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"She ne'er had known pomp. Though't be temporal. Yet, if that quarrel, Fortune, do divorce it from the bearer, 'tis a sufferance panging as soul and body's severing."

- William Shakespeare, from Henry the VIII:2.3, 13-16.

ABSTRACT

We study consumption-based asset pricing models which allow for both habit persistence and durability of consumption goods, using quarterly consumption and asset return data for six countries. We estimate the parameters representing habit persistence or durability, risk version and time preference for each of the countries. We find that time-nonseparable preferences improve the fit of the model. When the nonseparability parameter is statistically significant, its magnitude indicates that the effect of habit persistence dominates the effect of durability in consumption expenditures. However, the international evidence for habit persistence is weaker than it is for the United States. The results indicate that the simple model of time nonseparability does not provide a satisfactory explanation of consumption and asset returns.

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1. Introduction

The consumption-based asset pricing model of Lucas (1978) and Breeden (1979) has attracted extensive empirical study using data from the U.S. and abroad. The most common version of the model uses a time- and state-separable power utility function of a nondurable consumption good. The model has met with little empirical success. Its failures include the "equity premium puzzle" [Mehra and Prescott (1985)] and rejections of the Euler equations [e.g. Hansen and Singleton (1982) and Hansen and Jagannathan (1991)].

Dunn and Singleton (1986) and Eichenbaum, Hansen and Singleton (1988), among others, incorporated into their tests the idea that measured consumption expenditures represent the purchase of durable goods, which produce a flow of services over time. Durability introduces a form of nonseparablility over time since the flow of services depends on past consumption expenditures. Using monthly U.S. data these studies found mixed evidence for durability. Durability improves the fit of the model, but in some cases the relevant durability coefficients are estimated to be of the wrong sign. Furthermore, durability in expenditures leads to a higher volatility of expenditures relative to the flow of services and the implied marginal utility of consumption. In the equity premium puzzle, Mehra and Prescott (1985) found that the volatility of the marginal utility is too low in a time separable model. Therefore, durability has the wrong implication for the volatility of marginal utility.

Time-nonseparable utility exhibiting habit persistence was studied theoretically in Ryder and Heal (1973), Sundaresan (1989), Constantinides (1990), Novales (1990), and Detemple and Zapatero (1991), among others. If habit is formed over past consumption expenditures as in Constantinides (1990), the past expenditures enter the utility with a negative coefficient. Habit persistence tends to reduce the volatility of expenditures relative to the implied volatility of marginal utility. With habit persistence a consumer smooths consumption more than in a time-separable model. Ferson and Constantinides (1991) modeled both durability of consumption expenditures and habit persistence, and empirically examined the Euler restrictions on U.S. monthly, quarterly and annual data. They showed that habit persistence and durability combine as opposing effects. Habit persistence tends to make the coefficients on lagged consumption expenditures negative while durability tends to reverse their sign. Ferson and Constantinides found that the evidence of durability in the U.S. monthly data is weak, and that habit persistence dominates durability in U.S. quarterly and annual data. Winder and Palm (1990) studied a linearized time-nonseparable model and found evidence for habit persistence in quarterly consumption data for the Netherlands.

Using quarterly data for Canada, France, Japan, the United Kingdom, the United States and West Germany, we extend the empirical analysis of time-nonseparability in consumption-based asset pricing models. Following Ferson and Constantinides, we allow for both habit persistence and durability. We estimate the parameters and test the model separately for each of the countries. We then compare the estimates and test results across countries. We find that abandoning time-separable preferences in favor of time-nonseparable preferences improves the fit of the model, as measured by the usual goodness-of-fit statistics. In those cases where the nonseparability parameter is statistically significant, it is always negative. This provides some evidence that the effects of habit persistence dominate the effects of durability in consumption expenditures. However the evidence for habit persistence is weaker in many countries than in the U.S.

The paper is organized as follows. The model is stated in section 2, the methodology is reviewed in section 3 and the data are described in section 4. The main empirical results are presented in section 5 and section 6 concludes the paper.

2. The Model

Consider a stylized single-good economy in discrete time. Expenditures on the good at time t by a representative consumer are denoted by c_t. The good may be durable; specifically, the expenditures c_t at time t produce consumption services $\delta_\tau c_t$ at time $t+\tau$, where $\tau \geq 0$, $0 \leq \delta_\tau < 1$ and the infinite summation of the δ_τ equals one. The total flow of consumption services at time t is given by

$$c_t^F = \sum_{\tau=0}^{\infty} \delta_\tau c_{t-\tau} \quad . \tag{1}$$

A representative consumer's utility is defined over the flow of services, c_t^F. Habit persistence is modeled with a time-nonseparable von Neumann-Morgenstern utility function:

$$(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t \{c_t^F - h \ (\sum_{s=1}^{\infty} a_s c^F_{t-s})\}^{1-A} \quad . \tag{2}$$

The time-preference parameter β is restricted by $0 < \beta < 1$. The habit parameter h, $0 \leq h < 1$, represents the fraction of the weighted sum of lagged consumption flows which establishes the subsistence level. The term $h \Sigma_{s=1}^{\infty} a_s c^F_{t-s}$ is the subsistence level. If $h=0$ there is no habit persistence and utility is time-separable in consumption flows (but not in consumption expenditures, unless δ is zero also). The parameters a_s, $0 \leq a_s < 1$, measure the persistence of lagged consumption flows in the subsistence level. The concavity parameter A, $A \geq 0$, represents the relative risk aversion coefficient (RRA) in the special case $h = 0$. Constantinides (1990) argues that with habit persistence ($h > 0$) the parameter A approximately equals the RRA coefficient.

Combining equations (1) and (2), the utility function may be written as:

$$(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A} \tag{3}$$

where

$$C_t = \delta_0 \sum_{\tau=0}^{\infty} b_\tau c_{t-\tau} \tag{4}$$

and

$$b_0 = 1,\ b_\tau = (\delta_\tau - h \sum_{i=1}^{\tau} a_i \delta_{\tau-i})/\delta_0,\ \tau \geq 1. \tag{5}$$

A special case of the model illustrates the opposing forces of habit persistence and durability. Consider the case where depreciation of the good is exponential and habit persistence is exponential; that is, $\delta_\tau = (1-\delta)\delta^\tau$ and $a_s = (1-\alpha)\alpha^{s-1}$, where both δ and α are between 0 and 1. In this case:

$$b_\tau = \delta^\tau \left[1 - h \left(\frac{1 - \alpha}{\delta - \alpha}\right) \right] + \alpha^\tau \left[h \left(\frac{1 - \alpha}{\delta - \alpha}\right) \right]. \tag{6}$$

If there is habit persistence but goods are not durable ($\delta=0$), then equation (6) implies that $b_\tau = -(1 - \alpha)h\alpha^{\tau-1} < 0,\ \tau \geq 1$. With no habit persistence ($h=0$) but with durable goods,

$b_\tau = \delta^\tau > 0;\ \tau \geq 1$. When both effects are present, the coefficient b_τ is positive or negative depending on the relative magnitude of the durability parameter δ and the habit persistence parameters h and a. There are three possible cases. If $\delta \geq \alpha + h(1 - \alpha)$, the coefficient b_τ is positive for all lags; if $\delta \leq h(1 - \alpha)$ then b_τ is negative for all lags; finally, if $h(1 - \alpha) < \delta < \alpha + h(1 - \alpha)$, b_τ is positive for recent lags and negative for distant ones. In other words, if habit persistence dominates durability for a given lag j ($b_j < 0$), then habit persistence must dominate durability at all greater lags ($b_k < 0$ for all $k > j$).

The intertemporal Euler equation follows from equation (3) using a standard perturbation argument. Consider a reduction of the representative consumer's expenditures in period t from c_t to $c_t - \epsilon$, $|\epsilon| << 1$, the investment of ϵ in an asset with (stochastic) return R_{t+1} over one period and an increase of the consumption expenditures in period $t + 1$ from c_{t+1} to $c_{t+1} + \epsilon R_{t+1}$. The consumer takes into account the effect of the changes in consumption expenditures in periods t and $t + 1$ on the flow of consumption services and on the subsistence level in all future periods through equation (4). Optimality of the consumption and investment plan requires that the expectation in period t of the utility of the consumption flows is maximized at $\epsilon = 0$, leading to the Euler equation:

$$E_t [\Sigma_{\tau=1}^{\infty} \beta^\tau (C_{t+\tau} / C_t)^{-A} (b_{\tau-1} R_{t+1} - b_\tau) - 1] = 0 , \tag{7}$$

where C_t is defined by equation (4).

