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THE PERMANENT INCOME HYPOthesis: REGARDING THE HOUSING BOOM

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THE PERMANENT INCOME HYPOTHESIS: REGARDING THE HOUSING BOOM

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ABSTRACT

The influential work by R. Hall (1987) is replicated with more recent data to test the modified version of the Permanent Income Hypothesis, specifically in testing the predictability and stability of the reduced consumption function. One aspect is to test the implication of the joint permanent income hypothesis with rational expectations is that no other lagged variable other than the previous period's consumption, value of stock prices, and the index of housing prices should be of any use to predict current consumption. The data used are quarterly time series data from 1954-2012. Hall's results are replicated, that the previous period's real disposable income is confirmed to be insignificant in predicting current consumption with the addition to the significance of housing prices. The second aspect is to test whether a reduced consumption function on periods is *stable* during the significant increases and decreases of housing prices. The paper concludes that the reduced consumption function is indeed stable even during the two separate events.

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INTRODUCTION

Since the influential work of Milton Friedman (1957) and Ando and Modigliani (1954), it has become standard to model aggregate consumption starting from a foundation built on strong microeconomic principles. Unlike the simple Keynesian consumption function, where consumers spend a constant fraction of current income, the Permanent Income Hypothesis-Life Cycle Models (PIHLC) models are based on microeconomic foundations where individuals choose consumption based on lifetime earnings and the value of their assets.

In an influential paper, Robert Hall (1978) showed that if the assumption of the permanent income hypothesis is combined with the assumption of rational expectations a very simple prediction of the model emerges; that is, current consumption should depend only on lagged consumption and the contemporaneous interest rate; no other lagged values of income or assets should have predictive power in explaining current consumption. Of course, current income and contemporaneous changes in asset prices could impact current consumption as changes in these variables may reflect new information.

This paper builds on the insightful work by Hall (1978). The goal of this paper is to update that work to further examine the stability of a reduced form consumption function to evaluate whether the function behaved differently during the housing boom and the Great Recession. Using the dates from the National Bureau of Economic

Research, the most recent recession lasted 18 months, December 2007 to June 2009 (NBER.org*).* Because of this period of great changes in economic activity, any hypothesis depending on macroeconomic variables is greatly stressed.

In a world of certainty and with the individuals subjective discount rate equal to the (constant) real interest rate, the permanent income hypothesis states that consumption should be equal to the discounted value of lifetime income; that is,

$$C_t = \frac{r}{1+r}\left(A_0 + \sum_{t=1}^{T} \frac{Y_t}{(1+r)^t}\right) \quad \text{for all t.} \qquad \text{Eq.1}$$

Where:

C_t = consumption in period t;

T = is time period t;

A_0 = initial wealth;

r = is the real interest rate; and

Y_t = labor income at time t, (Barro, 1989).

Hall (1978) builds on this basic framework, to show how the permanent income hypothesis links current consumption to previous period's consumption. Consumers take into account all information each period on current and future earnings, then determine an appropriate level of current consumption for the current period. In terms of utility, when consumers maximize expected utility, we get:

$$E_t u'(c_{t+1}) = [(1+\delta)/\,(1+r)]u'(c_t) \qquad \text{Eq. 2}$$

Where:

E_t = expectation conditioned on all information available at period t;

δ = rate of subjective time preference;

r = real interest rate, assumed constant and r≥0;

$u()$ = one-period utility function; defined as concave.

The main implication from this model is tested in this paper is that to predict C_{t+1}, only C_t is needed amongst all of the other information from period *t,* such as income or wealth. In Hall's original framework, he uses a quadratic utility function that allows for simple closed form solutions. In this case, he shows that consumption at time t should only be a function of t-1 consumption. No other variables dated at time t-1 should influence current consumption.

