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Dundee Discussion Papers in Economics

Does Consumption Deviate from the
Permanent Income Path?
An Empirical Study of UK Data

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**DOES CONSUMPTION DEVIATE
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An empirical study of U.K. data**

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ABSTRACT

It has become something of a stylised fact that the change in consumer spending exhibits persistence. This is often interpreted as indicating a violation of the rational expectations-permanent income (RE-PI) hypothesis. This paper considers an alternative interpretation, namely that such persistence reflects portfolio disturbances from the financial sector which temporarily push consumption away from its RE-PI path. Empirical support for this interpretation is provided using a UK data set.

KEYWORDS: *permanent income; wealth allocation; portfolio adjustment; cointegration; error correction*

JEL CLASSIFICATION: E21, G11

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1. Introduction

The permanent income hypothesis postulates that consumption is proportional to permanent income. However, the change in consumption is often found to exhibit a strong autocorrelation pattern and hence be rather predictable. This empirical regularity about the pattern of consumption has cast severe doubt on the validity of the rational expectations version of the permanent income hypothesis (RE-PIH), which requires the change in permanent income to be an unpredictable random series. But because permanent income is unobservable, the empirical studies of the RE-PIH have concentrated on testing the relationship between consumption and some, arbitrarily constructed, measure of permanent income based on the observed or actual income. It is however possible to perceive a situation in which the change in permanent income is genuinely unpredictable, and that the change in consumption deviates from the latter because the original consumption plans are disturbed by, for instance, factors concerning agents' financial activities. In such a situation, therefore, the change in consumption will be predictable if the effect of the latter persists, but the RE-PIH will still hold if this persistence could be shown to be due to disturbances originated in the financial sector. In other words, consumption will eventually return to its RE-PIH path once the disturbances which caused the deviations stop.

This paper develops the above idea by providing an empirical investigation of links between fluctuations in private consumption and wealth allocation. Because the existence of such links allow policies aimed at financial objectives to also affect the real side of the economy, the importance of detecting them has long been recognised and stressed in the literature (see, for instance, Purvis, 1978 and Owen, 1981). However, the typical models of the consumption function based on the life-cycle principle do not allow for any explicit relationship between consumption and portfolio decisions. This is because in these models non-human, or financial, wealth usually acts as a buffer to enable consumers to smooth their consumption. As a result, the optimal path of consumption turns out to be affected only by those factors which are relevant for revising the human capital component of wealth. For instance, as shown by Hall (1978), the standard RE-PIH model predicts that the change in consumption is simply an unpredictable random process stemming from the surprise in labour income.

During the last decade or so, there has seen an overwhelming accumulation of evidence on the stochastic behaviour of consumption. Denoting consumers' expenditure (in constant prices) on goods and services by C , almost all recent empirical studies of

consumption report that ΔC is stationary, exhibits a strong serial correlation pattern, and is relatively smooth. Although the first property is in line with the prediction of the RE-PIH, the other two strongly reject the so-called martingale version of the Euler equation associated with the RE-PIH. This conflict between theory and evidence has led to a number of interesting developments which focus on various shortcomings of the RE-PIH framework (see Hall, 1989; and Deaton, 1992, for details). But there has been little attempt to investigate whether disturbances due to portfolio adjustments can explain the fluctuations in ΔC . This possibility would arise if households temporarily departed from their long-run consumption plans in order to comply with their committed, and/or discretionary, saving contracts. The finding by Mankiw and Zeldes (1991) that stockholders' consumption exhibits a more volatile pattern than that of nonstockholders supports this conjecture.

In this paper we suggest a new way of capturing the interaction between consumption and portfolio decisions. In particular, we propose an approach which links consumption and portfolio fluctuations but under certain restrictions yields as its long-run solution the standard RE-PIH path. This approach involves specifying an empirical relationship between changes in consumption and short-run disturbances in the portfolio system and identifying a set of restrictions which enables us to test whether the link between consumption and portfolio decisions persist in the long-run. The failure to reject these restrictions implies that disturbances which cause, and prolong, portfolio adjustments only cause a temporary deviation of consumption from the PIH path. It then follows that financial policies do not have lasting effects on the pattern of private consumption, and that the dichotomised approach to modelling consumption and portfolio decisions which has dominated the literature is justified empirically. Anticipating the results, our application of this approach to UK data supports the existence of significant but temporary links between consumption and portfolio adjustments. In other words, our results show that the UK data supports the controversial RE-PIH model.

The rest of the paper proceeds as follows. Section 2 outlines the relevant theoretical issues and explains how the RE-PIH path of consumption may be modified to incorporate short-run deviations due to disturbances unrelated to income. Section 3 describes the data. Section 4 reports on the specification and estimation of the portfolio allocation system which yields consistent estimates of the short-run disturbances and uses the latter to test whether a significant permanent link between consumption and portfolio disturbances exists. Section 5 concludes the paper.

2. Theoretical Issues

The life cycle hypothesis and its permanent income version enable consumers to formulate their optimal long-run consumption plan. The application of the rational expectations hypothesis imposes a restriction on how this plan is revised. The combination of these hypotheses and certain assumptions about the shape of preferences and the discount rates has led to the theoretical conclusion that fluctuations in consumption are due to random unpredictable shocks to labour income. One particular implication of this framework is that it completely isolates the path of consumption from short-run disturbances related to activities concerning the allocation of non-human or financial wealth. However, a brief examination of the balance sheets for the UK personal sector shows that at the aggregate level households do in fact engage in considerable portfolio management activities. From a theoretical point of view, households may do so in order to, say, *(i)* take advantage of the speculative opportunities in financial markets, and/or *(ii)* alter their wealth composition to benefit from changes in the institutional aspects of the financial sector. These activities are quite likely to involve significant short-run financial adjustments. One way to facilitate such adjustments and comply with committed or discretionary saving contracts is to temporarily depart from the long-run consumption plan. It could therefore be argued that disturbances in portfolio adjustment are likely to be reflected in the change in consumption.

As mentioned in the introduction, the theoretical justification for the existence of a link between consumption and portfolio allocation decisions can be found in a framework developed by Purvis (1978). He combines the traditional portfolio allocation model with the budget constraint to illustrate that the consumption function may be derived as a residual equation whose parameters satisfy the adding-up restrictions suggested by Brainard and Tobin (1968) (see also Owen, 1981, for further details). This approach is known in the literature as the "integrated" model and has been empirically examined by Backus and Purvis (1980), Owen (1985, 1986), Bayoumi (1993), and MacDonald and Molana (1993) amongst others. However, in extreme contrast to the RE-PIH which implies a one-to-one association between stochastic behaviour of consumption and human wealth, the integrated approach links consumption entirely to portfolio adjustment activities. As a result, it cannot be easily reconciled with the long-run proportionality between consumption and permanent income which is usually considered as the most plausible equilibrium outcome. In what follows we propose a more flexible approach which allows for a short-run link between consumption and

portfolio decisions but yields the long-run proportionality which is consistent with both the RE-PIH and the empirical evidence on stochastic evolution of aggregate consumption.