In the absence of both habit persistence ($h = 0$) and durability ($\delta = 0$), we obtain $b_\tau = 0, \tau \geq 1$, and the Euler equation reduces to the time- and state-separable model examined by Hansen and Singleton (1982):

$$E_t [\beta (c_{t+1} / c_t)^{-A} R_{t+1} - 1] = 0 . \tag{8}$$

Ferson and Constantinides (1991) were unable to estimate more than one nonseparable lag parameter, b_τ, with any precision and focused on a one-lag model of the Euler equation. That is, they assumed $b_\tau = 0$ for all $\tau > 1$. Since consumption expenditure levels are highly correlated, it is not surprising that it is difficult to distinguish empirically which of several lags determines the subsistence level or to uncover a lag structure on several coefficients. This means that it is not possible to precisely estimate the half-lives of habit persistence and durability. Hansen and Jagannathan (1991), Eichenbaum and Hansen (1990), Gallant Hansen and Tauchen (1990), and Ferson and Harvey (1992) also limited their attention to one-lag models. The one-lag model implies the following form of the Euler equation:

$$E_t \left(\beta \left[\left\{\frac{c_{t+1} + b_1 c_t}{c_t + b_1 c_{t-1}}\right\}^{-A} + b_1 \beta \left\{\frac{c_{t+2} + b_1 c_{t+1}}{c_t + b_1 c_{t-1}}\right\}^{-A}\right] R_{t+1} - b_1 \beta \left\{\frac{c_{t+1} + b_1 c_t}{c_t + b_1 c_{t-1}}\right\}^{-A} - 1\right) = 0. \quad (9)$$

3. Methodology

The model parameters $\{\beta, A, b_1\}$ are estimated and the Euler equation (9) is tested using Hansen's (1982) Generalized Method of Moments (GMM). Equation (9) defines an error term u_{it} for each asset i, $i=1,\ldots,N$, such that $E_t[u_{i(t+1)}] = 0$, where $E_t[.]$ denotes the conditional expectation given information at time t. With a set of L instruments, z_{jt}, $j=1,\ldots,L$, known to the market at time t, we obtain $E[u_{t+1} | z_t] = 0$ and therefore $E[\, u_{t+1} \otimes z_t \,] = 0$, where u_{t+1} is the vector of N error terms and z_t is the vector of L instruments. Given N assets and L instruments there are NxL orthogonality conditions. The GMM estimates are based on minimizing the quadratic form $g'Wg$ where g is the NxL vector $(1/T)\Sigma_t\, [u_{t+1} \otimes z_t\,]$ and W is the inverse of a consistent estimate of the covariance matrix of these orthogonality conditions. Hansen (1982) discussed the formation of the weighting matrix W and provided conditions under which the parameter estimates are consistent and asymptotically normal and the minimized value of the quadratic form is asymptotically chi-square under the null hypothesis. The model is overidentified provided that the number of orthogonality conditions, NxL, exceeds the number of parameters. The minimized quadratic form provides a test-statistic for the goodness-of-fit of the model; the number of degrees of freedom is the difference between the number of orthogonality conditions and the number of parameters. The parameters are $\{\beta, A, b_1\}$.

If we choose $A=0$ in the Euler equation (9), we obtain $u_{t+1} = -(1+b_1\beta) + \beta R_{t+1}(1+b_1\beta)$. If we also choose b_1 and β such that $(1+b_1\beta)=0$ we obtain a trivial solution to the Euler equation. Following Eichenbaum and Hansen (1990) and Ferson and Constantinides (1991), we divide the orthogonality conditions by $(1+b_1\beta)$ when we estimate equation (9) in order to avoid trivial solutions.

A negative value of the concavity parameter, A, is economically implausible because it implies negative risk aversion. Also, the Euler equation may no longer be a necessary first-order condition of utility maximization if the parameter A is negative. In estimating the Euler equations we restrict the domain of the parameter A to nonnegative values.[1]

In the time-separable model u_t is a function of the variables R_t, c_{t-1}, and c_t, which are known at time t. The Euler equation implies that $E[u_{t+s} | u_t]=0$, $s>0$, and we say that u_t follows an MA(0) process. The time-separable model implies the null hypothesis,

$$H_0\colon\ b_s = 0,\ s > 0,\ \text{with an MA(0) error term } u_t.$$

In the one-lag model ($b_s = 0, s \geq 2$) u_t is a function of R_t, c_{t-2}, c_{t-1}, c_t and c_{t+1}. Since c_{t+1} is not in the time-t information set neither is u_t, and the model does not imply that $E[u_{t+1}|u_t] = 0$ but implies that $E[u_{t+s}|u_t]=0, s \geq 2$; therefore, u_t follows an MA(1) process. In general, the model implies that the error term u_t will follow an MA(q) process, where q is the smallest number such that $b_j=0$ for all $j>q$. The one-lag model therefore implies the hypothesis,

$$H_a\!: \; b_s = 0, s \geq 2 \text{ with MA(1) error term } u_t.$$

The covariance matrix is adjusted to account for the moving-average terms as described by Hansen (1982). Note that when b_1 is zero, the model implies that the autocorrelation of the error becomes zero, hence the null hypothesis H_0.

We model the representative consumer's decisions at fixed quarterly intervals and measure asset returns and consumption over the same intervals. Consumption decisions may actually be made more frequently. If decisions are made within the observation interval and the measured consumption expenditures are the sum of the expenditures over the interval, then the consumption data are said to be time-aggregated. Formally modeling time-aggregation in the Euler equation is difficult. Theoretical results adjusting for time-aggregation are only available in the literature, imposing a first-order approximation on the marginal utility. With such a first-order approximation it can be shown that one effect of time-aggregation is to increase by one the order of the MA process followed by u_t.[2] In the nonlinear Euler equation the results of time-aggregation are more complex. Therefore, under time aggregation, the residuals may appear to behave like a higher-order MA process even if the nonseparability parameter is zero. Time-aggregation can also induce a spurious correlation between the error terms and the information set for time t. Because of time-aggregation, variables in the market's information set at t which were not in the market's information set at t - 1 may not be valid instruments for the equation $E_t[u_{t+1}] = 0$. We assess the sensitivity of our results to these effects by conducting experiments in which the order of the MA process of the errors is varied and in which the instruments for the information set at time t either admit or do not admit the most recent lagged values of the variables.

The parameter estimates and statistical tests using GMM are justified from asymptotic distribution theory. There is a natural concern about the properties of these procedures in small samples. Tauchen (1986), Kocherlakota (1990), and Mao (1991) provided simulation evidence for the time-separable model. Tauchen found that the test statistics perform well with as few as 50 annual observations, although he found a slight tendency to reject the model too infrequently. Kocherlakota and Mao, using different parameter values, found cases where the model is rejected too often. These studies suggest that the estimates and their asymptotic standard errors can be unreliable in small samples.

Ferson and Foerster (1992) studied the finite-sample properties of the GMM in a regression context with nonlinear, cross-equation restrictions. They found that a two-stage GMM approach, as described in Hansen and Singleton (1982), tends to reject the model too often in large systems, while an iterated GMM approach provides more accurate test statistics. We use an iterated GMM approach in this study.[3] Although we report the coefficient estimates and their asymptotic standard errors, we stress that the reliability of these estimates cannot be assessed until simulation studies of the finite sample properties of the GMM become available for nonseparable consumption models. We therefore refrain from deriving detailed implications from the models which depend on the point estimates of the coefficients.

4. The Data

Our data consist of quarterly consumption expenditures and returns of common stocks and short-term bonds for six countries from 1970-1988. The countries are Canada, France, Japan, the United Kingdom, the United States and West Germany.

A. Stock Return Data

The international common stock return data are from Morgan Stanley Capital International. Month-end indices are available from December, 1969. These are based on common stocks from a list of 1476 (as of December, 1989) firms. The market value of these companies equals approximately 60% of the aggregate market value of the stock exchanges of the 19 countries for which the returns data are available. The selected stocks are generally those with large market capitalization. Investment companies and foreign-domiciled companies are excluded to minimize double-counting.[4] Within each index, the stocks are value-weighted.[5]

B. Short-Term Bond Data

We obtained short-term bond data from the Organization for Economic Cooperation and Development's (OECD) *Financial Statistics Monthly*. We selected 90-91 day Treasury bill rates when they were available (U.S., U.K. and Canada). When such rates were not available, other short-term rates were substituted.

C. Consumption Data

The consumption data for all countries are from OECD's *Quarterly National Income and Product Accounts* publication. We use quarterly real per capita consumption expenditures for the period 1970 through 1989. The data are seasonally adjusted, with the exception of West Germany and Japan, for which the reported series exhibit strong seasonalities. We seasonally adjust these two series using the following procedure. We regress the logarithm of the consumption expenditure level on a time-trend and dummy variables indicating the quarters. We add to the residuals the sample mean of the logarithm of the consumption measure, plus the coefficient on the time-trend multiplied by the (mean-centered) time index, and we exponentiate the sum. This procedure removes seasonal fluctuations in the form of deterministic (percentage) quarterly shifts in expenditures, while retaining the overall mean and trend in the original expenditure series. Total real consumption expenditures are divided by each country's population to obtain the real per capita consumption series. The population numbers are from the International Monetary Fund's data base. The population data are available on an annual basis, mid-year estimates. These annual figures were interpolated geometrically to get quarterly population numbers for each country.[6]

D. Deflators

The nominal local country return series are converted to real returns using local currency consumption deflators. Consumption deflators for all countries are from OECD's

Quarterly National Income and Product Accounts publication. All deflators are indexed in 1985 local currency units.

E. Predetermined Instruments

Previous studies of consumption-based models showed that the results are sensitive to the choice of instruments. The earliest studies [e.g. Hansen and Singleton (1982)] concentrated on lagged consumption and returns as their instruments. However, measurement errors and time-aggregation can result in spurious correlation between consumption and real returns and their lagged values, and this could bias the coefficient estimates and lead to spurious rejection of the Euler restrictions. Ferson and Constantinides (1991) focused on financial variables, different from the lagged values of the model variables, which predict both returns and consumption growth. They argued that such instruments are robust to spurious correlation problems and provide powerful tests of the Euler equation restrictions. We adopt a similar strategy in this paper.

Previous studies indicate which predetermined variables are useful in predicting international common stock and bond returns. For example, Harvey (1991) showed that dividend yields and short-term interest rates predict stock returns in many countries. Solnik (1992) found economically significant predictability by such instruments. We include both of these variables in our list of instruments. We also include a term spread for each country, measured as the difference between the yield to maturity of a long-term bond and that of a short-term bond.

