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AN INTEGRATED MODEL OF HOUSEHOLD FLOW-OF-FUNDS ALLOCATIONS

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ABSTRACT

This paper extends the multivariate stock-adjustment model commonly used in empirical studies of portfolio behavior in order to analyze the complete set of flow allocation decisions made by households (including consumption, expenditures on durables and houses, and various financial aggregates). The model is then confronted with quarterly household sector data from the United States Flow of Funds Accounts for the period 1954 to 1975. Besides presenting OLS estimates, we test parameter restrictions suggested by our theoretical structure; the data supports the view that the explanatory power of the model is enhanced by allowing non-zero cross-effects on interest rates and lagged stocks, and by the integration of real and financial decisions.

While these results are encouraging, the specification requires a large number of independent variables. This leads, in many cases, to rather poor determination of a number of coefficients. We therefore combine with the data some inexact subjective information about the coefficients, using the Theil-Goldberger mixed estimation technique. The OLS estimates and the mixed estimates are then compared by examining the forecasting accuracy of the model in- and out-of-sample. Overall the model performs very well, and the simulation results confirm that inclusion of prior information is of considerable value for forecasting purposes.

Since the publication of William Brainard and James Tobin's pioneering paper, "Pitfalls in Financial Model Building," the multivariate stock-adjustment model has been widely used to study dynamic portfolio adjustment. The framework which they developed is especially useful for analyzing a given sector's allocation of a predetermined aggregate among competing alternatives; when dealing with the household sector most applications (including their own) have specified *wealth* as a predetermined aggregate which, in turn, was allocated to various assets and liabilities. The purpose of the present paper is to use an extended version of the Pitfalls model to examine in an integrated manner the household sector's allocation of *income* to financial *and* real expenditures for the United States from 1954 to the present.

The plan of the paper is as follows. In Section I we outline our basic theoretical framework, explain its motivation, and relate our approach to other recent flow-of-funds models. Then in Section II we describe the data and present ordinary least squares estimates of the model; in addition, we test for the "asset composition effect" which is central to our particular extension of the Pitfalls model. In Section III we use Brainard and Gary Smith's adaptation of the Theil-Goldberger mixed estimation technique to combine subjective prior information about the coefficients with that embodied in the data. We further examine in Section IV both the model and the value of our *a priori* beliefs by performing in-sample and out-of-sample dynamic simulations. Finally, conclusions are drawn in Section V.

I. *Theoretical Framework and Perspective*

In the Pitfalls article Brainard and Tobin emphasized the importance of the budget constraint for systems of asset demand equations. Since the constraint imposes certain "consistency" or "adding-up" conditions which the behavioral relations to be estimated must satisfy, one should either incorporate the consistency conditions explicitly in the full system specification, or take care to ensure that unrealistic properties are not inadvertently attributed to the residual equation.

The message is a very general one. Brainard and Tobin then apply it to a multivariate stock-adjustment model in which a predetermined flow of saving is allocated among competing assets. This specification has proven useful for modelling the financial sector within a larger macroeconomic model, but the implicit separation of portfolio decisions from savings decisions seems inappropriate to our goal of analyzing the complete set of household flow allocations.

Rather than simply add to the Pitfalls model an equation explaining the level of saving, we explain the complete set of decisions simultaneously; that is, we integrate the decisions underlying the real and financial flows of the household sector. Purvis (1978) has argued that such an integration is to be expected in the face of the adjustment costs implicit in the stock-adjustment specification. The substantive implication of this integrated model is that the *composition*, and not just the level, of wealth is potentially an important determinant of household expenditure in the short run.[1] In Section II below we test this asset composition effect.

The basic model has been described in detail by Purvis, so our treatment here will be brief. We start with the long-run model: desired asset holdings a^* depend on a set of explanatory variables x

$$\underset{n\times 1}{\frac{a^*}{YE}} = \underset{n\times k}{A} \; \underset{k\times 1}{x} \qquad [x_1 = 1] \tag{I.1}$$

where we have assumed that the demands are linearly homogeneous in expected income, YE .

The desired wealth-income ratio $(w^*/YE = \sum a_i^*/YE)$ can be viewed as resulting from an economy of life-cycle savers; thus interest rates, reflecting the terms of trade between present and future consumption, determine the long-run, steady-state wealth position. In the short run, due to costs of shifting assets and of foregone consumption, actual and desired asset holdings will differ; short-run changes are modelled as a multivariate stock-adjustment process:

$$\Delta a = \underset{n\times n}{E} \, [a^* - a(-1)] + \underset{n\times 1}{F} \, [Y - YE] \tag{I.2}$$

where E is the matrix of stock-adjustment coefficients and F is the vector of coefficients of unanticipated income.

The consumption equation, which is implicit in the analysis, can be derived from the budget constraint

$$C = Y - \sum \Delta a_i \; . \tag{I.3}$$

From (I.2) it can be seen that the components of wealth enter the consumption equation individually; their influence arises from the discrepancies between actual and desired asset holdings. In general (that is, without *a priori* restrictions on E) the components will enter the consumption equation with different coefficients, a feature of the model emphasized by Purvis and given further attention in Section II below. Also, note that while consumption does not depend directly on interest rates, interest rates do influence consumption via the desired assets a^* .

Combining (I.1)-(I.3) yields the complete short-run system to be estimated:

$$\text{(I.4)} \qquad \begin{bmatrix} \frac{C}{YE} \\ \\ \frac{\Delta a}{YE} \end{bmatrix} = \begin{bmatrix} g_0 & e_0 & f_0 \\ \\ G & E & F \end{bmatrix} \begin{bmatrix} x \\ -\frac{a(-1)}{YE} \\ \frac{Y-YE}{YE} \end{bmatrix}$$

$$\text{column sums} \quad \frac{Y}{YE} \qquad 1 \quad 0 \ldots 0 \quad 1$$

The adding-up constraints are indicated as column sums.

Our work is similar in several respects to a number of recent contributions. In terms of structure our approach is close to Patric Hendershott's: in both cases the basic Pitfalls consistency conditions are strictly enforced. Hendershott's dynamics, however, are an irregular pattern of distributed lags rather than stock-adjustment. Also, he focuses on economy-wide market clearing equations and interest rate determination rather than on the behavior of the household sector.

In terms then of this latter issue, our approach is more closely related to that of Mitsuo Saito. He is also primarily interested in household sector flow-of-funds allocation. However, he restricts his analysis to portfolio flows, and utilizes the restrictive linear expenditure system. We discuss this in more detail in Section III below.

Frederic Mishkin is also primarily interested in the household sector and, as we mentioned above, shares our interest in the relationship between balance-sheet items and household expenditure. However, rather than try to explain these in an integrated fashion as we do, he treats the former as exogenous and hence considers only the causation running from assets and liabilities to expenditure. We return to this issue below in our simulation experiments.

II. OLS Estimates and Tests of the Asset Composition Effect

The model described in Section I above was estimated for nine categories of household flows: three expenditure items--consumption of non-durables and services, expenditures on consumer durables, and expenditures on residential housing; four asset categories--broadly-defined money (M3), bonds, corporate equities, and non-marketable securities; and two liabilities--mortgages and consumer loans. The data are from the Federal Reserve Flow of Funds accounts, and are described in more detail in Appendix A.

The dependent variables are real expenditures and first differences of asset/liability stocks. The sole exception is equity, for which capital gains are subtracted from the stock change; thus capital gains are kept entirely as equity in the first period. Income is the sum of the flows to be explained; this is of course the same procedure by which wealth measures are constructed in portfolio models. Expected income is an exponential trend on income with a correction for serial correlation (see Appendix A).