Hall found that lagged values of income did not provide any predictive power in terms of explaining contemporaneous consumption. However, when he added lagged values of the stock market, a measure of wealth, the current consumption did depend on these lagged values. Thus, while Hall found some support for the joint permanent income hypothesis and rational expectations, there were some lagged variables that did seem to be important in terms of predicting contemporaneous consumption. The first part of this paper updates Hall's original test. In addition to testing whether lagged values of income and the stock market matter for determining contemporaneous consumption, I also include the percent change in housing prices (measured by the Case-Schiller index). This is interesting because many people argue that during the run-

up of the housing market and the subsequent collapse, consumption increased with the housing prices. After the collapse of the housing market, it could then be argued that consumption growth would slow because of the lower value of housing.

The second question this paper addresses is: Does a reduced form equation for consumption, modeled along the lines of Hall become more sensitive during (and after) the housing boom; that is, does this reduced form consumption function appear to be stable when there are economic bubbles. This leads to a related question about aggregate consumption going forward: If the reduced form consumption function is stable, what does this imply about aggregate consumption as the economy recovers from the Great Recession?

A LOOK AT THE DATA

Aggregate year-over year consumption growth averages roughly 1.6 percent per year from 1954-2012. However, the growth rate is far from smooth. Figure 1 depicts average consumption growth over this time period, including the steep drop in consumption during the housing crisis.

The basic Keynesian consumption function states that consumption should be linearly related to income. A simple regression of consumption on income covering the period 1954 to 2012 show that

$$C=2032+0.598*Y \qquad \text{Eq.3}$$
$$(71.4)\ \ (0.011)$$

The coefficient on income is the marginal propensity to consume. In this case, the marginal propensity to consume out of total income is 0.598, may seem lower than other estimates by other authors, but one must keep in mind that I am using current income rather than disposable income, which is frequently used in most studies.

In this paper, we also investigate the sensitivity of consumption to changes in housing prices; similar to the stock market index used in Hall's work, housing is an asset that when its value changes consumption may respond in a similar manner. Housing prices, generally, follow a cyclical trend, as can be seen in Figure 2. The outlier that is the focus of this work's models concentrates on the housing bubble and following burst that occurs in over an approximately ten year period, 2000-2010 with the burst in late 2005 according to the Case-Shiller housing data used.

IMPACT OF LAGGED CHANGES IN INCOME AND WEALTH

The variables used to test on consumption are similar to Hall's, although the primary difference is that I transform stock and housing prices to show natural log differences of consecutive periods, periods labeled in subscript. For consumption and GDP, I use transform those into natural logs only. Tables 1a and 1b represent the results for this section, with significance testing reported in Table 4.

First, I attempt to predict current consumption from changes in income, DOW averages, and S&P averages. Table 1a lists the results from these tests. In terms of

lagged coefficients, it seems that lagged real GDP is barely significant at the 10% level (not at 5%) when only one lagged period is included. This result from this single variable is the same as Hall's in which there is a small amount of statistical evidence that lagged real GDP matters in predicting current consumption. When a second lagged period is included, regression (3), I find a similar result as Hall, that the second lag has almost the same magnitude, only negative. The result of Test 1 in Table 4 shows that two lags of GDP does not have a statistically significant effect on current consumption. When I add a third lag of GDP, a repeat of the same joint-significant test shows the same result of joint insignificance, which is consistent with Hall's findings.

Next, I include lagged changes in the natural logs of the DOW industrial average, reported in regressions 5-7 of Table 1a; this can be interpreted as the percent change in housing prices. Therefore, the coefficient on lagged stock prices reflects the elasticity of contemporaneous consumption with respect to changes in housing prices. I find that one lag is statistically significant, as are two lags shown in Test 4. When a third lag is added, the result is confirmed again that including up to three lags of DOW averages has a statistically significant effect on current consumption. However, it should be noted that including only a single lag explains most of the dynamics of the effect on current consumption due to changes in the DOW, as can be seen from Test 5. This result is compatible with a modification of the PIHLC model discussed in Hall's work. Essentially, due to stock representing a form of wealth, which when increased can be interpreted as

an increase in wealth, any change in stock prices, in terms of the PIHLC, is seen as new information to be accounted for in determining consumption.

