The Stochastic Implications of Permanent Income Hypothesis for US Speculative Traders: Implications for Consumption-Based Asset Pricing

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Abstract

This paper examines the stochastic implications of permanent income hypothesis for speculative prices from a sample of economic data from 1967 to 2017 in the United States. One of the standard assumptions of the Consumption-Based Capital Asset Pricing Model (CCAPM)—the time separability of utility—is relaxed in the model specification of Mankiw and Shapiro (1985) and finds that the expected change in earnings has no obvious connection with stock price changes for monthly and yearly data. This finding, while accepting the excess sensitivity of consumption to income, suggests that the past consumption—unconstrained by expected change in income of that period—influences the utility of future consumption. Disposable income and consumption expenditure are highly autoregressive and non-stationary for monthly, quarterly, and yearly time series. The hypothesis that disposable income follows a random walk is clearly rejected for three-time horizons and the consumption is excessively sensitive to income for monthly and yearly data. The rejection of income follows a random walk due to liquidity constraint for quarterly data. The results of impulse response functions question the OLS/AR type of (univariate) regressions used to test the randomness of disposable income and the excess sensitivity. Equity price changes are, however, found to be completely independent from disposable income for frequent observations of income, which suggests that the use of consumption as a variable in capital asset pricing is a subjective assessment. Furthermore, the empirical evidence shows that the equity price changes cannot be effectively forecasted by the predictable change in disposable income.

Keywords: disposable income, consumption expenditure, permanent income hypothesis, excess sensitivity, consumption-based asset pricing

JEL classification: E01, E12, E21, E22, G12, G14

1 Introduction

The permanent income hypothesis of Milton Friedman[1] suggests that the consumption of a person at any given point in time is determined by the current income and the future expected income. Hall (1978) demonstrates that the permanent income follows a random walk under rational expectation assumption, in the sense that, no variable except current consumption would be helpful in forecasting future consumption. He finds that the real disposable income does not have any predictive power of consumption, whereas Mankiw and Shapiro (1985) show that disposable income[2] is a random walk under univariate regression and argue contrary to the conclusion that the consumption is excessively sensitive to income. Friedman (1957) demonstrates that the household consumption always

1 See Friedman (1957).

2 They, however, use disposable personal income per capita over the post-war period.

corresponds to permanent income shocks more than it does to temporary shocks. Permanent income hypothesis is built upon the argument that people desire to shift their consumption from periods of high income to low income so that the excessive variability in the consumption could be eliminated. This is largely debated in the literature with reference to Flavin (1981) and Bernanke (1985), in which they find evidence inconsistent with permanent income hypothesis.

Consumers, on the other hand, maximize their welfare in such a way that the expenditure could be financed by borrowing cheap and saving any excess at a higher rate of interest whenever arbitrage opportunities are available in the interest on savings and borrowing mismatches. The consumption is therefore a deterministic function of interest rate (see Romer, 2010).

Assume an economy where the permanent income hypothesis does not hold. If an economic agent receiving a certain level of income could distinguishably identify the consumption bundle and the investment[3] bundle, maximizing a given level of utility, the changes in equity prices could be regressed on income in proportion to the ratio between consumption and income[4] because the consumption is excessively sensitive to disposable income in the sense of Flavin (1981, 1984) and Bernanke (1985). This is particularly true because the utility gained by speculative investors[5] (i.e. speculative traders) from investing (i.e. trading) in equities differs from consumption (see Hakansson, 1970); and the association between consumption and investment must be manifested in economic data. This has a particular influence on the forecastability of the return on equity when utility is time inseparable[6]. On the other hand, the randomness of the payoffs accruing to equity holders from investing in the long run (i.e. investing or infrequently trading) differs from the short run (i.e. frequent or speculative trading) in efficient equity markets. As such, equity price changes

3 The terms *investment* and *trading* are used interchangeably.

4 Sørensen and Whitta-Jacobsen (2005) show that the ratio of aggregate consumption to aggregate income is roughly constant over the long run.

5 The terms *investors*, *equity holders*, and *speculators* are used interchangeably.

6 Although the investment is omitted, a classical preposition can be found in Barro and King (1984).

cannot be predicted on the basis of serial correlation associated with disposable income in speculative markets.

Moreover, the consumption is related to capital asset prices where the consumption is used as a variable in capital asset pricing (Rubinstein, 1976; Lucas, 1978; Grossman, Melino, & Shiller, 1987; Hansen & Singleton, 1983). In particular, consumption-based capital asset pricing suggests that the expected return of a risky capital asset is proportional to the covariance of its return and consumption. However, the model assumes that the past consumption is not related to utility of future consumption. Asset pricing on the basis of consumption may be more prudent, if the consumption and price changes are excessively sensitive to income and income itself is related to consumption and price changes because consumption is constrained by an expected change in income. A number of models incorporate consumption smoothing in intertemporal asset pricing (see especially Merton, 1973; Lucas, 1978; Breeden, 1979) and more recent models, such as Koutmos (2012), include trading behavior in intertemporal asset pricing. On the other hand, speculative prices cannot be predicted as price changes are completely random (see Fama, 1965; Clark, 1973). As such, changes in equilibrium prices are determined only by idiosyncratic information and speculators receive nothing from the common market expectation in efficient stock markets (see Senarathne & Jayasinghe, 2017).

The consumption-based capital asset pricing models (CCAPM) of Campbell and Cochrane (1999, 2000) are based on the assumption of time-separability of utility[7], which implies that past consumption has no obvious connection with the current or future satisfaction. If this is not held, no motivation is formed for future or current consumption by earning an additional income from past periods to present because the consumption (or its utility) is unconstrained by the expected change in income. The lagged income and the expected change in income should then have no obvious connection with the change in the current or future consumption, but utility on expected profitability (e.g. payoff)

7 This is what CCAPM assumes.

from investments may be formed. However, if there is no relationship between the lagged income and change in the value of investments (i.e. increments) in economic time-series data, the excess sensitivity of return (i.e. price change) on investment to expected change in income must be tested before considering the consumption as a variable in predicting the return on investment.