In addition to these local country-specific instruments, we employ a related set of financial instruments drawn from the U.S. market. The rationale for doing this is that the

U.S. financial data available to us are more accurate than financial data from the OECD and Citibase for the other countries. Campbell and Hamao (1992), Harvey (1991) and Ferson and Harvey (1992) found that financial instruments for the U.S. often predict stock returns in other countries. We use a one-month Treasury bill rate as our measure of the short-term U.S. interest rate and calculate a term spread as the difference between a long-term U.S. government bond return and the one-month bill. Finally, we use the dividend yield on the Standard and Poors' 500 stock index.

5. Empirical Results

A. Summary Statistics

Tables 1 and 2 present summary statistics for the basic data. Table 1 records the means, standard deviations and autocorrelations of the series and Table 2 presents correlations among the variables across the countries.

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insert Table 1 here

Table 1 shows that the U.S. stock market return series has the lowest mean and variance relative to the other countries, while Japan has the highest mean return and the United Kingdom has the highest variance. The first-order autocorrelations of the stock index returns are positive in all countries. The short term nominal bond returns, measured in local currency units, are the highest in the U.K. and France, while the volatilities are similar in all of the countries. The first-order autocorrelations for these short-term bond returns are all in excess of 0.83.

Canada has enjoyed the largest per capita personal consumption growth over the period, while West Germany and Japan have the lowest. The first-order autocorrelations of quarterly consumption growth in Canada and the U.S. are positive, while the autocorrelations of the other four countries are negative. On the one hand, measurement error in the levels of consumption can induce spurious negative autocorrelation in consumption growth. On the other hand, some components of consumption expenditures are calculated by interpolation, which can induce positive autocorrelation. Such measurement errors are troublesome in evaluating nonseparable consumption models. Durability of consumption expenditures induces negative autocorrelation. For example, a consumer purchasing an automobile in one period is unlikely to purchase another for several periods. Habit persistence induces positive autocorrelation in consumption growth, since the consumer maximizes utility by smoothing consumption more than would be optimal with time-separable preferences. Therefore, spurious autocorrelation may lead to erroneous conclusions about habit persistence and durability. Such problems are expected to be pronounced if the recent-lag consumption growth is used as an instrument.

Measured by the growth rates of the consumption price deflators, the U.K. has both the highest average inflation rate and the most volatile inflation rate, while West Germany and the U.S. have enjoyed the lowest and most stable inflation rates over this period. The first-order autocorrelations of the inflation rates are in excess of 0.7 in five of the six countries.

Panel II of Table 1 shows summary statistics for the predetermined instruments. The first-order autocorrelations of some of the instruments exceeded 0.8. In the case of the dividend yields, this is expected given the overlapping nature of the numerator. The autocorrelations decay toward zero at longer lags for all of the variables.

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insert Table 2 here

Table 2 presents the correlations across the countries of the asset returns, exchange rates and instruments. The stock and bond return correlations are generally low, illustrating the well-known view that there are significant gains from international diversification. Also, per-capita consumption growth correlations are generally low. This suggests that using an international representative agents' utility of consumption may not be useful and motivates our examination of the distinct Euler equations of a representative agent in each country.

B. Diagnostic Regressions

If expected returns and expected consumption growth rates are modeled as linear regressions on the predetermined instruments, as is common in recent studies, then the expected returns and growth rates are highly autocorrelated. We report regressions of this type to further describe the data and help interpret the results, but our formal tests do not assume that expected returns or consumption growth rates are linear functions of these variables.

Table 3 shows the time-series regressions, using the U.S. instruments to predict the future returns of the common stock and bond portfolios and the future growth rates of consumption. The first panel shows regressions for the stock returns, the second panel for the bond returns and the third panel for the consumption growth rates. The regressors are the lagged nominal stock market return for the U.S., the U.S. one-month bill yield, lagged U.S. consumption growth, the U.S. term spread and the dividend yield of the Standard and Poors 500. To be conservative, all of the regressors are lagged twice in relation to the dependent variables. The results are representative of the patterns that we find using other choices for the lagged instrumental variables. (We report the adjusted R-squares for other choices of instruments in the tables below where they are used.)

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insert Table 3 here

In the first panel of Table 3 there is evidence that quarterly real stock returns in the six countries are predictable to some extent using the lagged instruments. The dividend yield and the Treasury bill return are the instruments with the most forecast power, which is consistent with earlier work [e.g. Harvey (1991), Solnik (1992)]. The S&P 500 dividend yield has a positive and significant coefficient for five of the six countries, and an insignificant one for Japan. The Treasury bill rate has a negative coefficient in all countries, but significant only in the U.S. and Canada.

The second panel of Table 3 shows the regressions for the short-term real bond returns. The term spread and the short-term bill rate are powerful predictors in these regressions, although the dividend yield and the lagged stock return also have t-ratios larger than two in many cases. The term spread has a negative coefficient in each country regression, indicating that expected real short term bond returns are low, other things equal, when the slope of the term structure is steep. The lagged consumption growth has negative coefficients in all regressions and suggests that the high real returns on short term bonds are associated with recessions or times of recent poor economic growth. The high adjusted R-squares for the short-term bond returns in Table 3 are remarkable. This is a peculiarity of the 1970-1988 sample period, when interest rates were high, volatile and highly autocorrelated in many countries. (See the autocorrelations in Table 1.) We checked these regression results against alternative data for the U.S. and found similar results. Although the short term bond returns are highly predictable in the quarterly data over this period, they do not seem to contain a unit root.[7]

The bottom panel of Table 3 reports regressions of the continuously-compounded consumption growth rates on the lagged instruments. While we do not use these growth rates directly in our tests of the models, the regressions provide information about the likely power of our tests. The Euler equation implies that the product of a real asset return and the marginal rate of substitution of consumption should not be predictable by lagged instruments. In the time-separable model the marginal rate of substitution is one plus the growth rate of consumption raised to the power -A. In the nonseparable model the marginal rate of substitution is a more complicated function of consumption. If the instruments do a good job in predicting consumption growth and returns, the tests should be powerful. The consumption regressions and the regressions in the first two panels suggest that our tests may be more powerful in testing the Euler equations of the U.S. and Canadian representative consumers than of the representative consumers of the other four countries.

C. Empirical Tests Using Own-country Instruments

For each country the asset system corresponding to (9) consists of the local value-weighted common stock index return and the short-term bond return. Consumption is the local real, per-capita consumption. The instruments are six: a constant and five own-country variables. The five variables are the real consumption growth rate lagged twice and the nominal stock market return, short term bond return, term spread and dividend yield, each lagged once. We use nominal, instead of deflated, financial instruments to avoid the possibility of spurious correlation introduced by deflating both the returns and the instruments by the same deflator series.[8] The errors u_{t+1} in the Euler equation $E_t[u_{t+1}] = 0$ are assumed to follow an MA(0) process in the time-separable model and an MA(1) process in the nonseparable model.

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insert Table 4 here

The results are presented in Table 4. The notation $b_1 \equiv 0$ means that we set the nonseparability parameter equal to zero, thereby estimating and testing the time-separable model. For the time-separable model the subjective discount rate (β) is estimated precisely and is less than 1.0 in all countries. The point estimates of the concavity parameter, subject to the restriction that $A \geq 0$, are all around one. The standard errors are low, except for France and West Germany. The right tail p-values for the goodness-of-fit tests are less than 5% in the U.K. and Japan; they are between 5% and 10% in the U.S.; and they exceed 10% in France, Canada, and West Germany.

In the second row of each panel of Table 4 the nonseparability parameter (b_1) is estimated along with β and A. The model is not rejected by the goodness-of-fit test in any of the six countries, the p-values exceeding 15%. The point estimates of A are plausible but the standard errors are large. The estimates of the nonseparability parameter are all negative, but significant only in the U.S. The evidence for habit persistence in the U.S. is consistent with the results of Ferson and Constantinides (1991).

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insert Figure 1 here

Figure 1 illustrates the sensitivity of the model to the value of the nonseparability parameter. The values of the objective function are illustrated when the objective is minimized over the choice of A and β, for given values of b_1. An MA(1) weighting matrix [from Hansen (1982)] is used. Results for the U.S., Canada, and France are shown using the local instruments, as in Table 4. The objective function is highly nonlinear in the parameter b_1. Often we find local minima both in the region of durability $(b_1 > 0)$ and in the region of habit persistence $(b_1 < 0)$.[9] This suggests that both effects may be present.[10]

Time aggregation implies that the first lagged values of the instruments, as we used them in Table 4, may not be valid instruments. Time aggregation may also induce a higher -order moving average process in the error terms. Therefore, we modify the procedure by imposing an MA(1) process on the error terms in the time-separable model and imposing an MA(2) process in the nonseparable model. The results are reported in Table 5. Neither the time-separable nor the nonseparable model is rejected in any of the countries. The coefficient b_1 is significantly negative in Japan and well as in the U.S., but is insignificantly different from zero in the other countries.

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insert Table 5 here

In a different variation of the procedure, we lag all of the instruments twice (recall that in Table 4 we lagged consumption growth twice and the financial variables only once). This experiment is reported in Table 6. We use an MA(0) process on the error terms in the time-separable model and an MA(1) process in the nonseparable model. We find that none of the models are rejected for any of the countries by the goodness-of-fit tests. The estimates of the coefficient b_1 are negative in all countries but significant only for Japan.

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insert Table 6 here

D. Tests Using U.S. Instruments

The adjusted R-squares reported in Table 3 suggest that U.S. instruments have reasonable forecasting power for the returns and consumption growth of other countries. This motivates a replication of the experiments reported in Tables 4, 5, and 6 but replacing the own-country instruments by the U.S. instruments. The results are reported in Tables 7,8, and 9.