The inclusion of Case-Shiller housing index results in similar results as stock prices, reported in regressions 8-11 of Table 1b. The first and second lags are significant successively. The addition of the third lag is similar to the DOW, having a significant effect on current consumption, shown by Test 6. However, when adding the fourth lag, the third and fourth lags are insignificant, shown by Test 7. The results conclude that lagged housing prices, like stock prices, have a positive, statistically significant effect on current consumption.

Now, I attempt to find the right combination of the lagged variables in order to find a single, consolidative model of consumption on the previous lagged variables. These results are reported in regressions 12 and 13 of Table 1b. I conclude that only one lag of stock prices and two lags of housing prices capture all of the meaningful variation in consumption.

In sum, these results are broadly consistent with Hall's work, lagged GDP does not have a statistically significant effect in predicting current consumption, while lagged asset prices, such as stock and housing prices, have a positive, statistically significant effect on current consumption.

IMPACT OF CONTEMPORANEOUS VARIABLES

This section focuses on testing a part of the PIHLC discussed by Hall that changing current information about lifetime income and wealth should affect current consumption. I include current period variables along with the model from the previous section. This section's results are in Table 2 only.

The result of Test 8, which uses Regression 15, concludes that current and lagged GDP have no significant impact on current consumption. Test 9 gives the conclusion that current and lagged DOW prices have a significant impact on current consumption. Test 10 also gives the conclusion that current and lagged housing prices have a significant impact on current consumption. Similarly to Hall, positive changes in current information on asset prices have a positive effect on current consumption, while current GDP does not have an impact on current consumption.

STABILITY OF THE CONSUMPTION FUNCTION

The final section on current consumption is to determine whether stability of the reduced form of consumption changed during the housing boom. First, a dummy variable, *D_House*, was created to interact with housing prices. If this dummy variable is significant, then consumption, and therefore consumers, behaved differently during the sudden rise in housing prices. Another consequence if *D_House* is significant is that this result would make predicting future consumption behavior as post housing boom due to the instability of the reduced consumption function.

The first test introduces the interaction during the housing boom to the previous section's model, giving us regression 17. The significance of the interaction variable is reported as Test 11, which concludes that the current and lagged interaction term is insignificant. The second test looks for a level shift in consumption during the housing boom, shown in regression 18. The dummy shift is not significant.

The second test uses another interaction for after the housing boom when housing prices started falling to test the stability of the reduced consumption function after the housing boom. This test is represented by regression 19 in Table 3 with the result of the significance of the interaction of post housing boom prices current and lagged as Test 12 in Table 4. Based on the result, the consumption function remained stable after the housing bust. Both of these results confirm that the consumption function remained relatively stable during and after the housing boom. From this specification, we can conclude that the reduced form consumption function is indeed stable. Therefore, one should be able to predict, reasonably well, the path of aggregate consumption given the previous period's consumption, changes in the stock prices and changes in the housing prices. To the extent that consumption represents approximately 60 percent of aggregate demand. This reduced form consumption function provides some insights regarding how we expect consumption and aggregate demand to respond to given changes in the stock market and the recovery of the housing market. This could be useful in projecting the path of consumption and aggregate demand for hypothetical changes in the stock market and the housing market in the future.

CONCLUSION

In terms of the PIHLC, Hall's results are mostly replicated. Lagged changes in stock and housing prices are significant, while lagged GDP is not. The significance of housing prices was expected due to housing being a form of wealth, similar to stock prices. The implications of these results further confirm the permanent income hypothesis, that future consumption can be predicted using information from the current period and an assumption of future income.

Comparatively, it seems that one lag of stock prices has a higher impact on consumption relative to one lag of Shiller housing prices, while the impact of the second lag of housing prices on current consumption is greater than the second lag of stock prices.

The stability of the reduced consumption function is confirmed by the last set of tests, putting the function through the two periods when housing prices ran-up and then down. The implication from these results is that future consumption can be predicted during sudden changes in asset prices, which cause a re-evaluation and consequent adjustment to future consumption.

