Structural Break or Asymmetry? An Empirical Study of the Stock Wealth Effect on Consumption*

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Abstract

The purpose of this paper is to examine whether the stock wealth effect of consumption exhibits structural change(s) or behaves asymmetrically over business cycles. We first perform a general test of linearity for the behavior of aggregate consumption in response to changes in stock wealth based on Hamilton's (2001) approach. When a nonlinear relation is discovered, we move on to investigate the source(s) of this nonlinearity. We consider two types of nonlinearity: structural break and asymmetry. It is of interest to policy makers whether the sensitivity of consumption to changes in households' financial wealth shows a significant shift over time due to institutional and policy changes, and whether consumption is likely to decline more due to stock wealth shrinkage when the economy is in a downturn, as has been found in investment.

Key words: consumption, stock wealth, asymmetric effect, structural change

JEL classification: *E21, E30, E44, G10*

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1 Introduction

The wealth effect of changes in stock prices (returns) on consumption spending has long intrigued policy makers and economists and has been extensively studied in the past. Even though much empirical works has been devoted to gauge this wealth effect, as stock markets have become increasingly volatile in recent years, the question of how asset wealth or specifically stock wealth affects consumption spending has gained new importance.[1]

In this paper we are interested in not only the significance, but also the stability and symmetry, of the relationship between stock wealth and consumption.[2] Our paper combines two strands of literature that investigate the nonlinearity among macroeconomic variables and applies it to the study of the stock wealth effect of consumption. The first line of research on nonlinearity studies the existence of structural break(s) in the long-term cointegrating relation. For example, Judd and Scadding (1982) study the stability of money demand due to financial innovation. Friedman (1988) concerns the stability of money demand incorporating stock market transactions.[3] Lettau and Ludvigson (2002) perform tests of parameter stability to study the relation between consumption and household wealth, and find that the cointegrating relation they identify does not suggest instability in post-war U.S. data.

[1]See, for example, Campbell et al. (1997), Cochrane (1994), Lettau, et al. (2001), Lettau and Ludvigson (2001, 2002), Ludvigson and Steindel (1999), and Poterba (2000). These works find that the stock wealth effect of consumption is generally small. However, as stressed by Poterba (2000, p.107-108), a change in one percentage of consumption is substantially large in magnitude due to the overwhelming importance of consumption in aggregate demand.

[2]The line of literature that motivates this paper is the observed instability of the empirical relation between oil prices and output. Studies find that oil shocks affect short-run economic activity by temporarily disrupting purchases of consumer durables and investment goods and by triggering an allocative effect between sectors, which generates a nonlinear relation between oil prices and GDP. For example, Bresnahan and Ramey (1993) report that the oil shocks of 1974 and 1980 caused a significant shift in the mix of demand for different size classes of automobiles. Davis and Haltiwanger (2001) find that the effect of oil price shocks on the rate of job losses differs across individual economic sectors. Moreover, Balke et al. (1999), Davis and Haltiwanger (2001), Hooker (1996), and Mork (1989), among others, all attribute the observed instability of the empirical relation between oil prices and output to a misspecification of the functional form, and suggest that the relation between oil prices and economic activity is nonlinear.

[3]See also Lucas (1988) and Stock and Watson (1988) on the stability of the money demand function.

The second line of research concerns whether a macroeconomic variable behaves asymmetrically in response to an exogenous shock over the business cycles.[4] Hamilton (2003) finds that increases in oil prices affect the economy significantly while oil price decreases do not, and that oil price increases that occur after a long period of stable prices have a bigger effect than those that simply correct previous decreases. Moreover, a fast-growing vein of literature concerning asymmetry has established that changes in the condition of entrepreneurs' net worth (collateral value) through "balance sheet effect" asymmetrically affect firms' ability to borrow and invest (Bernanke and Gertler (1989) and Gertler and Gilchrist (1994)). In particular, Gertler and Gilchrist (1994) consider the asymmetric effect of the "financial accelerator" by examining whether the credit constraints are likely to be more severe in downturns, and find that sales and inventory investments for small firms drop more significantly in recessions than in booms.

We differ from previous efforts on the stock wealth effect of consumption by starting with a general test of linearity based on Hamilton's (2001, 2003) approach. The methodology developed by Hamilton (2001) in identifying nonlinearity provides a valid test of the null hypothesis of linearity against a broad range of alternative nonlinear models, which is more flexible than other studies that may risk misspecifying functional forms. When a nonlinear relationship is discovered, we move on to investigate the source(s) of this nonlinearity. We first test whether the behavior of aggregate consumption in response to changes in stock wealth exhibits a structural change during the sample period. Secondly, we perform asymmetry tests by examining whether consumption responds more to an upturn in stock wealth or to a downturn in stock wealth.

We specifically employ Seo's (1998) tests for a structural change of the cointegrating vector and the adjustment vector in the error correction model (ECM), which are based on the maximum likelihood estimator (MLE) from the ECM and allow for the break point to be unknown. We then devise an estimation procedure to investigate whether positive movements and negative movements in stock wealth have the same effect on consumption

[4] The literature that concerns business cycle asymmetry characterizes business cycles with sharp troughs and round peaks. Many studies test whether a time series displaying cycles exhibits a similar behavior around peaks and troughs. See, for example, Diebold and Rudebusch (1999) and Boldrin (1999).

and use Wald Tests to test for this asymmetry hypothesis. The five countries under consideration are: Japan, Hong Kong, Taiwan, Korea and the U.S.