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insert Tables 7-9 here

In Table 7 the time-separable model is rejected by the goodness-of-fit tests only in Japan. The nonseparability parameter is significantly negative only in the U.S. In Table 8 none of the models are rejected by the goodness-of-fit tests. The nonseparability parameter is significantly negative only in the U.S.

In Table 9 the time-separable model is rejected by the goodness-of-fit tests at the 5% level in the U.K. and West Germany, and at the 10% level in the U.S. and Japan also. The nonseparable model is not rejected in any country at the 10% level. The nonseparability parameter is significantly different from zero and negative in the U.S., Canada and West Germany.

6. Conclusions

We estimated and tested consumption-based asset pricing models which incorporate both durability of goods and habit persistence in the preferences of country-specific representative consumers. By postulating a representative consumer in each country, as opposed to a global representative consumer, we recognized the incompleteness of markets across countries, but implicitly assumed that markets are effectively complete within each country. We broadened the investigation of Ferson and Constantinides (1991) on U.S. data to the representative consumers of six major countries. A series of controlled experiments was conducted to evaluate the sensitivity of the results to different instruments, timing conventions for the instruments and assumptions about the autocorrelation of the model error terms.

We found evidence in favor of habit persistence against a net effect of durability in consumption expenditures in the U.S., and to a lesser extent for Japan. The point estimates of a nonseparability parameter are in the direction of habit persistence, as opposed to durability, in all of the countries and in most of the experiments. Goodness-of-fit tests indicate improved fit when the models allow for habit persistence. However, the parameter estimates are imprecise and even the time-separable models can not be rejected by the goodness-of-fit tests in many of the experiments. The low power of the tests may be partly due to the poor quality of the available data on international consumption and returns.

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FOOTNOTES

1. We do this by dividing the error term u_{t+1} by $(1 + e^{5-10A})$. This is permissible by the same argument which justifies our scaling factor to avoid trivial solutions. Note that at given parameter values, the objective function, g'W g, is invariant to the scaling factor.

2. Heaton (1990) models time aggregation using monthly U.S. data and a first order approximation of the Euler equation in this paper. See also Ermini (1992).

3. We construct the weighting matrix W using the parameter estimates from the n-th stage, and use this matrix to find parameters for the stage n + 1 which minimize the quadratic form. The new parameters are used to update the weighting matrix. The iterations continue until a minimum value of the quadratic form is obtained. When an unconstrained optimization using this procedure chooses negative values of the parameter A, we use the scaling factor $(1+e^{5-10A})$ in the Euler equation and a variation of this procedure. We perform a grid search over the parameters A, β and b_1 and evaluate W at the parameter values which produce the approximate minimum value of the objective, subject to A>0. We then minimize the objective function again, holding the W matrix fixed, to obtain the final parameter estimates.

4. However, because of differences in corporate cross-holdings across countries, the relative value weights of MSCI indices may still are biased by double counting. See French and Poterba (1991), Harvey (1991), and Fedenia, Hodder and Triantis (1991) for discussions.

5. Further details of the construction of these indexes are found in Morgan Stanley's "Capital International Perspective," quarterly issues, pages 3-6.

6. The last two years, (1988,1989) were extrapolated from the 1987 series using the average growth rates for the previous ten years.

7. We examined the U.S. three-month spot rates from CRSP as an alternative to the OECD data. The series plots tracked each other closely. Regressing the real returns using this alternative nominal rate series on the instruments in Table 3 produced an adjusted R-square equal to 81%. We estimated an AR(3) model for the real returns. The first order lagged coefficient in the model was 0.69, with a (heteroskedasticity-consistent) standard error equal to 0.12. The adjusted R-square of this model is 72.9%.

8. We use consumption at lag 2 only while allowing the financial instruments to enter at lag 1 in an attempt to avoid spurious correlations while obtaining good predictive power. Spurious correlation due to time aggregation is a problem for the consumption data, because time aggregation implies that the same underlying "true" consumption appears in the time-averaged consumption data over two adjacent periods. Time aggregation also can induce spurious correlation with other variables at lag one, to the extent that the underlying true contemporaneous consumption in the future time-averages consumption data is correlated with the financial variables. As this correlation is likely to be much smaller than 1.0, the spurious correlation induced by time aggregation is likely to be less

of a problem for the lagged financial instruments than for lagged consumption expenditures.

9. Ferson and Constantinides (1991) found similar results for U.S. monthly, quarterly and annual data.

10. Heaton (1990) found evidence in U.S. data which he interpreted as consistent with the presence of durability, which operates with a relatively short half life, and also of habit persistence which operates with a longer half life. Constantinides (1990) suggested that habit persistence in the U.S. may have a half-life in excess of one year.

Table 1 - Quarterly Summary Statistics[1]

Variable	Mean	Std. Dev.	Autocorrelations ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_8	ρ_{12}
PANEL I: ASSET RETURNS AND CONSUMPTION GROWTH										
Stock Market Returns (U.S. Dollars): 1970:1-1989:4 (80 observations)										
Canada	0.032	0.098	0.09	-0.04	-0.05	-0.07	-0.03	-0.17	-0.04	-0.04
France	0.043	0.142	0.16	-0.08	0.04	0.12	-0.06	-0.26	-0.08	0.12
W Germany	0.038	0.114	0.16	-0.07	0.09	0.15	-0.21	-0.18	-0.09	0.13
Japan	0.060	0.123	0.08	0.11	0.08	0.19	-0.19	-0.10	-0.07	0.12
United Kingdom	0.041	0.143	0.08	-0.11	-0.01	-0.15	-0.16	-0.03	0.08	-0.07
United States	0.030	0.088	0.11	-0.18	-0.11	0.03	0.04	-0.12	-0.09	0.01
Stock Market Returns (Local Currencies): 1970:1-1989:4 (80 observations)										
Canada	0.032	0.091	0.12	-0.01	-0.06	-0.07	-0.04	-0.15	-0.03	-0.07
France	0.040	0.120	0.08	-0.08	0.02	0.05	-0.06	-0.14	-0.09	0.17
W Germany	0.026	0.094	0.06	0.03	0.14	0.07	-0.15	-0.09	-0.09	0.16
Japan	0.045	0.097	-0.03	-0.02	0.05	0.06	-0.17	0.05	-0.10	0.19
United Kingdom	0.045	0.130	0.10	-0.08	-0.03	-0.15	-0.14	-0.02	0.02	-0.07
United States	0.030	0.088	0.11	-0.18	-0.11	0.03	0.04	-0.12	-0.09	0.01
Short-Term Nominal Bond Returns (Local Currencies) 1970:1-1989:1 (77 observations)										
Canada	0.023	0.009	0.91	0.82	0.79	0.71	0.64	0.58	0.43	0.25
France	0.025	0.007	0.91	0.78	0.64	0.51	0.38	0.29	0.14	-0.07
W Germany	0.017	0.007	0.91	0.78	0.61	0.45	0.29	0.14	-0.09	-0.18
Japan	0.017	0.006	0.92	0.78	0.59	0.39	0.19	0.02	-0.18	-0.19
United Kingdom	0.025	0.007	0.85	0.69	0.54	0.43	0.31	0.24	0.05	-0.05
United States	0.019	0.007	0.83	0.74	0.75	0.65	0.57	0.48	0.29	0.02
Exchange Rates (U.S. Dollars per currency unit): 1970:1-1989:4 (80 observations)										
Canada	0.881	0.101	0.98	0.97	0.95	0.94	0.92	0.90	0.84	0.70
France	0.184	0.040	0.96	0.92	0.89	0.85	0.80	0.73	0.62	0.36
W Germany	0.421	0.093	0.92	0.85	0.80	0.74	0.64	0.55	0.36	0.02
Japan	0.005	0.001	0.95	0.90	0.86	0.80	0.72	0.66	0.53	0.29
United Kingdom	1.928	0.392	0.95	0.90	0.86	0.80	0.77	0.72	0.58	0.32
Real Consumption Growth Rates: 1970:2-1989:1 (76 observations)										
Canada	0.010	0.010	0.13	0.22	0.13	0.08	0.19	0.02	-0.14	-0.10
France	0.007	0.008	-0.18	0.15	0.25	-0.22	0.17	-0.06	-0.15	0.06
W Germany[2]	0.001	0.015	-0.28	0.05	-0.53	0.30	-0.19	0.01	0.16	0.14
Japan[3]	0.001	0.015	-0.18	-0.02	0.13	0.21	-0.14	-0.30	0.26	0.25
United Kingdom	0.007	0.014	-0.12	0.11	0.30	-0.24	0.27	-0.02	-0.03	-0.01
United States	0.008	0.008	0.19	0.16	0.30	0.11	-0.12	-0.02	-0.37	-0.15