Consider the following decomposition of the change in consumption

$$(1) \quad \Delta C_t = v_t + u_t,$$

where v_t and u_t may be interpreted as the ‘*fundamental*’ and ‘*noise*’ components of ΔC_t (see Blanchard and Quah, 1993, for an example of this type of decomposition). According to the RE-PIH, in the absence of transitory consumption $u_t=0$ and v_t is the shock to permanent income. The latter is usually assumed to be proportional to the surprise in current labour income, e.g. an unpredictable random process with zero mean. It is clear that the empirical evidence – regularly reported in the literature, see, for example, Flavin (1993 and 1981) – on the existence of a strong serial correlation in ΔC_t cannot be reconciled with these theoretical restrictions; i.e. the existence of a one-to-one association between ΔC_t and unpredictable cyclical fluctuations in human capital. To understand this, consider the standard definition of permanent income as the annuity associated with the present value of the human and non-human wealth

$$(2) \quad Y_t^p = r \left(W_t + \sum_{j=0}^{\infty} \rho^{j+1} E_t X_{t+j} \right),$$

where Y^p denotes permanent income, X is the real (after tax) labour income, W the real value of stock of non-human wealth, r is the real (after tax) interest rate¹, $\rho=1/(1+r)$, the subscript t denotes the observation date and E_t denotes the expectations operator conditional on the information at t . The period-by-period and life-time budget constraints are, respectively,

$$(3) \quad W_{t+j+1} = (1/\rho)W_{t+j} + X_{t+j} - C_{t+j}, \quad j \geq 0,$$

and

$$(4) \quad \sum_{j=0}^{\infty} \rho^{j+1} C_{t+j} = W_t + \sum_{j=0}^{\infty} \rho^{j+1} X_{t+j}.$$

¹ The constancy of r is a typical assumption in the literature considered here.

Given the above, it is straightforward to show that the following also hold

$$(5) \quad (1 - \rho) \sum_{j=0}^{\infty} \rho^j E_t C_{t+j} = Y_t^p,$$

and

$$(6) \quad Y_t^p = (1/\rho)Y_{t-1}^p - ((1-\rho)/\rho)C_{t-1} + v_t,$$

where v_t is the present value of the revisions in future labour income, or human capital, due to the additional news and is given by²

$$(7) \quad v_t = \sum_{j=0}^{\infty} \rho^j (E_t \Delta X_{t+j} - E_{t-1} \Delta X_{t+j}).$$

The standard PIH approach imposes the well known restriction that individuals consume their permanent income, the implication of which is that both consumption and permanent income are expected to remain constant. To see this, note that when $C_{t-1} = Y_{t-1}^p$, equation (6) implies $Y_t^p = Y_{t-1}^p + v_t$, and because v_t is unpredictable, $Y_{t-1}^p = E_{t-1} Y_t^p$ should hold. But disregarding this restriction and substituting from equation (4) into (5) we obtain

$$(1 - \rho) \sum_{j=0}^{\infty} \rho^j E_t C_{t+j} = ((1 - \rho)/\rho) \sum_{j=0}^{\infty} \rho^j E_{t-1} C_{t+j-1} + ((1 - \rho)/\rho) C_t + v_t,$$

which can be rearranged as follows

$$(8) \quad \sum_{j=0}^{\infty} \rho^j (E_t \Delta C_{t+j} - E_{t-1} \Delta C_{t+j}) = v_t.$$

This equation states that the present value of the revision in the consumption plan should be equal to the present shock to permanent income. Now, by imposing the additional restrictions that $E_t \Delta C_{t+j} = E_{t-1} \Delta C_{t+j}$, for all $j \geq 0$, one obtains the standard result, namely $\Delta C_t = \Delta Y_t^p = v_t$. Hence, when v_t is unpredictable this implies the so-called *random walk*

² A more familiar expression is $v_t = r \sum_{j=0}^{\infty} \rho^{j+1} (E_t X_{t+j} - E_{t-1} X_{t+j})$, from which the expression in (7) can be obtained. See Campbell and Deaton (1989) for details.

behaviour which requires the change in consumption to be unpredictable too. But the existing empirical evidence is against this behaviour and almost all studies of consumption data find the change in consumption to be stationary but to exhibit a strong first order autocorrelation pattern (see Hall, 1989, for a survey).

Recently, some have argued that there is no reason to impose the above restriction (see, for instance, Quah, 1990). In particular, Galí (1991) has proposed allowing ΔC to obey a decomposition similar to the following

$$(9) \quad \Delta C_t = \sum_{j=0}^{\infty} \phi_j v_{t-j} + \sum_{j=0}^{\infty} \gamma_j \varepsilon_{t-j},$$

where ϕ_j and γ_j are constant parameters. The first part on the right-hand-side of (9) is the fundamental component of ΔC which is related to the RE-PIH principle through v , the income surprise defined in (7). The second part defines the noise component of ΔC , which is captured by independently distributed random disturbances, $\varepsilon_{t,j}$. Galí uses the above to examine the smoothness of consumption with respect to income. He therefore does not associate ε with any particular source and only restricts its influence on consumption to ensure consistency. He obtains these restrictions by noting that any plan should satisfy the life-time budget constraint; i.e. equation (8), whose imposition on (9) is shown to yield the following parameter restrictions

$$\sum_{j=0}^{\infty} \rho^j \phi_j = 1, \quad \text{and} \quad \sum_{j=0}^{\infty} \rho^j \gamma_j = 0.$$

However, the approach proposed by Galí is rather flexible and can be extended to allow ΔC to be serially correlated, to explain the deviation between ΔC_t and v_t by another disturbance or set of disturbances, and to find those parameter restrictions whose imposition ensures consistency. The failure to reject these restrictions statistically then implies that any deviation between ΔC_t and v_t is in fact a temporary phenomenon; consumption returns to its optimal stochastic path implied by RE-PIH, $\Delta C_t = \Delta Y_t^p = v_t$, once such disturbances cease to perturb consumers' plans.

To proceed with the above, we deviate from Galí's model and postulate the following generalisation of the path of consumption

$$(10) \quad \Delta C_t = v_t + \sum_{s=1}^k \sum_{j=0}^m \gamma_{sj} \xi_{s,t-j},$$

where γ_{sj} are constant parameters and $\xi_{s,t}$ s are independently distributed random shocks. From the above we obtain:

$$E_t \Delta C_t - E_{t-1} \Delta C_t = v_t + \sum_{s=1}^k \gamma_{s0} \xi_{s,t},$$

$$E_t \Delta C_{t+j} - E_{t-1} \Delta C_{t+j} = \sum_{s=1}^k \gamma_{sj} \xi_{s,t}, \quad 1 \leq j \leq m,$$

and

$$E_t \Delta C_{t+j} - E_{t-1} \Delta C_{t+j} = 0, \quad j \geq m,$$

and by substituting these back in equation (8) we derive the following consistency conditions

$$(11) \quad \sum_{j=0}^m \rho^j \gamma_{sj} = 0, \quad 1 \leq s \leq k,$$

whose imposition on (10) will restore the desired long-run requirement. Thus, if $\xi_{s,t}$ is considered as the shock to one of the assets included in the wealth portfolio ($s=1, \dots, k$) then the above framework can be employed to investigate whether disturbances to portfolio adjustment cause consumption to temporarily depart from its RE-PIH path. To do so, one needs to replace $\xi_{s,t}$ with consistent estimates of the portfolio adjustment shocks. This is explained in Section 4 below. We conclude this section by noting that the above framework enables us to empirically investigate the following questions:

- i) Given a broad classification of assets as physical, liquid, non-liquid, and liabilities, disturbances to which type of assets are more likely to affect consumption decisions?
- ii) Do these effects capture the persistence in the change in consumption as well as obeying the restrictions imposed by the RE-PIH? Or, put differently, do portfolio effects consistently explain the deviation of consumption from its RE-PIH path?