The objective of this paper is to examine the stochastic implications associated with disposable personal income on speculative stock price changes when time-separability of utility assumption is relaxed[8]. The hypothesis that the stock price changes of speculative securities are independent from economic variables such as disposable personal income and consumption will be tested in the sense of Mankiw and Shapiro (1985). In particular, this paper utilizes the stochastic behavior of speculative equity price changes[9] to justify the conclusions of Mankiw and Shapiro (1985). The paper is organized as follows: section two brings the methodological framework and section three the data. Section four is devoted to the results and discussion, while section five brings the conclusion.

2 Methodological Framework

Assume a fictitious economy where every economic agent participates in the equity market in which the ratio (r) between investment and consumption is proportional to income[10] so that the payoffs justify a part of increments in wealth of each agent. Define δ_{st} as the payoffs attributable to speculators from the s^{th} intraday trade carried out in the market so that, at the end of each trading day, a trader satisfies with $p_{it} - p_{it-1} = \sum_{s=1}^{nt} \delta_{st}$ amount of stochastic payoffs collected at n amount of observations (i.e. operations) in each day[11] in the market for

8 This problem is also noted by Mankiw and Shapiro (1985, p. 173).

9 In other words, this paper shows how the operational clock could testify the framework used by Mankiw and Shapiro (1985) to test the random walk behavior in permanent income and excess sensitivity.

10 The aggregate difference (in ratio) among agents is assumed to be negligible. The ratio is assumed to vary throughout without saving and, $r > 0$.

11 This stochastic element of wealth may also be summed up over a monthly, quarterly or yearly horizon for the purpose of this study.

price increments $(p_{it} - p_{it-1}) > 0$ given that the information set I is available to investors at time t. The conditional price increments are stationary, stochastic, and represent an increasing function of operational time t observed by n number of observations in the market because this market is efficient[12].

The permanent income hypothesis suggests that the permanent income equals current income Y received at time t (Y_t) plus a negligible constant Ω[13]. Further, if permanent income hypothesis is invoked, the current income equals the consumption C consumed at time t (C_t).

Then, the representation in the sense of Mankiw and Shapiro (1985) can be written as:

$$C_t - C_{t-1} = \Omega + \varphi Y_{t-1} + u_t \ . \tag{1}$$

Under the null hypothesis of income follows a random walk, $\varphi = 0$[14]. If past consumption is related to utility or taste of future consumption, there should be no correlation between the expected change in income and the change in consumption and investment because the consumption is unconstrained by the expected change in income (i.e. budget constraint)[15]. Current budget constraint, of course, determines the future consumption and investment plan and the amount of utility associated with expected consumption. Clark, Frijters, and Shields (2008) argue that higher income brings both consumption and status benefits to individuals (vice versa), which drive the utility of consumption. As such, the excess sensitivity of consumption to income must be tested with respect to income (here, the expected change in income). The test procedures used in

12 Let the liquidity assumption be silent for the time being. It is also assumed that this version of efficiency largely converges to a functional form of efficiency shown by Roll (1988) and Tobin (1984) (see Clark, 1973; Senarathne & Jayasinghe, 2017). Also, note that Keynesian theory implies that the marginal propensity to consume (MPC) is positive $(0 \leq \text{MPC} < 1)$ and the consumption is an increasing function of income and the increase in consumption is less than that of the increase in income. As such, one must keep in mind that the expected utility with respect to investment (i.e. equity) is associated with an uncertain outcome. Let this form of expectation be called *speculative* rather than a *gambling*.

13 See Mankiw and Shapiro (1985, p. 168).

14 Note that $C_t = bY_t$ in this fictitious economy, where a simple letter b is an unknown proportion, which is assumed to vary throughout without saving.

15 See especially Clark et al. (2008). The expectation of consumption and increments is constrained by the budget.

Mankiw and Shapiro (1985, pp. 168–169) provide a good basis for the purpose of this analysis. Flavin's (1981) measure of excess sensitivity is given by:

$$Y_t = \mu + \alpha Y_{t-1} + \varepsilon_t \tag{2}$$

$$C_t - C_{t-1} = \pi + \gamma(E_{t-1}Y_t - Y_{t-1}) + \upsilon_t \ . \tag{3}$$

Under the null hypothesis, the consumption is not excessively sensitive to income and, as such, the coefficient $\gamma = 0$. Then, the forecastable change in income must not have any form of association with the change in consumption[16]. Contrarily, the predictable change in income is related to change in consumption and investment, which implies that the past consumption (i.e. C_{t-1}) is related to next period's consumption C_t when its utility (or consumption) is constrained by the expected change in income (Clark et al., 2008 derive the utility function considering that the past income may affect current consumption). Note that the regression equations (3) and (5) below purposely omit additional variables (e.g. number of hours worked, interest rate etc.) due to the uniqueness of permanent income hypothesis and the intrinsic randomness in consumer and investor behavior. Thus, the disturbance term may well account for this randomness (see the rationale of Hall, 1978). It would also be interesting to examine whether the number of observations of income or the frequency of observations could bear any consequences on these hypotheses[17]. One would test the same hypothesis under the condition of time t, so that different sets of data horizons will be involved (i.e. monthly, quarterly, and annually).

As already mentioned, the ratio between investment and consumption is proportional to income of each agent, which is clearly unknown but assumed to vary throughout without saving:

16 However, Flavin's (1981) alternative method of estimating γ is subject to parametric assumptions in the unconditional income distribution (e.g. normality).

