation of the derivations by Campbell and Mankiw (1989), in "Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence, in Oliver Blanchard and Stanley Fischer, NBER Macroeconomics Annual: 1989, Cambridge, MA: MIT Press, 1989, pp. 185-216", and also those from Campbell and Shiller (1986), in "Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors", in order to transform the accumulation equation for aggregate wealth (1), into the following expression in which the consumption-wealth ratio is expressed as a function of expected future returns on wealth, and expected future consumption growth (in logarithms):

$$(c_t - w_t) = E_t \sum_{i=1}^{\infty} \rho_w^i (r_{w,t+i} - \Delta c_{t+i}) \tag{2}$$

Where E_t is the expectation operator conditional on information available at time t.

Now, considering the decomposition of aggregate wealth into financial, tangible, and human assets, as $W_t = F_t + T_t + H_t$, where:

W_t = Market Value of wealth at time t,

F_t, T_t, and H_t, Market value of financial, tangible and human assets at time t, measured as the present value at time t, of the stream of expected future returns from F_t, T_t, and H_t, respectively. The human assets here can consist of the training, the experience, the knowledge, or any combination of these that an individual may poses, and is assumed here to have a marketable value of H_t at any time t, and is included in the aggregate wealth value

W_t.

Since the stock of human wealth is not directly observable, we follow Ludvigson and Lettau (2001), in "Consumption, Aggregate Wealth, and Expected Stock Returns JOF vol.56", by assuming that the non-stationary component of human capital, denoted H_t, can be well described by aggregate labor income, Y_t. Campbell (1996), in "Understanding Risk and Return, JPE vol. 104-2", considers labor income as the dividend on human capital.

Considering the breakdown of the aggregate wealth variable, and under the additional assumption that the aggregate wealth returns $R_{w, t+1}$, can be considered as a weighted sum of the returns from each individual wealth components, our log consumption – wealth ratio can be represented as follows:

$$c_t - \alpha_f f_t - \alpha_\tau \tau_t - \alpha_y y_t \approx \mathrm{E}_t \sum_{i=1}^{\infty} \rho_w^{\ i} \left\{ \left[\omega_f \Delta f_{t+i} + \omega_\tau \Delta \tau_{t+i} + \left(1 - \omega_f - \omega_\tau \right) \Delta y_{t+i} \right] - \Delta c_{t+i} \right\} \qquad (3)$$

Where the parameters α_f, α_τ, and α_y are theoretically equal to the shares of financial assets, tangible assets, and labor income in the log of aggregate wealth respectively, and ω_f, ω_τ, and $(1 - \omega_f - \omega_\tau)$ their respective shares in the aggregate wealth return.

Equation (3) is a consumption-based present value relation involving future growth of each component of our wealth decomposition, as well as future consumption growth. This equation suggests that in case Δf_t, $\Delta \tau_t$, Δy_t, and Δc_t are covariance stationary, then consumption, financial assets, tangible assets, and labor income, are cointegrated. It also implies that deviations from their common trend, represented by the left-hand-side of (3), provide a rational growth forecast of any one of the four variables in the system, or of some combination of them. The parameters α_f, α_τ, and α_y represent the cointegrating coefficients.

4. Empirical Framework: Model and Variables Description

The main empirical approach in this study is the use of cointegration to identify permanent and transitory components between consumption, financial assets, tangible assets, and labor income. We denote by $x_t = (c_t, f_t, \tau_t, y_t)'$ the vector of dependent variables in the model, representing respectively log of real consumption expenditures, log of real net financial assets, log of real tangible assets, and log of real labor income respectively.

The Augmented Dickey Fuller test is performed on these four variables. Said and Dickey (1984) demonstrate that the ADF test is asymptotically valid in the presence of a moving average (MA) component, provided that sufficient lagged difference terms are included in the test regression. We choose to run the test with the more general specification that includes both a constant and a linear trend, and without additional exogenous variables. The standard recommendation is to choose a specification that is a plausible description of the data under both the null and alternative hypotheses, (Hamilton 1994, p. 501). In specifying the number of lagged difference terms to be added to the test regression, the usual recommendation is to include a number of lags sufficient to remove serial correlation in the residuals. The unit roots test on each variable in the system suggests that all the variables contained in x_t are first order integrated, or I(1).

