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Discussion Paper

No. 8901

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ABSTRACT

Empirical implementation of the buffer stock money (BSM) notion tends to concentrate either on the 'shock absorber' aspects or the 'spillover' ('disequilibrium money') aspects but rarely combines both. Moreover, a potential buffer role for non-money assets is usually precluded without explicit empirical testing. This paper examines the role of financial buffers in an ex ante sectoral model of expenditure and portfolio behaviour incorporating both the shock absorber and spillover aspects in terms of cross-equation parameter restrictions. These are tested for a range of different assets and liabilities using quarterly data for the UK personal sector.

I. Introduction

In its broadest terms, the notion that money acts as a financial buffer stock has wide ranging implications for analysis of the transmission mechanism of monetary policy (see Laidler 1984; Goodhart 1984). The existing literature on the buffer stock money (BSM) approach is, however, dominated by two main features: the 'shock absorber' role of money and the subsequent 'spillover' effects. It is argued that in a world of uncertainty and adjustment costs, agents will respond to unforeseen shocks by temporarily (and voluntarily) accumulating (or running down) money holdings in the short run. This shock absorbing role of money will be an important factor leading to discrepancies between agents' long-run demand for money and actual holdings. Over time such discrepancies will be removed through changes in expenditures and/or other asset holdings. These spillover effects are therefore viewed as an important aspect of the transmission mechanism of monetary changes.

Empirical implementation of BSM tends to concentrate <u>either</u> on the shock absorber aspects <u>or</u> the spillover aspects but very rarely combines both. More importantly, despite the existence of a priori arguments suggesting that other financial assets and liabilities could have a role as financial buffers and that the choice of financial buffer(s) may be different for different types of economic agents, money is invariably assumed to be the relevant financial buffer asset. Hence, a potential buffer role for other assets and liabilities is precluded without basing such a decision on explicit empirical testing.

The aim of this paper is to characterize financial buffer assets (or liabilities) in terms of testable parameter restrictions in a sectoral, integrated model of expenditure and portfolio behaviour.

This provides the opportunity for the data to determine whether, for any given sector, money and/or non-money assets have a role as financial buffers. This approach is in sharp contrast to the existing empirical literature which makes this decision on a priori grounds; there are no previous studies that empirically test which of a set of assets and liabilities in a portfolio (if any) act as buffers. In addition, the framework suggested provides a natural context for the discussion of both the shock absorber and spillover aspects of buffer assets hence providing some degree of unification of the two main strands of the existing literature.

In Section II we briefly examine the nature of financial buffers and explain why a general-equilibrium expenditure-portfolio approach at the sectoral level is a natural and useful framework for combining some of the important aspects of the buffer asset literature. In Section III we outline an integrated model of expenditure and portfolio behaviour which is a development of Ortmeyer and Peek's (1986) ex ante portfolio model; this incorporates an explicit role for ex ante capital gains and distinguishes between anticipated and unanticipated changes in the relevant constraint variable. Within this framework the characterization of buffer assets in terms of testable parameter restrictions is examined. In Section IV the model is estimated using data for the UK personal sector. The relevant restrictions are tested in order to identify the nature of any financial buffer(s) for this sector. Section V contains a summary and conclusions. Definitions of the variables used are given in an Appendix.

II. Financial Buffers in Sectoral Portfolios

The existence of buffer stock assets is usually argued to be a rational response by economic agents to an uncertain environment. Since the costs of adjusting holdings of relatively liquid assets are significantly less than the costs of adjusting output, employment, real assets (durables, stocks of goods, capital), illiquid financial assets, expenditures, etc. "economic agents may rationally and optimally decide to respond to the continuing stream of developments, 'news' and 'shocks' *not* by a thorough-going, continuous reconsideration of their full economic dispositions, but allowing such shocks to impinge initially upon certain assets/liabilities whose characteristics make them suitable to act as buffers" (Goodhart, 1984, p.255). As Laidler (1984) notes, adopting a buffer asset is a substitute for devoting scarce resources to gathering information. Therefore, increased (reduced) holdings of these buffer assets are voluntarily held in the short-run (and hence constitute part of short-run equilibrium demand for the buffer asset) to absorb the initial effects of unforeseen shocks. A micro-theoretical rationale for the BSM notion is usually cast in terms of developments of the Miller-Orr (1966) precautionary demand for money theory (e.g. Akerlof and Milbourne, 1980; Milbourne, Buckholtz and Wasan, 1983) incorporating upper and lower limits between which money holdings can drift and a 'return point' to which holdings are adjusted if one of the limits is breached. Milbourne (1987), however, argues that the size of the aggregate buffer holdings of money implied by such micro theory is likely to be extremely small.

The second important element of the BSM literature is consideration of the longer-run effects of the build-up or run-down of the buffer asset. Money may be voluntarily held in the short-run as a rational response to unforeseen shocks but this short-run demand (including both planned holdings and buffer holdings) will not, in general, equal longer-run target holdings. Hence, over time, buffer holdings will be 'unwound' or dissipated. The gap between actual money balances and long-run target holdings will systematically 'spill-over' into expenditure, asset allocation and possibly other household/firm decisions. The potential importance of such 'disequilibrium real balance effects', which have a pedigree going back to Archibald and Lipsey (1958) and Patinkin (1965), and revived by Jonson (1976a), has been stressed in the 'disequilibrium money' literature. The existence of slow real balance effects of this type is held to be consistent with the existence of long and variable lags of monetary policy changes.

The existing empirical implementations of BSM tend to be selective in their coverage of this scenario. The shock absorber literature, e.g. Carr and Darby (1981), MacKinnon and Milbourne (1984), Carr, Darby and Thornton (1985), Cuthbertson and Taylor (1986, 1987, 1988), Kanniainen and Tarkka (1986), Muscatelli (1988), concentrates on incorporating unanticipated shocks to the aggregate money supply in single-equation aggregate demand for money functions and, in general, ignores the potentially important subsequent spillover effects. The disequilibrium money models, e.g. Jonson (1976b), Jonson, Moses and Wymer (1976), Laidler and O'Shea (1980), Laidler and Bentley (1983), Davidson (1987), concentrate on the spillover effects of BSM through the inclusion of excess money holdings in various equations in a macro system. In some of these models the money stock is taken to be exogenous; in others it is determined as a residual in the flow of funds. Hence, overall, the existing shock absorber and disequilibrium-money empirical literature does not provide an appropriate framework for characterizing and empirically identifying *both* the shock absorber and spillover effects which are crucial to the BSM

Money has traditionally been highlighted as the 'obvious' buffer on a priori grounds because of its medium of exchange function but Bain and McGregor (1985) argue that it is instead the temporary store of value function which is the essence of the buffer role. Hence, whether money and/or other assets and liabilities fulfil the buffer role depends on their liquidity. Moreover, since the nature of any financial buffer is a matter of transactor choice, it is quite possible that different financial assets or liabilities may act as financial buffers for different types of agents. Currie and Kenally (1985), for example, stress that the structure of adjustment costs across different financial instruments is important in determining the choice of financial buffers and costs of gathering information and 'entry fee'/financial service charges are likely to be different for different types of agents. Kanniainen and Tarkka (1986) also argue that payments processes and information constraints faced by different agents are likely to be different.