17 The operational clock will be ticking fast, if the number of observations of income or the frequency of observations (i.e. cyclical effects of earnings) could bear any consequence on stochastic stock price increments. The theory clearly shows that the behavior of economic agents, subject to liquidity constraint, varies from periods of high income to low income. As such, the higher (lower) the income, the higher (lower) the market operation (ultimately the increments) and consumption under usual circumstances (i.e. without liquidity constraint). In the presence of liquidity constraint, the additional income must be utilized to repay the borrowing obligations by shifting (i.e. postponing) the consumption plan.

$$P_t - P_{t-1} = \theta + \eta Y_{t-1} + u_t \; . \tag{4}$$

Under the null hypothesis, the conditional price changes are random and determined independently from past income and, as such, $\eta = 0$.

The excess sensitivity of equity price changes to forecastable change in income under the assumption that equity prices are speculative, could be measured by the following equations[18]:

$$Y_t = \mu + \alpha Y_{t-1} + \varepsilon_t \qquad \textit{recall } (2)$$

$$P_t - P_{t-1} = \pi + \zeta \, (E_{t-1} Y_t - Y_{t-1}) + \upsilon_t \; . \tag{5}$$

Under the null hypothesis, no forecastable change in income could predict equity price changes. Then, the coefficient ζ should equal to zero for conditional price increments[19] $(P_t - P_{t-1}) | U_t$, where U_t is the utility of consumption at operational time t formed on the basis of expected change in income, subject to the acceptance of the null hypotheses of equation (3). If the utility is time-separable, the ratio r should be an increasing function of operational time t. If the price changes are predictable on the basis of consumption in asset pricing, the price increments conditional on utility of current consumption should be related to predictable change in the income because the utility of current or future consumption is constrained by the expected change in income (alternative hypothesis)[20].

If the coefficient ζ becomes negative[21] and statistically significant, while the consumption is excessively sensitive to income, the liquidity constraint does not impact any rejection of random walk in permanent income. If the liquidity constraint is invoked, the investment must be financed by borrowing or shifting

18 Note that, it is meaningless to regress equity price changes on the expected change in consumption because the theory of consumption does not advise to do so and the utility of consumption is constrained by the expected change in income (see Flavin, 1981 for a complete understanding).

19 It is now conditional on utility of consumption.

20 Because, the consumption is expected to be excessively sensitive to income at the same time.

21 If the coefficient ζ becomes positive and statistically significant, while the consumption is excessively sensitive to income, the agents are either not confronted with liquidity constraint or wealthy enough to disregard borrowing (the meaning of *excess sensitivity* in the case of consumption and investment must be carefully understood).

(i.e. deferring or postponing) the consumption plan. As such, the additional income must be utilized to repay the borrowing obligations instead of excessive consumption.

The following systems of equations examine the impulse responses of consumption and income:

$$Y_t = \omega + \sum_{i=1}^{p} \psi Y_{t-i} + \sum_{i=1}^{p} \varpi C_{t-i} + \in_t \tag{6}$$

$$C_t = \alpha + \sum_{i=1}^{p} \varkappa C_{t-i} + \sum_{i=1}^{p} \xi Y_{t-i} + o_t \, , \tag{7}$$

where ω and α are the constants of equations (6) and (7) and the rest of the coefficients are assigned to capture the evolution to either variable with a 1σ shock to each variable at a time. The excess sensitivity, if established under equations (2) and (3), could be further substantiated by the results of equations (6) and (7) of the defined systems.

3 Data

Equity index data are obtained from the New York Stock Exchange[22]. Personal consumption expenditures (PCE) and the disposable personal income data (DSPI) are obtained from the Federal Reserve Bank of St. Louis and the *NIPA Handbook* of the US Bureau of Economic Analysis (BEA). Monthly data are obtained from the sampling period 1967 to 2017 and personal consumption expenditure and disposable personal income data are sorted in Eviews statistical software for three-time horizons[23].

Engle's (1982) Autoregressive Conditional Heteroscedasticity – Lagrange Multiplier (ARCH-LM) test is employed to understand the heteroscedasticity of time series, caused by serial correlation in price changes, consumption

22 Index data are also available via Yahoo Finance.

23 A note of thanks is due to Kyle Brown and Brian Smith of the US Bureau of Economic Analysis for timely responses to the inquires made on descriptions of survey data and methodology.

expenditure, and disposable income. The augmented version of the Dickey and Fuller (1979)[24] test is used to check for unit root in data and the normality is tested by employing the Jarque and Bera (1980) test procedures in Eviews.

Table 1: *Statistical Properties*

Variable	Mean	Median	Max.	Min.	JB	ADF	LM
C - monthly	4980.05	3982.40	13160.00	465.80	56.77*	6.17	609.86*
Y - monthly	5509.97	4483.40	14168.70	537.90	55.55*	5.10	609.07*
$(P_t - P_{t-1})$ - monthly	17.47	12.74	771.73	-1471.71	1801.80*	-22.22*	79.22*
C - quarterly	5027.96	4001.20	13239.70	475.70	18.88*	5.49	201.82*
Y - quarterly	5562.89	4528.70	14276.60	545.00	18.54*	5.54	200.99*
$(P_t - P_{t-1})$ - quarterly	53.83	43.36	1005.73	-1775.75	293.43*	-12.70*	39.93*
C - yearly	5246.84	4196.65	13711.90	492.60	4.68	7.68	48.75*
Y - yearly	5801.88	4812.15	14596.00	570.70	4.66	1.22	47.86*
$(P_t - P_{t-1})$ - yearly	242.09	121.70	1956.81	-3983.27	242.18*	-6.46*	0.15

Notes:

- *JB* is the Jarque-Bera test statistic for normality. Under the null hypothesis for normality, the critical value of $\chi 2$ (2) distribution at 5 percent significance level is 5.99;
- *ADF* is the Augmented Dickey-Fuller test statistic for stationarity of data for lags 10, 14, and 18 for yearly, quarterly, and monthly data, respectively. Under the null hypothesis for data having a unit root, the critical value at 5 percent significance levels are -2.92, 2.87, and 2.86, respectively (MacKinnon [1996] one-sided p-values);
- *LM* is the ARCH-LM test statistic for the number of observations multiplied by the R-squared value for 3 lags. Under the null hypothesis, critical value of $\chi 2$ (3) distribution at 5 percent significance level is 7.815 (separate OLS equations $R_t - R_{t-1} = c + \varepsilon_t$, $C_t = c + \varepsilon_t$, $Y_t = c + \varepsilon_t$; * denotes significance at 5 percent;
- The Pearson correlation coefficient between marginal propensity to consume and marginal propensity to invest for three-time horizons is recoded as 56.53 percent, 63.68 percent, and 73.63 percent, respectively.