table 1 page 2

Variable	Mean	Std. Dev.	Autocorrelations ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_8	ρ_{12}
Inflation Rates from Price Deflators: 1970:2-1989:1 (76 observations)										
Canada	0.016	0.007	0.83	0.75	0.68	0.59	0.55	0.42	0.19	-0.09
France	0.020	0.009	0.79	0.68	0.65	0.57	0.51	0.47	0.36	0.05
W Germany[1]	0.010	0.008	0.35	0.05	0.32	0.72	0.28	0.00	0.57	0.43
Japan[2]	0.014	0.013	0.73	0.68	0.68	0.50	0.39	0.41	0.26	0.26
United Kingdom	0.023	0.014	0.80	0.69	0.60	0.53	0.49	0.44	0.27	0.09
United States	0.015	0.006	0.81	0.72	0.65	0.55	0.45	0.38	0.15	-0.03
PANEL II: INSTRUMENTS										
Short-Term Nominal Bond Yields (Local Currency): 1969:1-1988:4 (80 observations)										
Canada	0.022	0.009	0.91	0.83	0.79	0.72	0.66	0.60	0.47	0.29
France	0.024	0.008	0.88	0.75	0.63	0.52	0.41	0.32	0.17	-0.01
W Germany	0.017	0.007	0.91	0.77	0.59	0.42	0.27	0.12	-0.10	-0.16
Japan	0.018	0.006	0.92	0.78	0.60	0.39	0.19	0.03	-0.18	-0.20
United Kingdom	0.025	0.007	0.85	0.70	0.55	0.46	0.34	0.27	0.11	0.01
United States	0.019	0.007	0.83	0.74	0.75	0.65	0.57	0.49	0.31	0.06
Term Spreads[4] (Local Currency): 1969:1-1988:4 (80 observations)										
Canada	0.003	0.004	0.78	0.61	0.52	0.42	0.38	0.32	0.15	-0.05
France	-0.000	0.006	0.75	0.46	0.25	0.07	-0.09	-0.18	-0.32	-0.22
W Germany	0.002	0.005	0.86	0.66	0.43	0.22	0.06	-0.08	-0.25	-0.09
Japan	0.000	0.004	0.86	0.63	0.36	0.08	-0.17	-0.34	-0.47	-0.18
United Kingdom	0.004	0.005	0.81	0.66	0.52	0.43	0.34	0.26	0.16	0.30
United States	0.004	0.004	0.70	0.53	0.52	0.35	0.28	0.15	-0.03	-0.27
Dividend Yields (local currency): 1969:4- 1988:4 (77 observations)										
Canada	0.010	0.002	0.85	0.68	0.53	0.39	0.29	0.19	0.16	0.09
France	0.013	0.004	0.89	0.80	0.73	0.67	0.59	0.49	0.34	0.11
W Germany	0.011	0.003	0.91	0.82	0.76	0.68	0.58	0.49	0.34	0.02
Japan	0.005	0.003	0.94	0.88	0.80	0.72	0.63	0.55	0.43	0.38
United Kingdom	0.013	0.004	0.82	0.62	0.47	0.33	0.24	0.20	0.11	-0.19
United States	0.011	0.003	0.91	0.81	0.74	0.69	0.61	0.54	0.46	0.26
U.S. Instrumental Variables: 1969:4-1988:4 (77 observations)										
U.S. One-month Bill	0.071	0.027	0.87	0.79	0.74	0.65	0.56	0.46	0.31	0.04
S&P 500 Div. yield	0.042	0.009	0.88	0.76	0.67	0.59	0.50	0.42	0.34	0.19

1. All return and growth rates are compounded quarterly.

2. Seasonally-adjusted by the authors using dummy variables.

3. Available only for 1970.1-1988.1 (73 observations), and seasonally adjusted by the authors using dummy variables.

4. The term spread is the difference between a long-term government bond yield to maturity and a short-term bond yield.

TABLE 2
CORRELATIONS OF THE VARIABLES

PART I: CORRELATIONS AMONG THE (U.S Dollar) STOCK MARKET RETURNS:

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Canada	1.00					
(2) France	0.33	1.00				
(3) W Germany	0.32	0.66	1.00			
(4) Japan	0.41	0.45	0.44	1.00		
(5) United Kingdom	0.46	0.48	0.40	0.43	1.00	
(6) United States	0.79	0.47	0.45	0.45	0.58	1.00

PART II: CORRELATIONS AMONG THE (Local Currency) STOCK MARKET RETURNS:

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Canada	1.00					
(2) France	0.37	1.00				
(3) W Germany	0.37	0.53	1.00			
(4) Japan	0.43	0.33	0.36	1.00		
(5) United Kingdom	0.49	0.46	0.44	0.43	1.00	
(6) United States	0.81	0.53	0.51	0.49	0.62	1.00

PART III: CORRELATIONS AMONG THE (Local Currency) SHORT TERM BOND RETURNS:

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Canada	1.00					
(2) France	0.29	1.00				
(3) W Germany	0.55	-0.08	1.00			
(4) Japan	0.03	-0.13	0.33	1.00		
(5) United Kingdom	0.75	0.33	0.49	0.15	1.00	
(6) United States	0.88	0.20	0.66	0.22	0.66	1.00

PART IV: CORRELATIONS AMONG THE EXCHANGE RATES:

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Canada	1.00					
(2) France	0.66	1.00				
(3) W Germany	-.47	0.16	1.00			
(4) Japan	-.62	-.26	0.83	1.00		
(5) United Kingdom	0.76	0.76	-.26	-.45	1.00	

PART V: CORRELATIONS AMONG THE REAL CONSUMPTION GROWTH RATES:

	(1)	(2)	(3)	(4)*	(5)	(6)
(1) Canada	1.00					
(2) France	0.23	1.00				
(3) W Germany	0.21	0.30	1.00			
(4) Japan*	0.08	0.28	0.38	1.00		
(5) United Kingdom	0.18	0.22	0.44	0.28	1.00	
(6) United States	0.25	0.21	0.14	0.25	0.22	1.00

table 2 page 2:

PART VI CORRELATIONS AMONG THE INFLATION RATES:

	(1)	(2)	(3)	(4)*	(5)	(6)
(1) Canada	1.00					
(2) France	0.74	1.00				
(3) W Germany	0.35	0.43	1.00			
(4) Japan*	0.45	0.56	0.49	1.00		
(5) United Kingdom	0.61	0.62	0.48	0.56	1.00	
(6) United States	0.75	0.72	0.44	0.58	0.65	1.00

PART VII CORRELATIONS AMONG THE DIVIDEND YIELDS:

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Canada	1.00					
(2) France	0.78	1.00				
(3) W Germany	0.51	0.70	1.00			
(4) Japan	0.28	0.16	0.10	1.00		
(5) United Kingdom	0.73	0.68	0.58	0.06	1.00	
(6) United States	0.69	0.74	0.78	-.10	0.66	1.00

PART VIII CORRELATIONS AMONG THE TERM SPREADS:

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Canada	1.00					
(2) France	0.35	1.00				
(3) W Germany	0.30	0.65	1.00			
(4) Japan	-.05	0.40	0.27	1.00		
(5) United Kingdom	0.29	0.14	0.29	0.05	1.00	
(6) United Stateμ	0.55	0.55	0.57	0.25	0.10	1.00

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* Data for 1970:Q2 - 1988:Q1 only.

TABLE 3
Regressions of Real Returns and Consumption Growth on Lagged Variables.

Instrument:	a_i	CGROW	RSTOX	TBILL	DIVYLD	TERM	R^2%	r_1
Real Stock Returns:								
U. S.	1.03	-0.15	-0.10	-0.01	5.65	0.51	17.6	0.13
	(0.68)	(0.10)	(0.94)	(2.24)	(3.89)	(0.85)		
U. K.	-0.41	1.26	-0.22	-0.02	8.08	0.17	11.2	0.07
	(0.22)	(0.68)	(0.72)	(1.57)	(2.30)	(0.16)		
Japan	-0.30	1.42	-0.13	-0.10	-1.32	1.12	6.4	-0.06
	(0.22)	(1.06)	(0.90)	(0.30)	(3.66)	(2.02)		
W. Ger.	0.17	0.71	0.01	-0.00	3.66	1.12	6.4	-0.06
	(0.16)	(0.68)	(0.11)	(0.64)	(1.94)	(2.02)		
France	-1.26	2.12	-0.27	-0.01	6.28	0.57	13.5	-0.03
	(0.77)	(1.31)	(1.94)	(1.24)	(2.73)	(0.72)		
Canada	-0.59	1.49	-0.05	-0.02	6.66	-0.49	15.3	0.21
	(0.50)	(1.27)	(0.53)	(2.53)	(3.88)	(0.64)		
Real Short Term Bond Returns:								
U. S.	1.08	-0.07	0.00	0.00	0.32	-0.30	83.8	0.25
	(13.8)	(0.83)	(0.08)	(5.53)	(3.81)	(7.51)		
U. K.	1.56	-0.53	-0.00	-0.00	0.97	-0.50	36.8	0.57
	(7.03)	(2.41)	(0.12)	(1.69)	(3.16)	(5.07)		
Japan	1.56	-0.50	-0.05	-0.00	-0.20	-0.46	27.4	0.52
	(7.63)	(2.49)	(2.83)	(1.43)	(0.54)	(3.73)		
W. Ger.	1.40	-0.36	-0.03	0.00	-0.59	-0.19	40.3	0.27
	(10.6)	(2.78)	(2.60)	(3.64)	(3.05)	(2.63)		
France	1.32	-0.30	-0.01	0.00	0.28	-0.18	58.1	0.50
	(9.07)	(2.11)	(0.95)	(4.80)	(1.52)	(2.34)		
Canada	1.12	-0.12	0.00	0.00	0.62	-0.10	78.3	0.49
	(13.5)	(1.51)	(0.30)	(5.20)	(4.99)	(1.85)		

Instrument:	a_i	CGROW	RSTOX	TBILL	DIVYLD	TERM	R^2%	r_1
Real Consumption Growth:								
U. S.	0.03	-0.02	0.02	-0.00	-0.05	0.20	37.6	-0.06
	(0.32)	(0.25)	(2.17)	(0.98)	(0.33)	(4.13)		
U. K.	-0.09	0.10	-0.01	-0.00	-0.13	0.00	-0.2	-0.20
	(0.50)	(0.57)	(0.35)	(0.42)	(0.49)	(1.07)		
Japan	-0.06	0.07	-0.04	-0.00	-0.26	0.03	1.8	-0.22
	(0.38)	(0.47)	(2.77)	(0.51)	(0.90)	(0.30)		
W. Ger.	0.15	-0.14	-0.01	-0.00	-0.03	0.09	4.9	-0.40
	(0.72)	(0.70)	(0.41)	(1.66)	(0.13)	(0.89)		
France	0.09	-0.08	0.01	-0.00	-0.15	0.00	2.7	-0.23
	(0.95)	(0.80)	(0.99)	(0.60)	(0.77)	(0.44)		
Canada	0.14	-0.11	0.02	-0.00	-0.45	-0.00	26.6	-0.21
	(1.25)	(0.98)	(1.17)	(1.02)	(2.38)	(0.01)		