Aggregate single-equation studies of the demand for narrow definitions of money are, therefore, inadequate for evaluating whether money acts as <u>the</u> crucial financial buffer. As Muscatelli (1988, pp.19-20) notes: "Once one admits that financial buffers operate in a multi-asset world, the joint modelling of asset demands and saving behaviour may be a more useful vehicle to capture the complex interactions between different parts of the financial sector and the real sector". In this respect, there are considerable advantages in adopting a sectoral portfolio approach of the type originally associated with Brainard and Tobin (1968). This allows a broader view of the accumulation of buffer assets and their interaction with non-buffer assets and expenditures.

The essence of the Brainard-Tobin approach is that the agents in the sector are assumed to adjust the endogenous items in their balance sheet or flow-of-funds account subject to the constraint that these sum to the exogenous balance sheet or flow-of-funds constraint variable. At the sectoral level, therefore, the focus of attention shifts naturally from anticipated and unanticipated changes in the aggregate money supply (the key variable in most existing empirical applications of the BSM approach) to anticipated and unanticipated changes in the variable which constrains the sector's (or representative agent's) relevant decision-making, e.g. total wealth in a portfolio allocation framework or income in an integrated portfolio-expenditure framework. Particularly given the emphasis on spillover effects of buffer stock disequilibrium on expenditure, an integrated model of expenditure and portfolio behaviour is the more appealing framework. Development of significant discrepancies of buffer holdings (or expenditure) from longer-run targets will signal the need for readjustment of expenditure and/or other asset holdings.

Discussion of financial buffers in a sectoral portfolio context is fairly rare. Some applications of integrated models of expenditure and portfolio behaviour (Backus and Purvis, 1980; Poloz, 1986) incorporate what are regarded as transitory income terms which could pick up, amongst other things, a buffer stock response for some assets in the portfolio, but little explicit attention is given to the interpretation of the estimated transitory income coefficients from this perspective. Currie and Kenally (1985) explicitly attempt to characterize the shock absorber role of a buffer asset in a wealth allocation framework although spillover effects are not considered. Their operational theoretical model considers a two-equation wealth allocation model including structural equations for the demand for net buffer stock and net non-buffer stock holdings. In empirical application to the UK personal sector only the net buffer stock equation is explicitly estimated; the buffer asset category is assumed on a priori grounds to be personal sector sterling deposits with the banking sector and building societies. No attempt is therefore made to estimate and test for any other possible categories of assets/liabilities acting as financial buffers.

We are aware of only one study (Kohli and McKibbin, 1982) that attempts to test whether money is a buffer stock and none where a wider range of options is considered. Kohli and McKibbin's parameter restrictions characterizing money as the only buffer asset involve the other asset/liability categories in the portfolio having *no* response to changes (anticipated *and* unanticipated) in total wealth and only own and money disequilibria affecting non-buffer demands. This formulation is rather counterintuitive; it rules out any spillover effects in the portfolio between non-buffer assets (regardless of how the asset disequilibria are generated) therefore constituting a severely constrained form of the multivariate adjustment model and effectively imposes a zero wealth elasticity on all assets other than money.

III. Buffer Assets in an Ex Ante Integrated Model

The basic framework is an integrated model of expenditure and portfolio behaviour of the type advocated by Purvis (1978) as a development of the widely used Brainard-Tobin (1968) 'Pitfalls' wealth-allocation model. This model allows for the joint determination of a sector's portfolio allocation and expenditure decisions subject to an income flow constraint. Following Ortmeyer and Peek (1986) (hereafter O-P) the integrated model is extended to distinguish between the effects of anticipated and unanticipated capital gains, and anticipated and unanticipated changes in the relevant constraint variable, in this case income.[1]

Consider, for example, the household sector which allocates its income between non-durable consumption expenditure (C) and the acquisition of n different assets and liabilities (A_i; i=1,...,n); liabilities are treated as negative assets. The relevant income flow constraint is of the form

$$Y + \sum_{i=1}^{n} G_i = C + \sum_{i=1}^{n} \Delta A_i \qquad (1)$$

where Y is income (excluding capital gains) and G_i is the capital gain (or loss) on the ith asset. Income and capital gains are decomposed into their anticipated and unanticipated components:

$$Y = Y^a + Y^u \qquad (2)$$

$$G_i = G_i^a + G_i^u \qquad i=1,\ldots,n \qquad (3)$$

where superscripts a and u denote anticipated and unanticipated components respectively.[2] Expectations are formed at the beginning of each period for the values of variables in that period.

Planned accumulation of the ith asset in each period is modelled along the lines of O-P's (1986, eq.(4)) modification of the standard multivariate stock-adjustment model:[3]

$$\Delta A_i^p = \sum_{k=1}^{n} \beta_{ik}\left[A_k^* - (A_k(-1) + G_k^a + \delta_k Y^a)\right] + \beta_{i0}\left[C^* - (C(-1) + \delta_0 Y^a)\right]$$

$$+ \delta_i Y^a + G_i^a + u_i \qquad i=1,\ldots,n \qquad (4)$$

where A_i^p are planned end-of-period holdings of asset i, A_k^* and $A_k(-1)$ are target holdings and actual beginning-of-period holdings of asset k respectively. C^* and C(-1) are target and previous-period non-durables expenditure respectively, and u_i is a stochastic disturbance term. This formulation allows for the planned holdings of asset i to be accumulated:

(i) as a result of expected capital gains on asset i,

(ii) through allocation of the flow of expected income to asset i,[4]

(iii) through reallocation of the portfolio depending on discrepancies of all assets and expenditures from their target values. Following O-P (1986, p.209) the relevant discrepancy for the kth asset is the gap between A_k^* and the agents' expected holdings of asset k at the end of the period, i.e. $[A_k(-1)+G_k^a+\delta_k Y^a]$.

With regard to (ii), (4) uses the version of the multivariate adjustment model in which the current period flows are allocated according to fixed coefficients. While allocation on the basis of variable coefficients is more appealing, as in Friedman's (1977) 'optimal marginal adjustment model', this incurs heavy costs in terms of loss of degrees of freedom, increased collinearity, and a requirement for more complicated estimation procedures (see, for example, O-P, 1986, p.210).