Source: Authors' calculations.

4 Results and Discussion

The results of the Augmented Dickey-Fuller test show that the personal consumption expenditure and disposable personal income are non-stationary for all three-time horizons and the non-stationarity is highly increased from quarterly to monthly time-series data. However, the price increments are stationary as test statistics fall outside the acceptable range of the null hypothesis for data having unit root. The heteroscedasticity of errors (i.e. serial correlation in error term) is

24 Mackinnon (1996) one-sided p-value is used.

very high for disposable income and consumption expenditure in monthly and quarterly time series. Although the null hypothesis of no ARCH effect in residuals is rejected for price changes for monthly and quarterly data, the recorded test statistics are substantially lower than the test statistics for disposable income and consumption expenditure. However, there is no ARCH effect in yearly equity price changes as test statistics fall below the critical value of 7.815. It can clearly be observed that the disposable income and consumption expenditure exhibit very similar characteristics with respect to normality, non-stationarity, and serial correlation in errors. Price changes are highly non-normally distributed. Surprisingly, the non-normality of distributions of disposable income and consumption expenditure is increased from quarterly series to monthly series, whereas the yearly data are normally distributed. This inference is inconsistent with the law of large numbers and it may be due to the level-off effect of the annual pay or income (i.e. income smoothing effect).

The hypothesis that the income follows a random walk is tested by equation (1) and the excess sensitivity of consumption to income is estimated by the regression (3) together with equation (2).

Table 2: *Test Results of Estimation Equations (1), (2), and (3)*

$C_t - C_{t-1} = \Omega + \varphi Y_{t-1} + u_t$, $Y_t = \mu + \alpha Y_{t-1} + \varepsilon_t$ and $C_t - C_{t-1} = \pi + \gamma (E_{t-1}Y_t - Y_{t-1}) + \upsilon_t$									
Data Horizon	φ	**t-stat**	**p-value**	α	**t-stat**	**p-value**	γ	**t-stat**	**p-value**
Monthly	0.002*	6.749	0.000	1.002*	1712.64	0.000	0.089*	3.517	0.000
Quarterly	0.007*	5.650	0.000	1.007*	570.09	0.000	0.065	0.859	0.391
Yearly	0.029*	5.909	0.000	1.027*	173.37	0.000	0.310*	2.377	0.021

Notes:

- Coefficients are estimated by the Newey and West (1987) procedures for the estimate of regression coefficients on the robust standard errors for consistent heteroscedasticity and autocorrelation;
- * denotes significance at 5 percent.

Source: Authors' estimation.

The results of regression of change in consumption on lagged income for three-time horizons provide the statistically significant coefficient φ, which implies that the disposable income does not follow a random walk. Disposable income is highly autoregressive as coefficient α is statistically significant at 5 percent significance level. This is also confirmed by the results of the ARCH-LM test in the preliminary analysis of sample data. Although the regression coefficient γ of quarterly regression is statistically insignificant, the test results of equation (3) confirm that the predictable change in income is related to change in consumption. These findings are consistent with the propositions claimed by Flavin (1984) and her successors (Baxter & Jermann, 1999; Benito & Mumtaz, 2006, 2009). Further, these findings suggest that the consumption is excessively sensitive to income. No significant change is observed in the results of different time horizons of data sets, except for the results of equation (3) in quarterly regression.

Table 3: *Test Results of Estimation Equations (2), (4), and (5)*

$P_t - P_{t-1} = \theta + \eta Y_{t-1} + u_t$, $Y_t = \mu + \alpha Y_{t-1} + \varepsilon_t$ and $P_t - P_{t-1} = \pi + \zeta (E_{t-1} Y_t - Y_{t-1}) + \upsilon_t$

Data Horizon	η	**t-stat**	**p-value**	α	**t-stat**	**p-value**	ζ	**t-stat**	**p-value**
Monthly	0.002	0.892	0.372	1.002*	1712.64	0.000	0.167	0.780	0.435
Quarterly	0.008	0.985	0.325	1.007*	570.09	0.000	-0.510**	-1.676	0.095
Yearly	0.042**	1.782	0.080	1.027*	173.37	0.000	0.609	1.066	0.292

Notes:

- Coefficients are estimated by the Newey and West (1987) procedures for the estimate of regression coefficients on the robust standard errors for consistent heteroscedasticity and autocorrelation;
- * denotes significance at 5 percent; ** denotes significance at 10 percent.

Source: Authors' estimation.

To the authors' surprise, the regression results do not suggest that equity price changes can be forecasted either by lagged disposable income or predictable change in disposable income, except for yearly and quarterly time series (respectively), whose coefficients are significant at 10 percent significance level. This evidence suggests that there is no obvious connection between stock price changes and the predictable change in the income[25], especially when the observation of income is frequent (i.e. monthly). Therefore, the stock price changes cannot be effectively forecasted[26] on the basis of consumption because the time separability of utility assumption does hold when the consumption is not constrained by the expected change in income (see the preposition of equation 5). Moreover, the coefficient ζ, assigned to measure the sensitivity of equity price changes to expected change in income, becomes negative and statistically significant at 10 percent significance level for quarterly data[27], while the consumption is not excessively sensitive to income. As such, the rejection of random walk in permanent income is subject to liquidity constraint[28]. These findings are, however, inconsistent with the findings of Santos and Veronesi (2006), who demonstrate that there is a statistically significant relationship between stock returns and lagged values of the labor income to consumption ratio; whereas Sarantis and Stewart (1999) find that the consumption-income ratios of OECD countries are non-stationary. Also, Mankiw and Zeldes (1991) find that the consumption of stockholders is correlated with the excess return on equity.