It is worth noting that in addition to enabling us to test the RE-PIH, an empirical investigation of the above questions will also reveal interesting information about the nature of

the impacts on consumption - and hence on aggregate demand - of disturbances which are originated in the financial sector.

3. Data and Some Descriptive Statistics

This section introduces the relevant series and examines their pattern of evolution over the period of analysis. Given the explanations in the previous section, we need to use data on consumption as well as variables which capture the short-run portfolio disturbances; i.e. the ξ_s in equation (10). But the latter are unobservable and in order to find observable approximations for them we need to specify and estimate a portfolio adjustment model. Given our main objective, we only consider a broadly disaggregated portfolio model corresponding to the main categories of real and financial assets and liabilities. Also, rather than attempting to model the private sector's portfolio behaviour, we confine the analysis to obtaining consistent estimates of disturbances from traditional wealth allocation models. These models are particularly appropriate for our purpose because they explicitly distinguish between the long-run and short-run portfolio behaviours.

The long-run, or equilibrium, portfolio shares are assumed to be determined by relevant interest rates and relative prices and, given that instantaneous adjustments are rather costly, an error correction process is postulated to characterise the short-run behaviour. Thus, the disturbance terms of the short-run adjustment equations provide appropriate approximations for ξ_s , and the variables entering the underlying long-run portfolio allocation system consist of the main assets and liabilities of personal sector and the relevant interest rates and prices.

Table 1 below gives the list and description of the variables used in the analysis where the asset classification is chosen to reflect a feasible 'first stage' allocation of personal wealth and the interest rates and relative prices listed beneath them in the table could be considered as the main determinants of the portfolio shares³. Data on personal wealth and its components – i.e. assets and liabilities of the personal sector – are obtained from the Balance Sheet Tables which are now regularly published by the U.K. Central Statistical Office (CSO). All series are

³ In addition to these interest rates and prices, we also examined: Clearing Banks 7 days Notice Rate; Building Societies Rates on Shares, Deposits and Mortgages; Yield Rates for All Shares, Ordinary Shares, Medium Dated Bonds and Consols; and Price Indices for Durable Goods, Ordinary Shares and Consols. Our final selection was guided by searching for those series which could be used as the representative indicators.

quarterly and the sample period⁴ is 1966:Q4 to 1990:Q4. While quarterly data are available for all financial assets and liabilities in the above list, data on the real, or physical, components of personal wealth are provided with annual frequency only. We have therefore constructed the quarterly series for durable goods and housing by means of a simple interpolation method using the quarterly expenditure and price data for each of the series in question.

Table 1. List and Description of Variables used in the Analysis

Variable	Description
a_1	Portfolio Share of Real (or Physical) Assets: <i>Stock of Durable Goods</i> <i>Stock of Housing (Dwellings)</i>
a_2	Portfolio Share of Liquid Financial Assets: <i>Notes and Coin</i> <i>Deposits with Banks</i> <i>Deposits and Shares with Building Societies</i> <i>Deposits with Local Authorities</i>
a_3	Portfolio Share of Non-Liquid Financial Assets: <i>Public Sector Debt (including Pensions)</i> <i>Debenture, Loan Stock, Ordinary and Preference Shares</i> <i>Unit Trusts</i> <i>Life Insurance and Pension Funds</i>
a_4	Portfolio Share of Financial Liabilities: <i>Bank Lending</i> <i>Hire Purchase and Installment Debt</i> <i>Loans for House Purchase</i>
R_1	Interest Rate: <i>3 Months Treasury Bills</i>
R_2	Interest Rate: <i>Short Dated, 1-5 years, Bonds Par Yield</i>
R_3	Interest Rate: <i>Long Dated, 15-20 years, Bonds Par Yield</i>
P_1	Relative Price: <i>Price of Housing/Consumer Price Index</i>
P_2	Relative Price: <i>Price of FT All Shares/Consumer Price Index</i>
C	Expenditure on Nondurable Goods and Services (<i>constant prices</i>)
Y	Personal Disposable Income (<i>constant prices</i>)

Figures 1-4 below show how the portfolio shares and the interest rates and relative prices in Table 1 have fluctuated over the sample period. Together, these figures give some indication of the underlying portfolio adjustment. Given the perspective of our objectives in

⁴ The choice of our sample period, namely 1966:Q4 - 1990:Q4, was restricted by the availability of homogenous series on components of personal wealth since any extension beyond this period would introduce breaks in series due to changes in definitions regarding money, liquid and nonliquid assets.