Actual, ex post, accumulation of the ith asset is given by

$$\Delta A_i = \Delta A_i^p + \Delta A_i^u \qquad i=1,\ldots,n \qquad (5)$$

where ΔA_i^u is the unanticipated change in the holdings of asset i over the period. Assuming that unexpected capital gains are held in the assets to which they accrue for at least the current period:

$$\Delta A_i^u = G_i^u + \phi_i Y^u \qquad i=1,\ldots,n \qquad (6)^5$$

Net transactions in asset i, S_i, are defined by

$$S_i \equiv \Delta A_i - G_i \qquad i=1,\ldots,n \qquad (7)$$

Hence, from (4)-(7)

$$S_i = \sum_{k=1}^{n} \beta_{ik}\left[A_k^* - (A_k(-1)+G_k^a)\right] + \beta_{i0}\left[C^* - C(-1)\right]$$

$$+ \left[\sum_{k=0}^{n} \beta_{ik}\delta_k + \delta_i\right] Y^a + \phi_i Y^u + u_i \qquad i=1,\ldots,n \qquad (8)$$

Target asset holdings are specified as

$$A_k^* = \alpha_k + \sum_{j=1}^{m} \alpha_{kj} X_j + \alpha_{ky} Y^a \qquad k=1,\ldots,n \qquad (9)$$

$$C^* = \alpha_0 + \sum_{j=1}^{m} \alpha_{0j} X_j + \alpha_{0y} Y^a \qquad (10)$$

where the X_j's include rates of return and other relevant variables. Substituting (9) and (10) in (8) gives

$$S_i = \gamma_{i0} + \sum_{j=1}^{m} \gamma_{ij} X_j + \theta_i Y^a + \phi_i Y^u - \sum_{k=1}^{n} \beta_{ik}\left[A_k(-1)+G_k^a\right]$$

$$- \beta_{i0} C(-1) + u_i \qquad i=1,\ldots,n \qquad (11)$$

where $\gamma_{i0} = \sum_{k=0}^{n} \beta_{ik}\alpha_k$, $\gamma_{ij} = \sum_{k=0}^{n} \beta_{ik}\alpha_{kj}$ and $\theta_i = \sum_{k=0}^{n} \beta_{ik}(\alpha_{ky} - \partial_k) + \partial_i$.

Similarly, an equation for ex post non-durables expenditure can be obtained which is consistent with the n asset equations in (11) and the income constraint in (1):

$$C = \gamma_{00} + \sum_{j=1}^{m} \gamma_{0j}X_j + \theta_0 Y^a + \phi_0 Y^u - \sum_{k=1}^{n} \beta_{0k}\left[A_k(-1)+G_k^a\right]$$

$$- \beta_{00}C(-1) + u_0 \qquad (12)$$

where u_0 is a stochastic disturbance term. From (1), (2) and (7):

$$\sum_{i=1}^{n} S_i + C = Y^a + Y^u \qquad (13)$$

Therefore, the system of equations in (11) and (12) is subject to the following adding-up restrictions:

$$\sum_{i=0}^{n} \theta_i = \sum_{i=0}^{n} \phi_i = 1$$

$$\sum_{i=0}^{n} \gamma_{ij} = \sum_{i=0}^{n} \beta_{ik} = 0 \quad j=0,1,\ldots,m; \; k=0,1,\ldots,n \qquad (14)$$

$$\sum_{i=0}^{n} u_i = 0$$

Note that by comparison with O-P's model there is no necessity to drop one of the lagged asset stocks to avoid a perfect linear relationship between the set of explanatory variables in the estimating equation.[6]

In terms of this framework, assets (or liabilities) acting as financial buffers would have two main characteristics, corresponding to the two main areas of emphasis in the current buffer-stock-money literature:

(i) A buffer asset would bear a significant proportion of short-run adjustment in absorbing unexpected shocks to the constraint variable, i.e. would act as a shock absorber.

(ii) Build-up (or run-down) of the buffer asset would lead to discrepancies between target and actual holdings of the buffer asset which would have implications for expenditures and/or the accumulation of other assets and liabilities, i.e. there would be 'spillover' effects in the expenditure-portfolio system.

As noted in Section II, since the portfolio-expenditure system in (11) and (12) is an allocation model, unanticipated variations in the constraint variable, income, activate the shock- absorber role of the buffer asset; unanticipated increases (decreases) in income would lead to accumulation (running-down) of the buffer asset, given the costs involved in adjusting buffer assets relative to non-buffer assets in the short run. Hence, assets (or liabilities) performing the shock absorber role would be characterized by relatively large coefficients on unanticipated income compared to the corresponding coefficients for non-buffer assets, liabilities and expenditures. In most of the current literature money is treated as <u>the</u> buffer asset. In this extreme case where a single asset (say asset i) acts as the <u>sole</u> shock absorber in the portfolio

$$\phi_i = 1 \quad \text{and} \quad \phi_j = 0 \quad \forall\ j \neq i \tag{15}$$

Less restrictively, different assets or liabilities may share the shock absorber role; in this case their relative importance as buffer assets would show up as a set of cross-equation inequality restrictions. For asset i to act as the 'primary' (but not necessarily sole) shock absorber requires[7,8,9]

$$\phi_i > 0 \quad \text{and} \quad \phi_i > \phi_j \quad \forall\ j \neq i \tag{16}$$

In this case assets other than i can also serve as supplementary shock absorbers; e.g. if asset j is the 'secondary' shock absorber

$$0 < \phi_j < \phi_i \quad \text{and} \quad \phi_j > \phi_k \quad \forall\ k \neq i, j \tag{17}$$

Indeed, there may well be a hierarchy of buffer assets reacting to differing degrees to unexpected shocks in the constraint variable, with, for example, $\phi_i > \phi_j > \phi_k > \ldots \phi_r > 0$ with other non-buffer assets, liabilities and expenditures not reacting to such shocks (e.g. $\phi_s = 0 \ \forall \ s \neq i,j,k,\ldots,r$). In this paper we concentrate on testing (15) and (16) to see if emphasis on money as *the* buffer asset is supported by the data at the sectoral level.[10]

The other key feature of a buffer asset, the subsequent spillover effects, can be characterized by significant effects of the discrepancy between actual and target holdings of the buffer asset on expenditure and the accumulation of other assets and liabilities in the portfolio. Hence, if asset i acts as a buffer which generates significant spillover effects then $\beta_{ji} \neq 0$ for some $j \neq i$. Discrepancies between target and actual holdings for buffer assets are likely to be more volatile than for non-buffer assets; hence such significant cross-equation adjustment effects should be easier to pick up empirically for buffer assets than for non-buffer assets. However, such discrepancies can occur for reasons other than through the buffer role of an asset, e.g. due to variations in the determinants of the target asset demands and expenditures, and, as Laidler (1984, p.20) notes "... there is no reason to believe that the way in which [the agent] responds to such a discrepancy depends in any way upon what generates it". Significant cross-equation adjustment coefficients can occur as a result of interrelated adjustment (as in Brainard and Tobin's (1968) original multivariate adjustment model) independently of whether any of the assets act as a financial buffer.[11] Hence, while significance of the discrepancy between target and actual holdings of asset i in other asset and expenditure equations is clearly a necessary condition for asset i to be a buffer asset (which generates a significant spillover effect) it is far from being a sufficient condition. It would be incorrect to label asset i as a buffer asset if, for example, $\phi_i = 0$ but $\beta_{ji} \neq 0$ for some j. Similarly, it would be misleading to describe asset i as *the* buffer asset if $\beta_{ji} \neq 0$ for some j, but $\phi_j > \phi_i$ for one or more $j \neq i$. However, by concentrating on spillover effects the 'disequilibrium monetary models' approach runs this risk since the justification for (15) or (16) for money as asset i is based on a priori rather than empirical considerations.

IV. Estimation and Results

The model in Section III was estimated using quarterly data for the UK personal sector. The basic data set is that used in Owen (1986b).[12] The dependent variables in the system consist of real expenditure on non-durable goods (CND), real expenditure on durables (CD) and real net acquisitions of seven asset or liability categories: money (M), other liquid assets (LA), other financial assets (OFA), life assurance and pension fund holdings (LAPF), dwellings (DWEL), short-term loans (SL) and loans for house purchase (LHP).[13] A summary of relevant definitions is given in the Appendix; a more detailed discussion is available in Owen (1986b, Ch.6).