To obtain a correctly specified error-correction model, we begin by testing for both the presence and number of cointegrating relations in x_t. Prior for doing that, two important issues needed to be investigated. That's whether to include the trend and/or the drift parameters in the model, and what is the appropriate lag length of the system.

Johansen (1994) suggests that:

One should include a time trend in the VECM if we suspect that:

- The components of the vector $\alpha' X_t$ (or some combination of them) are trend stationary, so that they veer apart.

- X_t is trend stationary rather than a multivariate unit root with drift process. We may want to test this hypothesis under the trend stationarity hypothesis that the matrix $A(1) = \gamma \alpha'$ has full rank (n). One of Johansen's cointegration tests, the trace test, has this as alternative hypothesis.

Following these recommendations by Johansen (1994), the plot of all our four variables expressed in logs (Appendix B), suggests that we should not include drift, nor trend in our analysis.

The remaining issue which is the lag length, is dealt with by relying on the minimum value of the Akaike Information Criterion, AIC.

The cointegration test suggest the presence of a single cointegrating vector; which we impose in the VECM

specifcation from now on. The cointegrating coefficient on consumption is normalized to one, and we denote the single cointegrating vector for $x_t = (c_t, f_t, \tau_t, y_t)'$, as $\alpha = (1, -\alpha_f, -\alpha_\tau, -\alpha_y)'$.

We therefore consider from now on, the VECM representation specified below, using lower case for the system vectors of variables:

$$\Delta x_t = \gamma\alpha' x_{t-1} + \Gamma(L)\Delta x_{t-1} + e_t \tag{4}$$

Δx_t is the vector of log first differences, $(\Delta c_t, \Delta f_t, \Delta \tau_t, \Delta y_t)'$, $\gamma = (\gamma_c, \gamma_f, \gamma_\tau, \gamma_y)'$ is the (4×1) vector of adjustment coefficients. It will be an important factor in telling us which variables subsequently adjust to restore the common trend when a deviation occurs. The Granger Representation Theorem states that, if a vector x_t is cointegrated, at least one of the adjustment parameters, $\gamma_c, \gamma_f, \gamma_\tau,$ or γ_y must be nonzero in the error-correction representation (4). Thus if x_j does at least some of the adjusting needed to restore the long-run equilibrium subsequent to a shock that distorts this equilibrium, γ_j should be different from zero in the equation for Δx_j of the error-correction representation. $\Gamma(L)$ is a finite order distributed lag operator, and $\alpha = (1, -\alpha_f, -\alpha_\tau, -\alpha_y)'$ is the (4×1) vector of cointegrating coefficients. Throughout this paper, we use "hats" to denote the estimated values of parameters. The term $\alpha' x_{t-1}$ gives last period's equilibrium error, or cointegrating residual.

5. Main Results and Implications

Table 1. Minimum information criterion

Lag	MA 0	MA 1	MA 2	MA 3	MA 4	MA 5
AR 0	-11.78861	-11.63212	-11.57118	-11.50699	-11.4516	-11.39751
AR 1	-36.77828	-36.69077	-36.65201	-36.7775	-36.83518	-36.87385
AR 2	-36.99628	-36.97361	-36.88726	-36.88588	-36.86558	-36.93982
AR 3	-36.99651	-36.9579	-36.89507	-36.886	-36.83848	-36.84815
AR 4	**-37.02186**	-36.95866	-36.90829	-36.80901	-36.76287	-36.78745
AR 5	-36.98839	-36.96623	-36.87961	-36.79413	-36.812	-36.75959

The test indicates a number of lag length of 4 periods.