Figure 1. Portfolio Shares for Physical Assets and Liabilities

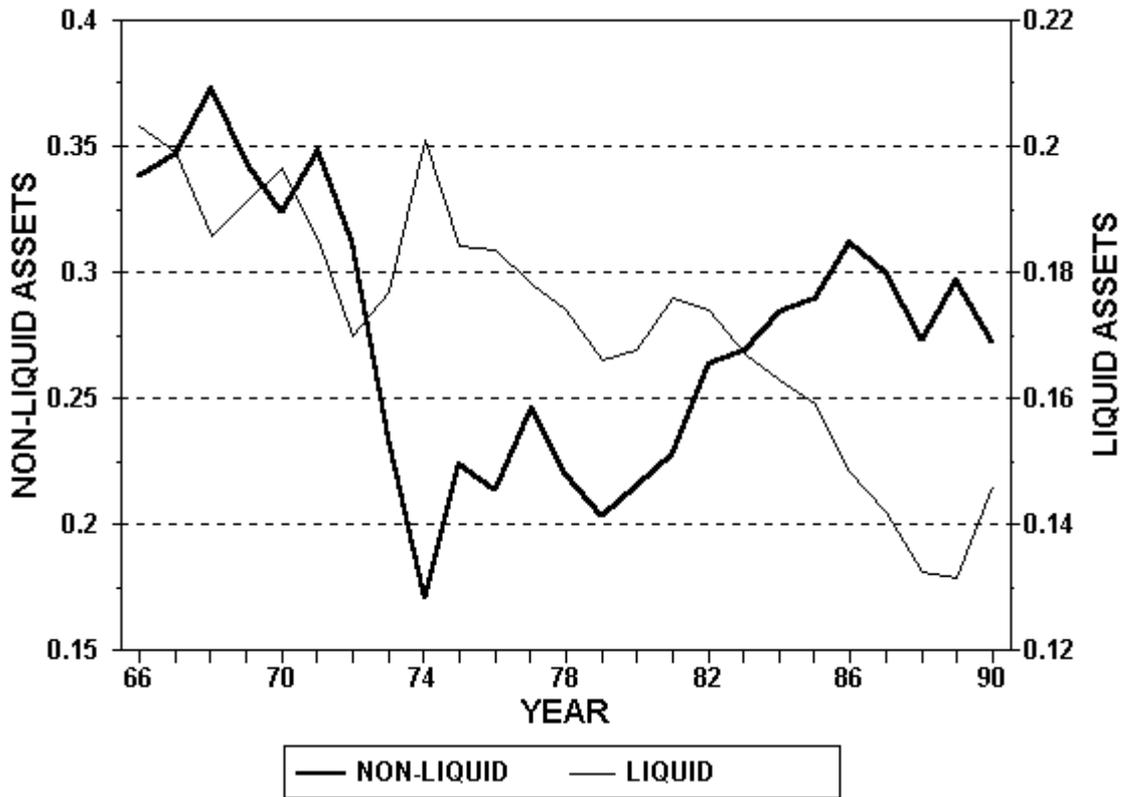


Figure 2. Portfolio Shares for Liquid and Nonliquid Financial Assets

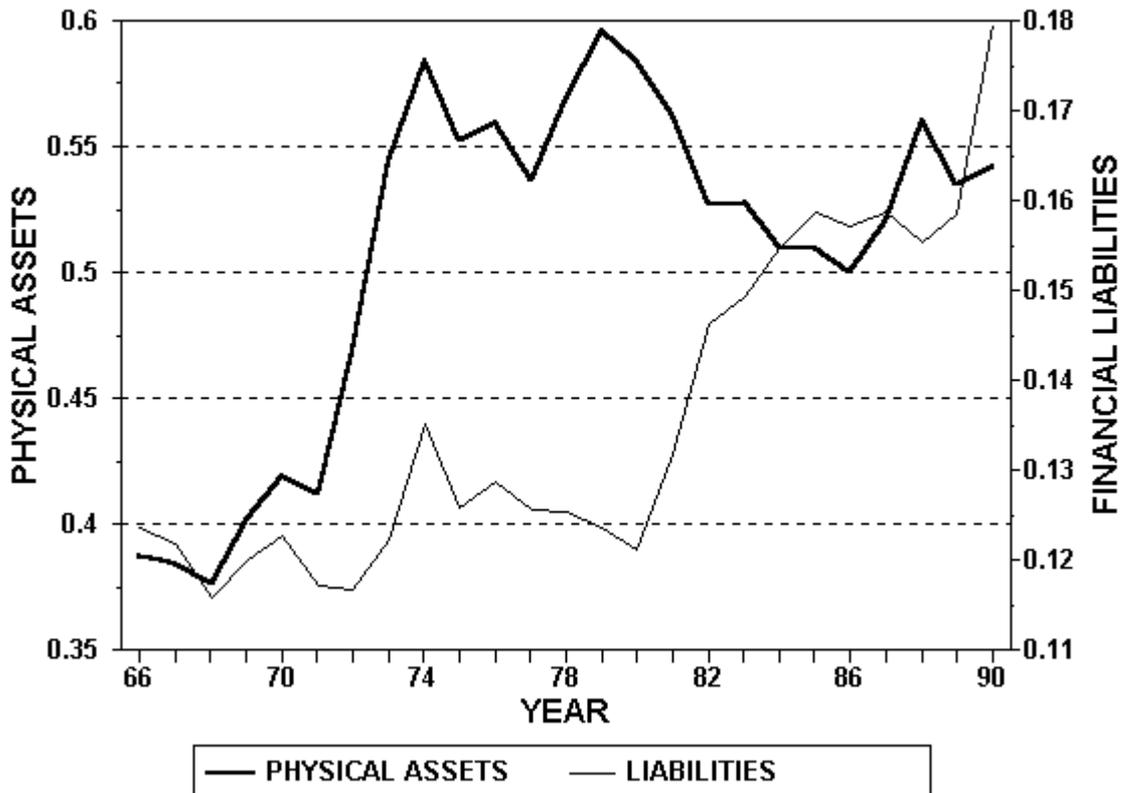


Figure 3. Interest Rates

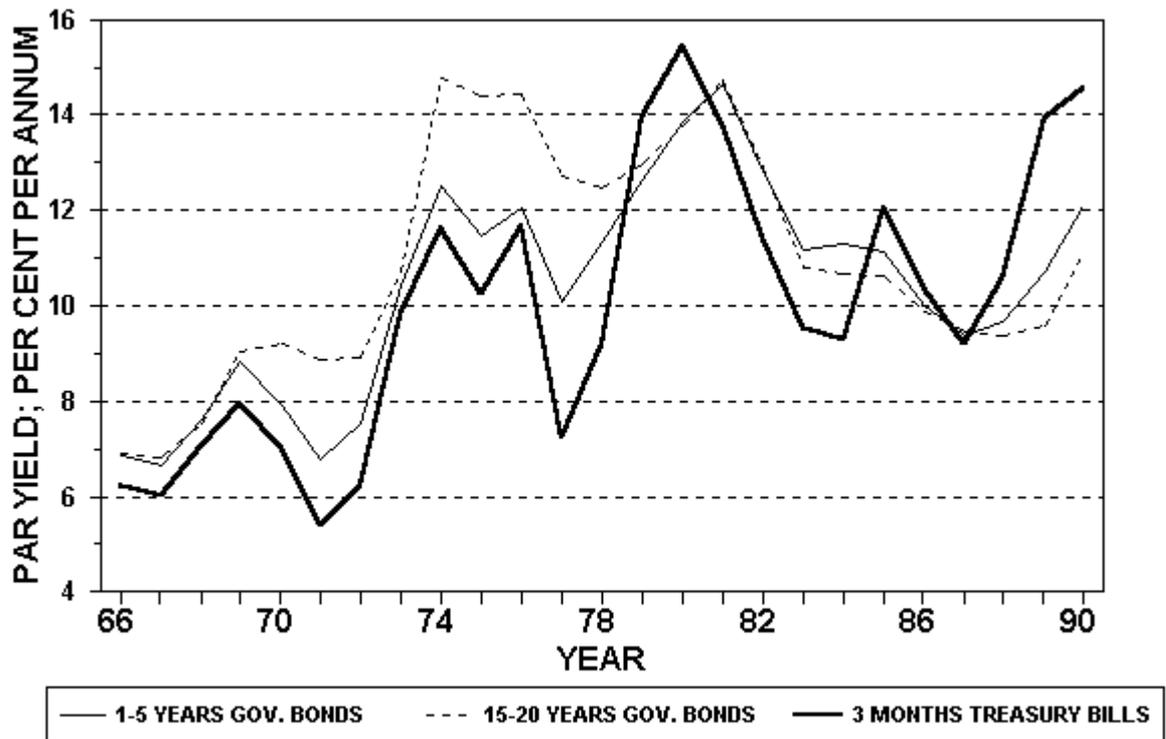
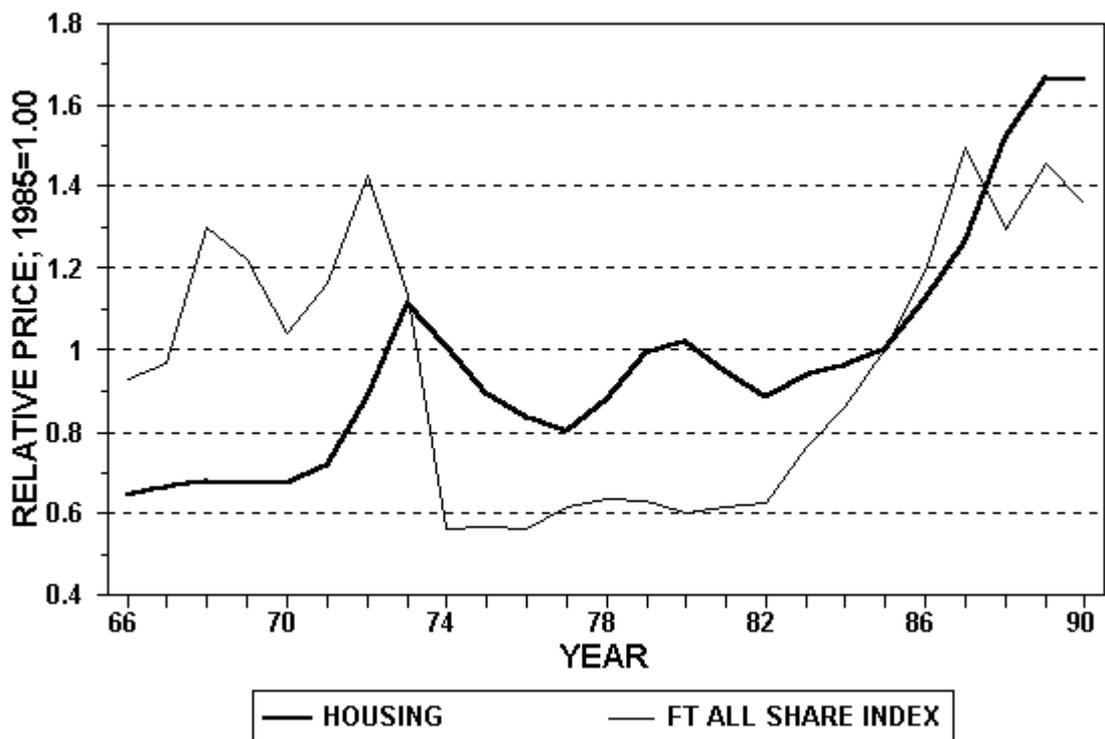