The explanatory variables are the lagged values of the stocks of the above assets and liabilities, unanticipated income, the expected rate of inflation (from the Michigan Survey), the prices of consumer durables and housing relative to the overall price index for households, and rates of return for the three marketable assets and both liabilities. Again, sources and further details are provided in Appendix A.

The model was estimated by OLS (Ordinary Least Squares) using quarterly data for the United States Household Sector for the period 1954:I to 1975:IV. OLS estimates automatically satisfy the adding-up conditions. The results are displayed in Table 1. These estimates must be considered amazingly good; despite the alarming potential for multicollinearity that exists with eighteen explanatory variables, *fifty-five* coefficients differ

TABLE 1. *Household Short-Run Coefficients: OLS Estimates*

Dependent Variable	Price and Interest Rate Responses: 1	$(\dot{P}/P)^E$	$\ln\frac{PCD}{PH}$	$\ln\frac{PIH}{PH}$	$\ln RM3$	$\ln RBOND$	$\ln REQUITY$	$\ln RMORT$	$\ln RLOAN$	Adjustment Coefficients: $\frac{\phi KCD}{YE}$	$\frac{\phi KIH}{YE}$	$\frac{\phi M3}{YE}$	$\frac{\phi BOND}{YE}$	$\frac{\phi EQUITY}{YE}$	$\frac{\phi NONMKT}{YE}$	$\frac{-\phi MORT}{YE}$	$\frac{-\phi LOAN}{YE}$	$\frac{Y-YE}{YE}$	Sum of Squared Residuals	Durbin-Watson Statistic	R^2
$\frac{CON}{YE}$	-.238 (.91)	-.0026 (.74)	.0838 (.33)	.2631 (.97)	.0507 (1.36)	-.0404 (.80)	.2783 (3.70)	.0068 (.90)	.0588 (1.57)	.178 (1.99)	-.029 (.58)	-.327 (3.60)	-.514 (3.99)	-.025 (2.67)	-.190 (2.60)	-.073 (.78)	-.747 (6.69)	.503 (8.78)	$.201 \times 10^{-1}$	2.68	.738
$\frac{CDEXP}{YE}$	-.224 (1.72)	-.0021 (1.20)	.2677 (2.13)	.3830 (2.83)	.0066 (.46)	.0232 (.92)	.1580 (4.21)	-.0517 (1.32)	-.0024 (.13)	.092 (2.07)	.012 (.47)	-.241 (5.33)	-.288 (4.49)	-.015 (3.24)	-.015 (.42)	-.033 (.72)	-.347 (6.23)	.162 (5.65)	$.498 \times 10^{-2}$	2.24	.682
$\frac{HEXP}{YE}$	.001 (.01)	.0004 (.45)	.0505 (.77)	-.0005 (.01)	.0173 (1.77)	-.0118 (.90)	.0118 (.60)	.0282 (1.37)	-.0076 (.78)	.073 (3.11)	-.042 (3.23)	-.014 (.57)	.039 (1.17)	-.005 (2.09)	-.004 (.22)	-.068 (2.81)	.032 (1.09)	.082 (5.47)	$.137 \times 10^{-2}$	1.40	.898
$\frac{\Delta M3}{YE}$	.132 (.39)	.0013 (.29)	-.6716 (2.06)	.2109 (.60)	.1576 (3.26)	-.0079 (.12)	.1028 (1.06)	-.0932 (.92)	-.0422 (.87)	-.063 (.54)	.070 (1.09)	.036 (.30)	-.185 (1.12)	-.001 (.08)	-.208 (2.21)	-.085 (.71)	-.289 (2.00)	.399 (5.39)	$.333 \times 10^{-1}$	2.32	.644
$\frac{\Delta BOND}{YE}$	.192 (.79)	-.0033 (1.01)	.1667 (.71)	-.0534 (.21)	-.1022 (2.93)	.0993 (2.11)	-.0041 (.06)	.0315 (.43)	.0809 (2.31)	.082 (.98)	-.011 (.23)	.180 (2.13)	.618 (5.15)	.005 (.61)	-.043 (.63)	.157 (1.81)	.283 (2.72)	-.058 (1.08)	$.174 \times 10^{-1}$	1.87	.578
$\frac{\Delta EQUITY - CG}{YE}$	.016 (.21)	.0011 (1.03)	-.0471 (.64)	-.1954 (2.45)	-.0284 (2.59)	.0525 (3.54)	-.0333 (1.51)	-.0306 (1.33)	-.0231 (2.09)	-.007 (.27)	-.034 (2.32)	.057 (2.13)	.084 (2.23)	.088 (2.85)	.013 (.59)	.009 (.33)	.162 (4.97)	-.059 (3.50)	$.172 \times 10^{-2}$	2.27	.597
$\frac{\Delta NONMKT}{YE}$	.285 (1.27)	.0003 (.11)	.4730 (2.19)	-.1381 (.59)	-.0332 (1.04)	-.0930 (2.15)	-.4287 (6.66)	.0563 (.84)	-.0531 (1.65)	-.218 (2.08)	-.009 (.22)	-.159 (2.05)	-.256 (2.32)	.010 (1.31)	.377 (6.04)	.001 (.01)	-.034 (.35)	.236 (4.80)	$.147 \times 10^{-1}$	1.56	.803
$-\frac{\Delta MORT}{YE}$	.073 (1.03)	.0011 (1.20)	-.1035 (1.51)	-.0502 (.68)	-.0365 (3.59)	-.0009 (.07)	.0255 (1.25)	-.0291 (1.36)	.0200 (1.97)	-.110 (4.53)	.053 (3.98)	.049 (1.99)	-.047 (1.34)	.002 (.67)	.009 (.45)	.079 (3.15)	-.021 (.70)	-.038 (2.47)	$.147 \times 10^{-2}$	1.28	.761
$-\frac{\Delta LOAN}{YE}$	.764 (3.58)	.0037 (1.29)	-.2195 (1.07)	-.4195 (1.90)	-.0340 (1.11)	-.0209 (.51)	-.1104 (1.80)	.0816 (1.29)	-.0312 (1.02)	-.032 (.43)	-.011 (.27)	.419 (5.67)	.549 (5.23)	.021 (2.74)	.062 (1.05)	.013 (.17)	.960 (10.56)	-.226 (4.85)	$.133 \times 10^{-1}$	2.02	.686

Notes: 1. $\Delta X \equiv X - X_{-1}$.

$\phi X \equiv X^* - X_{-1}$. (The actual regressors are $-X_{-1}$.)

2. Numbers in parentheses are t-statistics (absolute values).

3. Sample period: 1954.I to 1975.IV (88 observations).

significantly from zero.[2] Still, many of the signs and magnitudes conflict with our subjective expectations, and the estimates are, in that sense, not entirely satisfactory. The following discussion is intended to clarify what we consider the strengths and weaknesses of these estimates.

The lagged stock variables[3] play an important role, and their estimated coefficients are generally both plausible and significant. With the single exception of consumer durables, lagged stocks influence consumption positively. Six of the eight estimates are significant, including the coefficient of the lagged stock of consumer durables. Note that while the lagged stock of money has a relatively large effect on expenditure, it is not so large as that of bonds. Hence the monetarist view of the transmission process as interpreted by Purvis (1978, p.) receives at best only partial support from these estimates. Further, note the large depressant effect on expenditures of consumer loans.