Table 2. Cointegration rank test using trace

H0: Rank=r	H1: Rank>r	Eigenvalue	5% Critical Trace	Drift Value	Drift in in ECM	Process
0	0	0.1979	60.8726	39.71	NOINT	Constant
1	**1**	**0.0406**	**14.1274**	**24.08**		
2	2	0.0136	5.3317	12.21		
3	3	0.0114	2.4329	4.14		

Table 3. Long-run parameter (alpha) estimates when RANK=1

Variable	
consumption	1.00000
financial assets	0.01237
tangible assets	-0.62314
labor income	-0.45246

Table 4. Adjustment coefficient (gamma) estimates when RANK=1

Variable	
consumption	-0.00728
financial assets	-0.01383
tangible assets	0.00040
labor income	0.00388

The stationarity tests performed on all four variables of the system: C_t, f_t, τ_t, and y_t, respectively consumption, net financial assets, tangible assets, and labor income, (all variables are in logs) suggest that all four variables are I(1). The cointegration test has been conducted using the cointegrating rank test and an AIC minimum value, with a lag length of 4 periods (Table 1). They suggest the presence of a single cointegrating vector, at a significance level of 5% (Table 2). The estimates of the cointegrating vector represented in this study by α, is then given by $\hat{\alpha}' = (1, 0.0124, -0.6231, -0.4525)$ with all the coefficients normalized with respect to consumption (Table 3). Also, the estimates of the unrestricted long-run adjustment coefficients, whose vector is represented by γ in this study, are given by $\hat{\gamma}' = (-0.00728, -0.01383, 0.00040, 0.00388)$, for consumption, net financial assets, tangible assets, and labor income, respectively (Table 4).

Table 5. Error correction model estimates

	Dependent Variables			
	Δc_t	Δf_t	$\Delta \tau_t$	Δy_t
$cfty_{t-1}$	**-0.00728**	-0.01383	0.00040	0.00388
t-Value	**(-5.73)**	(-1.46)	(0.19)	(1.66)
Δc_{t-1}	0.10524	0.00788	0.05397	**0.42404**
t-Value	(1.40)	(0.01)	(0.43)	**(3.10)**
Δc_{t-2}	0.04163	0.26677	0.24718	0.05106
t-Value	(0.54)	(0.47)	(1.92)	(0.36)
Δc_{t-3}	0.05568	-0.31752	**0.28290**	**0.34894**
t Value	(0.73)	(-0.56)	**(2.21)**	**(2.51)**
Δf_{t-1}	0.03563	0.24421	**0.31959**	0.14881
t-Value	(0.86)	(0.80)	**(4.59)**	(1.97)
Δf_{t-2}	-0.00616	-0.13318	0.08784	-0.09865
t-Value	(-0.15)	(-0.43)	(1.24)	(-1.29)
Δf_{t-3}	0.05148	-0.25899	**0.19258**	0.09909
t-Value	(1.26)	(-0.85)	**(2.80)**	(1.33)
$\Delta \tau_{t-1}$	**0.03000**	0.02724	0.02890	**0.05001**
t-Value	**(3.21)**	(0.39)	(1.84)	**(2.93)**
$\Delta \tau_{t-2}$	0.01351	0.01344	0.02065	**0.04764**
t-Value	(1.42)	(0.19)	(1.29)	**(2.73)**
$\Delta \tau_{t-3}$	0.01515	0.04952	0.00431	**0.06503**
t-Value	(1.58)	(0.69)	(0.27)	**(3.70)**
Δy_{t-1}	0.04350	-0.10332	-0.07000	-0.00097
t-Value	(1.09)	(-0.35)	(-1.04)	(-0.01)
Δy_{t-2}	-0.00769	-0.21282	0.00504	**0.04764**
t-Value	(-0.20)	(-0.73)	(0.08)	**(2.73)**
Δy_{t-3}	-0.01337	0.16172	-0.09533	-0.14762
t-Value	(-0.35)	(0.57)	(-1.48)	**(-2.11)**
R-squared	**0.1549**	0.0143	**0.3167**	**0.3408**
Pr > F	**0.0033**	0.9997	**<.0001**	**<.0001**