Figure 4. Price Indices



this paper, a striking feature of these figures is the variability over the sample period of the portfolio shares in relation to the trend and fluctuations in the interest rates and relative prices.

We conclude this section by investigating the deterministic and/or stochastic evolution of the above series through time. This involves conducting some simple univariate unit root tests designed to identify the nature and order of integration of the economic time series. There are a number of proposals for implementing such tests (see, for example, Dickey and Fuller, 1979; Phillips and Perron, 1988; Park and Choi, 1988; and Stock, 1990) and each of these has been used intensively in the applied macroeconomics literature. However, there now seems to be a growing consensus that the earliest form of unit root test proposed by Dickey and Fuller (1979) has superior small sample properties to its competitors (see Campbell and Perron, 1992, for a discussion). Therefore, here we only use the augmented version of their test. For the series listed in Table 1, this test is reported in Table 2 below.

Table 2. Unit Root Tests for the Series in Table 1

Series	Level		1 st Difference		2 nd Difference	
	t_1	t_2	t_1	t_2	t_1	t_2
a_1	-1.91	-1.65	-4.32	-4.42	-7.45	-7.40
a_2	-1.52	-1.64	-5.03	-5.09	-8.01	-7.96
a_3	-1.17	-2.79	-5.07	-5.05	-7.77	-7.73
a_4	-0.56	-2.05	-6.07	-6.03	-9.11	-9.06
R_1	-2.82	-3.43	-5.86	-5.82	-8.78	-8.73
R_2	-2.36	-2.34	-6.28	-6.21	-8.79	-8.74
R_3	-2.15	-1.96	-4.96	-5.06	-8.36	-8.30
P_1	-1.58	-1.47	-2.94	-2.90	-4.86	-4.83
P_2	-1.44	-1.47	-3.95	-4.02	-6.19	-6.16
C	-1.00	-0.85	-3.59	-3.65	-9.31	-9.27
Y	0.52	-1.22	-3.03	-3.00	-11.48	-11.47

t_1 and t_2 denote the augmented versions of the Dickey-Fuller statistic without and with a deterministic time trend with 5% critical values -2.89 and -3.34, respectively.

The results suggest that the first difference of each variable is stationary and none of the series seem to be stationary around a deterministic trend. An interesting outcome worth noting here is the presence of a stochastic trend component in all asset ratios which indicates the existence of an on-going portfolio adjustment. Moreover, because the hypothesis that a and the interest rates and relative prices are first difference stationary cannot be rejected, the existence of a long-run relationship between each a and the latter which constitutes the equilibrium behaviour cannot be ruled out.

Finally, given the importance of the time series properties of consumption for the validity of the RE-PIH model outlined in Section 2, it is worthwhile to conduct further investigations of the autoregressive structure of ΔC . In Figures 5-7 below, therefore, we present the change in consumption and its autocorrelation and partial autocorrelation coefficients, respectively. While these figures reinforce the unit root tests that ΔC appears to be generated by a stationary process, they clearly reject the hypothesis that the change in consumption is an unpredictable random process. A further statistical test in this case can be conducted by calculating the variance ratio statistic recently proposed by Cochrane (1988). For a series X and a number of lags k , this has the following form

$$(12) \quad V_k = \frac{1}{k} \cdot \frac{\text{Var}(X_t - X_{t-k})}{\text{Var}(X_t - X_{t-1})}$$

Note that V_k can also be expressed in terms of the sum of k autocorrelation coefficients, it has the additional advantage of showing how fast X reverts to or deviates from its mean when V_k lies below or above unity. Table 3 below gives our estimates of V_k for $X = \Delta C$ and a representative selection of lags, k . These confirm that ΔC is stationary and reverts to its mean rather rapidly⁵.

Table 3. Estimates of the Variance Ratio for DC

	Lags (k)					
	2	4	8	12	24	48
V_k	0.39	0.27	0.13	0.09	0.06	0.03
L-M	0.00	0.00	0.00	0.02	0.18	0.34
L-M'	0.00	0.00	0.00	0.00	0.00	0.00

L-M and L-M' are the marginal significance levels for the hypothesis $V_k = 1$ proposed by Lo and MacKinlay (1988). L-M assumes ΔC has a normal distribution while L-M' allows for deviations from the normality assumption.

⁵ Compare the results in Table 3 with those reported for the exchange rate literature where it is found that it can take as long as ten years before estimates of V_k falls to 0.5. See Huizinga (1987) for examples.

Figure 5. Quarterly Changes in Consumers' Expenditure on Nondurable Goods & Services, ΔC