Of the eight own adjustment parameters in the portfolio equations, seven are significant; the exception is the surprisingly small money coefficient. Except for the lagged stock of housing, which has a significant but small positive effect on housing expenditure, the signs are "correct." Twenty-four of the fifty-six off-diagonal adjustment coefficients are significant. Again, most are sensible, but several surprising results stand out: lagged stocks of money and bonds have very large positive effects on the demand for loans, and a large proportion of the own adjustment for bonds is financed by selling "non-marketables." Indeed non-marketables are generally more active than their name would suggest.

Allocation of transitory income is roughly consistent with previous studies (e.g., Darby). Half is consumed within the first quarter and altogether 75% goes toward real expenditures. About one-third of the latter is financed by borrowing. Another 40% goes initially into money balances.

The price and interest rate responses are less precisely determined --only five of twenty-seven price coefficients and twelve of forty-five rate coefficients are significant. The rates on money and bonds have significant positive coefficients in the own equations while those for equity, mortgages, and loans are negative but insignificant.

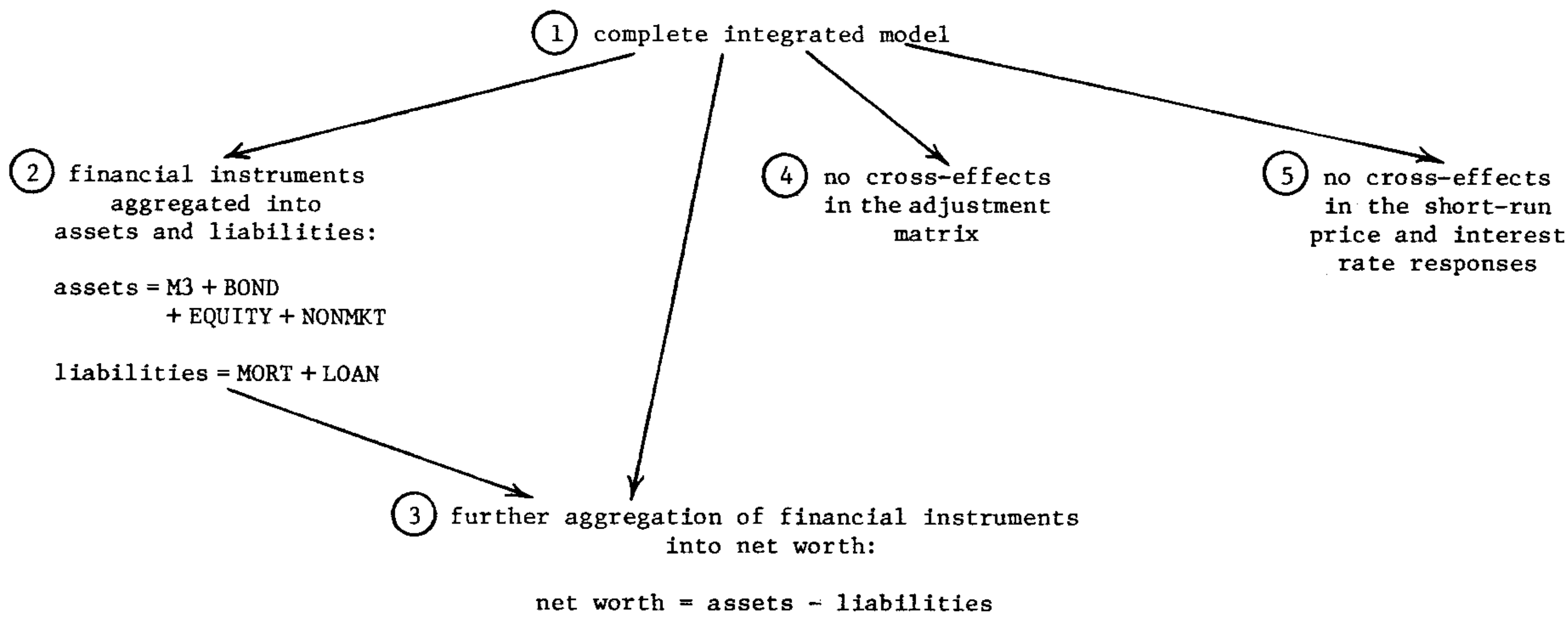
From this discussion two points emerge: first while the OLS estimates are good there is considerable room for improvement. Second, the source of our dissatisfaction is that we possess a great deal of loosely held *a priori* information about the signs and magnitudes of many of the parameters. The next step (Section III) is to include such information directly in the estimation process and to see how the data modify it.

Before turning to those mixed estimates, we examine the statistical validity of the integrated-pitfalls approach in the light of our OLS estimates. The gains from that approach are indicated using standard F-tests for special cases of the integrated model. The relations among the complete integrated model and the various restricted models are illustrated in Figure 1; test results are listed in Table 2.

The first set of tests is motivated by Purvis's theoretical work on consumption: Does disaggregation of wealth improve our estimation of consumption expenditures? The answer (Table 2, alternative model 3) is, emphatically, yes. Furthermore, the integrated model is also distinctly better than a partial disaggregation into total assets and total liabilities (Table 2, alternative 2). The asset composition effect is clearly important.

The second set of tests is motivated by the original Brainard-Tobin pitfalls lesson: because of the budget/wealth constraint, asset demands

FIGURE 1. Lattice of Models: The Integrated Model and Some Special Cases



Note: Arrows indicate nesting of models; e.g., (3) is nested in (2) and (1).

TABLE 2. Test Results

Equation	*Alternative Hypothesis*[a] 2	3	4	5
CON	12.15	9.97		
CDEXP	12.53	10.05	12.80	4.03
HEXP	3.35	3.56	4.41	1.04
M3			1.90	2.30
BOND			2.37	4.85
EQUITY			4.62	5.01
NONMKT			4.42	10.51[b]
MORT			7.34	5.24
LOAN			16.01	1.42
Critical Value (5%)	$F(4,70) = 2.51$	$F(5,70) = 2.35$	$F(7,70) = 2.15$	$F(6,70) = 2.23$

Notes: [a]Numbers refer to Figure 1. The null hypothesis is always the complete integrated model (model 1). The alternative hypotheses are:

model 2: financial instruments aggregated into assets and liabilities;
model 3: financial instruments further aggregated into net worth;
model 4: no cross-effects in the adjustment matrix; and
model 5: no cross-effects in the short-run price and interest rate responses.

[b]There is no own rate for this equation so all seven price and interest rate coefficients have been set to zero. The degrees of freedom are (7,70).

depend in general on the entire vector of interest rates (not just the own rate) and the adjustment mechanism involves discrepancies from desired holdings for *all* assets. This is certainly true, but many would counter that, as a practical matter, problems from violating the budget constraint slightly by setting small coefficients equal to zero are more than outweighed by the inconvenience of keeping all explanatory variables in every equation. Our test results show that cross-effects, taken as a group, do have an important and statistically significant impact on the demand equations. Off-diagonal price and rate responses are significant in six of eight equations (Table 2, alternative 5) and off-diagonal adjustment parameters improve the significance in seven of eight equations (Table 2, alternative 4). We conclude that piecewise estimation of demand equations is not only theoretically indefensible but also empirically unjustified.

These results are very encouraging, and suggest that the data are not as impotent as one might have thought. Nevertheless, in many places the results are contrary to our expectations. Brainard and Smith have argued persuasively that the proper way to incorporate the prior information contained in those expectations is to include it in the estimation procedure. This is done in the next section.