Estimation of the model in (11) and (12) requires measures of expected capital gains for the various assets, and anticipated and unanticipated values of the income constraint variable. *Nominal* capital gains or losses accrue to four of the asset categories: OFA, LAPF, DWEL and durable goods (DUR). For the 'capital-certain' asset and liability categories (M, LA, SL, LHP) nominal capital gains (both actual and anticipated) equal zero and therefore, $A\$_i - A\$(-1)_i = S\$_i$ for i = M, LA, SL, LHP, where A$ and A$(-1) are nominal end-of-period and beginning-of-period asset holdings and S$ represents nominal transactions during the period. For all assets and liabilities net actual real capital gains were calculated as

$$CG_i = \frac{A\$_i}{P} - \frac{A\$_i(-1)}{P(-1)} - \frac{S\$_i}{\overline{P}} \qquad \text{for asset } i$$

where P, P(-1) and $\overline{P}$ are end-of-period, beginning-of-period and period-average values of the general price level. Following O-P the real capital gains series were converted to real rates of return as $[CG_i/A_i(-1)]100$, where $A_i(-1)$ $(=A\$_i(-1)/P(-1))$ is the beginning-of-period real stock of asset i. Since the rate of real capital loss on the capital-certain assets equals the inflation rate a single rate of real capital loss series was calculated for the sum of the capital-certain assets and liabilities. Expected real capital gains (expressed as rates of return) were calculated as the predictions from a set of auxiliary equations in which real capital gains returns were regressed on a set of variables whose values were known at the beginning of each period.[14] Each of the five real capital gains series and income was regressed on four own lagged values and four lagged values of each of the following variables: changes in short rates (ΔSR), long rates (ΔLR), the real money supply (ΔM3), real output (ΔGDP), share prices (ΔFT) and the marginal personal income tax rate (ΔMTR), the level of inflation ($\dot{p}$) and a set of three quarterly dummy variables. Most of the explanatory variables appear in first-difference form following O-P's argument that if an asset's price depends on the level of a variable, say X, then capital gains on the asset depend on ΔX (O-P, 1986, appendix p.5).

Since there is considerable scope for the use of different search procedures for imposing simplifications on this general formulation we followed Mishkin's (1983, p.22) approach of deleting the full set of four lagged values of each of these variables in turn and testing the implied joint exclusion restrictions relative to the most general model using an F-type test (with a 10% significance level). For variables where the F test result marginally failed to reject the null, inclusion of that block of four lags was further considered in the short list of simplified forms. Four own lagged values and the set of seasonal dummies were retained in each auxiliary equation. In addition, the full set of restrictions obtained by this procedure was tested against the most general model using an F-type test (REST in Table 1).[15] The form of the chosen auxiliary equations and some relevant diagnostics are also given in Table 1.

If the fitted values generated by these auxiliary equations are to be interpretable as (weakly) rational expectations they should not omit any relevant explanatory variables from the information set and the residuals should not contain any systematic patterns. The higher the R^2 the less likely there are to be doubts about excluded variables. However, there is little a priori guidance on what could be regarded as an 'acceptable' value; this depends, for example, on the volatility of the variable being forecast and the degree of autocorrelation in the series itself. For Y and the quarter to quarter rates of return from capital gains on OFA, DWEL, DUR and the capital-certain assets (RCGO, RCGD, RCGDUR, and RCGC respectively), the R^2's appear reasonable.[16] The poor fit for the corresponding return for LAPF, RCGL, is largely due to increased volatility in the dependent variable in the latter part of the sample period. The chosen regressors give a fitted equation with an R^2 of .900 for (approximately) the first half of the period and .541 for the second half; however an analysis-of-covariance F-type test for structural stability (labelled STAB) with the sample period split at 1974(4) does not reject (at the 5% significance level) the hypothesis of coefficient stability for the RCGL equation or for any of the other auxiliary prediction equations.

Two tests for autocorrelated disturbance terms were calculated: an asymptotically valid modified Lagrange multiplier (LM) test calculated as a t test (Dt) for the significance of one-period lagged residuals in Durbin's (1970) alternative method for testing for first-order autocorrelation and the F form of an LM test for up to fourth-order autocorrelation (Harvey, 1981, p.173; Kiviet, 1986). The hypothesis of lack of serial correlation is acceptable at the 5% significance level for each equation for both tests.[17]

The G_k^a components of the augmented asset stock terms in (11) and (12) were obtained by multiplying the expected real capital gains returns by the beginning-of-period real asset stocks. The anticipations-augmented asset stocks, $[A_k(-1)+G_k^a]$, are denoted by ASM, ASLA etc. Anticipated and unanticipated income were obtained as the fitted values and residuals, respectively, from the fitted equation for Y. The X_j variables include rate of return variables; for these we separately included one-period-lagged nominal, net of tax, rate of return variables (denoted by the prefix R) and expected current-period rates of capital gain . The former correspond to O-P's ex post 'strawman returns' and are weighted average or representative net returns.[18,19] Expected inflation is automatically included as the expected capital loss on capital-certain assets. Following Owen (1986b) other X variables include a measure of accumulated changes in

Table 1

Summary of specifications of auxiliary forecasting equations*

	Dependent Variables					
	RCGC	RCGO	RCGD	RCGL	RCGDUR	Y
Regressors						
4 lags of:+	RCGC	RCGI	RCGD	RCGL	RCGDUR	Y
	ΔSR	ΔLR	ΔSR	ΔFT	ΔSR	ΔM3
	ΔGDP	ΔM3	ΔM3	ΔGDP	ΔLR	ΔLR
	ΔLR	ΔFT	ΔFT	ΔLR	$\dot{p}$	
R^2	.913	.643	.881	.334	.719	.944
REST	1.366 (16,19)	.644 (16,19)	1.492 (16,19)	.984 (16,19)	.809 (16,19)	.947 (20,19)
STAB	1.728 (20,15)	1.287 (20,15)	.764 (20,15)	.853 (20,15)	1.513 (20,15)	.526 (16,23)
Dt	.448	.381	.471	.809	-1.762	-.763
LMF4	1.608 (4,27)	.998 (4,27)	.705 (4,27)	.896 (4,27)	.979 (4,27)	.672 (4,31)

*R^2 is the coefficient of determination, REST is an F-type test statistic for the chosen restricted model relative to the general model, STAB is an F-type test for structural stability, Dt is a t-type statistic for first-order autocorrelation and LMF4 is an LM test (F form) for up to fourth-order autocorrelation. Where appropriate, relevant degrees of freedom are given in brackets.

+Seasonal dummy variables and a constant term are also included in each equation.

the unemployment rate (CUDU) and a variability of inflation measure (VARI) to capture some aspects of uncertainty which could affect the desirability of liquid versus less liquid assets. Seasonal dummy variables were also included.