Result #1: From this four-variables cointegrating system, the presence of a single cointegrating equation suggests that there are three permanent components and one transitory component, following Gonzalo and Ng. In order to determine which are the common long-memory components of the system of variables, we follow Gonzalo and Granger (1995), in identifying the common factors. Since the last three adjustment coefficients are not statistically significant (very low t-statistics), Gonzalo and Ng (2001) recommend to restrict them to zero. When we impose that restriction, our restricted vector of adjustment coefficient estimates becomes, $\hat{\gamma}' = (-0.00728, 0, 0, 0)$. We use these values to obtain the orthogonal matrix $\hat{\gamma}_{\perp}$, defined such that $\hat{\gamma}'_{\perp} \hat{\gamma} = 0$. We then implement the permanent-transitory decomposition of the variables in the system. Our decomposition indicates that the common factors, i.e those variables that exhibit a permanent shocks, are financial assets, tangible assets, and

labor income. Consumption shocks however are transitory. This means, according to Engle and Granger (1987) interpretation, that a deviation from the common trend shared by consumption, financial assets, tangible assets, and labor income, can better be described as transitory movements mostly in consumption. This indicates that consumption is the variable that adjusts itself to push the system back to equilibrium after a temporary move away from it.

The finding that consumption shocks are transitory, and wealth shocks are permanent, seems contrary to those obtained by Lettau and Ludvigson (2003), where, with a different wealth decomposition into assets wealth and non-assets, they found assets' shocks essentially transitory, whereas consumption shocks were mostly permanent. One possible explanation of the difference between the two results, could well be explained by the difference in the lag-length used in the VECM estimation: Our lag-length test suggested a four periods lag, which we have applied in the estimation, while the other uses one period lag. According to Gonzalo and Ng (2001), the number of lag-length periods included in the estimation, has an important effect on the statistical significance of the adjustment coefficients; And the vector of adjustment coefficients estimates $\hat{\gamma}$ itself, is very important when implementing the permanent-transitory decomposition. As Ng and Gonzalo (2001) point out, the role of γ in any Permanent-Transitory decomposition is very crucial since $\gamma_{\perp}$ defines the permanent shocks.

Our results however, are consistent with the idea that agents are expected to adjust their consumption expenditures to changes in their wealth with a certain time delay which, we can refer to as the delay of consumption adjustment to wealth.

Table 6. Cross correlation of residuals

Lag	Variable	cons	f. assets	t. assets	income
0	cons	1.00000	0.15901	0.14481	0.40638
	f. assets	0.15901	1.00000	0.07427	0.09272
	t. assets	0.14481	0.07427	1.00000	0.26512
	income	0.40638	0.09272	0.26512	1.00000
1	cons	-0.00218	0.00759	-0.01546	-0.01510
	f. assets	-0.01479	-0.01249	0.00353	-0.01339
	t. assets	0.02537	0.03110	-0.02087	0.00781
	income	-0.01378	0.00461	-0.04739	-0.04319
2	cons	0.00348	0.01026	0.00531	-0.02468
	f. assets	-0.00818	-0.00558	-0.00363	-0.00698
	t. assets	0.02665	0.02665	0.01184	-0.01523
	income	-0.00097	0.01615	0.03983	-0.08706
3	cons	0.00968	0.00035	0.00848	-0.04104
	f. assets	-0.00604	0.00561	-0.00969	-0.02101
	t. assets	0.06782	0.03105	0.02225	0.05197
	income	0.02765	-0.00684	0.04418	-0.02218
4	cons	0.00256	-0.00918	0.07954	0.08651
	f. assets	0.11887	0.05410	0.06566	0.15697
	t. assets	-0.03591	-0.07988	0.06511	-0.03898
	income	0.06703	0.03993	-0.02447	0.08475

Result #2: From the table 6, we can also see that there's a low contemporaneous correlation between innovations in consumption and innovations in financial assets, 15.9%; also, a low contemporaneous correlation between innovations in consumption and innovations in tangible assets, 14.48%. This finding is consistent with Lettau and Ludvigson's finding that, only a small fraction of the variation in wealth is related to variation in consumption. However according to the generated Cholesky variance decomposition for consumption growth residuals (Appendix A, Tables A1, and A2), this statement appears to be true only in a very short horizon. Table A1 appears to indicate that consumption's variance is mostly explained by itself in a very short horizon, and over the time, a significantly increasing proportion of consumption shock is explained by financial assets. The proportions of consumption shocks explained by tangible assets and labor income are relatively insignificant, both at short and long horizon time periods. When the restrictions are imposed on the adjustment coefficients (table A2), the proportion of the consumption shocks explained by financial assets becomes even larger, and the one explained by tangible assets and labor income becomes much smaller, compared to the results obtained without restriction on the adjustment coefficients.