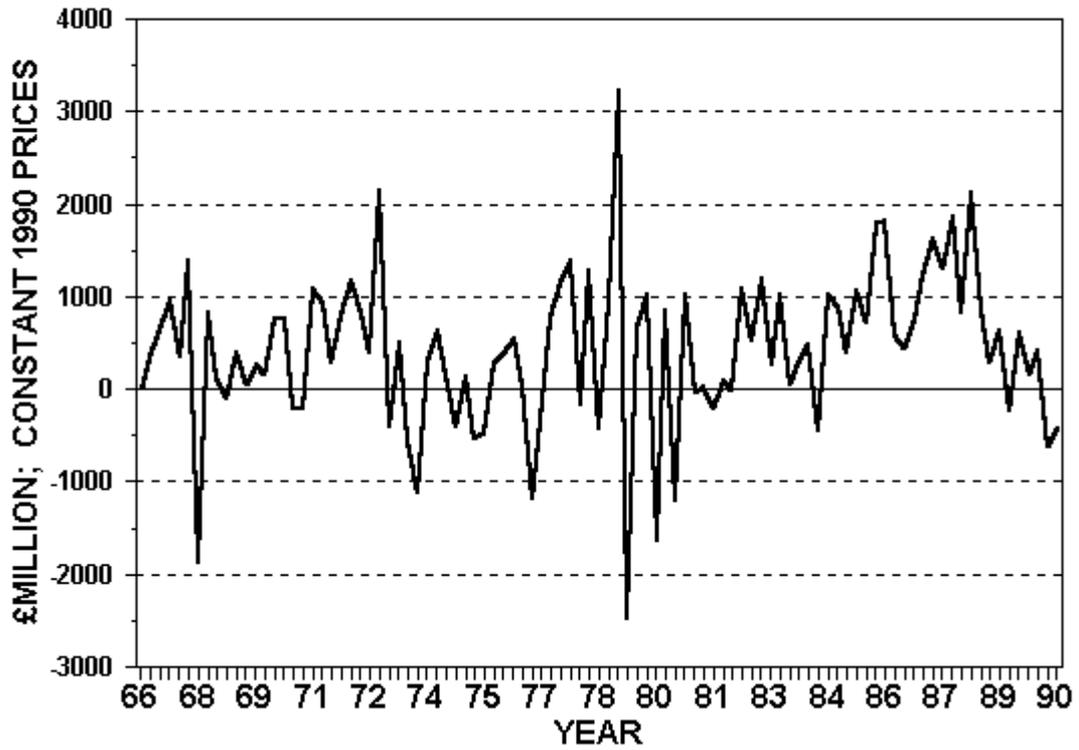


Figure 6. Autocorrelation Coefficients for ΔC

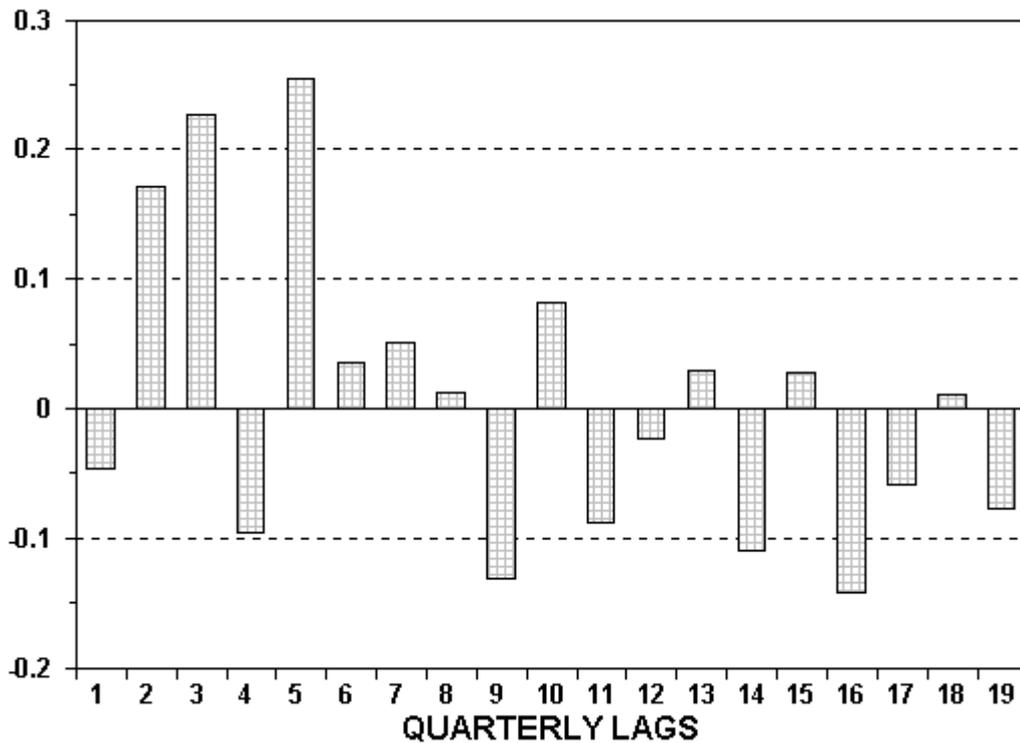
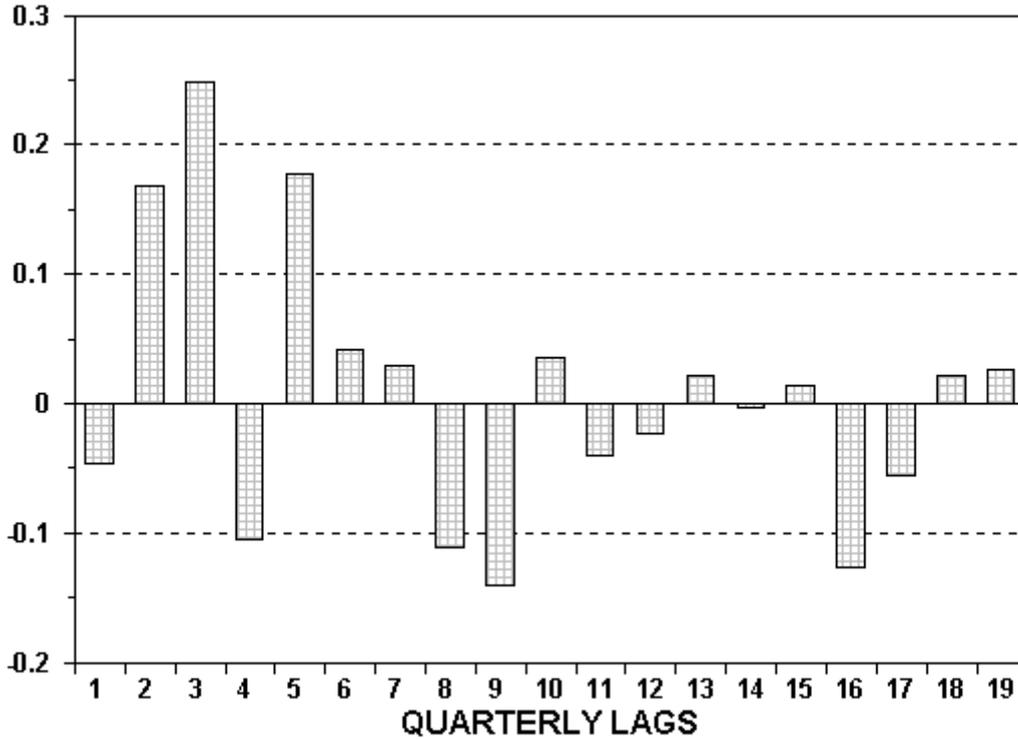


Figure 7. Partial Autocorrelation Coefficients for ΔC



4. Portfolio Disturbances and Divergence of ΔC from the RE-PIH Path

In this section we first explain the specification of the portfolio adjustment equations whose estimation yields consistent estimate of the short-run disturbances – i.e. the $\xi_{s,t}$ – and then perform the tests which enable us to examine whether these disturbances have permanent effects on the RE-PIH path of consumption.