The disturbance terms in the system of equations in (11) and (12) are assumed to have zero means, constant variance and to be intertemporally uncorrelated, both within and across equations. Since $\sum_{i=0}^{n} u_i = 0$, the variance-covariance matrix of every set of contemporaneous disturbance terms is singular. In such situations, systems estimation methods are usually applied to a truncated system with one of the equations deleted, the estimated parameters in the deleted equation being obtained from the estimated parameters in the truncated system and the adding-up restrictions. In this case, however, since each equation contains the same set of explanatory variables, maximum likelihood (ML) estimation or seemingly unrelated regression equations (SURE) estimation of the system of equations and unrestricted equation-by-equation ordinary least squares (OLS) estimation yield equivalent parameter estimates which are consistent provided income is exogenous (Barten, 1969). Parameter estimates automatically satisfy the adding-up restrictions in (14) since the regressors are the same in each equation and, from (13), a linear combination of the regressors equals the sum of the regressands (Denton, 1978).

Table 2 contains estimates of the coefficients that are directly relevant to the characterization of buffer assets; to save space estimated coefficients on the constant term, expected rates of capital gains, nominal interest rates and the other variables noted above are not reported. Given the large number of estimated parameters and the unrestricted nature of the model, multicollinearity leads to imprecision in the parameter estimates. In addition, the estimated parameters are short-run coefficients which can differ in sign from the coefficients in the target relationships. However, we are not here generally concerned with the size and significance of individual short-run coefficients but with tests of hypotheses involving sets of coefficients which are likely to be less affected by this imprecision.

The point estimates of the coefficients on Y^a and Y^u seem sensible on a priori grounds. They imply that (approximately) 33% of unanticipated income flows into money holdings, 28% into (reducing) short-term loans, and 27% into less liquid financial assets. The relatively large coefficient for TOFA compared to TLA is a surprising result. However, the point estimates suggest that while money may act as the 'primary' buffer it does not appear to be the sole buffer but one element in a hierarchy of assets that react to shocks in the constraint variable; this is investigated in more detail below.[20]

Economic theory does not give unambiguous results for the signs of the own and cross-equation adjustment coefficients (see Owen (1986b, p.27) for a summary of some of the arguments) although, on balance, we would expect own-lagged stock effects to be predominantly negative and cross-equation lagged stock effects to be predominantly positive. Four of the eight own-lagged stock coefficients are negatively signed. 30 of the 56 cross-equation lagged stock coefficients are positive. Overall, 91 of the 243 coefficients in the full model are significant at the 10% level (74 at the 5% level). However, as discussed further below, these estimated standard errors should not be taken literally.

Table 2

Selected estimates for the unrestricted model[+]

	CND	CD	TM	TLA	TOFA	TLAPF	TDWE	TSL	TLHP
Y^a	.082 (.78)	.134 (1.92)	.140 (.82)	.087 (.76)	.083 (.53)	.042 (.68)	-.008 (.29)	.466 (2.89)	-.027 (.46)
Y^u	.000 (.00)	.067 (1.82)	.332 (3.66)	.006 (.10)	.267 (3.21)	.014 (.44)	.007 (.52)	.282 (3.30)	.024 (.77)
ASDUR	.152 (2.13)	.146 (3.06)	-.032 (.28)	-.141 (1.83)	.069 (.65)	.046 (1.08)	.041 (2.33)	-.319 (2.91)	.039 (.98)
ASM	.031 (.38)	-.052 (.96)	.020 (.15)	.166 (1.88)	.353 (2.89)	-.014 (.28)	.048 (2.39)	-.519 (4.14)	-.033 (.73)
ASLA	-.036 (.41)	-.097 (1.69)	.418 (2.98)	-.358 (3.85)	.398 (3.08)	-.079 (1.55)	.027 (1.30)	-.419 (3.17)	.146 (3.07)
ASOFA	.002 (.16)	.027 (4.07)	-.019 (1.17)	-.010 (.94)	-.034 (2.29)	.006 (.95)	-.001 (.36)	.041 (2.65)	-.010 (1.92)
ASLAPF	.005 (.22)	.002 (.17)	-.011 (.33)	.074 (3.31)	-.086 (2.77)	.006 (.46)	-.012 (2.37)	.043 (1.35)	-.021 (1.78)
ASDWEL	-.010 (.87)	.013 (1.67)	.017 (.92)	-.034 (2.77)	-.056 (3.22)	.001 (.17)	-.001 (.35)	.067 (3.81)	.002 (.38)
ASSL	.013 (.21)	.031 (.72)	.288 (2.73)	-.051 (.72)	.125 (1.29)	-.002 (.04)	.045 (2.84)	-.494 (4.96)	.043 (1.21)
ASLHP	-.253 (3.62)	-.138 (2.98)	.271 (2.39)	-.211 (2.81)	.074 (.71)	-.082 (1.99)	-.004 (.26)	.255 (2.38)	.090 (2.33)
R^2	.991	.898	.825	.894	.717	.944	.864	.799	.927
$\bar{R}^2$	.983	.804	.662	.796	.454	.891	.738	.613	.859
LMF1 (1,27)	.142 (16)	4.652 (267)	.929 (60)	8.655 (394)	5.287 (256)	3.867 (207)	4.814 (256)	.045 (11)	.385 (24)
LMF4 (4,24)	3.495 (163)	1.810 (38)	.329 (1)	6.342 (361)	3.275 (158)	5.799 (328)	3.920 (203)	1.216 (12)	1.533 (24)
CHOW (10,18)	2.368	4.253	2.001	.985	1.944	1.707	2.725	2.055	1.876
IND	.385	1.256	1.188	1.384	1.754	0.420	1.091	4.206	.583

[+]Sample period: 1968(2)-1981(4). Asymptotic t values are given in brackets.

The model whose estimates are summarized in Table 1 was used as the maintained model for the tests of buffer stock restrictions. The results of standard misspecification tests are, therefore, reported as a rough guide to the validity of this underlying model, although the small-sample properties of these tests when applied to heavily parameterized equations are uncertain. Given the desire to maintain a uniform, integrated-systems framework no attempt was made to modify the individual equations separately, although there is clearly scope for improving the dynamic specification of some of the equations.

The F form of the LM test for first-order and up to fourth-order autocorrelation (LMF1 and LMF4 respectively) were calculated. At face value the results suggest that there is significant autocorrelation in the disturbance terms in the equation for CND, CD, TLA, TOFA, TLAPF and TDWE at the 5% significance level although the underlying auxiliary equations did not suggest an obvious common form for autoregressive estimation of the system of equations as a whole. Testing the same null hypotheses with an Edgeworth-corrected LM test (Kiviet, 1986, eq.(4)) gave similar results. However, while these forms of the LM test are recommended by Kiviet (1986) on the basis of Monte Carlo evidence for an AD(1,1) model, their exact distributions under the null are unknown and there is little evidence on their small-sample properties in heavily parameterized models. To shed more light on this issue a bootstrap resampling procedure (e.g. Efron, 1982) was applied to the LMF values for each of the 8 equations with the mean of the 8 LMF values providing a systems test for autocorrelation (Theil and Shonkwiler, 1986). Equal probability was assigned to each of the T=55 data-based contemporaneous residual vectors, $(e_{1t} \dots e_{8t})$. For each replication T values were sampled with replacement from this distribution. The selected residual vectors were treated as vectors of disturbance terms and combined with the data-based coefficient estimates and data-based design matrix to generate the implied simulated values of the dependent variables and hence the values of the LMF test statistics for both AR(1) and AR(4) processes. 499 replications were obtained. Table 2 shows (in brackets below the reported LMF values) the rank of the data-based value among the 500 values (1=smallest; 500=largest). If the rank is greater than 475 absence of autocorrelation would be rejected at the 5% significance level. The rankings suggest that autocorrelation is not a problem for any of the individual equations nor for the system as a whole.[21] Note, however, that although this procedure ensures that the size of the test is known, further investigation is required of its power properties for these particular tests in heavily parameterized models.