FIGURES AND TABLES

Figure 1: Consumption Growth (Year-to-Year)

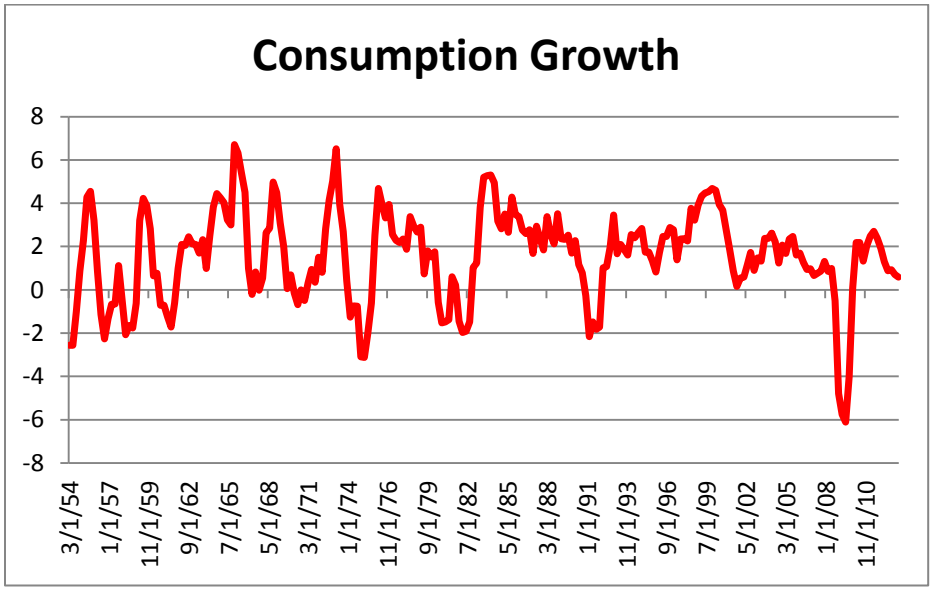

Figure 2: Consumption and Housing Growth Rates (Year-to-Year)