Quarterly data from 1970.Q4-1988.Q4 (72 observations) are used (for Japan, the data are for 1970.Q4-1988.Q1 and there are 69 observations). The regression is:

$$R_{i,t+1} = a_i + \beta_{i1} Z_{1,t-1} + \dots + \beta_{i5} Z_{5,t-1} + \epsilon_{i,t+1},$$

where R_i is the real asset return measured in local currency units and the Z_j are the lagged instruments. The instruments are (1) the real, per capita growth of total personal consumption expenditures in the United States, denoted by CGROW; (2) the lagged nominal return of the U.S. stock market index, denoted by RSTOX; (3) the lagged nominal return of a U.S. Treasury Bill, denoted TBILL; (4) the Dividend yield of the Standard and Poors 500 stock index, denoted DIVYLD; and (5) a U.S. term spread, denoted TERM, and measured as the difference between the yield to maturity of a long term U.S. government bond and a one-month Treasury bill. All of the instruments are lagged two quarters relative to the real return. The regression betas are listed in the table. The absolute values of the heteroskedasticity-consistent t-statistics are in parentheses. r_1 is the first order autocorrelation of the regression residual. The R-squares are adjusted for degrees of freedom.

Table 4

Test Results for time separable and time nonseparable models using own-country instrumental variables.

Models with habit persistence or durability of consumption expenditures using quarterly returns and consumption data for individual countries. The returns are measured for 1970:Q4-1988:Q4 (72 observations). The model assumes that a representative agent in a given country maximizes:

$$E_0\left[(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A}\right]$$

where $C_t = c_t + b_1 c_{t-1}$ and c_t is the real per-capita consumption expenditures at date t. A is the concavity parameter, β is the subjective discount rate and b_1 is the parameter representing habit persistence ($b_1 < 0$) or durability ($b_1 > 0$). Estimation is by generalized method of moments (GMM). The error terms are assumed to follow an MA(0) process when the time-separable model ($b_1=0$) is estimated and an MA(1) process when the one-lag model is estimated. Asymptotic standard errors are in parentheses. P-value is the probability that a χ^2 variate exceeds the minimized sample value of the GMM criterion function. The asset returns are a value-weighted common stock return index and a short term bond return for each country. Both are measured in local currency units and are deflated by the consumption price deflator for the country. R_s^2 is the adjusted R-square for regressing the country stock return on the instruments; R_b^2 is for the short term bond and R_c^2 is for the consmption growth measure; all are in percent. The instruments include a constant and the consumption growth measure at lag two. The instruments also include the local nominal stock return, the local nominal bond return, the local dividend yield and the local term spread, all measured at lag one.

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
United States	8.6	84.8	37.8	0.979	1.10	=0[a]	16.79	0.079
				(0.011)	(1.58)			
				0.754	3.11	-0.92	13.24	0.152
				(0.240)	(21.4)	(0.40)		
United Kingdom	24.3	56.1	7.5	0.967	0.87	=0[a]	21.82	0.016
				(0.007)	(0.89)			
				0.547	6.30	-0.82	1.07	0.999
				(0.741)	(124.5)	(3.08)		

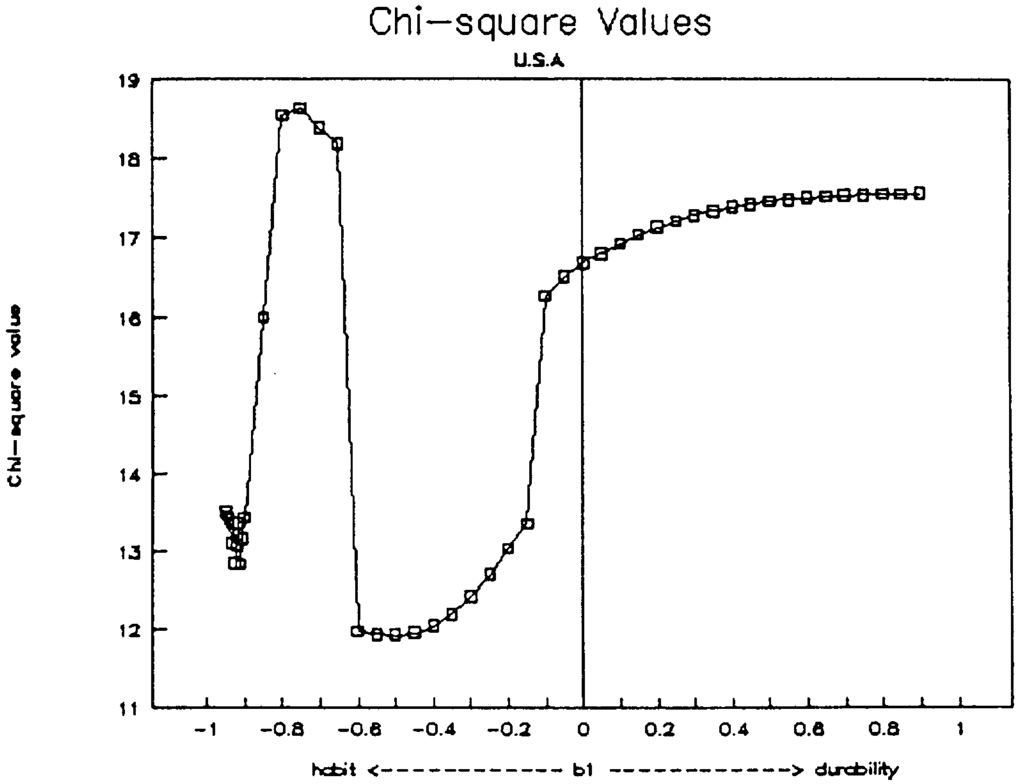
table 4 page 2

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
France	0.5	66.9	4.5	0.962 (0.020)	1.07 (3.45)	=0[a]	9.03	0.529
				0.94 (0.27)	1.18 (52.4)	-0.69 (5.67)	3.25	0.954
Canada	5.4	81.6	32.0	0.978 (0.012)	0.98 (1.19)	=0[a]	13.77	0.184
				0.16 (7.14)	12.76 (1018.)	-0.93 (5.04)	0.01	0.999
West Germany	-0.9	63.8	2.8	0.983 (0.017)	1.17 (4.44)	=0[a]	8.36	0.594
				0.90 (1.15)	2.09 (198.1)	-0.63 (20.4)	0.09	0.999
Japan	-0.2	47.8	3.2	0.970 (0.001)	0.35 (0.40)	=0[a]	21.70	0.017
				0.918 (0.036)	3.10 (7.39)	-0.64 (0.42)	10.98	0.277

[a] An "=0" indicates that the parameter is set to zero.

1. An exception is Japan, for which there are only 69 observations and the data are for 1970:Q4-1988:Q1.

Figure 1

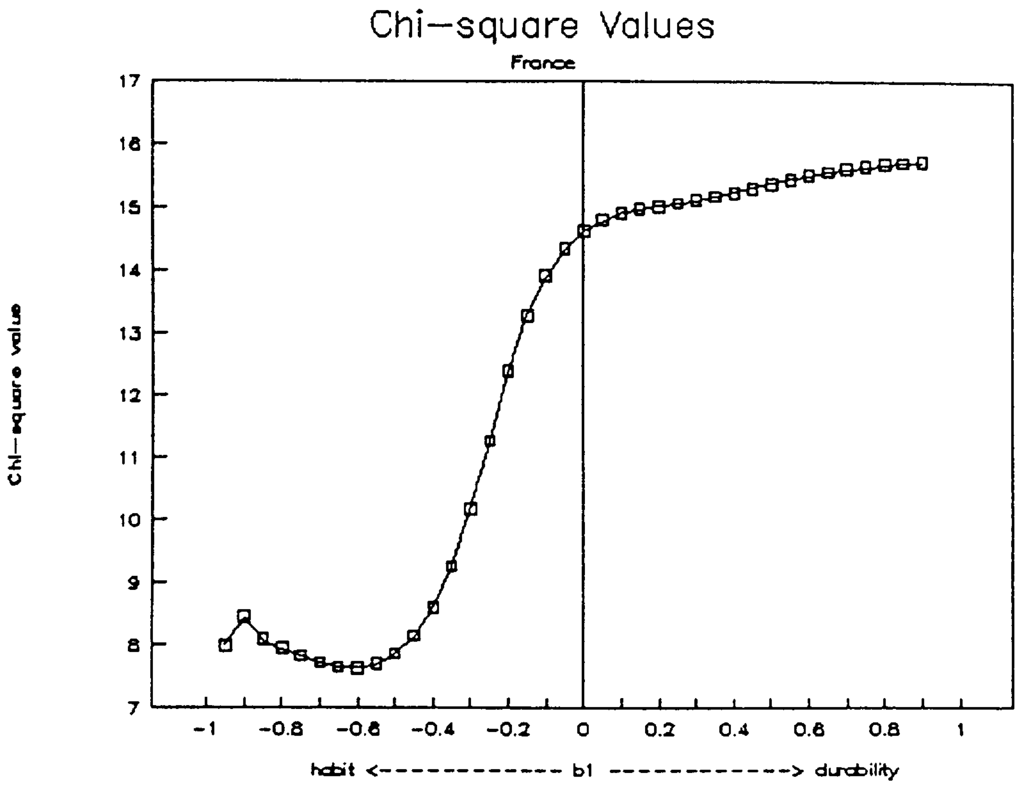


The Generalized Method of Moments objective function is plotted when the objective is minimized over the choice of the parameters A and β, for given values of the parameter b_1. The data and instruments are as in Table 4. The model assumes that a representative agent in a given country maximizes:

$$E_0\left[(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A}\right]$$

where $C_t = c_t + b_1 c_{t-1}$ and c_t is the real per-capita consumption expenditures at date t. A is the concavity parameter, β is the time preference factor, and b_1 is the parameter representing habit persistence ($b_1 < 0$) or durability ($b_1 > 0$). The error terms are assumed to follow an MA(1) process.