III. Mixed Estimation of the Integrated Model

Most economists hesitate to use their personal beliefs explicitly in the estimation process. The typical view is that subjective information should play as small a role as possible in scientific research. In the same spirit, Bayesian statisticians have been among the most outspoken critics of indiscriminate applications of personal opinions in published reports.[4] In their view, with which we concur, opinion has a legitimate place in private analysis but the primary goal of published work must be to describe as completely as possible the information present in the data. In this way each reader will be able to draw his or her own conclusions. We hope to have accomplished this in the previous section.

The limitations common to economic time series data make additional information, whatever its source, very attractive. Simulation experiments by Brainard and Smith and by ourselves illustrate the potential practical value of even inexact subjective information. This, however, provides only the incentive; our defense of Bayes-like techniques lies on different grounds.

We think that economists, using what might fairly be termed economic common sense, can often agree *a priori* about the signs and approximate magnitudes of many estimable parameters.[5, 6] For example, in selecting our priors, we have been guided by two seemingly inoffensive propositions: that own-adjustment coefficients are positive and less than one and that assets are gross substitutes in the long run. The jump to numerical values is difficult but in the Bayesian framework any degree of *a priori* uncertainty can be included; anything more than complete uncertainty (i.e., a diffuse prior distribution) will be useful. (Of course, if there really were complete uncertainty there would be no grounds for disappointment in classical results.)

The case for mixed estimation is fortified by observing that applied econometricians generally use *a priori* information informally. Several such approaches have been described by Smith and Frank Campbell (1978, pp. 1-2):

> [Economists] may initially limit themselves to a small number of explanatory variables...or they may begin with a more complete model and then drop those variables with coefficients which are found to be incorrectly signed or statistically insignificant. The most ambitious seem to toil endlessly for that elusive combination of variables which will yield statistically significant and plausibly signed parameter estimates.

These methods are grossly *ad hoc* and highly unsatisfactory; when only the final estimates are reported, the relation between subjective and data information is completely obscured so that others have no opportunity to draw their own conclusions from the data. As a direct consequence, reported estimates are now often viewed with a high degree of skepticism.

More satisfactory perhaps is to choose a functional form which conserves degrees of freedom. An example of this is Saito, who used the linear expenditure system to estimate household portfolio demands. This system greatly reduces the number of parameters to be estimated by severely restricting the substitution relationships. The success of this approach clearly depends on the accuracy of these restrictions. These restrictions are imposed exactly, while Bayes' methods allow more flexible use of *a priori* information.

We have decided to be explicitly Bayesian. One obvious advantage is that the influences of both the data and our priors are clear. And if other economists agree with our priors they should agree also that the mixed estimates summarize our knowledge of the coefficients.

Following Smith and Brainard we use the Theil-Goldberger mixed estimation technique--see Theil (1974), pp. 346-352, 670-672. Mixed estimation is an application of the Aitken generalized least squares estimator to a combined system of data and prior information. The data for each equation i can be expressed in standard notation as

$$\underset{T\times 1}{y_i} = \underset{T\times K}{X} \; \underset{K\times 1}{\beta_i} + \underset{T\times 1}{u_i} \quad .$$

Similarly the priors may be represented as

$$\underset{M\times 1}{r_i} = \underset{M\times K}{R} \; \underset{K\times 1}{\beta_i} + \underset{M\times 1}{v_i} \quad .$$

In our work R is $[0 \,\vdots\, I_{K-1}]$ reflecting the fact that the priors are formulated directly on all parameters except the constant term (the first element of β_i). Assuming that the u_i's satisfy the usual OLS assumptions and the prior errors are independent with zero means the system is

$$\begin{pmatrix} y_i \\ r_i \end{pmatrix} = \begin{pmatrix} X \\ R \end{pmatrix} \beta_i + \begin{pmatrix} u_i \\ v_i \end{pmatrix} ,$$

with error covariance matrix

$$\text{Cov} \begin{pmatrix} u_i \\ v_i \end{pmatrix} = \begin{pmatrix} \sigma_i^2 I_T & 0 \\ 0 & \Sigma_{ii} \end{pmatrix} .$$

The best linear unbiased estimator is the Aitken estimator:

$$\hat{\beta}_i = \left(\frac{1}{\sigma_i^2} X'X + R'\Sigma_{ii}^{-1} R \right)^{-1} \left(\frac{1}{\sigma_i^2} X'y + R'\Sigma_{ii}^{-1} r \right) .$$

When σ_i^2 is known, the Aitken estimator is, with the additional assumption of normality for u_i and v_i, the Bayes posterior mean. We use Theil's convenient substitution of the OLS estimate of σ_i^2 and interpret the results as approximations to the Bayes estimates.

In order that single-equation mixed estimates satisfy the adding-up restrictions, the prior covariance matrices must satisfy

(III.1) $$\frac{1}{\sigma_i^2}\Sigma_{ii} = \frac{1}{\sigma_j^2}\Sigma_{jj}$$

for each pair of equations (i,j) . While this will rarely hold *a priori* the difficulties of specifying the prior covariances for the complete system make it a rewarding simplification.[7]

Table 3 contains three sets of estimates: our prior means, the mixed estimates, and the OLS estimates (reproduced from Table 1). Table 4 lists the long run asset coefficients implied by the short run estimates. (Recall that long run consumption equals disposable income.)

The priors were obtained in the following manner. Prior means were formulated for the long-run asset parameters (Table 4) and adjustment coefficients (Table 3); from these short-run price and rate responses were calculated. Long-run rate of return responses were scaled using the rule of thumb that the own rate elasticity be in the range 1 to 1.5. Own price elasticities are about -.5. Long run interest rate effects on total wealth are positive for asset rates (the substitution effect) and zero for liability rates (intertemporal terms of trade are reflected only by asset rates). The impact of expected inflation is illustrated by the following thought experiment: raise all interest rates from 5% to 6% and $(\dot{P}/P)^e$ from 0