These ECM estimates of the R-square are respectively, 0.1549 for consumption, 0.0143 for financial assets, 0.3167 for tangible assets, and 0.3408 for labor income (table 5). Their values seem to indicate that, tangible assets growth and labor income growth show strong reliance on the past, consumption growth shows a weak reliance on the history, while financial assets' growth does not seem to rely on its past. In other words, it is not possible to rely on past information to predict financial assets growth, this finding is somehow consistent with the idea behind the efficient market hypothesis.

Table 7. Long-horizon growth of financial assets, tangible assets, labor income, and consumption, on cfty

Horizon	Variables	Panel A		Panel B		Panel C		Panel D	
		$\sum \Delta f_{t+h}$	R^2	$\sum \Delta \tau_{t+h}$	R^2	$\sum \Delta y_{t+h}$	R^2	$\sum \Delta c_{t+h}$	R^2
1	intercept	0.06759		**-0.02771**		**0.03255**		**0.01693**	
		[1.56]		[-2.34]		[2.46]		[2.65]	
	$cf\tau y_t$		0.0087		0.0463		0.0164		0.0074
		0.07844		**-0.05022**		0.03296		0.01063	
		[1.37]		[-3.22]		[1.89]		[1.26]	
2	intercept	**0.12947**		**-0.06840**		**0.05596**		**0.03026**	
		[2.06]		[-3.48]		[2.64]		[3.01]	
	$cf\tau y_t$		0.0151		0.0885		0.0170		0.0072
		0.14927		**-0.11739**		0.05376		0.01648	
		[1.80]		[-4.54]		[1.92]		[1.24]	
3	intercept	**0.17928**		**-0.11499**		**0.07004**		**0.04108**	
		[2.28]		[-4.29]		[2.43]		[3.10]	
	$cf\tau y_t$		0.0181		0.1232		0.0123		0.0055
		0.20407		**-0.19228**		0.06220		0.01898	
		[1.97]		[-5.45]		[1.64]		[1.09]	
4	intercept	**0.21055**		**-0.16930**		**0.08164**		**0.04550**	
		[2.27]		[-5.08]		[2.31]		[2.81]	
	$cf\tau y_t$		0.0172		0.1595		0.0096		0.0018
		0.23419		**-0.27707**		0.06722		0.01311	
		[1.92]		[-6.31]		[1.44]		[0.61]	
5	intercept	**0.21938**		**-0.22861**		**0.08990**		**0.04807**	
		[2.07]		[-5.87]		[2.17]		[2.57]	
	$cf\tau y_t$		0.0133		0.1981		0.0072		0.0002
		0.23450		**-0.36827**		0.06779		0.00475	
		[1.68]		[-7.18]		[1.24]		[0.19]	
6	intercept	**0.23131**		**-0.28834**		**0.10852**		**0.04688**	
		[1.98]		[-6.59]		[2.35]		[2.26]	
	$cf\tau y_t$		0.0115		0.2347		0.0084		0.0004
		0.23905		**-0.45989**		0.08200		-0.00846	
		[1.56]		[-7.99]		[1.35]		[-0.31]	
7	intercept	0.23158		**-0.34317**		**0.13040**		**0.04810**	
		[1.82]		[-7.18]		[2.56]		[2.13]	
	$cf\tau y_t$		0.0089		0.2660		0.0103		0.0018
		0.22804		**-0.54480**		0.10041		-0.01852	
		[1.36]		[-8.66]		[1.49]		[-0.62]	
8	intercept	0.22934		**-0.39701**		**0.15775**		**0.05078**	
		[1.68]		[-7.72]		[2.84]		[2.10]	
	$cf\tau y_t$		0.0069		0.2954		0.0136		0.0033
		0.21371		**-0.62838**		0.12583		-0.02672	
		[1.19]		[-9.29]		[1.72]		[-0.84]	
12	intercept	0.34286		**-0.63520**		**0.20242**		**0.06112**	
		[2.00]		[-10.33]		[2.88]		[2.02]	
	$cf\tau y_t$		0.0099		0.4272		0.0115		0.0105
		0.31975		**-0.99130**		0.14461		-0.05949	
		[1.42]		[-12.27]		[1.56]		[-1.50]	