The consumption-based asset pricing models suggest that the expected return of an asset is proportional to the covariance between return and consumption. If equity price changes are not sufficiently sensitive to income when the consumption is excessively sensitive to income[29], the consumption as a variable explaining equity price changes may not play the expected role in models of consumption-based asset pricing.

25 Also, the lagged disposable income. Hakansson (1970, p. 1) argues that "the optimal investment strategies have the property that the optimal mix of risky investments is independent of wealth, noncapital income, age, and impatience to consume".

26 Because the price changes are not excessively sensitive to income.

27 The accuracy of data processing, regressions and results generated from the Eviews statistical software has been carefully verified and no error whatsoever has been found.

28 Because, the additional income, as expected, is utilized to settle the borrowing obligations while maintaining a moderate level of consumption.

29 Note that the consumption is excessively sensitive to income in the sense of equation (3), which is subject to the acceptance of the null hypothesis of regression (5) and it means that the past consumption influences the utility of future consumption when it comes to the expectation of increments, unconstrained by the expected change in income.

Table 4: ***VAR Test Results of Impulse Response of Systems of Equations (6) and (7), and VAR Residual Diagnostics***

Lags	**Monthly**		**Quarterly**		**Yearly**	
	C **to** *Y*	*Y* **to** *C*	*C* **to** *Y*	*Y* **to** *C*	*C* **to** *Y*	*Y* **to** *C*
1-SVAR***	0.334*	0.030	0.847*	0.025	0.253	0.594*
	(3.588)	(1.553)	(5.946)	(0.567)	(0.804)	(2.002)
1-VEC***	0.316*	0.015	0.769*	0.035	0.985*	-0.215
	(3.377)	(0.811)	(5.252)	(0.813)	(2.870)	(-0.477)
2-SVAR	0.040	0.033	-0.924*	-0.169*	0.649	-0.369
	(0.327)	(1.463)	(-4.163)	(-3.512)	(1.377)	(-1.153)
2-VEC	0.371*	0.054*	-0.208	-0.141*	1.551*	(-0.585)
	(3.893)	(2.723)	(-1.316)	(-2.846)	(3.218)	(-1.311)
3-SVAR	0.141	0.010	0.826*	0.054	-1.423*	0.659*
	(1.131)	(0.422)	(3.581)	(1.064)	(-2.551)	(2.326)
3-VEC	0.503*	0.060*	0.664*	-0.088	0.334	-0.015
	(5.210)	(2.931)	(4.173)	(-1.600)	(0.619)	(-0.029)
4-SVAR	-0.479*	-0.062*	-0.551*	0.006	1.235*	-0.573*
	(-3.849)	(-2.747)	(-2.296)	(0.124)	(2.071)	(-2.053)
4-VEC	0.005	-1.34E-05	0.102	-0.087	1.193*	-0.620
	(0.053)	(-0.000)	(0.592)	(-1.544)	(2.354)	(-1.338)
5-SVAR	-0.051	-0.073*	0.626*	0.122*	0.045	-0.345
	(-0.403)	(-3.186)	(2.500)	(2.434)	(0.077)	(-1.182)
5-VEC	-0.046	-0.077*	0.743*	0.032	1.560*	-1.016
	(-0.462)	(-3.588)	(4.276)	(0.547)	(2.877)	(-1.966)
6-SVAR	-0.026	-0.005	-0.534*	-0.040	-1.099	0.864
	(-0.207)	(-0.218)	(-2.112)	(-0.784)	(-1.799)	(1.653)
6-VEC	-0.065	-0.087*	0.139	-0.021	0.160	-0.038
	(-0.649)	(-4.028)	(0.769)	(-0.367)	(0.247)	(-0.052)
7-SVAR	0.208	0.024	0.180	0.043	1.825*	-0.573
	(1.673)	(1.049)	(0.712)	(0.856)	(2.520)	(-0.899)
7-VEC	0.143	-0.069*	0.374*	0.017	2.024*	-0.633
	(1.438)	(-3.189)	(2.081)	(0.297)	(3.579)	(-1.118)
8-SVAR	0.102	0.004	-0.325	0.014	-2.214*	1.046
	(0.821)	(0.184)	(-1.291)	(0.291)	(-2.777)	(1.568)
8-VEC	0.233*	-0.066*	0.011	0.016	0.136	0.306
	(2.455)	(-3.121)	(0.061)	(0.295)	(0.179)	(0.389)
9-SVAR	-0.018	0.016	0.042	0.045	1.095	-1.043
	(-0.144)	(0.687)	(0.172)	(0.963)	(1.272)	(-1.340)
9-VEC	0.236*	-0.058*	0.136	0.056	0.731	-0.683
	(2.567)	(-2.836)	(0.740)	(1.043)	(1.190)	(-1.079)
10-SVAR	-0.132	0.029	-0.018	-0.031	-0.738)	0.745
	(-1.429)	(1.492)	(-0.113)	(-0.710)	(-1.221)	(1.287)
10-VEC	0.257*	-0.070*	-0.157	0.007	0.368	-0.146
	(2.772)	(-3.643)	(-0.978	(0.164)	(0.357)	(-0.210)
VAR-LM	Monthly		Quarterly		Yearly	
Lag	LM*	p-value	LM*	p-value	LM*	p-value
1	16.733*	0.002	1.606	0.808	2.899	0.575
2	14.101*	0.007	4.332	0.363	9.066	0.060
3	7.139	0.129	7.792	0.100	3.985	0.408
4	16.775*	0.002	17.458*	0.002	5.871	0.209
5	27.365*	0.000	21.072*	0.000	4.101	0.393