An F-type Chow post-sample prediction test was calculated for the last ten observations in the sample. This test gave significant values for CD and TDWE at the 5% level.

The two-step estimation of the model (using residuals and fitted values obtained from auxiliary (first-step) regressions as proxies for unanticipated and anticipated variables in the main (second-step) regressions) is convenient given the computational difficulties likely to arise with joint estimation. This two-step ('generated regressors') procedure gives consistent parameter estimates. However, in general, estimated standard errors from the second-step regressions are inconsistent and (downward) biased estimates of the true standard errors (Pagan, 1984), although to some extent this may be offset (to differing degrees for different coefficients) by the likely effect of multicollinearity in increasing estimated standard errors. As Hoffman

(1987) notes, the adjustments required to give accurate inferences are non-trivial. Hoffman proposes an indicator of generated regressor bias to evaluate situations where correcting the estimated standard errors is likely to have an appreciable effect on inference. The indicator for the rth equation in the system is calculated as

$$\mathrm{Ind}_r = \sum_{j=1}^{J} \gamma_{rj}^2 \sigma_{\eta j}^2 / \sigma_{\varepsilon r}^2 + \sum_{l=1}^{L} \delta_{rl}^2 \sigma_{rl}^2 / \sigma_{\varepsilon r}^2 \qquad (15)$$

where $\gamma_{rj}(j=1,\ldots,J)$ and $\delta_{rl}(l=1,\ldots,L)$ are the coefficients on the J unanticipated and L anticipated variables in the second-step regressions, $\sigma_{\eta j}^2$ and $\sigma_{\nu l}^2$ are the variances of the disturbance terms in the auxiliary equations generating the corresponding unanticipated and anticipated variables respectively, and $\sigma_{\varepsilon r}^2$ is the variance of the disturbance terms in the rth second-step equation. Hoffman notes that this indicator, under reasonable assumptions, is monotonically related to generated regressor bias in the rth equation and is scale invariant. Ind_r, reported in Table 2, was computed for each of the equations in the system using OLS estimates for the parameters in (15) and the amended formula in Hoffman's (1987, p.341, fn.9) to allow for the fact that unanticipated and anticipated income values are generated by the same auxiliary equation.[23] The values for the calculated indicator vary considerably across the different equations but suggest that overestimation of the t values is likely to be particularly marked for the estimated coefficients in the equation for TSL. This is unfortunate since on the basis of the point estimates short-term loans are indicated as potential shock absorbers. The key parameters of interest in evaluating the shock absorber role for different assets are the coefficients on Y^u. For these coefficients Hoffman's analysis suggests that, for models with no lags, "the effect of a given indicator change has considerably less impact on bias of the shock variance estimates" (Hoffman, 1987, p.343).

Given the biased nature of the estimated standard errors and the computational difficulties of obtaining a corrected variance-covariance matrix of the estimated coefficients we concentrated instead on applying asymptotically valid tests of the hypotheses of interest based on a consistent estimate of Σ, the contemporaneous variance-covariance matrix of disturbance terms in the system. As Hoffman (1987, p.339) demonstrates, residuals from OLS estimation of the second-step equations can be used to form a consistent estimate, $\hat{\Sigma}$, of Σ (provided the estimates of the parameters in the auxiliary equations are consistent). The validity of the imposed restrictions was tested using an analogue of the likelihood ratio test suggested by Gallant and Jorgenson (1979). This 'quasi likelihood ratio' (QLR) test is calculated as QLR = $S_0 - S_1$, where S_0 and S_1 are the minimized values of the objective function, $S(\theta)=[f(\theta)]'[\hat{\Sigma}^{-1}\otimes Z(Z'Z)^{-1}Z']f(\theta)$, under the null ($H_0$) and alternative ($H_1$) hypotheses respectively; $f(\theta)$ is the stacked vector of residuals from the model and Z is the matrix of observations on the instruments which, for SUR, are the full set of common (assumed) exogenous variables in each equation. QLR has an asymptotic χ^2 distribution with (r-s) degrees of freedom given H_0, where r and s are the numbers of unknown parameters in the models corresponding to H_1 and H_0 respectively. In deriving S_0 and S_1, $\hat{\Sigma}$ must be held constant across H_0 and H_1. Hence $\hat{\Sigma}$ obtained from the unrestricted model's estimates was used as a constant weighting matrix for estimation of all the restricted models.

We also calculated the conventional likelihood ratio test, LR = $2\log L(\tilde{\theta}) - 2\log L(\tilde{\theta}_0)$, where $L(\tilde{\theta})$ and $L(\tilde{\theta}_0)$ are the maximized likelihood function values for the unrestricted and restricted models respectively. Given H_0, LR has an asymptotic χ^2 distribution with m degrees of freedom (equal to the number of restrictions).

It is well known that the use of asymptotic tests on heavily parameterized models estimated using relatively modest sample sizes tends to lead to over-rejection of null hypotheses (e.g. Deaton, 1974; Laitinen, 1978; Bera, Byron and Jarque, 1981) and small-sample adjustments to the test statistics and/or critical values have been suggested (e.g. Anderson, 1958; Rothenberg, 1984; Byron and Rosalsky, 1985). Note, however, that the adjustments in the literature were proposed in relation to the conventional LR test rather than QLR so there is little available evidence on small-sample adjustments for QLR. As a rough guide to the likely robustness of the results we applied Anderson's (1958, pp.207-10) suggested adjustment factor.[24]

The sole shock absorber restrictions in (15) were tested for each asset (and expenditure) in turn. The results for the unadjusted and adjusted LR and QLR test statistics are given in Table 3 as LR_1, LR_1^*, QLR_1, and QLR_1^* respectively. The results suggest rejection of the hypotheses that any single asset (or expenditure) acts as <u>the</u> sole shock absorber using either the unadjusted or adjusted test statistics. Money, other financial assets, and short-term loans have the lowest test statistic values with non-money liquid assets ranked a distant fourth. In line with prior expectations, the hypotheses that LAPF, DWEL, LHP and DUR act as sole buffers is resoundingly rejected. A similar result applies to non-durables expenditure.

Table 3

Tests of 'shock absorber' restrictions+

Asset	LR_1	LR_1^*	QLR_1	QLR_1^*	P
M	60.68	26.48	56.41	24.61	.528 (.005)
LA	109.66	47.85	177.72	77.55	0
OFA	61.02	26.63	56.89	24.82	.206 (.004)
LAPF	176.14	76.86	660.86	288.37	0
DWEL	269.18	117.46	3712.92	1620.18	0
SL	68.58	29.93	69.58	30.36	.267 (.004)
LHP	122.60	53.50	1075.55	469.33	0
DUR	163.90	71.52	523.54	228.46	0
CND	202.08	88.18	232.33	101.38	0

+LR_1 and QLR_1 are, respectively, likelihood ratio and quasi-likelihood ratio test statistics for the sole shock absorber hypothesis. LR_1^* and QLR_1^* are adjusted statistics using Anderson's (1958) adjustment factor. The critical values of χ_8^2 are 15.51 (5%) and 20.09 (1%). P is the proportion of replications satisfying the primary shock absorber hypothesis; asymptotic standard errors are given in brackets.