20	intercept	**0.82346**		**-0.91400**		**0.26217**		0.07289
		[3.85]		**[-13.56]**		**[2.88]**		[1.95]
	$cf\tau y_t$		0.0465		0.5829		0.0069	0.0371
		0.86118		**-1.45438**		0.14108		**-0.13697**
		[3.07]		**[-16.46]**		[1.18]		**[-2.79]**

$\Sigma \Delta x_{t+h} = \beta_0 + \beta_1 cf \tau y_t + \varepsilon_{t+h}$, with $\Sigma \Delta x_{t+h} = \Delta x_{t+1} + \Delta x_{t+2} + ... + \Delta x_{t+h}$

Result #3: In order to assess the predictive content of the consumption-wealth ratio for future consumption growth, the growth of future financial assets, future tangible assets' growth , and future labor income growth, we estimate long-horizons simple regressions of consumption growth, $\Sigma \Delta c_{t+h}$, financial assets growth $\Sigma \Delta f_{t+h}$, tangible asset growth $\Sigma \Delta \tau_{t+h}$, and labor income growth $\Sigma \Delta y_{t+h}$, against the cointegrating residuals $cf\tau y_t$ respectively. For this purpose, we make use the following specification: $\Sigma \Delta x_{t+h} = \beta_0 + \beta_1 cf \tau y_t + \varepsilon_{t+h}$, where

$\Sigma \Delta x_{t+h} = \Delta x_{t+1} + \Delta x_{t+2} + ... + \Delta x_{t+h}$.

Since all the variables were shown to be I(1), both our dependent and independent variables (expressed in differences) are stationary. Hence, we can rely on the regular t-statistic to assess the statistical significance of the regression coefficients.

The regression results presented in Tables 2 appear to indicate that: On one hand, there's no significant relation between future consumption growth and the consumption-wealth ratio at short horizons. However, at long-horizons the relation appears to be significant (Table 7, Panel D). These results appear to suggest first, that the consumption-wealth ratio significantly predict the future consumption growth only at a long horizon. Second, such an outcome would itself, be consistent with the finding mentioned earlier in *Result #1*, that when the system is out of its equilibrium path in short horizon, consumption is the variable that will adjust gradually to allow the whole system to converge back to its long-horizon common trend.

On the other hand, we can observe from Table 7 Panel B, that there's a significant negative relation between future tangible assets' growth and the consumption-wealth ratio over the entire horizon considered. This seems to indicate that: First, the consumption-wealth ratio does significantly predict the growth of future tangible assets. Second, the negative relation between the consumption-wealth ratio and the growth of future tangible assets indicates that a high consumption-wealth ratio today can be related to a low tangible asset growth in the future, and vice-versa. Secondly, this also means, if we consider our data set and, as far the US economy is concerned, that the excess of saving implied by the delay of consumption adjustments to changes in wealth, has significantly and persistently explained the growth of future tangible assets over the entire horizon considered in this study, with a much stronger effect as the time horizon gets longer.

However, there appears to be some weak and unstable relation between future financial asset growth and the consumption-wealth ratio (Table 7 Panel A), and no significant relation between future labor income growth and the consumption-wealth ratio over the entire horizon considered (Table 7 Panel C).