Denoting by Z the vector of variables which determine the long-run portfolio shares, a linear model may be written as $a_s^* = Z'\beta_s$ where a_s is the ratio of the s th asset to wealth and the asterisk refers to its equilibrium value, \hat{a} is a conformable vector of long-run coefficients, and recall that Z contains the relevant interest rates and relative prices⁶. A consistent estimate of $\xi_{s,t}$ can then be obtained by estimating a dynamic relationship between $a_{s,t-j}$ and $Z_{s,t-j}$ which incorporates an appropriate long-run solution. The typical way to proceed in this case is to use the cointegration-error-correction methodology. Two alternative estimation methods may be

⁶ When using aggregate data at a macro level, some scale factor may also be included in Z to capture the growth and/or income distribution effects which may cause a shift from financial to real assets or vice versa. We shall use disposable income to capture these effects. Also note that when the portfolio model is fully specified and all assets are included, the elements of β_s ought to be restricted to satisfy the relevant adding-up restrictions for $s=1, \dots, k$. Because here we do not cover all components of wealth we shall relaxed this restriction.

considered. One method is the two step procedure outlined by Engle and Granger (1987) and later elaborated by Johansen (1988 and 1991). The first step of this approach requires the estimation of β_s , $s=1, \dots, k$, from

$$(13) \quad a_{s,t} = Z_t' \beta_s + \zeta_{s,t}$$

where $\zeta_{s,t}$ is a stationary disturbance term. In this case, $a_{s,t}^* = Z_t' \hat{\beta}_s$ may be interpreted as the long-run, or desired, component of $a_{s,t}$ and the estimates of the disturbance of (13), denoted by $\hat{\zeta}_{s,t}$, is used in the second step that involves estimating the short-run, error-correction, adjustment equations,

$$(14) \quad \alpha_s(L)(1-L)a_{s,t} = \delta_s(L)(1-L)Z_t + \varphi_s \hat{\zeta}_{s,t-1} + \xi_{s,t}$$

where $\alpha_s(L)$ and $\delta_s(L)$ are conformable well behaved polynomials in the Lag Operator L , and φ_s is a constant parameter capturing the disequilibrium effect due to $a_{s,t} \neq a_{s,t}^*$. Thus, although the estimation of the above equations for $s=1, \dots, k$, will yield consistent measures of the disturbance ξ_s , there is a problem with the efficiency of this estimators because $\hat{\zeta}_s$ for each s may not be unique.

Alternatively, it is possible to estimate the short-run adjustment equation directly by applying the method suggested by Phillips and Loretan (1991). This involves estimating the long-run parameters and the short-run adjustment coefficients jointly⁷, and hence the corresponding residuals which approximate $\hat{\zeta}_s$ are obtained in one step from the following equation

$$(15) \quad a_{s,t} = Z_t' \beta_s + \sum_{j=0}^J \Delta Z_{t+k-j}' \delta_{sj} + \sum_{m=1}^M \varphi_{s,m} (a_{s,t-m} - Z_{t-m}' \beta_s) + \xi_{s,t}$$

for some $J > k > 0$ and $M > 1$.

However, both methods described above require each a_s to be cointegrated with elements of Z . It is therefore important that we first investigate the existence of a long-run

⁷ See Wickens and Bruecsh (1988) for other alternatives.

relationship between each asset ratio and the explanatory variables in vector Z . To do so, we follow the procedure proposed by Johansen (1988, 1991 and 1992). The two test statistics which we use below to determine the number of significant cointegrating vectors are the Trace statistic and the Maximum Eigenvalue statistic. These are denoted by J_{Trace} and λ_{Max} respectively, and provide the likelihood ratio test statistics for the following

$$H_0: n \leq r \quad \text{vs} \quad H_1: n = \bar{n} \quad (\text{or} \quad n \geq r + 1),$$

and

$$H_0: n \leq r - 1 \quad \text{vs} \quad H_1: n = r,$$

for some n , where r is the number of possible (independent) cointegrating relationships between elements of $X_s' = (a_s, Z')$ denoted by \bar{n} . As for the choice of a_s and the elements of Z , recall that these were explained above (see Table 1 for notation and definitions) and we let $Z' = (R_1, R_2, R_3, \ln P_1, \ln P_2, \ln Y)$.

Our estimates of the J_{Trace} and λ_{Max} statistics for each X_s are presented in Tables 4.1 to 4.4 below. These results indicate the existence of at least two cointegrating linear combinations of elements of the vector associated with each asset ratio. As a result, we can proceed to estimate the short-run adjustment equations in order to obtain consistent estimates of the residuals, ξ_s .

Table 4.1 Multivariate Cointegration Tests for
 $X_1' = (a_1, R_1, R_2, R_3, \ln P_1, \ln P_2, \ln Y)$

Trace Test			Eigenvalue Test		
Hypothesis	J_{Trace}	5% c.v.	Hypothesis	λ_{Max}	5% c.v.
$n \leq 6$ vs $n = 7$	0.00	8.18	$n \leq 6$ vs $n = 7$	0.00	8.18
$n \leq 5$ vs $n \geq 6$	9.16	17.95	$n \leq 5$ vs $n = 6$	9.16	14.90
$n \leq 4$ vs $n \geq 5$	19.82	31.53	$n \leq 4$ vs $n = 5$	10.65	21.07
$n \leq 3$ vs $n \geq 4$	40.31	48.28	$n \leq 3$ vs $n = 4$	20.49	27.14
$n \leq 2$ vs $n \geq 3$	71.99	70.59	$n \leq 2$ vs $n = 3$	31.69	33.32
$n \leq 1$ vs $n \geq 2$	106.95	95.18	$n \leq 1$ vs $n = 2$	34.96	39.43
$n = 0$ vs $n \geq 1$	167.10	124.25	$n = 0$ vs $n = 1$	60.14	44.91

n is the possible number of stationary linear combinations between elements of X .

Table 4.2 Multivariate Cointegration Tests for
 $X_2' = (a_2, R_1, R_2, R_3, \ln P_1, \ln P_2, \ln Y)$

Trace Test			Eigenvalue Test		
Hypothesis	J_{Trace}	5% c.v.	Hypothesis	λ_{Max}	5% c.v.
$n \leq 6$ vs $n = 7$	0.12	8.18	$n \leq 6$ vs $n = 7$	0.12	8.18
$n \leq 5$ vs $n \geq 6$	9.27	17.95	$n \leq 5$ vs $n = 6$	9.14	14.90
$n \leq 4$ vs $n \geq 5$	22.35	31.53	$n \leq 4$ vs $n = 5$	13.08	21.07
$n \leq 3$ vs $n \geq 4$	40.30	48.28	$n \leq 3$ vs $n = 4$	17.95	27.14
$n \leq 2$ vs $n \geq 3$	68.10	70.59	$n \leq 2$ vs $n = 3$	27.80	33.32
$n \leq 1$ vs $n \geq 2$	99.82	95.18	$n \leq 1$ vs $n = 2$	31.71	39.43
$n = 0$ vs $n \geq 1$	146.91	124.25	$n = 0$ vs $n = 1$	47.09	44.91

See the note in Table 4.1

Table 4.3 Multivariate Cointegration Tests for
 $X_3' = (a_3, R_1, R_2, R_3, \ln P_1, \ln P_2, \ln Y)$

Trace Test			Eigenvalue Test		
Hypothesis	J_{Trace}	5% c.v.	Hypothesis	λ_{Max}	5% c.v.
$n \leq 6$ vs $n = 7$	0.01	8.18	$n \leq 6$ vs $n = 7$	0.01	8.18
$n \leq 5$ vs $n \geq 6$	7.24	17.95	$n \leq 5$ vs $n = 6$	7.23	14.90
$n \leq 4$ vs $n \geq 5$	21.30	31.53	$n \leq 4$ vs $n = 5$	14.06	21.07
$n \leq 3$ vs $n \geq 4$	42.25	48.28	$n \leq 3$ vs $n = 4$	20.95	27.14
$n \leq 2$ vs $n \geq 3$	71.82	70.59	$n \leq 2$ vs $n = 3$	29.57	33.32
$n \leq 1$ vs $n \geq 2$	104.68	95.18	$n \leq 1$ vs $n = 2$	32.86	39.43
$n = 0$ vs $n \geq 1$	161.51	124.25	$n = 0$ vs $n = 1$	56.83	44.91