The primary shock absorber restrictions in (16) were also examined for each asset (and expenditure) in turn using the Bayesian approach suggested by Geweke (1986) as implemented in SHAZAM version 6.1 (White, 1988). The estimated parameter values and covariance matrix for the unrestricted model corresponding to the results in Table 2 were used together with the assumption of normality to generate 5,000 replications (plus the antithetic replications, giving 10,000 replications in total) by the Monte Carlo method. Following Chalfant and White (1987) the proportion of replications satisfying the inequality restrictions is interpreted as the probability that these restrictions hold. Money is the asset with the largest such probability (.528) followed by SL and OFA. The corresponding probability for all the other assets and non-durable expenditure is zero; none of the 10,000 replications satisfied the relevant restrictions. Note that while these results are compatible with the story from the point estimates they use the biased standard errors and so are, at best, illustrative.

The test statistics for the absence of any spillover effects (e.g. $\beta_{ij} = 0$ for all $j \neq i$ which, given the adding-up restriction in (14), also implies $\beta_{ii} = 0$) are given in Table 4. As well as the unadjusted and adjusted values for the LR and QLR tests, WLR, the "exact" test (based on Wilks's likelihood ratio criterion) suggested by Bewley (1986, pp. 129-130) for uniform mixed linear constraints (UMLCs) is also reported. $WLR = (1-\Lambda_w)d_2/\Lambda_w d_1$, where $\Lambda_w = \exp[-LR/T]$ and d_1 and d_2 are degrees of freedom.[25] Since the regressors are stochastic in this case, WLR does not have an exact F distribution under the null; however, on the basis of his Monte Carlo evidence, Bewley recommends using WLR for UMLCs even in dynamic models, although it is biased towards rejection of the null hypothesis.

For the unadjusted test statistics, the null of no spillovers is rejected for all assets using LR or QLR but is acceptable (at the 5% level) for M, DUR, LAPF, and DWEL using WLR. For the adjusted test statistics the null is rejected (at the 1% level) only for LA and SL using LR_2^* (plus OFA and LHP at the 5% level) and for LA (at the 1%

Table 4

Tests of absence of spillover restrictions+

Asset	LR_2	LR_2^*	QLR_2	QLR_2^*	WLR
M	33.94	14.81	23.88	10.42	2.24
LA	65.02	28.37	63.30	27.62	5.94
OFA	39.04	17.04	29.00	12.66	2.71
LAPF	33.22	14.50	23.20	10.12	2.18
DWEL	33.24	14.50	23.22	10.13	2.18
SL	49.58	21.63	40.98	17.88	3.84
LHP	39.74	17.34	29.73	12.97	2.78
DUR	29.98	13.08	20.24	8.83	1.90

+ LR_2 and QLR_2 are, respectively, likelihood ratio and quasi-likelihood ratio test statistics for the absence of spillover restrictions. LR_2^* and QLR_2^* are adjusted statistics using Anderson's (1958) adjustment factor. WLR is an F-type test based on Wilks's likelihood ratio criterion. For the LR and QLR tests the critical values of χ^2 are 15.51 (5%) and 20.09 (1%). For WLR the 5% critical value of $F(8,21)$ is 2.42.

level) and SL (at the 5% level) using QLR_2^*. The most surprising result here is the apparently weak evidence in support of significant spillovers from money. The clearest evidence for significant spillover effects is for LA which does not appear to have a significant shock absorber role in the portfolio. Of the other two potential buffers suggested by the results in Table 3, SL and OFA, the former receives more support as a potential buffer asset in terms of the spillover tests.

V. Conclusions

This paper examines the role of financial buffer assets in the context of an ex ante integrated model of expenditure and portfolio behaviour and characterizes the shock absorber and spillover aspects of such assets in terms of parameter restrictions. The model is estimated for the UK personal sector. On the basis of the results obtained there is little evidence to support the view that money acted as the sole financial buffer for this sector over the period examined. While money has the largest coefficient on unanticipated income it does not satisfy the restrictions for a sole shock absorber in the system and, more surprisingly, there is little support for the existence of significant spillover effects on the rest of the sector's portfolio and expenditure behaviour. Also, none of the other assets or expenditure is acceptable as a sole shock absorber; the bulk of the shock absorber role appears to be shared across three asset and liability categories. Considering point estimates and the overall results for both sets of tests, short-term loans appear to have as much claim to be an important financial buffer as does money.

Footnotes

1. For a detailed discussion of the Brainard-Tobin model and the motivation, development and application of integrated models see Owen (1986b).
2. Currie and Kenally (1985) also stress the need to distinguish between changes in wealth arising from net acquisition of assets on the one hand and revaluation of existing asset stocks on the other. They also choose to distinguish between the anticipated permanent, anticipated transitory, and unanticipated components of both net acquisitions and revaluations.
3. The conventional multivariate stock-adjustment equation can be generalized to incorporate deviations of target non-durable expenditure from last-period expenditure, as discussed in Owen (1986b, p.48, fn. 7). If this is justified predominantly on grounds of habit persistence then δ_0 in (4) may be zero.
4. By comparison, O-P's equation (4), specified in a wealth allocation model where planned changes in wealth are assumed to be predetermined, has planned saving as the relevant flow variable to be allocated, i.e. planned wealth allocations are separable from the planned consumption-savings decision. However, <u>all</u> changes in <u>unanticipated income</u> are assumed to lead (initially, at least) to changes in actual wealth not consumption.
5. Essentially, this implies that we are assuming that each asset acts as a buffer for current-period shocks to the own-capital-gain component of total income.
6. A "rational desires" assumption ($\Sigma A_k^* = W^e$, where W^e is

expected end-of-current-period wealth) implies over- description of portfolio disequilibrium (Smith, 1975; O-P, 1986, p.205) since $\Delta W^e = \sum_k [A_k^* - A_k(-1)]$ and requires deletion of the term in ΔW^e or one of the asset discrepancies in the asset demand equations. Even without this assumption, however, O-P need to drop one of the lagged stock terms to avoid perfect multicollinearity because their estimating equations contain W^e, the augmented stocks $(A_k(-1) + G_k^a)$ and S^p, planned savings, and, provided W^e, G^a and S^p are measured in a consistent manner, $W^e = \sum_k (A_k(-1) + G_k^a) + S^p$.

7. For a liability acting as a financial buffer ϕ_i would also be positive since, for liabilities, transactions and stocks are entered negatively. Hence increases (decreases) in unanticipated income absorbed by decreases (increases) in the outstanding stock of the liability would imply a positive relationship between Y^u and the appropriate S_i.

8. Note that any unplanned increases in expenditure in this system are a response to unanticipated variation in the income constraint rather than the cause of the accumulation of a financial buffer. Hence, in a system where expenditure and asset decisions are jointly determined expenditure (e.g. on non-durables) could act as a shock absorber.