Figure 1, continued

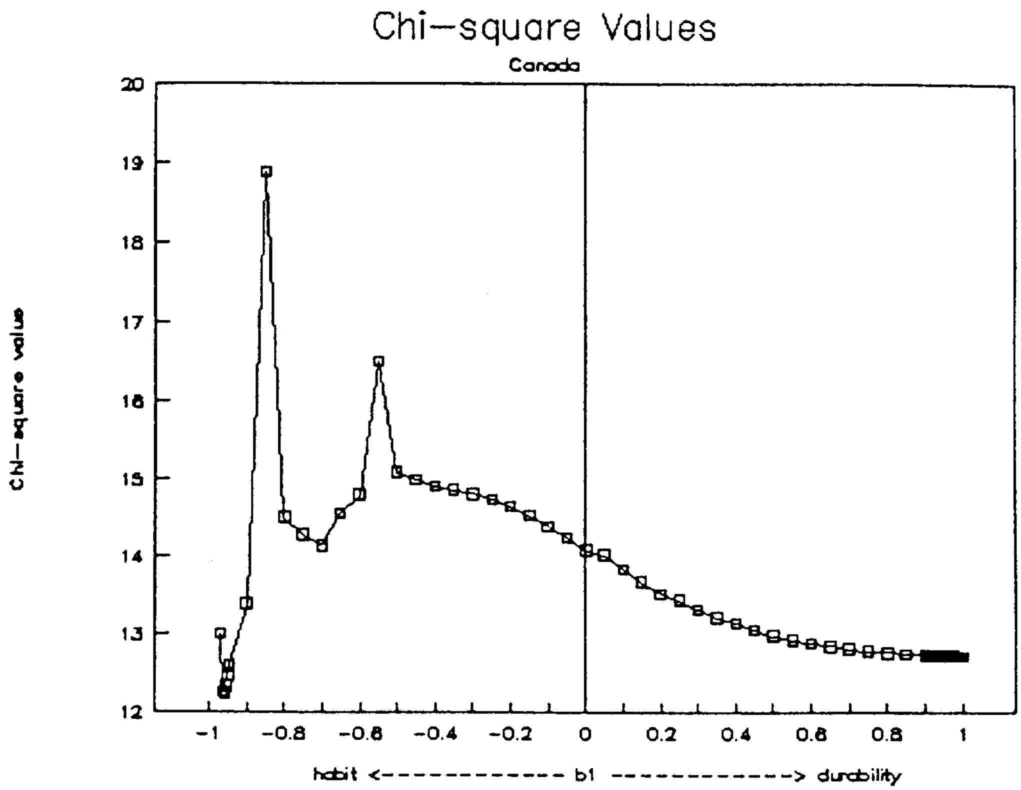


The Generalized Method of Moments objective function is plotted when the objective is minimized over the choice of the parameters A and β, for given values of the parameter b_1. The data and instruments are as in Table 4. The model assumes that a representative agent in a given country maximizes:

$$E_0\left[(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A}\right]$$

where $C_t = c_t + b_1 c_{t-1}$ and c_t is the real per-capita consumption expenditures at date t. A is the concavity parameter, β is the time preference factor, and b_1 is the parameter representing habit persistence ($b_1 < 0$) or durability ($b_1 > 0$). The error terms are assumed to follow an MA(1) process.

Figure 1, continued



The Generalized Method of Moments objective function is plotted when the objective is minimized over the choice of the parameters A and β, for given values of the parameter b_1. The data and instruments are as in Table 4. The model assumes that a representative agent in a given country maximizes:

$$E_0\left[(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A}\right]$$

where $C_t = c_t + b_1 c_{t-1}$ and c_t is the real per-capita consumption expenditures at date t. A is the concavity parameter, β is the time preference factor, and b_1 is the parameter representing habit persistence ($b_1 < 0$) or durability ($b_1 > 0$). The error terms are assumed to follow an MA(1) process.

Table 5

Test Results using own-country instrumental variables, with a higher order moving average term.

Models with habit persistence or durability of consumption expenditures using quarterly and consumption data for individual countries. The returns are measured for 1970:Q4-1988:Q4 (72 observations). The model assumes that a representative agent in a given country maximizes:

$$E_0\left[(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A}\right]$$

where $C_t = c_t + b_1 c_{t-1}$ and c_t is the real per-capita consumption expenditures at date t. A is the concavity parameter, β is the rate of time discount, and b_1 is the parameter representing habit persistence ($b_1 < 0$) or durability ($b_1 > 0$). Estimation is by generalized method of moments (GMM). The error terms are assumed to follow an MA(1) process when the time-separable model (b_1=0) is estimated and an MA(2) process when the one-lag model is estimated. Asymptotic standard errors are in parentheses. P-value is the probability that a χ^2 variate exceeds the minimized sample value of the GMM criterion function. The asset returns are a value-weighted common stock return and a short term bond return. Both are measured in local currency units and are deflated by the consumption price deflator for the country. R_s^2 is the adjusted R-square for regressing the country stock return on the instruments; R_b^2 is for the short term bond and R_c^2 is for the consmption growth measure; all are in percent. The instruments include a constant and the consumption growth measure for the country measured at lag two. Also included are the local nominal stock return, the local short term nominal bond return, the local dividend yield and term spread, all measured at lag one.

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
United States	8.6	84.8	37.8	0.983 (0.012)	1.49 (1.58)	=0[a]	12.33	0.263
				0.957 (0.012)	0.02 (0.15)	-0.97 (0.12)	10.14	0.340
United Kingdom	24.3	56.1	7.5	0.967 (0.999)	0.85 (115.9)	=0	0.01	0.999
				0.561 (0.511)	10.65 (83.24)	-0.76 (1.61)	1.68	0.995

table 5 page 2

Country	R_μ^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
France	0.5	66.9	4.5	0.972	1.04	=0	9.55	0.481
				(0.017)	(2.33)			
				0.985	1.15	-0.78	3.05	0.962
				(0.133)	(30.67)	(2.52)		
Canada	5.4	81.6	32.0	0.980	1.07	=0	9.44	0.491
				(0.012)	(1.20)			
				0.987	1.41	-0.65	7.44	0.591
				(0.049)	(5.92)	(0.77)		
West Germany	-0.9	63.8	2.8	0.988	1.21	=0	7.18	0.709
				(0.012)	(3.78)			
				0.905	1.60	-0.75	0.10	0.999
				(1.212)	(119.3)	(10.02)		
Japan	-0.2	47.7	3.2	0.970	0.34	=0	14.88	0.137
				(0.001)	(0.43)			
				0.917	2.36	-0.76	8.37	0.497
				(0.045)	(4.36)	(0.24)		

[a] An "=0" indicates that the parameter is set to zero.

Table 6

Test Results using own-country financial assets and instrumental variables at lag two only.

Models with habit persistence or durability of consumption expenditures using quarterly returns and consumption data for individual countries. The returns are measured for 1970:Q4-1988:Q4 (72 observations). The model assumes that a representative agent in a given country maximizes:

$$E_0\left[(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A}\right]$$

where $C_t = c_t + b_1 c_{t-1}$ and c_t is the real per-capita consumption expenditures at date t. A is the concavity parameter, β is the rate of time discount, and b_1 is the parameter representing habit persistence ($b_1 < 0$) or durability ($b_1 > 0$). Estimation is by generalized method of moments (GMM). The error terms are assumed to follow an MA(0) process when the time-separable model ($b_1=0$) is estimated and an MA(1) process when the one-lag model is estimated. Asymptotic standard errors are in parentheses. P-value is the probability that a χ^2 variate exceeds the minimized sample value of the GMM criterion function. The asset returns are a value-weighted common stock return index and a short term bond return for each country. Both are measured in local currency units and are deflated by the consumption price deflator for the country. R_s^2 is the adjusted R-square for regressing the country stock return on the instruments; R_b^2 is for the short term bond and R_c^2 is for the consmption growth measure; all are in percent. The instruments are a constant, the consumption growth measure, the local nominal stock return, the local nominal bond return, the local dividend yield and the local term spread, all measured at lag two.

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
United States	9.5	61.7	26.3	0.979 (0.011)	1.04 (1.44)	=0[a]	15.72	0.108
				0.974 (0.012)	0.10 (1.58)	-0.68 (2.05)	15.59	0.076
United Kingdom	19.1	48.4	0.6	0.982 (0.023)	5.51 (3.18)	=0	13.52	0.196
				0.990 (0.024)	5.82 (3.61)	-0.36 (0.18)	10.73	0.295

table 6 page 2

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
France	1.4	48.2	0.7	0.961	1.10	≡0	7.51	0.677
				(0.021)	(3.58)			
				0.939	1.23	-0.78	4.77	0.854
				(0.138)	(33.17)	(2.89)		
Canada	7.2	62.2	27.6	0.977	1.03	≡0	11.45	0.323
				(0.012)	(1.28)			
				0.965	0.01	-0.92	9.59	0.385
				(0.003)	(0.21)	(0.61)		
West Germany	-2.5	59.8	-1.2	0.982	1.12	≡0	8.95	0.537
				(0.018)	(5.88)			
				0.895	4.05	-0.65	0.17	0.999
				(0.977)	(131.8)	(6.01)		
Japan	0.4	24.6	5.9	0.969	0.94	≡0	15.69	0.109
				(0.002)	(0.34)			
				0.915	5.52	-0.58	9.18	0.420
				(0.055)	(8.54)	(0.32)		

[a] An "≡0" indicates that the parameter is set to zero.