6. Conclusion

In this study, we investigate some aspects of the relationship between wealth components and consumption. More specifically we decompose wealth into financial assets, tangible assets, and human assets, and, along with consumption, we first try to identify which variables exhibit permanent shocks and which ones exhibit transitory shocks. In order to achieve this, we use the model derived by Campbell and Mankiw (1988) and, apply our wealth decomposition to obtain a rational expectation intertemporal linear expression, relating the current consumption-wealth ratio to expected future consumption growth, expected future financial assets growth, expected tangible assets growth, and expected human asset's growth. Second, we rely on some of the results obtained from the above investigation, to try to assess the cross correlations, as well as the predictability of each of these variables by the consumption-wealth ratio. We make the assumption that the value of each wealth component reflects the sum of the present values of the stream of revenues expected from these assets. The human asset's value is proxied by labor income.

Our main results in this study indicate that all wealth components exhibit permanent shocks, while consumption shocks are transitory. They also indicate that there's a low contemporaneous correlation between innovations in consumption and financial assets, and also between innovations in consumption and tangible assets. However, a

variance decomposition of consumption shocks indicates that, over the time a significantly increasing proportion of consumption shocks is explained by financial assets. This particular aspect of our findings seems to suggest that the consumption-wealth linkage in this study manifests itself essentially through financial assets. Finally, we find that the consumption-wealth ratio persistently and significantly predicts future tangible assets growth. This last result appears to indicate that over the entire time horizon considered in this study, the excess of savings resulting from the delay of consumption adjustment to changes in wealth, has most likely and consistently, been converted into tangible assets.

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Appendix

Data Description

All the variable series are quarterly data covering the period from 1951-Q1 through 2015-Q3, and are described as follows:

Consumption

Consumption is measured as expenditure on non-durables and services. The quarterly data are seasonally adjusted at annual rates, in billions dollars. Real consumption data are obtained by deflating consumption data by the GDP deflator, with 2009 the base year. The source is the U.S. Department of Commerce, Bureau of Economic Analysis.

Labor Income

Labor income data are represented in this study by wage and salary disbursements, and are deflated by the GDP deflator, with 2009 the base year. The quarterly data are seasonally adjusted, in current dollars. The source is the

Bureau of Economic Analysis.

The other wealth variables

-Total wealth is household net worth in billions of current dollars, measured at the end of the period, not seasonally adjusted.

- Tangible Assets are measured in this study as Real estate + Equipments and software + Consumer durable goods.

- Financial Assets are made of total financial assets from households and non-profit organizations, in billions of dollars, and non-seasonally adjusted.

All these other wealth variables are deflated in this study, by the GDP deflator in order to have their values in real terms. The source for these data is the Board of Governors of the Federal Reserve System. A complete description of these data may be found at http://www.federalreserve.gov/releases/Z1/Current/

Appendix A

Variance Decomposition of consumption shocks (the transitory shocks), over a 30 (quarters) periods horizon

Table A1

Period	S.E.	C	FA	TA	Y
1	0.004512	100.0000	0.000000	0.000000	0.000000
2	0.007039	97.49167	1.844834	0.509162	0.154329
3	0.009213	94.70941	4.176935	1.012008	0.101643
4	0.011388	90.65578	7.179819	2.097801	0.066604
5	0.013484	85.50411	11.73058	2.713336	0.051965
6	0.015437	81.79405	15.01648	3.147360	0.042105
7	0.017245	79.06731	17.37070	3.527853	0.034135
8	0.018916	76.81313	19.36574	3.792643	0.028488
9	0.020460	75.05660	20.94725	3.970185	0.025957
10	0.021901	73.66154	22.17704	4.136156	0.025260
11	0.023251	72.49765	23.17743	4.298538	0.026383
12	0.024530	71.50181	24.00775	4.461275	0.029166
13	0.025755	70.62963	24.70254	4.633975	0.033861
14	0.026937	69.84271	25.29502	4.822981	0.039291
15	0.028086	69.11665	25.80806	5.030060	0.045226
16	0.029210	68.43211	26.25993	5.256710	0.051246
17	0.030313	67.77677	26.66316	5.502818	0.057251
18	0.031400	67.14301	27.02546	5.768608	0.062926
19	0.032473	66.52507	27.35339	6.053321	0.068219
20	0.033536	65.91888	27.65213	6.355929	0.073053
21	0.034589	65.32221	27.92503	6.675310	0.077450
22	0.035635	64.73334	28.17472	7.010548	0.081388
23	0.036675	64.15102	28.40355	7.360524	0.084903
24	0.037709	63.57436	28.61341	7.724214	0.088015
25	0.038740	63.00274	28.80585	8.100642	0.090763
26	0.039767	62.43566	28.98227	8.488908	0.093169
27	0.040792	61.87272	29.14389	8.888123	0.095264
28	0.041815	61.31364	29.29183	9.297457	0.097075
29	0.042837	60.75820	29.42705	9.716117	0.098626
30	0.043859	60.20626	29.55045	10.14335	0.099939