6	11.992*	0.017	3.352	0.501	10.492*	0.033
7	21.503*	0.000	1.969	0.742	6.077	0.194
8	14.958*	0.005	10.296*	0.036	4.939	0.294
9	12.261*	0.016	9.538*	0.049	21.400	0.000
10	20.534*	0.000	3.263	0.515	6.658	0.155
VAR	1		1		10	
VAR-N	84663.22*		4706.17*		0.8716	
VAR-W	368.62*		191.04*		123.73	
JCT – (Max-Eigen Statistic)						
None**	21.31*		16.09*		10.17***	
At most 1**	14.18*		8.63*		8.65*	

Notes:

- Asymptotic t-statistic of VAR test appears in parenthesis;
- *LM* is the VAR Residual Serial Correlation LM test. Null hypothesis: no serial correlation at lag order h. Probabilities from chi-square with 4 df;
- *VAR* is the stability condition test for roots of characteristic polynomial (the null hypothesis: all roots fall outside the unit circle). The number of roots outside the unit circle is reported;
- *VAR-N* is the VAR residual normality test (orthogonalization: Cholesky-Lütkepohl). The Jarque-Bera (joint) test statistic is reported. The null hypothesis: residuals are multivariate normal;
- *VAR-W* is the White's test (joint) for residual heteroscedasticity;
- *JCT* is the Johansen cointegration test for 10 lag intervals. Null hypothesis: no cointegrating equations;
- *SVAR* and *VEC* denote the standard VAR and Vector Error Correction, respectively;
- * denotes significance at 5 percent;
- ** corresponding Max-Eigen statistic for number of cointegrating equations;
- *** trace statistic, however, indicates two cointegrating equations at 5 percent significance level.

Source: Authors' estimation.

As outlined in Table 4, the results of *monthly* SVAR show that the coefficients of the first and fourth periods' consumption lags are statistically significant in the income equation (i.e. equation (6)) and the fourth and fifth periods' coefficients of income lags are statistically significant in the consumption equation (7), whereas the fourth and fifth periods' coefficients as reported are negative. The first, second, third, and eighth to tenth consumption lags are statistically significant at 5 percent significance level in the VEC model in the *monthly* income regression; and except for the coefficients of the first and the fourth income lags, coefficients of all income lags are statistically significant in the consumption equation of the VEC model. This shows that the lagged income is significant in explaining consumption. Before merely claiming the support for permanent income hypothesis from this finding, one must satisfy the specification of the systems of equations (see below). First six coefficients of *quarterly* consumption lags are statistically significant in the income equation (6), out of which the second, fourth, and sixth periods' coefficients are negative (under SVAR). The shocks to income due to change in the consumption seem to be consistent up to the sixth lag of *quarterly* SVAR income equation. Only the second and fifth periods' income lags are statistically significant in the consumption equation (7), of which the coefficient of the second period's income lag is negative (SVAR). The first, third, fifth, and seventh consumption lag coefficients are statistically significant in the income equation and only the second period income lag coefficient is statistically significant in the consumption equation under the VEC model. Coefficients of the third, fourth, seventh, and eight periods of consumption lags of *yearly* equations are statistically significant in the income equation (6) and only the first, third, and fourth periods' coefficients of income lags are statistically significant in the consumption equation (7) under SVAR. The coefficients of first, second, fourth, fifth, and seventh consumption lags are statistically significant in the income equation and none of the coefficients of lagged income are statistically significant in the consumption equation of the *yearly* VEC model[30]. The results are mixed and certainly the shocks to either variable at the desirable lag lengths of the systems of equations do not persist over time, except for monthly consumption regression under the VEC model.

Except for *yearly* and *quarterly*[31] specifications, the residuals of the systems of equations (6) and (7) are serially correlated as the null hypothesis of no serial correlation is mostly rejected in the *monthly* SVAR specification[32]. *Monthly* and *quarterly* equations are almost stable as only one root falls outside the unit circle; but ten roots fall outside the unit circle in the *yearly* regression, which confirms that the SVAR does not satisfy the stability condition. The joint test results

30 Regression results of quarterly and yearly consumption equations direct the authors to revisit the findings on regression (3).

31 Majority of lags.

32 Note that the conclusions are made on statistical insignificance of the coefficient ζ under monthly regressions, which is further testified by VAR (monthly series) test results and residual diagnostics.

for residual heteroscedasticity and normality show that *monthly* and *quarterly* specifications do not obey the homoscedasticity and normality principles of residual distributions. However, the residuals of yearly specification are homoscedastic and normally distributed. Except for the instability condition, the *yearly* SVAR regression equations are well specified. The null hypothesis of no cointegrating equations under Johansen cointegration test is rejected for the *monthly* and *quarterly* equations. However, *yearly* equations are not cointegrated[33] since the maximum eigenvalue statistic is below the critical value of 14.26 at the 5 percent significance level.

4.1 The Graphical Illustration of Impulse Responses of Consumption and Income[34]

The following figures illustrate the responses of consumption and income for ten periods under regressions (6) and (7). Ten periods are selected for the impulse response functions under three-time horizons subject to Akaike Information Criterion (AIK)[35]. More emphasis is given to responses of income to consumption and consumption to income in the discussion.

As per the Figure 1, panel 1, the response of income to income is positive and decreasing up to the fifth time period. From the fifth to the tenth time period, the response is somewhat stable. The response of consumption to consumption (Figure 1, panel 4) decreases in the first two periods and then increases gradually. The highest response is recorded in the tenth period. The response of income to consumption (Figure 1, panel 2) starts with zero in the first period and then gradually increases up to the fourth time period. After a slight decline from the fourth to the fifth period, a somewhat stable response is maintained until the