The reason why we concentrate on the nonlinearity of consumption is that it is a concern to policy makers whether the stock wealth effect of consumption exhibits a structural break or asymmetric behavior over the business cycles. In particular, it is important to know whether the sensitivity of consumption to changes in households' financial wealth has significantly shifted over time due to institutional and policy changes, and/or whether consumption is likely to decline more in response to stock wealth shrinkage when the economy is in a downturn.

The organization for the rest of the paper is as follows. In section 2 we conduct a general test of linearity based on Hamilton's (2001) method. Section 3 investigates the source(s) of nonlinearity, if any, and then analyzes its (their) implications. Section 4 concludes and discusses possible extensions.

2 A Test of Linearity

Following Hamilton (2001), we consider a flexible nonlinear model which takes the form:

$$\mu\left(\mathbf{z}_t, \mathbf{x}_t\right) = \beta + \delta' \mathbf{z}_t + \lambda m\left(\mathbf{g} \odot \mathbf{x}_t\right) \tag{1}$$

$$\triangle c_t = \mu\left(\mathbf{z}_t, \mathbf{x}_t\right) + \varepsilon_t, \tag{2}$$

where

$$\begin{aligned} \mathbf{x}_t &= \left(\triangle w_t, \triangle w_{t-1}, \triangle w_{t-2}, t\right)', \\ \mathbf{z}_t &= \left(\triangle c_{t-1}, \triangle c_{t-2}, \triangle y_{t-1}, \triangle y_{t-2}, \triangle w_{t-1}, \triangle w_{t-2}\right)'. \end{aligned}$$

The operator $\odot$ indicates an element-by-element multiplication. The dependent variable c_t is date t consumption, z_t and x_t are vectors of explanatory variables for linear and nonlinear parts, respectively, and ε_t is an error term. The vector x_t includes date t stock wealth growth, its lagged variable, and a time trend, and z_t contains lagged values of consumption growth, GDP growth, and stock wealth growth. The parameter λ represents the contribution of the nonlinear part to the conditional mean and g controls the curvature of the conditional mean.

The idea of the approach suggested by Hamilton (2001) is to view the unknown functional form as an outcome of a stochastic process. This single realization of $\mu(\cdot)$ is considered to have been generated prior to generating the observed data $\{c_t, w_t, y_t\}_{t=1}^{T}$. The task is to form an inference about the realized value of $\mu(\cdot)$ based on the observed data. To this end, Hamilton introduces a new Gaussian random field $m(\cdot)$ that generalizes finite-differenced Brownian motion to a vector field and whose realization could represent a large class of possible forms of $\mu(\cdot)$. The parameters that describe the relation between a given realization of $m(\cdot)$ and a particular value of $\mu(\cdot)$ for a given sample are then estimated by the maximum likelihood or Bayesian method. One advantage of this method is that we can run a hypothesis test of linearity against a broad class of nonlinear alternatives based on the Lagrangian multiplier principle or small-sample confidence intervals based on numerical Bayesian methods.

When $\lambda = 0$, the conditional expectation function (2) is linear. Given a fixed g, Hamilton (2001) proposes the LM statistic ν^2 to test the null hypothesis of linearity $(H_0 : \lambda^2 = 0)$. However, as explained in Dahl and Gonzalez-Rivera (2003), Hamilton's test may have the problem of unidentified nuisance parameters (g) under the null hypothesis of linearity. Hence, Dahl and Gonzalez-Rivera develop more robust LM tests, λ^A, λ^E, and g^A, for neglected nonlinearity.

2.1 Data and Diagnostic Analysis

Our sample includes five countries: Japan, Hong Kong, Taiwan, Korea and U.S. The quarterly data used in this study are taken from various sources, as described in the appendix. On top of availability of comparative data, the four Asian countries are selected as being highly representative due to their large boom-bust cycles of stock markets in the last two decades. The U.S. is also included here in order to compare our results with those recent studies using U.S. data. We report summary statistics of the data in Table 1.

For all countries, stock wealth growths are quite volatile. The standard deviations of quarterly stock wealth growth are about 7 (Hong Kong) to 15 (Taiwan) times as high as their respective consumption growths. Consumption growth has about the same volatility as income growth for each country. An interesting observation is that for all the three major variables under investigation ($\triangle c, \triangle w, \triangle y$), the volatility of each variable for Japan and the U.S. is much lower than that for Hong Kong, Taiwan, and Korea. Furthermore, the correlation between consumption and stock wealth growth is much lower for Japan (0.09) and the U.S. (0.05) than for Hong Kong, Taiwan, and Korea, which show 0.29, 0.43, and 0.30, respectively. These observations can be considered as preliminary evidence regarding the differential consumption behavior in response to changes in stock wealth between the two groups of countries.

[Insert Table 1 here]

The ADF test shows that there is an unit root for each series. We then use the Johansen trace and L-max statistics to estimate the number of cointegrating relationships. Cointegration tests are shown in Table 2. At the 10% level, the results suggest that there is only one cointegrating relationship for the $(c_t, w_t,\ y_t)'$ system in each country.