9. Currie and Kenally (1986) suggest that buffer assets can be characterized by within-equation inequality restrictions based on ranking the coefficients on the expected permanent, expected transitory, and unexpected components of net wealth. By comparison, our characterization stresses cross-equation inequality restrictions although in the case of extreme buffers their formulation is similar to our (15).

10. Throughout we assume that the ϕ's are constant parameters. It is possible that they may vary with, for example, the size of the unanticipated income flow. While parameter stability in the estimated models was tested using Chow tests, these are joint tests for stability over all the parameters; hence, they provide only a weak test for constant ϕ's. This may be an area worth further investigation.

11. Cross-equation adjustment effects are found to be significant in ex post integrated models of expenditure and portfolio behaviour of the US household sector by Backus and Purvis (1980) and the UK personal sector by Owen (1986a, 1986b).

12. This earlier work tests for portfolio composition, cross-equation, liquidity, and credit effects in ex post integrated models of expenditure and portfolio behaviour; however, it does not examine the role of financial buffers, nor does it distinguish between the effects of anticipated and unanticipated changes in the income constraint variable.

13. Justification for this level of asset disaggregation and further details of the characteristics of the asset categories are given in Owen (1986b, Ch. 6) The data period 1968(2) to 1981(4) was determined by the availability of the proxy variable for the stock of consumer durables.

14. As O-P (1986, p.211, fn. 10) note, while the variables in the information set are all lagged and hence their values can be assumed to be known at the beginning of each period, the estimated coefficient values in the auxiliary prediction equations are based on data for the whole sample period. Hence, later information is used indirectly in generating earlier fitted

values. Despite this drawback we follow O-P (and many others) in adopting this approach because 'true' one-period ahead forecasts would severely reduce available degrees of freedom and hence severely restrict the range of possible explanatory variables to be considered in the relevant information set.

15. The F-type tests calculated are degrees-of-freedom-adjusted approximations of the asymptotically valid chi-squared test since they do not have an exact F distribution under the null for dynamic models of this type.

16. By comparison, Mishkin's (1983, Appendix 5.1) prediction equations for monetary growth, production growth and inflation yield R^2's between .40 and .88 for multivariate models and between .15 and .76 for univariate models.

17. The auxiliary prediction equations were also re-estimated as a system of seemingly unrelated regression equations in case there were any efficiency gains to be obtained from exploiting covariances between the disturbance terms in the equations. The estimates obtained were very similar to the equation-by-equation OLS estimates (for the same set of regressors as in Table 1) so the latter were used to generate the anticipated and unanticipated values.

18. O-P include mostly current-period 'strawman' returns in their model. Since anticipated end-of-period holdings are implicitly compared to target asset demands at the beginning of each period it is more realistic to use lagged rates as proxies for the relevant determinants of the target asset holdings. However, entering the current-period values of the nominal rates does not markedly change the results obtained.

19. There is no uniquely identifiable rate of return for LAPF given the range of assets in which these funds can be held and the lack of information on their varying asset backing over time; however, the rates on other categories, etc. would be relevant. Similarly no attempt was made to approximate the user cost of housing. The rates on SL and LHP (to the extent that withdrawal of equity corresponding to mortgage lending occurs) also act as an opportunity cost return for durables expenditure.

20. By contrast, in O-P's more highly aggregated system of only four asset categories (real estate, consumer durables, corporate equities, and net financial assets) net financial assets has the largest coefficient on unexpected income (c.52%) followed by real estate (c.35%), a result which O-P have some difficulty in rationalizing.

21. The arithmetic means of the eight separate test statistic values are 3.197 for LMF1 and 3.079 for LMF4. These data-based "system" test statistics ranked 47 and 14 respectively, well below the critical rank of 475.

22. This test does not have an exact F distribution under the null due to the stochastic nature of the explanatory variables but was found to be the most reliable of the prediction tests in Kiviet's (1986) Monte Carlo study, at least for AD(1,1) models.

23. Its application is not entirely straightforward as in addition to the income and anticipated capital gains returns the latter also appear as multiplicative components of the levels of anticipated capital gains of the relevant assets (in the anticipations-augmented stocks). As an approximation, the coefficients on the augmented stocks were used although the marginal addition to Ind_r

from these terms was practically zero in all cases, due to the relatively small coefficients on the stock terms.

24. The adjustment factor used was $[T-q-0.5(n-q_1+1)]/T$ where T is the number of observations, n the number of equations, and q the number of parameters in each equation, of which q_1 are restricted. Wales's (1984) Monte Carlo evidence suggests that, for the conventional LR test, Anderson's adjustment leads to a considerable improvement in terms of the implied probability of a Type I error when testing within-equation functional form restrictions in a non-linear demand system. However, Bera, Byron and Jarque's (1981) results suggest that it is not so effective for testing cross-equation restrictions such as symmetry.

25. UMLCs can be written in the form $R_1BR_2 = G$ where R_1, R_2 and G are known matrices. R_1 is $m_1 \times k$, rank $R_1 = m_1 \leq k$, R_2 is $n \times m_2$, rank $R_2 = m_2 \leq n$ and G is $m_1 \times m_2$. B is a $k \times n$ matrix of coefficients with k parameters in each of the n equations in the (truncated) system. In this case, $d_1 = |m_1 - m_2| + 1$ and $d_2 = T - k - m_2 + 1$ where $m_1 = 1$ and $m_2 = 8$.

Appendix

Detailed data definitions and sources are given in Owen (1986b, Appendix to Ch. 6). Brief definitions of the variable labels are:

CND	real consumers' expenditure on non-durables
CD	real consumers' expenditure on durables
M	money (personal-sector component of M3)
LA	other liquid assets (National Savings, building society shares and deposits, savings bank deposits, local authority temporary deposits)
OFA	other financial assets (public-sector long-term debt, UK debenture and loan stock, UK ordinary and preference shares, unit trusts and property unit trust units, overseas assets); IFA in Owen (1986b)
LAPF	life assurance and pension fund holdings (equity in insurance and pension funds)
SL	short-term loans (bank lending (excluding loans for house purchase) hire-purchase and other instalment debt)
LHP	loans for house purchase (from public sector, banks, and other financial institutions)
DWEL	private dwellings
DUR	consumer durables stock
P	implicit consumers' non-durables expenditure deflator (PCE in Owen, 1986b, p. 126)
RM, RLA, ROFA, RSL, RLHP	weighted average rates of return
$\dot{p}$	inflation rate based on the general index of retail prices
CUDU	cumulative measure (four-quarter moving total) of changes in the unemployment rate

VARI variability of inflation proxy (eight-quarter moving-average of the absolute value of changes in inflation rates)

Additional variables:

FT Financial Times all share index (Source: *Financial Statistics*)

GDP real GDP: Nominal Gross Domestic Product at factor cost, unadjusted, (Source: *Economic Trends*) deflated by P

ΔM3 changes in total stock of real Sterling M3 balances: Changes in nominal stock, unadjusted, (Source: *Economic Trends Annual Supplement*) deflated by P

LR long-term rate of interest: calculated gross redemption yield on long-dated (20-year) British Government securities net of tax (see Owen, 1986b, p. 129)

SR short-term rate of interest: net rate of return on non-money liquid assets (RLA)

MTR marginal personal income tax rate (see Owen, 1986b, p. 127)

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