1. An exception is Japan, for which there are only 69 observations and the data are for 1970:Q4-1988:Q1.

Table 7

Test Results using own-country financial assets and U.S instrumental variables. Models with habit persistence or durability of consumption expenditures using quarterly and consumption data for individual countries. The returns are measured for 1970:Q4-1988:Q4 (72 observations). The model assumes that a representative agent in a given country maximizes:

$$E_0\left[(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A}\right]$$

where $C_t = c_t + b_1 c_{t-1}$ and c_t is the real per-capita consumption expenditures at date t. A is the concavity parameter, β is the rate of time discount, and b_1 is the parameter representing habit persistence ($b_1 < 0$) or durability ($b_1 > 0$). Estimation is by generalized method of moments (GMM). The error terms are assumed to follow an MA(0) process when the time-separable model (b_1=0) is estimated and an MA(1) process when the one-lag model is estimated. Asymptotic standard errors are in parentheses. P-value is the probability that a χ^2 variate exceeds the minimized sample value of the GMM criterion function. The asset returns are a value-weighted common stock return and a short term bond return. Both are measured in local currency units and are deflated by the consumption price deflator for the country. R_s^2 is the adjusted R-square for regressing the country stock return on the instruments; R_b^2 is for the short term bond and R_c^2 is for the consmption growth measure; all are in percent. The instruments include a constant and the consumption growth measure for the U.S measured at lag two. Also included are the U.S. nominal stock return, the U.S. 1-month Treasury bill rate, the dividend yield of the Standard and Poors 500 stock index, and the U.S. term spread (U.S. long term bond yield less 1 month bill rate), all measured at lag one.

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
United States	5.4	67.9	15.5	0.975 (0.010)	1.02 (1.50)	=0[a]	14.64	0.146
				0.942 (0.032)	0.23 (2.02)	-0.94 (0.32)	10.65	0.301
United Kingdom	0.8	29.5	-1.2	0.969 (0.021)	1.08 (2.75)	=0	9.09	0.523
				0.912 (0.349)	1.21 (52.1)	-0.72 (5.61)	3.83	0.922

table 7 page 2

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
France	-4.9	59.4	2.2	0.959 (0.025)	1.01 (4.32)	=0	7.44	0.683
				0.964 (0.055)	1.08 (9.93)	-0.60 (1.52)	3.48	0.943
Canada	-3.4	75.9	29.2	0.975 (0.012)	0.91 (1.28)	=0	10.64	0.386
				1.048 (0.976)	1.20 (123.1)	0.99 (1002.4)	0.41	0.999
West Germany	-1.3	30.4	7.9	0.976 (0.016)	1.19 (3.37)	=0	5.16	0.880
				0.967 (0.149)	1.45 (22.4)	-0.70 (2.10)	6.28	0.712
Japan	11.2	26.6	-1.6	0.970 (0.002)	0.65 (0.44)	=0	18.94	0.041
				0.972 (0.005)	0.09 (1.38)	-0.75 (1.70)	14.95	0.092

[a] An "=0" indicates that the parameter is set to zero.

Table 8

Test Results using own-country financial assets and U.S instrumental variables, with a higher order moving average term.

Models with habit persistence or durability of consumption expenditures using quarterly and consumption data for individual countries. The returns are measured for 1970:Q4-1988:Q4 (72 observations). The model assumes that a representative agent in a given country maximizes:

$$E_0\left[(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A}\right]$$

where $C_t = c_t + b_1 c_{t-1}$ and c_t is the real per-capita consumption expenditures at date t. A is the concavity parameter, β is the rate of time discount, and b_1 is the parameter representing habit persistence ($b_1 < 0$) or durability ($b_1 > 0$). Estimation is by generalized method of moments (GMM). The error terms are assumed to follow an MA(1) process when the time-separable model (b_1=0) is estimated and an MA(2) process when the one-lag model is estimated. Asymptotic standard errors are in parentheses. P-value is the probability that a χ^2 variate exceeds the minimized sample value of the GMM criterion function. The asset returns are a value-weighted common stock return and a short term bond return. Both are measured in local currency units and are deflated by the consumption price deflator for the country. R_s^2 is the adjusted R-square for regressing the country stock return on the instruments; R_b^2 is for the short term bond and R_c^2 is for the consmption growth measure; all are in percent. The instruments include a constant and the consumption growth measure for the U.S measured at lag two. Also included are the U.S. nominal stock return, the U.S. 1-month Treasury bill rate, the dividend yield of the Standard and Poors 500 stock index, and the U.S. term spread (U.S. long term bond yield less 1 month bill rate), all measured at lag one.

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
United States	5.4	67.9	15.5	0.964	1.12	=0[a]	13.62	0.191
				(0.01202)	(0.26)			
				0.952	0.36	-0.93	9.08	0.430
				(0.038)	(2.99)	(0.31)		
United Kingdom	0.8	29.5	-1.2	0.969	1.16	=0	7.57	0.670
				(0.019)	(2.77)			
				0.966	1.26	-0.71	4.42	0.881
				(0.217)	(31.6)	(3.17)		

table 8 page 2

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
France	-4.9	59.4	2.2	0.970 (0.011)	0.94 (1.62)	=0	12.62	0.245
				0.962 (0.096)	1.09 (19.3)	-0.63 (2.79)	0.96	0.999
Canada	-3.4	75.9	29.2	0.976 (0.012)	0.96 (1.19)	=0	7.80	0.629
				0.501 (1.751)	6.31 (7830)	-0.91 (1.32)	0.52	0.999
West Germany	-1.3	30.6	7.9	0.982 (0.013)	1.86 (3.10)	=0	4.72	0.909
				0.980 (0.086)	0.44 (9.41)	-0.81 (1.98)	5.87	0.752
Japan	11.2	26.6	-1.6	0.969 (0.002)	0.66 (0.45)	=0	15.20	0.125
				0.969 (0.002)	0.67 (0.57)	-0.01 (0.34)	13.32	0.148

[a] An "=0" indicates that the parameter is set to zero.

Table 9

Test Results using own-country financial assets and U.S instrumental variables at lag two only.

Models with habit persistence or durability of consumption expenditures using quarterly and consumption data for individual countries. The returns are measured for 1970:Q4-1988:Q4 (72 observations). The model assumes that a representative agent in a given country maximizes:

$$E_0\left[(1 - A)^{-1} \sum_{t=0}^{\infty} \beta^t C_t^{1-A}\right]$$

where $C_t = c_t + b_1 c_{t-1}$ and c_t is the real per-capita consumption expenditures at date t. A is the concavity parameter, β is the rate of time discount, and b_1 is the parameter representing habit persistence ($b_1 < 0$) or durability ($b_1 > 0$). Estimation is by generalized method of moments (GMM). The error terms are assumed to follow an MA(0) process when the time-separable model (b_1=0) is estimated and an MA(1) process when the one-lag model is estimated. Asymptotic standard errors are in parentheses. P-value is the probability that a χ^2 variate exceeds the minimized sample value of the GMM criterion function. The asset returns are a value-weighted common stock return and a short term bond return. Both are measured in local currency units and are deflated by the consumption price deflator for the country. R_s^2 is the adjusted R-square for regressing the country stock return on the instruments; R_b^2 is for the short term bond and R_c^2 is for the consmption growth measure; all are in percent. The instruments are a constant, the consumption growth measure for the U.S, the U.S. nominal stock return, the U.S. 1-month Treasury bill rate, the dividend yield of the Standard and Poors 500 stock index, and the U.S. term spread (U.S. long term bond yield less 1 month bill rate), all measured at lag two.

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
United States	17.6	83.8	37.6	0.979 (0.010)	1.05 (1.31)	=0[a]	17.28	0.068
				0.229 (0.176)	16.5 (24.2)	-0.93 (0.08)	13.55	0.139
United Kingdom	11.2	36.8	-0.2	0.971 (0.026)	1.15 (3.49)	=0	22.59	0.012
				0.975 (0.041)	1.18 (6.10)	-0.50 (0.98)	14.61	0.102

table 9 page 2

Country	R_s^2	R_b^2	R_c^2	β	A	b_1	χ^2	p-value
France	13.5	58.1	2.7	0.961 (0.023)	1.08 (4.06)	=0	15.61	0.111
				0.956 (0.077)	1.34 (18.8)	-0.82 (1.25)	9.71	0.375
Canada	15.3	78.3	26.6	0.978 (0.012)	1.00 (1.21)	=0	14.74	0.142
				0.23 (0.38)	9.33 (15.69)	-0.93 (0.07)	3.31	0.951
West Germany	6.4	40.3	4.9	0.978 (0.003)	0.94 (0.90)	=0	23.75	0.008
				0.714 (0.167)	3.69 (8.47)	-0.83 (0.28)	12.38	0.193
Japan	2.1	27.4	1.8	0.969 (0.002)	1.25 (0.45)	=0	16.03	0.098
				0.795 (0.108)	17.9 (23.6)	-0.38 (0.50)	11.46	0.245

[a] An "=0" indicates that the parameter is set to zero.