TABLE 3. Household Short-Run Coefficients

Dependent Variable	Type of Estimate				Price and Interest Rate Responses					
		1	$(\dot{P}/P)^e$	ln(PCD/PH)	ln(PIH/PH)	ln(RM3)	ln(RBOND)	ln(REQUITY)	ln(RMORT)	ln(RLOAN)
CON/YP	prior	none	0.126	0.012	0.125	-0.172	-0.028	-0.015	0.030	-0.047
	mixed	-0.045	-0.003	-0.000	0.061	0.046	-0.083	0.196	0.070	0.047
	OLS	-0.238	-0.003	0.084	0.263	0.051	-0.040	0.278	0.007	0.059
CDEXP/YP	prior	none	0.221	-0.202	0.120	-0.040	-0.014	-0.092	0.017	-0.054
	mixed	0.059	-0.004	-0.119	0.121	-0.005	0.025	0.182	-0.027	-0.002
	OLS	-0.224	-0.002	0.268	0.383	0.009	0.023	0.158	-0.052	-0.002
HEXP/YP	prior	none	0.138	0.025	-0.200	-0.023	-0.001	-0.036	-0.084	-0.005
	mixed	0.067	0.001	-0.014	-0.096	0.002	-0.005	0.003	-0.011	0.010
	OLS	0.001	0.000	0.051	-0.000	0.017	-0.012	0.012	0.028	-0.008
ΔM3/YP	prior	none	-0.254	0.105	-0.090	1.391	-0.118	-0.533	-0.193	-0.123
	mixed	0.036	0.004	-0.209	0.040	0.146	-0.017	-0.024	0.004	-0.066
	OLS	0.132	0.001	-0.672	0.211	0.158	-0.008	0.103	-0.093	-0.042
ΔBOND/YP	prior	none	0.076	0.023	-0.030	-0.424	0.289	-0.204	-0.014	0.010
	mixed	0.011	-0.002	0.110	-0.049	-0.057	0.077	0.033	-0.069	0.103
	OLS	0.192	-0.003	0.167	-0.053	-0.102	0.099	-0.004	0.031	0.081
ΔEQUITY/YP	prior	none	-0.214	-0.005	0.040	-0.400	-0.106	1.097	-0.089	-0.032
	mixed	-0.057	0.001	0.030	0.005	-0.005	0.045	0.014	-0.057	-0.020
	OLS	0.016	0.001	-0.047	-0.195	-0.028	0.052	-0.033	-0.031	-0.023
ΔNONMRT/YP	prior	none	0.050	0.000	0.000	-0.015	-0.010	-0.130	-0.020	-0.010
	mixed	0.618	-0.001	0.097	-0.079	-0.062	-0.002	-0.398	0.013	-0.037
	OLS	0.285	0.000	0.473	-0.138	-0.033	-0.093	-0.429	0.056	-0.053
- ΔMORT/YP	prior	none	-0.096	-0.008	0.060	-0.098	-0.010	-0.054	0.323	-0.010
	mixed	-0.043	0.000	0.025	0.030	-0.048	-0.016	0.049	0.065	-0.014
	OLS	0.073	0.001	-0.104	-0.050	-0.036	-0.001	0.025	-0.029	0.020
- ΔLOAN/YP	prior	none	-0.047	0.050	-0.025	-0.220	-0.003	-0.033	0.030	0.272
	mixed	0.353	0.004	0.079	-0.033	-0.017	-0.024	-0.056	0.012	-0.020
	OLS	0.764	0.004	-0.220	-0.420	-0.034	-0.021	-0.110	0.082	-0.031

Notes: See notes 1 and 3 in Table 1.

TABLE 3, continued

Dependent Variable	Type of Estimate				Adjustment Coefficients					
		♦KCD/YP	♦KIH/YP	♦M3/YP	♦BOND/YP	♦EQUITY/YP	♦NONMKT/YP	-♦MORT/YP	-♦LOAN/YP	YTR
CON/YP	prior	-0.030	-0.070	-0.130	-0.100	-0.070	-0.030	-0.070	-0.120	0.400
	mixed	0.030	-0.037	-0.143	-0.182	-0.019	-0.102	-0.042	-0.277	0.426
	OLS	0.178	-0.029	-0.327	-0.514	-0.025	-0.190	-0.073	-0.747	0.503
CDEXP/YP	prior	0.200	-0.010	-0.030	-0.020	-0.020	-0.010	-0.010	-0.020	0.200
	mixed	0.155	-0.002	-0.067	-0.071	-0.016	-0.069	-0.020	-0.092	0.176
	OLS	0.092	0.012	-0.241	-0.288	-0.015	-0.015	-0.033	-0.347	0.162
HEXP/YP	prior	0.000	0.100	-0.010	0.000	0.000	0.000	-0.020	-0.010	0.100
	mixed	0.008	-0.019	-0.012	0.029	-0.005	0.005	-0.054	-0.011	0.074
	OLS	0.072	-0.042	-0.014	0.039	-0.005	-0.004	-0.068	0.032	0.082
ΔM3/YP	prior	-0.100	0.020	0.400	-0.080	-0.070	-0.050	-0.050	-0.080	0.300
	mixed	-0.082	0.025	0.027	-0.056	0.011	-0.103	-0.113	-0.092	0.337
	OLS	-0.063	0.070	0.036	-0.185	-0.001	-0.208	-0.085	-0.289	0.399
ΔBOND/YP	prior	-0.020	0.010	-0.100	0.250	-0.040	-0.010	-0.020	-0.020	0.100
	mixed	0.018	-0.013	0.029	0.316	-0.010	0.003	0.056	0.039	0.002
	OLS	0.082	-0.011	0.180	0.618	0.005	-0.043	0.157	0.283	-0.058
ΔEQUITY/YP	prior	0.000	-0.020	-0.060	-0.050	0.200	0.000	-0.010	0.000	0.000
	mixed	0.006	-0.016	-0.021	-0.062	0.004	0.001	-0.012	0.005	-0.020
	OLS	-0.007	-0.034	0.057	0.084	0.008	0.013	0.009	0.162	-0.059
ΔNONMRT/YP	prior	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000
	mixed	-0.079	0.026	0.030	-0.050	0.022	0.166	0.070	0.035	0.181
	OLS	-0.213	-0.009	-0.159	-0.256	0.010	0.377	0.001	-0.034	0.236
- ΔMORT/YP	prior	0.000	-0.030	-0.020	0.000	0.000	0.000	0.150	0.000	0.000
	mixed	-0.022	0.029	0.031	-0.018	0.003	0.010	0.114	-0.007	-0.015
	OLS	-0.110	0.053	0.049	-0.047	0.002	0.009	0.079	-0.021	-0.038
- ΔLOAN/YP	prior	-0.050	0.000	-0.050	0.000	0.000	0.000	0.030	0.250	-0.100
	mixed	-0.033	0.008	0.126	0.094	0.010	0.090	0.002	0.399	-0.162
	OLS	-0.032	-0.011	0.419	0.549	0.021	0.062	0.013	0.960	-0.226

TABLE 4. *Household Long-Run Coefficient: Prior, Mixed, and OLS Estimates*

Dependent Variable	Mean	Type of Estimate	1	$(P/P)^e$	$\ln \frac{PCD}{PH}$	$\ln \frac{PIH}{PH}$	ln RM3	ln RBOND	ln REQUITY	ln RMORT	ln RLOAN
$\frac{KCD}{YE}$	1.95	Priors	none	0.900	-1.000	0.500	0.000	-0.050	-0.300	0.000	-0.250
		Mixed	6.828	0.017	-0.929	-0.422	-0.582	1.221	0.772	-1.123	-0.566
		OLS	-8.724	-0.049	2.326	-0.517	0.591	-2.741	-1.570	3.241	1.120
$\frac{KIH}{YE}$	4.32	Priors	none	1.200	0.250	-2.000	0.000	-0.050	-0.600	-0.500	0.000
		Mixed	-3.017	-0.186	-0.830	5.613	1.907	-2.681	-4.638	2.352	1.131
		OLS	2.754	-0.037	0.430	4.208	0.925	-1.215	-0.509	0.925	0.164
$\frac{M3}{YE}$	2.77	Priors	none	-0.750	0.000	0.000	3.000	-0.200	-0.900	-0.400	-0.250
		Mixed	11.098	0.166	-2.255	-5.075	-1.286	0.843	3.474	-0.041	-1.681
		OLS	-8.792	-0.019	-0.007	-3.064	0.575	-3.303	-2.020	3.578	1.315
$\frac{BOND}{YE}$	.68	Priors	none	-0.200	0.000	0.000	-0.750	1.000	-0.500	-0.150	-0.050
		Mixed	0.021	-0.026	0.332	0.479	0.121	0.283	-0.782	-0.404	0.412
		OLS	3.376	-0.001	-0.031	1.019	-0.031	0.758	0.058	-0.702	-0.243
$\frac{EQUITY}{YE}$	4.07	Priors	none	-1.250	0.000	0.000	-1.300	-0.350	5.000	-0.550	-0.250
		Mixed	20.761	0.056	0.512	4.365	0.307	9.577	-6.696	-10.437	-2.572
		OLS	-24.091	-0.242	-1.489	-3.527	4.955	-5.666	-14.511	6.892	0.173
$\frac{NONMKT}{YE}$	2.81	Priors	none	0.500	0.000	0.000	-0.150	-0.100	-1.300	-0.200	-0.100
		Mixed	4.404	-0.010	0.174	-1.528	-0.550	-0.424	-1.601	0.443	-0.013
		OLS	-4.564	-0.028	2.574	-1.011	0.325	-2.448	-2.353	2.735	0.837
$-\frac{MORT}{YE}$	-1.60	Priors	none	-0.500	0.000	0.000	-0.250	-0.100	-0.600	2.000	-0.100
		Mixed	-2.407	0.001	0.928	0.321	-0.587	0.362	0.975	-0.057	0.087
		OLS	-3.658	-0.004	1.267	-1.358	-0.872	0.207	0.646	0.073	0.506
$-\frac{LOAN}{YE}$	-.90	Priors	none	-0.100	0.000	0.000	-0.250	-0.050	-0.300	-0.200	1.000
		Mixed	-3.523	-0.030	0.716	1.495	0.367	-0.393	-0.368	0.168	0.383
		OLS	3.312	0.018	-0.279	0.508	-0.355	1.161	1.132	-1.285	-0.494