[Insert Table 2 here]

2.2 Testing Results

Table 3 shows the results of the LM test of linearity. The numbers in parentheses are p values. For all the test statistics, Japan and the U.S. show no sign of nonlinearity given any test statistics. The p values of test statistics λ^A and g^A for Hong Kong are respectively 0.08 and 0.05, and for those of Taiwan they are 0.02 and 0.09. Furthermore, the p values of test statistics ν^2 and g^E for Korea are respectively 0.08 and 0.03, suggesting that consumption expenditures in response to changes in stock wealth exhibit a certain type of nonlinearity in these three countries.

[Insert Table 3 here]

Given the results of Hamilton's linearity test, we move on to identify the source(s) of this nonlinearity. In the next section we consider a test structural change and a test of the asymmetric effect for Hong Long, Taiwan, and Korea.

3 The Sources of Nonlinearity

3.1 A Test for Structural Break

Nonlinearity may arise if the long-run equilibrium relationship among those variables under consideration is not stable. The stability of a long-run relationship can be evaluated by testing the structural change of the cointegrating vector between the variables.[5] Seo (1998) provides new tests for structural change of the cointegrating vector and the adjustment vector in the ECM. The novelty of this method is the following. First, the tests are based on the maximum likelihood estimator (MLE) from the ECM, which is not allowed in the literature. Second, conventional LM statistics are defined with respect to a known break point, but this constraint is relaxed here by allowing an unknown break point. In this case, since classical optimality theory does not hold, alternative testing procedures are required. Based on Andrews (1993) and Andrews and Ploberger's (1994) optimality arguments, Seo (1998) defines average (Ave-LM), exponential average (Exp-LM), and supremum (Sup-LM) LM statistics.

We now perform a test of structural change based on Seo's (1998) method. The estimated model is specified as follows:

$$\triangle \mathbf{x}_t = \theta + \gamma_t \alpha_t' \mathbf{x}_{t-1} + \Gamma(L) \triangle \mathbf{x}_{t-1} + e_t, \tag{3}$$

where $x_t = (c_t, y_t, w_t)'$ is the vector of consumption, GDP, and stock wealth, γ_t is a (3×1) vector, $\Gamma(L)$ is a finite-order distributed lag operator, and $\alpha_t = (1, -\alpha_y, -\alpha_w)'$ is the (3×1) vector of estimated cointegrating coefficients. Thus, α_t measures the long-run elasticities of one variable respective to another, and the term $\alpha_t' x_{t-1}$ measures the cointegrating residual. The vector $\gamma_t = (\gamma_c, \gamma_y, \gamma_w)'$ is the short-run adjustment vector,

[5] See, for example, Hansen (1992) and Quintos and Phillips (1993).

telling us how the variables react to the last period's cointegrating error while returning to long-term equilibrium after a deviation occurs.

We test the following three hypotheses: $H_0 : \alpha_t = \alpha_0$, $H_0 : \gamma_t = \gamma_0$, and the joint hypothesis $H_0 : \alpha_t = \alpha_0,\ \gamma_t = \gamma_0$, where α_0 and γ_0 are respectively vectors of constant values. The rejection of α_t being a vector of constants suggests that there exists a structural break in the long-term relation among variables. The rejection of γ_t being a vector of constants suggests that there exists a structural change in the short-term speed of adjustment of consumption.

3.1.1 Testing Results

We evaluate the significance of structural change using three different LM statistics: average (Ave-LM), exponential average (Exp-LM), and supremum (Sup-LM) LM statistics. Table 4 presents results of the stability test. The results indicate that, with all three LM statistics, there is a structural break in the short-term speed of adjustment (γ_t) in Hong Kong, Taiwan, and Korea, but there is no instability in the long-term cointegrating relation (α_t) between consumption and stock wealth in either of these countries. Next, the evidence of instability for the U.S. is rather weak: only the Sup-LM statistic is marginally significant among the three statistics; furthermore, the Sup-LM statistic also suggests that the structural break point is very close to the beginning point of the U.S. sample. This implies for almost all of the sample period there exists a stable cointegrating relation. Thus, we conclude that c_t, w_t, and y_t maintain a stable long-term relation in the US data. Finally, for the case of Japan, the testing result indicates that both long-term and short-term relations between consumption and stock wealth are quite stable.

[Insert Table 4 here]

We now investigate the implications of a structural break in the stock wealth effect on consumption in Hong Kong, Taiwan, and Korea. We first identify the break point of short-term adjustment coefficients at 1994:Q4 for Hong Kong, 1990:Q2 for Taiwan, and 1981:Q4 for Korea, according to the Sup-LM statistic. We then split the sample into two sub-periods and compare the forecasting error variance of consumption changes that can be accounted for by stock wealth innovations between these two sub-periods for each country.

Figure 1 presents the results. First note that Hong Kong's stock wealth innovations explain only a small fraction of consumption changes in both sub-periods, though in the second sub-period (1995:Q1-1998:Q4) stock wealth innovations explain consumption changes a little more than in the first sub-period (1980:Q1-1994:Q4). Examining the data we find what happened in Hong Kong around 1995 was that firstly there was a significant decline in the asset markets in 1995:Q1 and consumption declined subsequently, and secondly GDP and consumption were quick to pick up around mid-1995 due to a significant boost in aggregate demand.[6] This may explain why consumption substantially responded to changes in income in the second sub-period of the sample, as shown in Figure 1.