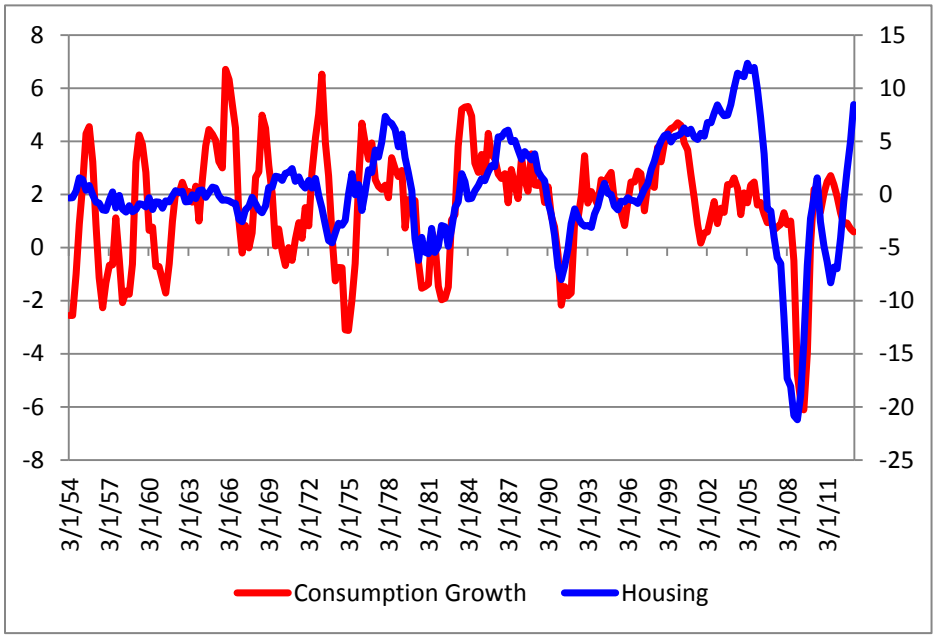

Table 1A: Lagged Testing								
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variable	Expected Coefficient	OLS $\ln\_C_t$	OLS $\ln\_C_t$	OLS $\ln\_C_t$	OLS $\ln\_C_t$	OLS $\ln\_C_t$	OLS $\ln\_C_t$	OLS $\ln\_C_t$
C_{t-1}	+	1.0003	0.981	0.987	0.988	1.0001	0.9997	0.9995
		(0.002)	(0.010)	(0.010)	(0.0097)	(0.002)	(0.002)	(0.002)
GDP_{t-1}	0		0.006	0.206	0.198			
			(0.003)	(0.059)	(0.066)			
GDP_{t-2}	0			-0.202	-0.191			
				(0.058)	(0.102)			
GDP_{t-3}	0				-0.003			
					(0.052)			
$\Delta DOW_{t,t-1}$	+					0.045	0.040	0.041
						(0.011)	(0.012)	(0.013)
$\Delta DOW_{t-1,t-2}$	?						0.011	0.006
							(0.009)	(0.0097)
$\Delta DOW_{t-2,t-3}$	?							0.010
								(0.009)
Constant		0.00083	0.143	0.091	0.086	0.002	0.0065	0.0087
		(0.019)	(0.075)	(0.071)	(0.072)	(0.017)	(0.017)	(0.017)
N		240	240	239	238	239	238	237
R^2		0.9993	0.9993	0.9993	0.9993	0.9993	0.9994	0.9994

Table 1B: Lagged Testing cont'd							
		(8)	(9)	(10)	(11)	(12)	(13)
Variable	Expected Coefficient	OLS ln_C_t	OLS ln_C_t	OLS ln_C_t	OLS ln_C_t	OLS ln_C_t	OLS ln_C_t
C_{t-1}	+	0.99998	0.9995	0.9992	0.9991	0.9995	0.9995
		(0.002)	(0.002)	(0.002)	(0.0017)	(0.0016)	(0.0016)
$\Delta Housing_{t-1,t-2}$	+	0.134	0.092	0.091	0.084	0.060	0.059
		(0.004)	(0.40)	(0.039)	(0.041)	(0.036)	(0.036)
$\Delta Housing_{t-2,t-3}$	?		0.085	0.063	0.066	0.087	0.090
			(0.029)	(0.036)	(0.038)	(0.029)	(0.028)
$\Delta Housing_{t-3,t-4}$	?			0.044	0.036		
				(0.046)	(0.050)		
$\Delta Housing_{t-4,t-5}$	?				0.017		
					(0.033)		
$\Delta DOW_{t,t-1}$	+					0.036	0.038
						(0.011)	(0.010)
$\Delta DOW_{t-1,t-2}$	?					0.0040	
						(0.0087)	
Constant	?	0.0039	0.0094	0.012	0.013	0.0088	0.009
		(0.018)	(0.018)	(0.018)	(0.018)	(0.017)	(0.017)
N		239	238	237	236	238	238
R^2		0.9993	0.9993	0.9993	0.9993	0.9994	0.9994

Table 2: Contemporaneous Results			
		(14)	(15)
Variable	Expected Coefficient	OLS ln_C_t	OLS ln_C_t
Ln_C_{t-1}	+	0.987	1.002
		(0.009)	(0.0084)
GDP_t	+	0.0038	0.340
		(0.0027)	(0.053)
GDP_{t-1}	+		-0.340
			(0.0089)
$\Delta DOW_{t,t-1}$	?	0.037	0.039
		(0.0095)	(0.0085)
$\Delta DOW_{t-1,t-2}$	?	0.023	0.016
		(0.0092)	(0.0089)
$\Delta Housing_{t,t-1}$	+	0.0036	-0.009
		(0.024)	(0.022)
$\Delta Housing_{t-1,t-2}$	?	0.059	0.038
		(0.030)	(0.027)
$\Delta Housing_{t-2,t-3}$	?	0.089	0.060
		(0.024)	(0.023)
Constant	?	0.101	-0.018
		(0.064)	(0.062)
N		238	238
R^2		0.9995	0.9996