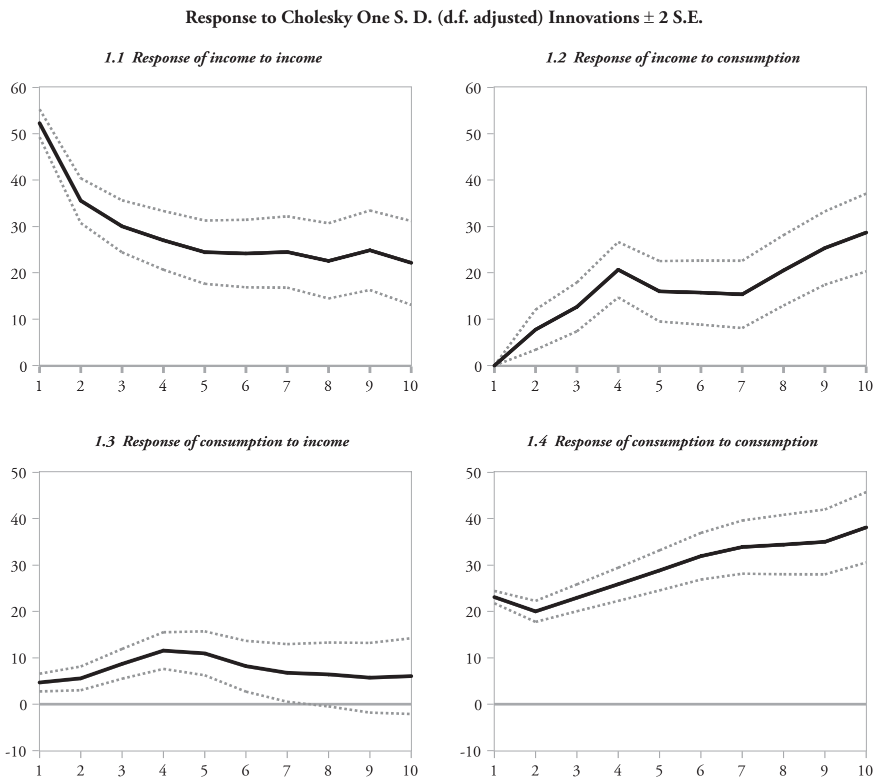
33 Trace statistic is, however, significant at 5 percent significance level.

34 Note that the behavior of impulse responses of SVAR and VEC models is the same.

35 The lag selection was based on AIK. The trial and error method was used to ascertain the optional lag length under each regression and a lag difference produced negligible improvements in the AIK. The selection of the desired lag length (i.e. 10 periods) for three regressions had a negligible impact on the overall system's AIK (any clarifications can be provided by the corresponding author at chamil@whut.edu.cn).

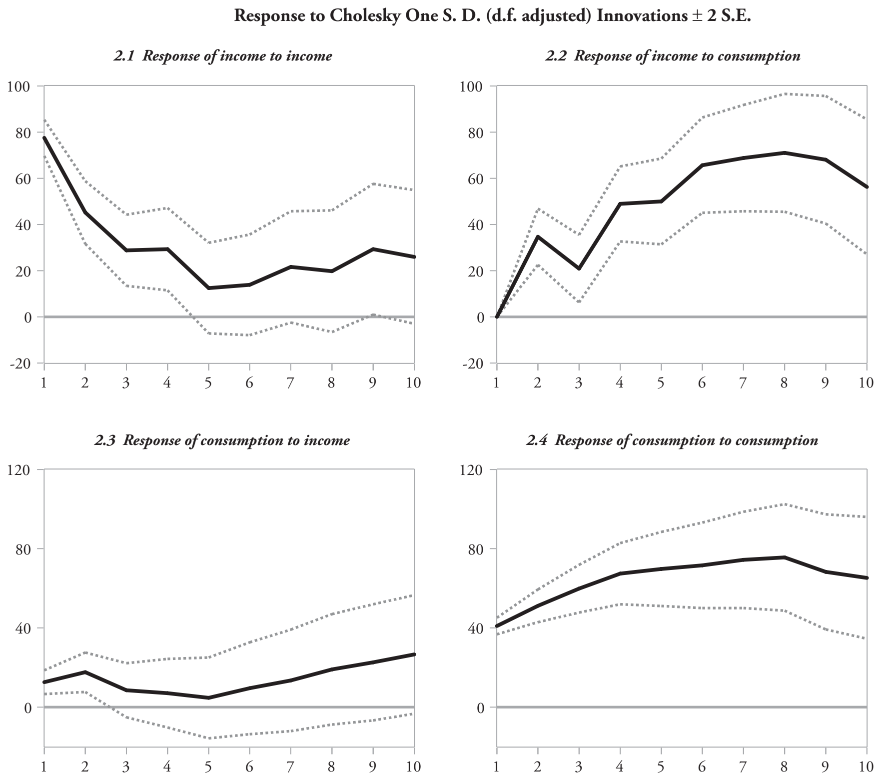
seventh period, before it starts a continuous increase up to the tenth time period. When compared with other panels of monthly impulse responses, the response of consumption to income (Figure 1, panel 3) is very low throughout the period. The response is gradually increasing from period one to four and then starts declining until the end of the tenth time period. The consumption is shown to provide a lower level of exposure to income.

Figure 1: *Monthly Impulse Responses*



Source: Authors' representation.