For the data of Korea, since our sample ends at 1997:Q4, the effect of the Asian crisis is not present here. The break point at 1981:Q4 indicates the end of the second oil shock and the stock market in Korea then took off rapidly. Splitting the sample into two sub-periods, 1977:Q1-1981:Q4 and 1982:Q1-1997:Q4, we find that the variance decomposition of consumption with respect to stock wealth behaves similarly to Hong Kong.

[Insert Figure 1 here]

For the case of Taiwan, during the second sub-period, 1990:Q3-2000:Q4, the forecasting error variance of consumption changes that can be accounted for by stock wealth innovations is almost negligible, but it was remarkably large (approaching 20%) in the

[6] There are a few candidate explanations for this "structural change." After March 14,1995, the interest rate agreement on all fixed rate deposits among banks in Hong Kong were "deregulated" by the Hong Kong Monetary Authority. Essentially, it allowed different banks to respond to financial market fluctuations differently through competition rather than through "black-box bargaining" within the Hong Kong Association of Banks. Thus, it improved the efficiency of the banking sector. Second, on June 30, 1995, the UK and China signed an agreement on financial support for the Chek Lap Kok airport, which relaxed outside borrowing constraint after years of wrangling. In July of the same year, China's combined Ninth Five Year Plan (1996-2000) and its economic blueprint for 1996-2000 came out. All these boosted Hong Kong's aggregate demand substantially.

first half of the sample. What happened around 1990:Q2 was the dramatic collapse of Taiwan's stock market from its peak around 12000 in early 1990 to under 3000 in a matter of six months. Due to the significant difference between the impulse responses of the two sub-periods in Taiwan, we further estimate the speed of adjustment, γ_t, for these two sub-periods. We find that the magnitude of γ_t is much larger in the first period (0.26) than in the second period (0.03), which means the speed of adjustment of consumption returning to the long-term equilibrium relation from a stock wealth innovation becomes slower in the second half of the sample. This says that when a negative stock wealth shock hits, the duration of a consumption slump and recession lengthened in the 1990s, compared with the 1970s and 1980s.

In sum, our estimation indicates that the boom-bust cycle of asset markets does not cause a structural break in the long-term relation between consumption and stock wealth, while only the short-term speed of adjustment is affected. Moreover, the overall explanatory power of stock wealth on consumption in both sub-periods across countries is not significant, except in the first sub-period of Taiwan. This is consistent with the literature which suggests that the stock wealth effect on consumption is generally small.[7]

3.2 A Test of Symmetry

We next examine whether there exist asymmetric responses of consumption to changes in stock wealth. We specify the following model:

$$\triangle c_t = \alpha + \sum_{j=0}^{q} \beta_j \triangle w_{t-j}^{+} + \sum_{j=0}^{q} \gamma_j \triangle w_{t-j}^{-} + \varepsilon_t, \tag{4}$$

where $\triangle w^+ = \triangle w$ if $\triangle w \geq 0$, and $\triangle w^+ = 0$ if otherwise, while $\triangle w^- = \triangle w$ if $\triangle w < 0$, and $\triangle w^- = 0$ if otherwise. Thus, $\triangle w^+$ ($\triangle w^-$) denotes the positive (negative) movement of stock wealth. The null hypothesis states that the response of consumption to changes

[7]This result corresponds to the finding by Campbell et al. (1997), Cochrane (1994), Lettau, et al. (2001), and Lettau and Ludvigson (2001, 2002) who suggest that the overall impact of a change in asset wealth (stock wealth) on consumption is small and non-persistent in the U.S. As for the magnitude, Ludvigson and Steindel (1999) find that the effect of total wealth on consumption is around 4% (1953-1997) for the U.S. Finally, Brayton and Tinsley (1996) estimate the MPC to be 3% for stock wealth and 7.5% for non-stock wealth.

in stock wealth is symmetric if the sum of the coefficients of a positive stock wealth movement is equal to that of a negative movement:

$$\begin{aligned} H_0 &: \sum\nolimits_{j=0}^{q} \beta_j = \sum\nolimits_{j=0}^{q} \gamma_j, \\ H_1 &: \sum\nolimits_{j=0}^{q} \beta_j > \sum\nolimits_{j=0}^{q} \gamma_j. \end{aligned}$$

Table 5 presents the Wald tests of symmetry. The numbers in parentheses are p values. Japan and Hong Kong both accept the null hypothesis, and the U.S. indicates only a slight asymmetry at the short horizon (lag periods $q = 2$). On the other hand, Taiwan and Korea exhibit a very significant and persistent asymmetry in the behavior of consumption in response to changes in stock wealth.

[Insert Table 5 here]

Does consumption respond more to a positive change in stock wealth or a negative change in stock wealth? We estimate a VAR model to see the variance decomposition of consumption changes in response to positive and negative changes in stock wealth respectively. The results are presented in Figure 2. It is immediate to see that the forecasting error variances of consumption changes in Taiwan and Korea can be better explained by positive changes of stock wealth than by negative changes of stock wealth, under various specifications of lags. This suggests that the stock wealth effect on consumption in Taiwan and Korea does exhibit asymmetric behavior, as the above asymmetry test shows, and more importantly, a boom in stock wealth raises consumption more than a bust in stock wealth suppresses consumption.