Note: Based on short-run estimates in table except priors, which were specified directly in long run form to 1% (thus holding the real rate constant). We first chose coefficients of $(\dot{P}/P^e)$ so that the dependent variables were unchanged, then modified them slightly so as to yield an increase in physical investment (durables and housing), a somewhat greater decrease in money and bond holdings, and a small decrease in total wealth (money illusion and nervousness about inflation). No priors (equivalently, diffuse priors) are used for the constant term.

The interpretation of adjustment coefficients is different from that of Pitfalls models. The own adjustment for money (.4) means, for example, that a $1 increase in the discrepancy between desired and actual money holdings (other discrepancies held constant) *accompanied by a $1 increase in desired wealth* causes a 40¢ increase in money holdings in the first quarter. Generally speaking, we have liquid assets adjusting more quickly than illiquid ones. Adjustment is financed in the first instance by drawing down other asset holdings as well as by saving more. We have no "downpayment effect" whereby money holdings, for example, are *increased* in preparation for future purchases of illiquid assets. Transitory income is divided almost evenly among consumption, physical investment (durables and housing), and liquid assets (money and bonds). In the spirit of Purvis's earlier work the various assets and liabilities have different effects on consumption, the effects of liquid assets being greater.

The prior variances and covariances are more difficult to formulate; our choices for the consumption equation, listed in Table 5, are based on the following rules of thumb. (Covariance matrices for other equations can be derived from (III.1).) For price and rate responses the standard deviations are about one-half of the largest element in the column. For the adjustment coefficients two standard deviation bounds are $\pm.1$ for durables

TABLE 5. *Prior Covariance Matrix for CON*

	$(\dot{P}/P)^E$	$ln\frac{PCD}{PH}$	$ln\frac{PIH}{PH}$	ln RM3	ln RBOND	ln REQUITY	ln RMORT	ln RLOAN	$\frac{\phi KCD}{YE}$	$\frac{\phi KIH}{YE}$	$\frac{\phi M3}{YE}$	$\frac{\phi BOND}{YE}$	$\frac{\phi EQUITY}{YE}$	$\frac{\phi NONMKT}{YE}$	$\frac{-\phi MORT}{YE}$	$\frac{-\phi LOAN}{YE}$	$\frac{YRT}{YE}$
$(\dot{P}/P)^E$	.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
$ln\frac{PCD}{PH}$		.01	.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0
$ln\frac{PIH}{PH}$			.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ln RM3				.4	.05	0	0	0	0	0	0	0	0	0	0	0	0
ln RBOND					.025	0	0	0	0	0	0	0	0	0	0	0	0
ln REQUITY						.25	0	0	0	0	0	0	0	0	0	0	0
ln RMORT							.025	0	0	0	0	0	0	0	0	0	0
ln RLOAN								.025	0	0	0	0	0	0	0	0	0
φKCD/YE									.0025	0	0	0	0	0	0	0	0
φKIH/YE										.0025	0	0	0	0	0	0	0
φM3/YE											.005	.001	.001	.001	.001	.001	0
φBOND/YE												.005	.001	.001	.001	.001	0
φEQUITY/YE													.005	.001	.001	.001	0
φNONMKT/YE														.005	.001	.001	0
-φMORT/YE															.005	.001	0
-φLOAN/YE																.005	
YTR/YE																	.005

and housing and $\pm.5$ for financial assets and liabilities. These approximately represent the degree of our uncertainty with perhaps a slight bias toward "loose" priors. The covariances are harder to justify; those in Table 5 are based on the consumption equation. The many zero covariances are particularly suspicious--note especially the lack of correlation between price/rate responses and adjustment coefficients--but no simple alternative suggests itself.

Turning to the estimates reported in Table 3, we find the mixed estimates are generally more believable than the OLS estimates. But some surprising estimates remain. A brief discussion will highlight the obvious differences from the OLS estimates. The consumption function is qualitatively unchanged. Interest rate coefficients are small except for the rate on equity which has a positive effect on consumption. The wealth effects have the same signs and, although the magnitudes have changed, bonds still have a greater bang than money--despite priors with the opposite property. In the portfolio equations the own price and rate coefficients now have the anticipated signs in every case but one, but the magnitudes often differ considerably from the priors. The expected rate of inflation has very little effect, partly reflecting our large prior variance. Own adjustment coefficients have some surprising results: the estimates for money and equity are still surprisingly small, and own adjustment for housing still is negative. Most others are closer to the priors than to the OLS estimates.

IV. Forecasting Accuracy of Mixed and OLS Estimates

The usefulness of prior information cannot be determined by examining the estimates alone. Mixed estimates will usually be closer than OLS estimates to the priors and in that sense will be more satisfactory, but if we follow this line of reasoning to its extreme we will always prefer the priors to any other estimates.[8] In this section we report the results of our efforts to judge our estimates by conducting a forecasting "contest" (i.e., by comparing the predictive accuracy of prior, mixed, and OLS estimates). The estimates used in this exercise differ slightly from those reported in Table 3: only observations through 1972 have been used, leaving twelve post-sample data points. Since our model was specified independently of the data (i.e., no data-mining was involved), the procedure is entirely legitimate.

We have calculated both in-sample and out-of-sample forecasts of the three expenditure categories and the *levels* of financial stocks for one to eight quarters ahead. Historical values were used for prices, interest rates, the stocks of consumer durables and housing, expected and transitory income, and capital gains on equity. Predicted variables are nominal amounts and not ratios to expected income. One-quarter-ahead forecasts are simply "fits" but the others use predicted values for the lagged stocks: in an i-quarter-ahead forecast, $(i-1)$-quarter-ahead forecasts of lagged stocks are used.

The complete set of forecasts is too large to reproduce here, but are available from the authors on request. In this paper we present only a small selection of the actual forecasts, and rely on calculation of root-mean-square prediction errors as summary statistics describing the accuracy of the various predictions.