See the note in Table 4.1

Table 4.4 Multivariate Cointegration Tests for
 $X_4' = (a_4, R_1, R_2, R_3, \ln P_1, \ln P_2, \ln Y)$

Trace Test			Eigenvalue Test		
Hypothesis	J_{Trace}	5% c.v.	Hypothesis	λ_{Max}	5% c.v.
$n \leq 6$ vs $n = 7$	1.01	8.18	$n \leq 6$ vs $n = 7$	1.01	8.18
$n \leq 5$ vs $n \geq 6$	7.55	17.95	$n \leq 5$ vs $n = 6$	6.53	14.90
$n \leq 4$ vs $n \geq 5$	18.86	31.53	$n \leq 4$ vs $n = 5$	11.31	21.07
$n \leq 3$ vs $n \geq 4$	35.84	48.28	$n \leq 3$ vs $n = 4$	16.98	27.14
$n \leq 2$ vs $n \geq 3$	62.28	70.59	$n \leq 2$ vs $n = 3$	26.44	33.32
$n \leq 1$ vs $n \geq 2$	98.44	95.18	$n \leq 1$ vs $n = 2$	36.15	39.43
$n = 0$ vs $n \geq 1$	160.10	124.25	$n = 0$ vs $n = 1$	61.66	44.91

See the note in Table 4.1

The above tables suggest that for each asset ratio there is at least one cointegrating relationship representing the long-run equilibrium situation. In the absence of any criteria to choose between these, we estimated the short-run disturbances using the method proposed by

Phillips and Loretan described above⁸. The estimated equations are not themselves of any special interest since they are auxiliary regressions whose residuals – the ξ_s s corresponding to equation (15) – provide consistent estimates of the portfolio adjustment disturbances. Our diagnostic tests suggested that the hypothesis that these residuals are realisations of unpredictable random disturbances could not be rejected⁹.

Thus, having obtained consistent estimates of the ξ_s , we now turn our attention to testing the existence of significant permanent links between them and ΔC . This involves estimating the following regression equation, which is the same as equation (10) but now the ξ_s are replaced by their estimates

$$(10)' \quad \Delta C_t = \sum_{s=1}^k \sum_{j=0}^m \gamma_{sj} \hat{\xi}_{s,t-j} + v_t$$

Table 5 below reports the unrestricted estimates of equation (10)' for $m=4$ and the ξ_s associated with the four portfolio ratios: physical assets ($s=1$); liquid assets ($s=2$); non-liquid assets ($s=3$); and liabilities ($s=4$), as well as the values of the relevant χ^2 test statistics for both separate and joint restrictions described by equation (11). The choice of m in this framework is an empirical matter and should be such that a white noise residual for v is obtained. This is because when the standard version of the RE-PIH is maintained, $v_t = Y_t^p - Y_{t-1}^p$ ought to be treated as an unpredictable random shock and the unrestricted estimates of (10)' will tell us whether there is a significant link between consumption and financial disturbances to portfolio adjustment. The unrestricted estimates of γ_{sj} and their t -ratios are given in the second and third rows of the table and show that the disturbances do affect the change in consumption significantly, with the significance being fairly evenly distributed across the four assets. The Durbin-Watson statistic for the residuals of the unrestricted equation is 2.058 which implies that ξ_s capture the serial correlation in ΔC ¹⁰.

⁸ An alternative would be to use the error correction approach in equation (14) above but replace $\varphi_s \hat{\xi}_{s,t}$ with $(\varphi_{s1} \hat{\xi}_{s1,t} + \dots + \varphi_{sn} \hat{\xi}_{sn,t})$ where n is the number of cointegrating vectors.

⁹ Hence the corresponding estimates are not reported here, but are available from the authors on request.

¹⁰ This was further supported by checking the Ljung-Box statistic for various lag lengths.

To test whether the effects of portfolio disturbances on consumption decisions comply with the RE-PIH path, we have constructed the χ^2 test statistics for the restrictions in equation (11) using various plausible values of $\rho=1/(1+r)$. The separate tests are given in the last three rows of the above table and the joint tests are shown in the last row. As these results indicate, the portfolio effects obey the restriction imposed by the RE-PIH, hence implying that consumption is likely to return to its permanent income path when these disturbances are eliminated.

Table 5. Testing the Impact of Portfolio Adjustment Disturbances on the Changes in Consumption

γ_{sj}	γ_{10}	γ_{11}	γ_{12}	γ_{13}	γ_{14}	γ_{20}	γ_{21}	γ_{22}	γ_{23}	γ_{24}	γ_{30}	γ_{31}	γ_{32}	γ_{33}	γ_{34}	γ_{40}	γ_{41}	γ_{42}	γ_{43}	γ_{44}
Estimate	95	126	-22	-26	37	54	111	-201	49	2	112	110	-48	-44	53	183	50	232	-69	67
t-ratio	1.83	2.36	0.37	0.53	0.70	0.88	1.55	2.33	0.66	0.05	2.17	1.93	0.79	0.62	1.13	1.80	0.57	2.24	0.77	0.79
$r=1\%; \rho=0.990$			1.310					0.383					0.539					2.286		
$r=3\%; \rho=0.971$			1.367					0.355					0.559					2.323		
$r=5\%; \rho=0.952$			1.428					0.323					0.582					2.358		

- Estimates of γ_{sj} reported in the second row are scaled down by 1000.
- The last three rows report, for three values of interest rate, the value of the $\chi^2_{(1)}$ for testing $\gamma_{s0}=\gamma_{s1}=\gamma_{s2}=\gamma_{s3}=\gamma_{s4}=0$ separately for each $s=1,2,3,4$.
- The joint test statistic for $\gamma_{sj}=0$ for all s and j is distributed as $\chi^2_{(4)}$ and its value is 6.215 for $r=1\%$, 6.408 for $r=3\%$ and 6.702 for $r=5\%$.
- The var-cov. matrix used to construct the t -ratios and the χ^2 statistics contain the White correction for heteroscedasticity.

5. Summary and Conclusions

In this paper we have re-examined the RE-PIH model of consumption using UK data. The main novelty in our work was to explain the well known serially correlated behaviour of the change in consumption using portfolio disturbances from a simple wealth allocation model. The motivation for this relationship has partly stemmed from the early work of Purvis (1978) who argued that the consumption function is closely linked to wealth allocation decisions. We have incorporated this idea into the RE-PIH model using a generalisation of the framework introduced by Galí (1991) in order to test whether the deviation between the actual and the PIH paths of consumption could be explained by short-run portfolio disturbances. The latter author has shown that when the change in consumption is decomposed into a series of permanent and transitory random shocks, the budget constraint can be used to derive a set of restrictions in order to test the consistency of the underlying decomposition.

We have estimated the short-run portfolio adjustment by nesting a traditional wealth allocation system within a dynamic error correction structure. The disturbances associated with this short-run portfolio adjustment were then used to approximate the shocks affecting consumption. Our results show that these disturbances explain the serial correlation in the change in consumption. Moreover, by imposing the consistency restrictions on the effects of these shocks we have found that the hypothesis that these effects comply with the RE-PIH path cannot be rejected. In conclusion, our results show that the UK data supports the controversial RE-PIH model. A useful topic for future research would be to apply our method to the modelling of consumption behaviour in other countries whose data have rejected the standard RE-PIH.

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