Our results are in sharp contrast to other asymmetry tests in the literature concerning, for example, an oil price shock and a financial accelerator. As discussed above, Hamilton (2003) finds that GDP growth declines much more when oil prices increase than it rises when oil prices decrease. Furthermore, the literature studying firms' investment expenditure find that the "financial accelerator" causes a more severe credit constraint in downturns. In particular, they show that sales and inventory investments for small firms drop more significantly in recessions than increasing during booms (Bernanke and Gertler

(1989), Gertler and Gilchrist (1994)). In general, these studies suggest that aggregate variables such as GDP and investment are more negatively affected in bad times than positively affected in good times. On the contrary, our results show that consumption responds positively more significantly in a stock market upturn than it responds negatively in downturns.

For the purpose of comparison, we also estimate a VAR system for Hong Kong. It is shown that the difference in the forecasting error variance of consumption change that is explained by positive and negative movements is insignificant, consistent with the above asymmetry test.

[Insert Figure 2 here]

4 Discussion and Concluding Remarks

In this paper we investigate whether the sensitivity of consumption to changes in stock wealth has significantly shifted over time, and whether consumption increases (declines) more in response to a stock wealth boom (bust). We first perform a test of nonlinearity and find that Japan and the U.S. show no sign of non-linearity, while the test result suggests that in Hong Kong, Korea, and Taiwan the stock wealth effect on consumption exhibits a certain type of nonlinearity. We then go on to identify whether the source(s) of this nonlinearity comes from a structural change and/or asymmetry.

We find that there exists a structural break in the short-term speed of adjustment in Hong Kong, Korea, and Taiwan, but there is no instability in the long-term cointegrating relation between consumption and stock wealth. The structural break point of the short-term speed of adjustment in Hong Kong, Taiwan, and Korea occurs at 1995:Q2, 1990:Q2, and 1981:Q4, respectively. The stock wealth innovations explain more of consumption changes in the second sub-period than in the first for Hong Kong and Korea, while they behave in the opposite for Taiwan. In general, the overall explanatory power of the stock wealth on consumption in both sub-periods across countries is not significant, except in the first sub-period of Taiwan. This is consistent with the literature which suggests that stock wealth effect on consumption is generally small (Campbell et al. (1997), Cochrane (1994), Lettau, et al. (2001), Lettau and Ludvigson (2001, 2002), and Ludvigson and Steindel (1999)).

The test of symmetry indicates that only Taiwan and Korea exhibit significant and persistent asymmetry in the behavior of consumption. Further investigation shows that booms in stock wealth raise consumption more than slumps in stock wealth suppress consumption. This is at odds with those works which find that aggregate variables such as GDP and investment are more negatively affected in bad times than positively affected in good times. Quite interestingly, we find that consumption increases in response to stock market booms more significantly than it decreases in response to a stock market bust.

In summary, the source of nonlinearity between consumption and stock wealth in Taiwan and Korea not only arises from a structural change in the short-term speed of adjustment, but also from asymmetry. On the other hand, since there is no sign of asymmetry in Hong Kong, the nonlinearity between consumption growth and stock wealth growth detected earlier is mainly due to a structural change.

Since the U.S. and Japan are found to have a stable long-term relation between consumption and stock wealth and there is also no sign of an asymmetric response in consumption, while Hong Kong, Korea and Taiwan strongly indicate a structural break and/or asymmetry in the behavior of consumption, we conjecture that it is the degree of development of a financial system that affects households' plan for consumption smoothing. This renders differential behaviors of consumption in these two groups of countries. It would be an interesting extension to further investigate what characteristics or institutional factors that may explain our findings here.

Lettau and Ludvigson (2002) find that 88% of the variation in the post-war U.S. variation in households' net worth is generated by transitory innovations, and the main source of the transitory movement comes from fluctuations in the stock market component of wealth. Moreover, transitory shocks display virtually no correlation with variations in consumption, meaning that only permanent changes in wealth can significantly affect consumption spending. We further decompose the movement of stock wealth into permanent and transitory changes and study the nonlinearity of consumption in response to permanent changes in stock wealth.

Another extension along this line of research is to decompose the aggregate consumption into expenditures on durables and nondurables. Studies have found that expenditures on durables are more sensitive to changes in stock wealth in the short run (Ludvigson and Steindel (1999)). It would be interesting to see whether durable consumption exhibits any type of nonlinearity.

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Appendix

All data are seasonally adjusted. Except for the U.S., stock wealth is measured using market capitalization as a proxy. Data sources are the following:

1. Japan (1975:Q1-1998:Q4): Consumption and GDP are from the Japan Economic and Social Research Institute. Stock wealth is from Datastream.

2. Hong Kong (1980:Q1-1998:Q4): Consumption and GDP are from the Monthly Digest of Hong Kong Statistics, Census and Statistics Department, Hong Kong Government. Stock wealth is from Datastream.

3. Taiwan (1976:Q1-2000:Q4): Consumption and GDP are from DGBAS, Taiwan. Stock wealth is from the Central Bank of Taiwan.

4. Korea (1977:Q1-1997:Q4): Consumption and GDP are from the Korea National Statistical Office. Stock wealth is from Datastream.

5. United States (1952:Q1-1997:Q4): Consumption and GDP are from the Bureau of Economic Analysis. Stock wealth is from Ludvigson and Steindel (1999).