Denoting the historical value by y_t and the i-period ahead prediction by $\hat{y}_t^i$ the root-mean-square prediction error (RMSE) is

$$\text{RMSE} = \sqrt{\frac{1}{T-i+1} \sum_{t=i}^{T} (y_t - \hat{y}_t^i)^2}\,, \quad i = 1,\ 2,\ \ldots,\ 8$$

where T is the length of the period. (In-sample T is 76 and out-of-sample T is 12.) In-sample and out-of-sample RMSE's for each equation, each type of estimate, and each forecast horizon are listed in Tables 6 and 7. Constant terms have been estimated for the priors. Table 8 presents the one-quarter out-of-sample forecasts for consumption, money, and equities.

The mixed estimates perform well. In-sample the OLS estimates are slightly better in one-quarter-ahead forecasts for every equation, but they deteriorate as the forecast horizon grows; by the eight-quarter forecasts the mixed and OLS estimates are roughly equal. Out-of-sample the results are more dramatic. In one-quarter-ahead forecasts mixed estimates predict more accurately in seven of the nine equations, and the differences are often large. But as the horizon is lengthened OLS predictions actually improve, and in the eight-quarter-ahead forecasts they do better than the mixed estimates in most cases.[9] The differences here, however, are generally small. Note that the performance of the mixed equations compares favorably with the results reported by Mishkin, although he reported results only for simulations with historical data and his model treated financial assets as exogenous.

Prior estimates perform poorly in all cases, indicating that the data contain a considerable amount of information. This illustrates an easily overlooked point: for Bayesians, priors are used only to incorporate outside information and are not intended to replace the data.

TABLE 6. Root-Mean Square Errors for In-Sample Forecasts (1954.I to 1972.IV)

Predicted Variable	Type of Estimate	One quarter ahead (76 obs.)	Two quarters ahead (75 obs.)	Three quarters ahead (74 obs.)	Four quarters ahead (73 obs.)	Five quarters ahead (72 obs.)	Six quarters ahead (71 obs.)	Seven quarters ahead (70 obs.)	Eight quarters ahead (69 obs.)
CON	Priors	14.43	10.80	9.04	9.48	11.63	14.65	17.58	20.14
	Mixed	2.04	2.62	2.32	2.53	2.40	2.48	2.45	2.48
	OLS	1.66	2.37	2.63	2.84	2.93	2.98	3.02	3.03
CDEXP	Priors	34.44	33.14	31.95	30.87	29.95	29.22	28.61	28.12
	Mixed	1.06	1.25	1.14	1.22	1.18	1.22	1.19	1.21
	OLS	.81	1.19	1.33	1.44	1.48	1.53	1.54	1.56
HEXP	Priors	23.35	23.16	22.98	22.78	22.60	22.48	22.39	22.34
	Mixed	.59	.58	.58	.58	.59	.60	.60	.61
	OLS	.42	.42	.43	.43	.43	.41	.44	.45
M3	Priors	29.28	44.79	53.38	61.53	67.53	72.82	77.71	82.34
	Mixed	2.61	2.48	3.31	3.12	3.16	2.99	2.91	2.94
	OLS	2.26	2.69	3.05	3.03	3.10	3.00	2.98	3.02
BOND	Priors	12.41	17.35	18.14	16.50	14.13	12.53	13.08	15.48
	Mixed	2.27	2.48	2.66	2.59	2.53	2.50	2.50	2.51
	OLS	1.86	2.21	2.28	2.30	2.27	2.31	2.33	2.39
EQUITY	Priors	71.53	126.67	169.90	204.61	232.29	254.81	273.38	288.75
	Mixed	.78	.82	1.02	.94	1.10	.94	1.02	.99
	OLS	.60	.79	.85	.83	.84	.84	.89	.97
NONMKT	Priors	7.26	12.69	17.57	22.03	26.05	29.67	32.87	35.72
	Mixed	1.56	2.11	2.52	2.73	2.88	3.09	3.21	3.26
	OLS	1.23	1.55	1.71	1.78	1.78	1.85	1.86	1.87
MORT	Priors	9.76	17.28	23.65	29.37	34.37	38.65	42.37	45.70
	Mixed	.62	.99	1.12	1.16	1.21	1.20	1.18	1.16
	OLS	.48	.74	.83	.91	1.03	1.16	1.26	1.32
LOAN	Priors	5.98	8.00	9.32	10.17	11.13	11.77	12.39	12.95
	Mixed	2.06	1.42	1.91	1.67	1.89	1.86	1.92	1.90
	OLS	1.45	1.75	1.91	2.00	2.06	2.14	2.23	2.26

Note: Estimates are analogous to those in Table 3 but use only data through 1972.IV.

TABLE 7. Root-Mean-Square Errors for Out-of-Sample Forecasts (1973.I to 1975.IV)

Predicted Variable	Type of Estimate	One quarter ahead (12 obs.)	Two quarters ahead (11 obs.)	Three quarters ahead (10 obs.)	Four quarters ahead (9 obs.)	Five quarters ahead (8 obs.)	Six quarters ahead (7 obs.)	Seven quarters ahead (6 obs.)	Eight quarte ahea (5 obs
CON	Priors	78.51	59.69	68.78	88.69	114.92	141.17	166.79	191.97
	Mixed	6.94	7.69	8.84	9.27	9.19	9.74	10.29	10.6
	OLS	25.07	22.07	13.53	8.84	11.64	10.43	12.36	12.7
CDEXP	Priors	219.69	219.21	218.88	216.41	222.11	206.55	197.04	185.67
	Mixed	5.83	5.62	5.66	5.76	6.00	6.19	6.58	6.9
	OLS	18.07	11.67	4.70	6.56	3.81	4.75	3.81	4.17
HEXP	Priors	133.02	133.63	136.40	136.82	142.04	134.83	130.19	124.0
	Mixed	7.14	7.31	7.56	7.56	7.32	6.92	6.89	5.3
	OLS	3.53	3.83	5.05	5.00	5.09	4.84	4.95	3.9
M3	Priors	246.24	398.79	506.31	598.17	681.18	738.84	778.32	788.4
	Mixed	21.66	38.21	51.60	61.75	67.60	71.70	72.73	70.37
	OLS	27.21	55.86	65.65	74.16	76.04	77.68	17.02	74.3
BOND	Priors	50.14	53.69	46.89	54.15	88.32	129.78	173.44	217.6
	Mixed	6.52	8.66	9.36	10.82	13.12	15.08	16.97	18.4
	OLS	18.37	7.39	6.63	5.91	5.47	6.71	9.21	11.7
EQUITY	Priors	189.57	341.33	470.83	588.32	697.71	775.79	829.97	863.6
	Mixed	1.49	2.22	3.67	5.46	7.45	9.65	11.65	13.2
	OLS	6.28	3.55	6.82	8.58	11.92	14.95	18.12	20.7
NONMKT	Priors	58.31	108.30	151.50	195.39	238.18	275.00	304.72	323.4
	Mixed	18.69	33.19	44.34	54.72	62.55	69.08	73.15	73.9
	OLS	29.99	38.76	46.13	49.46	51.52	51.87	51.41	48.4
MORT	Priors	77.34	142.21	200.45	258.94	315.54	360.92	398.34	425.4
	Mixed	6.62	12.58	17.95	23.59	29.38	34.53	38.77	41.4
	OLS	4.30	8.11	13.22	18.80	25.30	31.24	36.57	40.6
LOAN	Priors	30.67	57.33	81.87	108.46	134.37	154.44	171.94	187.2
	Mixed	7.77	12.88	16.67	19.85	22.44	24.43	25.36	24.1
	OLS	22.97	13.09	11.15	18.45	18.95	21.98	22.41	22.1

Note: See Table 6.