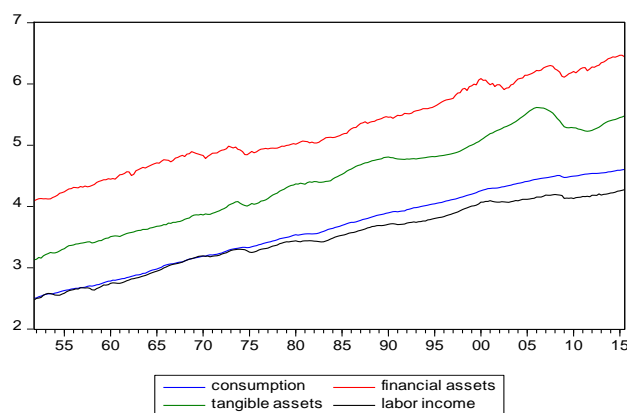*Note.* Cholesky Ordering: Consumption, Fin. Assets, Tan. Assets, Labor income.

Table A2

Period	S.E.	C	FA	TA	Y
1	0.004491	100.0000	0.000000	0.000000	0.000000
2	0.006986	97.36353	1.987846	0.516301	0.132320
3	0.009127	94.32370	4.571205	1.023987	0.081103
4	0.011274	89.92244	7.914164	2.106371	0.057026
5	0.013352	84.32064	12.93961	2.698294	0.041453
6	0.015289	80.32090	16.56864	3.076910	0.033548
7	0.017088	77.40388	19.18546	3.379109	0.031552
8	0.018756	75.00008	21.41931	3.549925	0.030678
9	0.020304	73.11799	23.23106	3.623954	0.026991
10	0.021754	71.59974	24.70318	3.673529	0.023544
11	0.023119	70.30953	25.96240	3.706911	0.021159
12	0.024418	69.18617	27.06507	3.728146	0.020619
13	0.025668	68.18540	28.04627	3.745536	0.022792
14	0.026880	67.27053	28.93822	3.763899	0.027343
15	0.028060	66.41883	29.76219	3.784719	0.034264
16	0.029217	65.61228	30.53534	3.809109	0.043271
17	0.030354	64.83989	31.26871	3.837139	0.054267
18	0.031476	64.09542	31.96856	3.869157	0.066865
19	0.032584	63.37394	32.64025	3.904894	0.080920
20	0.033680	62.67192	33.28791	3.943936	0.096239
21	0.034767	61.98746	33.91391	3.985887	0.112741
22	0.035844	61.31906	34.52016	4.030495	0.130277
23	0.036914	60.66543	35.10838	4.077404	0.148786
24	0.037977	60.02559	35.67989	4.126328	0.168186
25	0.039034	59.39874	36.23582	4.177013	0.188427
26	0.040085	58.78415	36.77716	4.229252	0.209437
27	0.041132	58.18119	37.30480	4.282838	0.231171
28	0.042175	57.58930	37.81953	4.337599	0.253572
29	0.043215	57.00798	38.32206	4.393373	0.276595
30	0.044251	56.43679	38.81300	4.450019	0.300192

Note. Cholesky Ordering: Consumption, Fin. Assets, Tan. Assets, Labor Income.

One can notice that from both tables there's a gradual increase along with the horizon, of the proportion of the consumption variance explained by financial assets, whereas the proportion explained by tangible assets and labor income respectively are relatively stable.

Appendix B
Variables' plot

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