Table 1 Summary Statistics

	Japan			H.K.			Taiwan			Korea			U.S.		
	Δc_t	Δw_t	Δy_t	Δc_t	Δw_t	Δy_t	Δc_t	Δw_t	Δy_t	Δc_t	Δw_t	Δy_t	Δc_t	Δw_t	Δy_t
Mean (%)	0.73	1.56	0.77	1.33	2.56	1.30	1.87	3.88	1.83	1.65	2.83	1.81	0.87	1.41	0.81
S.D. (%)	0.95	7.60	0.83	2.08	14.89	2.06	1.02	16.05	1.27	1.20	12.32	1.85	0.77	8.38	0.99
Correlation															
Δc_t	1	0.09	0.73	1	0.29	0.37	1	0.43	0.33	1	0.30	0.49	1	0.05	0.71
Δw_t		1	0.12		1	0.16		1	0.32		1	0.28		1	-0.05
Δy_t			1			1			1			1			1

Table 2 Cointegration Tests

	Japan		H.K.		Taiwan		Korea		U.S.	
	Trace	L-max	Trace	L-max	Trace	L-max	Trace	L-max	Trace	L-max
$r = 0$	32.99**	21.92**	27.47*	16.47	29.94**	17.17	32.06*	23.01*	24.93	19.04*
$r = 1$	11.07	9.01	11.01	7.73	12.77	8.98	9.04	8.60	5.88	4.95
$r = 2$	2.07	2.07	3.28	3.28	3.78	3.78	0.45	0.45	0.94	0.94

** represents 5% significance

* represents 10% significance

Table 3 LM Tests of Linearity

Test Statistic	Japan	H.K.	Taiwan	Korea	U.S.A
Hamilton's ν^2	0.21	1.27	0.18	**2.55**	0.90
	(0.63)	(0.25)	(0.64)	(0.08)	(0.33)
Dahl-Gonzalez-Rivera λ^A	5.01	**18.35**	**31.96**	9.64	4.01
	(0.69)	(0.08)	(0.02)	(0.35)	(0.96)
Dahl-Gonzalez-Rivera λ^E	0.05	0.39	0.83	**9.54**	0.01
	(0.91)	(0.66)	(0.55)	(0.03)	(0.97)
Dahl-Gonzalez-Rivera g^A	5.19	**12.52**	**9.59**	4.24	3.86
	(0.42)	(0.05)	(0.09)	(0.52)	(0.83)

Numbers in parentheses are p values.

Table 4 Stability Tests in the error-correction model

	Japan			H.K.			Taiwan		
	ave-LM	exp-LM	sup-LM	ave-LM	exp-LM	sup-LM	ave-LM	exp-LM	sup-LM
$H_0: \alpha_t = \alpha_0$	1.51	1.02	5.13	2.96	1.78	6.00	1.25	0.92	6.29
$H_0: \gamma_t = \gamma_0$	3.78	1.96	5.50	7.69*	6.48*	18.17*	6.03*	6.49*	20.79*
Joint Test	5.29	3.07	9.68	10.65*	7.29*	19.51*	7.28	7.14*	21.90*

	Korea			U.S.A		
	ave-LM	exp-LM	sup-LM	ave-LM	exp-LM	sup-LM
$H_0: \alpha_t = \alpha_0$	1.93	1.46	6.2	3.00	2.21	11.84*
$H_0: \gamma_t = \gamma_0$	9.85*	10.67*	25.91*	2.44	1.49	8.64
Joint Test	11.78*	12.76*	30.14*	5.44	3.46	12.71

*represents 10% significance level.

Table 5 Wald Tests of Symmetry

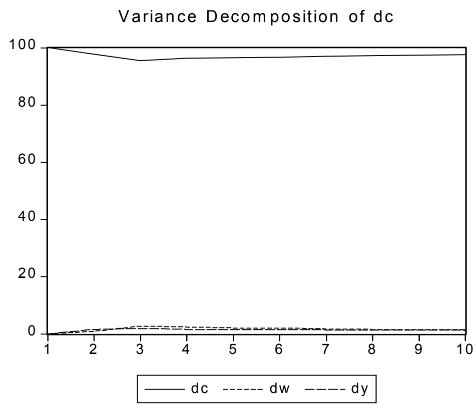
lags	Japan	H.K.	Taiwan	Korea	U.S.A
$q = 2$	0.19	0.15	**3.27**	**3.30**	**2.87**
	(0.66)	(0.70)	(0.07)	(0.07)	(0.09)
$q = 4$	0.49	0.63	**4.89**	**5.43**	0.01
	(0.48)	(0.43)	(0.03)	(0.02)	(0.92)
$q = 6$	0.17	0.47	**4.44**	**3.76**	0.26
	(0.68)	(0.49)	(0.04)	(0.05)	(0.61)

Numbers in parentheses are *p* value.