TABLE 8. Selected Out-of-Sample One-Quarter Forecasts

	Consumption			M3			Equity		
	OLS	Mixed	Actual	OLS	Mixed	Actual	OLS	Mixed	Actual
1973I	157.91	160.28	163.98	713.99	715.15	723.83	852.09	851.95	851.65
II	177.14	172.57	174.40	730.67	730.48	749.50	760.93	763.34	762.51
III	195.54	181.94	177.88	755.22	755.64	764.93	793.68	799.43	799.50
IV	195.50	184.26	191.36	751.74	454.13	787.36	682.81	686.80	683.39
1974I	199.82	181.68	182.25	781.13	787.39	803.25	675.41	680.58	683.19
II	217.74	191.01	195.38	788.29	794.68	825.65	594.49	600.68	601.55
III	223.63	191.42	199.85	790.85	800.76	832.75	428.24	435.41	436.74
IV	241.08	203.22	211.60	817.81	831.08	850.22	469.05	477.25	477.12
1975I	240.16	208.91	201.21	839.70	846.20	866.68	562.72	569.00	570.77
II	255.52	224.94	213.59	870.27	874.71	900.89	658.20	663.82	664.30
III	240.68	208.21	218.11	896.50	904.62	918.10	586.50	591.55	591.75
IV	266.01	225.43	232.25	926.19	931.13	941.88	622.82	631.71	630.51

The actual forecasts in Table 8 highlight a number of interesting features of our model. For example, many studies have had a good deal of trouble explaining the recent behavior of the demand for money; single equation models have dramatically overpredicted money holdings for the 1973-76 period. For both the OLS and the mixed estimates, our multi-asset, integrated framework consistently *underpredicts* the stock of real-balances for that period. This warrants closer scrutiny, and our planned future research includes this on the agenda. Table 8 also illustrates the value of prior information: in virtually every instance using the mixed estimates causes the forecast to move away from the OLS predicted value in the direction of the actual value. The OLS estimates cause us to consistently overpredict consumption; the mixed estimates lead to predictions which are not only closer to the actual values (as is obvious from the RMSE's reported in Table 7) but which also involve no systematic bias. A similar but less marked situation is true for the equities equation where the OLS estimates lead to systematic underprediction.[10] Similar results characterize many of the equations not reported here, with the exception of housing expenditures where the mixed estimates predict considerably worse than do the OLS estimates.

V. Summary and Conclusions

The results reported in the preceding sections of this paper are very encouraging, and suggest to us that this approach to modelling flows-of-funds is a fruitful one. Standard hypothesis tests reported in Section II verify the importance of the asset composition effect and also of "off-diagonal" price and interest rate responses and adjustment coefficients. Further, the estimates reported in Section III and the forecasts in Section IV suggest that explicit incorporation of *a priori* information is a valuable way of dealing with the "problems" of OLS estimates resulting from the large number of explanatory variables and weaknesses of the data. Mixed estimates, which combine our subjective beliefs about the coefficients with information present in the data, lead to an improvement in both the subjective appearance and, in many cases, the forecasting accuracy of the model. These mixed estimates will, it is hoped, be of greater use to other researchers than estimates heretofore available by virtue of the fact that our use of prior information has been explicit.

APPENDIX A

Variable Definitions and Sources

The definitions below, although verbal, follow Flow of Funds terminology very closely. Familiarity with the Flow of Funds accounts should enable the reader to duplicate all of the results in the paper.

A. Stocks and Flows

- *CON* consumption outlays on nondurables and services
- *CDEXP* expenditures on consumer durables
- *HEXP* expenditures on residential structures
- *M3* currency, demand deposits, time deposits, and savings accounts
- *BOND* U.S. securities except savings bonds, state and local government obligations, corporate and foreign bonds, and open market paper
- *EQUITY* corporate equity and investment company shares
- *NONMKT* "non-marketable" assets: life insurance reserves, pension fund reserves, savings bonds, and various miscellaneous assets
- *MORT* mortgage loans
- *LOAN* liabilities except mortgages (mostly consumer credit)
- *KCD* stock of consumer durables
- *KIH* stock of housing
- *Y* current income (the sum of expenditures and net acquisitions of financial assets)
- *YE* expected income (exponential trend on *Y* with serial correlation adjustment - see below)

CG capital gains on equity = ΔEquity(level) - flow (this may actually be an estimate of *unrealized* capital gains)

B. Prices, Interest Rates, and Miscellaneous

PCD durables deflator

PIH housing investment deflator

PH overall household deflator

RM3 rate on time deposits

RBOND = .1FYGM3 + .1FYG35 + .4FY20M + .4FYAVG

REQUITY effective yield on equity - see below

RMORT = FYFHA

RLOAN = FY35R

POP noninstitutional population 16 and over, thousands of persons

C. Sources

Stocks & Flows (except *KCD & KIH):* Flow of Funds accounts (not seasonally adjusted)

KCD, KIH: Fair (p. 36)

PCS, PCN, PIH, PCD: Fair (pp. 36, 37)

FYGMC market yield on 3-month treasury bills

FYG35 market yield on 3-5 year government securities

FY20M Bond Buyer average yield on 20 municipal bonds

FYAVG Moody's average yield on corporate bonds

FYFHA rate on new home mortgages (secondary market, FHA insured)

FY35R bank rate on short-term business loans

REQUITY Kim Kowalewski & Gary Smith

RM3 MPS data bank

POP Fair (p. 37)

Expected income was calculated in the following manner: We estimated an exponential time trend on real per capita income, Z = *Y/PH.POP*, over the period 1952.II to 1975.IV:

$$\ln \hat{Z} = -7.02 + .0228 \text{ time} + .138 \hat{u}_{-1}$$

where time = 0 in 1951.IV, measured in years, and the last term corrects for serial correlation. This correction eliminates successive mistakes in predicting income and thus gives a more reasonable estimate of transitory income. Expected income is then computed by

$$YE = \exp(\hat{Z}) . PH.POP.$$

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FOOTNOTES

[1] This "balance-sheet" effect also plays a central role in the recent work of Mishkin. Both he and Purvis relate this effect to differences in various views about the transmission mechanism by which monetary phenomena affect the real sector of the economy.

[2] By significance we mean a t-statistic greater than or equal to 1.67 in absolute value.

[3] These are labelled in the tables as discrepancies from the desired stocks in order to emphasize their interpretation as stock-adjustment behavior.

[4] See Savage (1962, pp. 98-100) and Roberts (1975).

[5] Savage (1962, pp. 99-100) would probably agree to Bayesian analysis in this case: "Not in principle as an essential but as a courtesy and perhaps as a practical necessity, the scientist may present an opinion that he hopes will be more or less public [i.e., commonly accepted]. His argument would be of the following form, though some parts of it may be left tacit: 'I suppose that you all, like me, will agree on such and such aspects of our prior opinions and on such and such a model of the experiment. According to Bayes's theorem we now all have approximately such and such opinions in common until one of us has more data on the basis of which to revise opinions.'"

[6] This argument obviously depends on the model in question. As a general rule, however, there is probably less disagreement about parameters than about specification.

[7]To estimate the complete model we would need to specify 144 variances and 10,296 covariances. Smith and Brainard are currently investigating methods of specifying the complete system covariance matrix.

[8]This argument is also non-Bayesian: after estimation a true Bayesian's beliefs are the mixed estimates since previous opinions have been modified by the data.

[9]Brainard and Smith also found this (1976, Tables 6 and 10), but we know of no reason why this should occur.

[10]Note that the apparent extraordinary accuracy of the equity equation arises because we have chosen, at this stage, not to try to explain capital gains on equities.