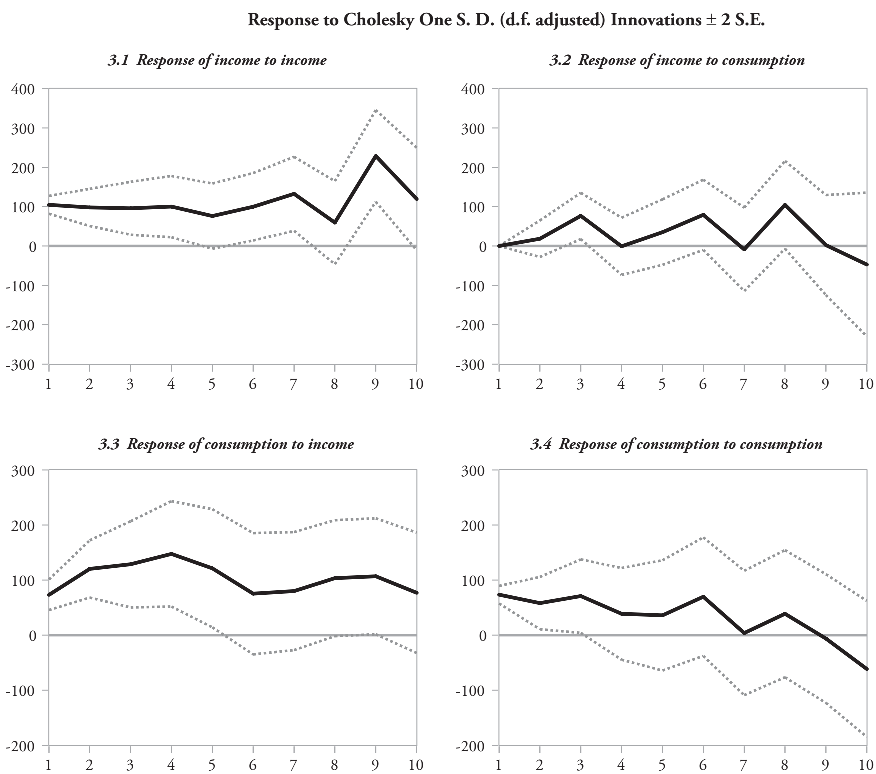
Figure 2: *Quarterly Impulse Responses*



Source: Authors' representation.

According to Figure 2, panel 1, the response of income to income starts with a very high value in the first period and firmly declines until third time period. One standard deviation shock to income itself has a noticeable change in its own time periods and a gradual increase is observed after the fifth period. The response of consumption to consumption (Figure 2, panel 4) starts with a high response value and then gradually increases up to the eighth period. After the eighth period, the response slightly decreases until period ten. The response of income to consumption (Figure 2, panel 2) sharply increases from period one to two and then declines at about the same rate until it begins another firm increase. From period six to nine, the response is somewhat steady while it starts declining thereafter. The income seems to be significantly exposed to consumption after the fifth time period. After a slight increase in period one, the response starts declining gradually until the fifth time period. Although the overall response value is low, a constant increase is recorded from period five to ten. Again, the response of consumption to income (Figure 2, panel 3) is significantly smaller when compared with peers.

Figure 3: *Yearly Impulse Responses*



Source: Authors' representation.

As Figure 3, panel 1 exhibits, the response of income to income remains steady until the fourth time period and then it gradually increases up to period seven. Note that the response value is very high when compared with monthly and quarterly impulse responses. After a drop in value (after period seven), the response reaches its peak in the ninth period before it starts declining immediately. As opposed to monthly and quarterly impulse responses, yearly response of consumption to consumption (Figure 3, panel 4) shows a declining trend, where the response value drops below zero in the ninth period and fails to regain. The response of income to consumption (Figure 3, panel 2) starts with an increasing trend up to period three. It reaches the value zero in the fourth, seventh, and ninth time periods and remains slightly variable around the neutral zone. The recorded response values are however very low when compared with its peers. The response of consumption to income (Figure 3, panel 3) shows an increasing trend up to the period four, where it reaches its highest value. The response value declines until it reaches the sixth time period where it gradually increases up to period nine, before declining again.

Overall, the response of income to consumption is highly considerable in the monthly and quarterly impulse response functions. It is observed that the variability and the value of response increase from monthly to quarterly regressions. However, the response is comparatively low in yearly time-series data. The response of consumption to income is low in monthly and quarterly time horizons but quite considerable in yearly time series.

5 Concluding Remarks

Although the disposable income and consumption expenditure do not obey strict stationarity, they are highly autoregressive. Their monthly and quarterly distributions are non-normal and yearly distributions are approximately normal. The hypothesis that disposable income follows a random walk is clearly rejected for three-time horizons and the consumption is excessively sensitive to income for monthly and yearly time series, which is consistent with the findings of Hall (1978) that the lagged disposable income is significant in forecasting current consumption[36].

There is no obvious association between lagged income and equity price changes, and the price increments are completely independent from income[37] when the frequency of observations is high. Also, the excess sensitivity of equity price changes to income is negligible as predictable change in the income is not significant enough to influence the stock price changes for monthly and yearly data. As such, the null hypothesis that the stock price changes are independent of expected change in earnings of individuals is accepted. Furthermore, the acceptance of this null hypothesis—while the consumption is excessively sensitive to income—suggests that the past consumption, unconstrained by the expected change in income, is related to the utility of future consumption[38]. This raises the question as to the usefulness of consumption as a variable in predicting stock returns[39]. The predictable change in income is negatively and significantly associated with equity price changes for quarterly data, while the consumption is not excessively sensitive to income. As such, the rejection of random walk in permanent income is due to liquidity constraint for quarterly data.

The results of impulse response functions are mixed but no variable has shown to provide permanent (long-term) shocks in their systems of equations, except

36 Mankiw and Shapiro (1985), however, use changes in consumption as in this paper.

37 Both the lagged income and the expected change in income.

38 i.e. the time insuperable.

39 Because the consumption is used as an economic variable. See also Breeden, Gibbons, and Litzenberger (1989).

for the monthly regression equations. The VAR is sufficiently specified for yearly regression equations, where no serial correlation, cointegration, homoscedasticity, and normality conditions are satisfied[40]. While these findings of VAR support the random walk in permeant income hypothesis for yearly time series, the issue of whether the specifications of the OLS/AR type (univariate) regressions that are used to test this phenomenon in the literature must be revisited[41]. In particular, these linear models fail to capture the intertemporal behavioral substance of permanent income and excess sensitivity[42]. Furthermore, the overall results (AR and VAR regressions) reveal that the forecastability of equity prices changes on the basis of consumption is subjective as past consumption is related to utility of future consumption. This warrants researchers to revisit unconditional asset pricing on the basis of consumption.

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40 Except for the violation of the stability condition.

41 Test results of estimation equations (4) and (5) together with the outcome of VAR/VEC confirm the validity of this statement.

42 A form of intertemporal behavior shown by Barro and King (1984).

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