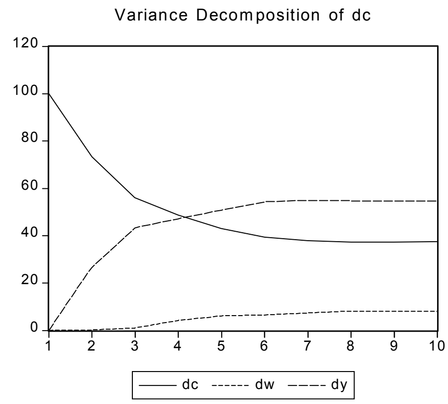
Figure 1. Variance Decomposition of Consumption Changes in Response to an Innovation in Stock Wealth

(a) Hong Kong

1980:1-1994:4

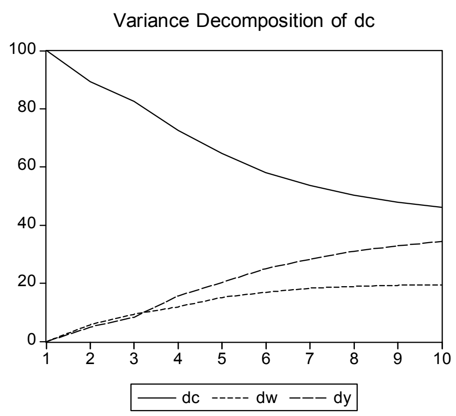


1995:1-1998:4

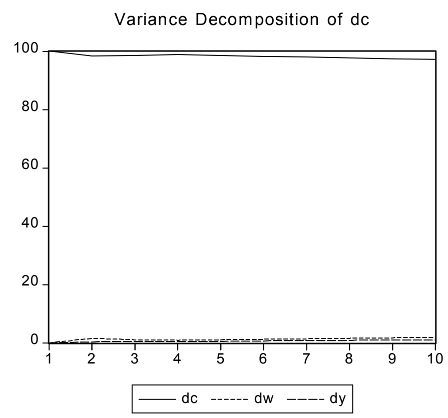


(b) Taiwan

1976:1-1990:2

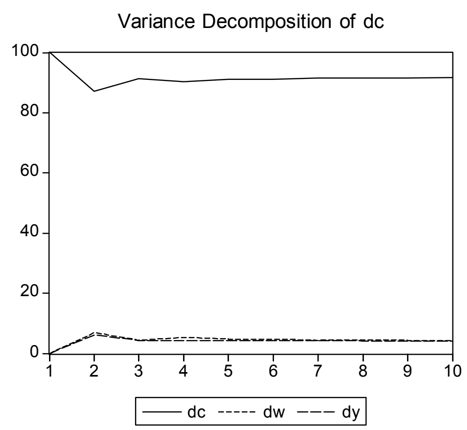


1990:3-2000:4



(c) Korea

1977:1 – 1981:4



1982:1 – 1997:4

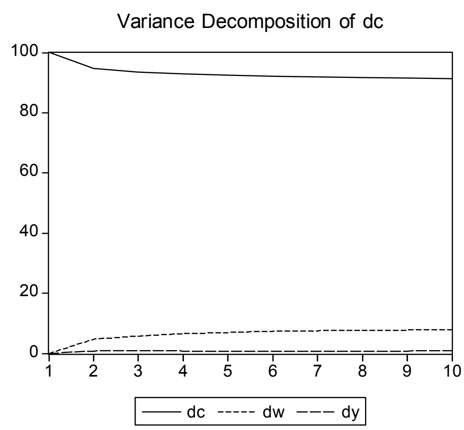
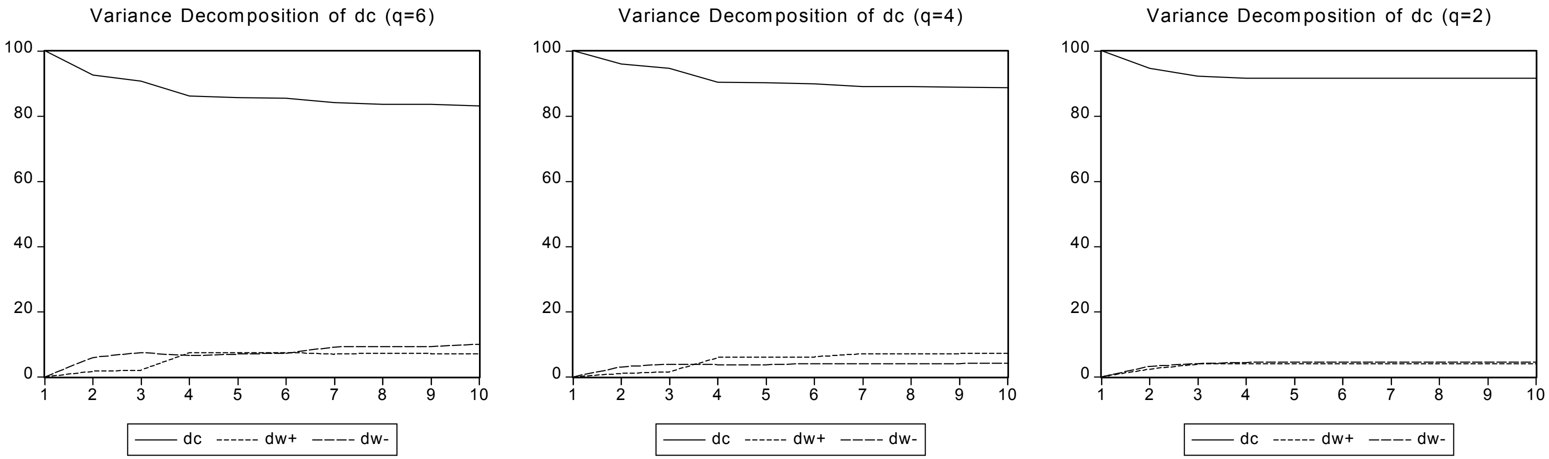
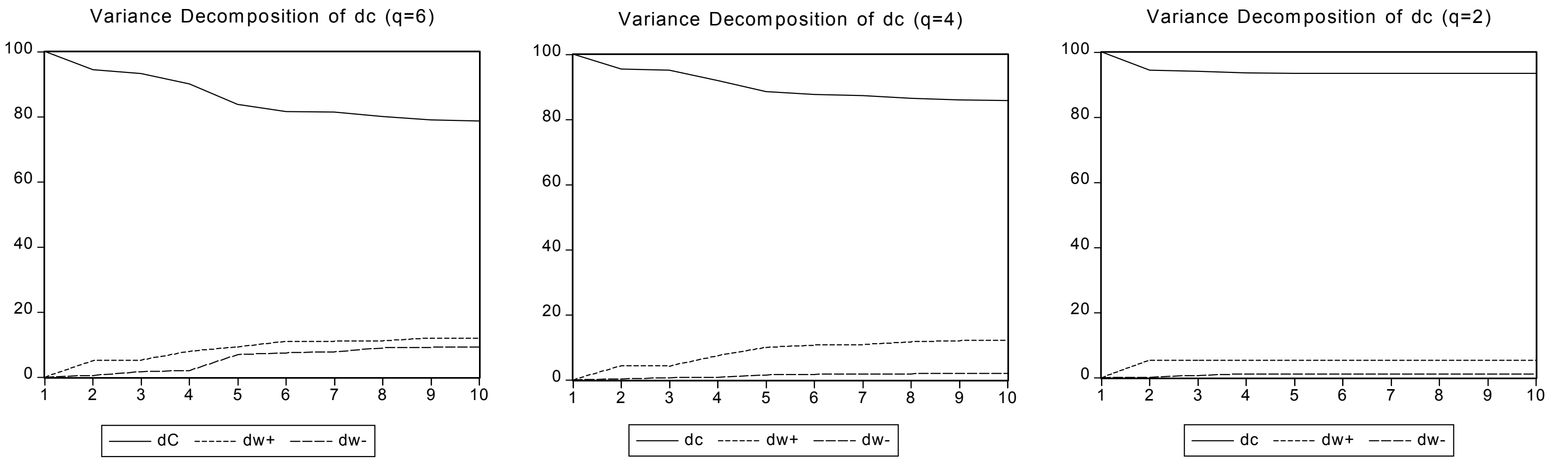