Table 3: Consumption Stability Results					
		(16)	(17)	(18)	(19)
Variable	Expected Coefficient	OLS ln_C_t	OLS ln_C_t	OLS ln_C_t	OLS ln_C_t
Ln_C_{t-1}	+	0.987	0.987	0.989	0.984
		(0.009)	(0.009)	(0.0097)	(0.0093)
GDP	+	0.0037	0.0037	0.0034	0.0044
		(0.003)	(0.0027)	(0.0029)	(0.0028)
$\Delta DOW_{t,t-1}$	+	0.037	0.037	0.038	0.038
		(0.01)	(0.0096)	(0.0096)	(0.0099)
$\Delta DOW_{t-1,t-2}$	?	0.023	0.023	0.023	0.022
		(0.009)	(0.0093)	(0.0093)	(0.0091)
$\Delta Housing_{t,t-1}$	+	0.0036	0.0099	0.011	0.022
		(0.024)	(0.028)	(0.028)	(0.049)
$\Delta Housing_{t-1,t-2}$	?	0.06	0.055	0.055	0.131
		(0.03)	(0.033)	(0.033)	(0.049)
$\Delta Housing_{t-2,t-3}$	?	0.089	0.091	0.093	0.099
		(0.024)	(0.025)	(0.026)	(0.026)
D_House	?		-0.068	-0.058	-0.069
			(0.077)	(0.077)	(0.086)
D_House_{t-1}	?		0.054	0.068	-0.01
			(0.077)	(0.076)	(0.083)
D_Boom_t	?			-0.0009	-0.0002
				(0.0013)	(0.0012)
$Post\_House_t$	?				-0.011
					(0.061)
$Post\_House_{t-1}$	?				-0.134
					(0.061)
Constant	?	0.101	0.097	0.086	0.1218
		(0.064)	(0.066)	(0.072)	(0.069)
N		238	238	238	238
R^2		0.9995	0.9995	0.9995	0.9995

Table 4: Significance Testing Results				
No.	Regression	Joint Significance Test	Prob > F	F-Test Interpretation
1	(3)	$RGDP_{t-1} + RGDP_{t-2} = 0$	0.1523	Can not reject the null hypothesis that the effect of two lags of GDP on current consumption is zero.
2	(4)	$RGDP_{t-1} + RGDP_{t-2} + RGDP_{t-3} = 0$	0.1956	Adding a third lag does not change the result as test 1.
3	(6)	ΔL1.DOW + ΔL2.DOW = 0	0.0000	Reject the null hypothesis that two lags of stock prices has no effect on current consumption.
4	(7)	ΔL1.DOW + ΔL2.DOW + ΔL3.DOW = 0	0.0001	Reject the null hypothesis that three lags of stock prices have no effect on current consumption.
5	(7)	ΔL2.DOW + ΔL3.DOW = 0	0.1003	Can not reject the null hypothesis that the second and third lags of stock prices do not impact current consumption.
6	(10)	ΔL2.House + ΔL3.House = 0	0.0059	Reject the null hypothesis that the second and third lag of housing prices do not matter.
7	(11)	ΔL3.House + ΔL4.House = 0	0.2803	Reject the null hypothesis that the third and fourth lags on housing prices are significant.
8	(15)	$RGDP_t + RGDP_{t-1} = 0$	0.9986	Reject the null hypothesis that current and lagged GDP have no impact on current consumption.
9	(15)	ΔDOW + ΔL1.DOW = 0	0.0000	Reject the null hypothesis that stock prices do not have an impact on current consumption.
10	(15)	ΔHouse + ΔL1.House + ΔL2.House = 0	0.0059	Reject the null hypothesis that housing prices do not have an impact on current consumption.
11	(17)	$Dum.House_t + Dum.House_{t-1} = 0$	0.8359	Can not reject the null hypothesis that current consumption was unstable during the housing price boom.
12	(18)	Post_House + L.Post_House = 0	0.1193	Can not reject the null hypothesis that current consumption was stable after the housing bust.

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