Figure 2. Variance Decomposition of Changes in Consumption

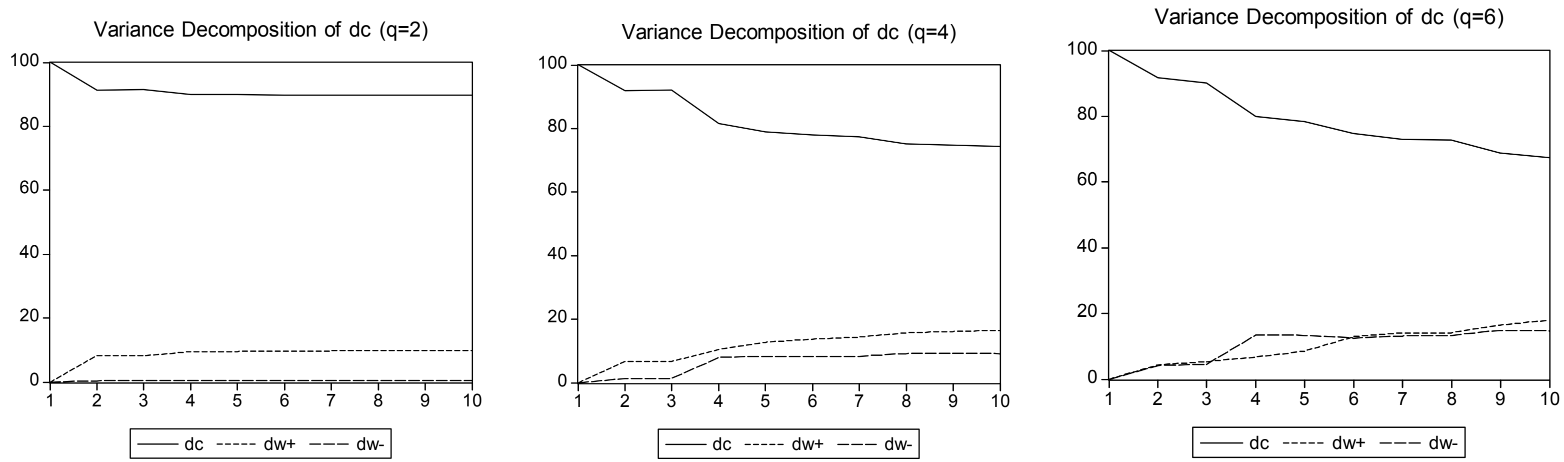
(a) Hong Kong



(b) Taiwan



(c) Korea


Variance Decomposition of dc (q=2)
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
dc
dw+
dw-
Variance Decomposition of dc (q=4)
dc
dw+
dw-
Variance Decomposition of dc (q=6)
dc
dw+
dw-