INTERTEMPORAL ASSET-PRICING RELATIONSHIPS IN 
BARTER AND MONETARY ECONOMIES 
An Empirical Analysis*

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This paper explores whether liquidity services and nonsuperneutral effects of money are important for and permit improved explanation of asset returns. Euler equations governing asset choices, implied by dynamic barter, cash-in-advance (CIA), and money-in-the-utility function models, are estimated and testing using generalized-method-of-moments techniques and monthly data for the U.S. Observational equivalence between CIA and barter models is shown under specific assumptions about the timing of information and decisions. The findings suggest that only for one CIA model are monetary effects both important for and permit improved explanation of asset returns. Success in this regard is (not) for stock (treasury-bill) returns.

1. Introduction

This paper empirically explores the intertemporal asset-pricing relationships implied by a variety of dynamic general-equilibrium barter and monetary economy models. The purpose is to ascertain whether the liquidity services and nonsuperneutral effects of money significantly affect the dynamics of asset-pricing relationships and whether their consideration permits improved explanation of those relationships. Here, these issues are addressed by systematically estimating, testing, and comparing the stochastic Euler equations governing agents' optimal asset choices, as specified by alternative barter and monetary economy models. The barter models considered are

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based on Rubinstein (1976), Lucas (1978), and Breeden (1979). The monetary models considered consist of cash-in-advance (CIA) models based on Lucas (1982), Lucas (1984), and Svensson (1985a) and a money-in-the-utility-function (MIUF) model based on Dixit and Goldman (1970), Fama and Farber (1979), LeRoy (1984a, b), and Stulz (1983). Preferences are assumed to be time-separable and of the constant-relative-risk-aversion type, defined over either an aggregate nondurable consumption good or a composite good comprising aggregate nondurable consumption and real money balances. The generalized-method-of-moments estimation technique proposed by Hansen (1982) and Hansen and Singleton (1982) and monthly data on U.S. consumption, money, prices, stock, and treasury-bill returns over the 1959:4–1986:12 time period are employed.

A sizeable empirical literature examines asset-pricing relationships derived from barter economy models under a wide variety of specifications of preferences and household technologies for producing services from goods, estimation methods, and data sets. One of the upshots of this literature is that barter economy models have had some success in individually explaining stock and treasury-bill returns but fall very far short of explaining both types of asset return simultaneously. This latter failure is dramatically encapsulated in the numerical simulation study of Mehra and Prescott (1985), which first stated the equity premium puzzle. Recently, there also have been some studies which empirically investigate asset-pricing relationships derived from monetary economy models. Singleton (1985) estimates an interest-rate return relationship derived from a Lucas (1982)-based CIA model. Poterba and Rotemberg (1987) jointly estimate treasury-bill, savings-deposit, and stock return relationships implied by a MIUF model. Ogaki (1988) individually estimates a treasury-bill return relationship and jointly estimates treasury-bill and stock return relationships derived from a Lucas (1984)-based CIA model. Eckstein and Leiderman (1989) estimate an interest-rate return relationship implied by a MIUF model. Marshall (1989) and Giovannini and Labadie (1989) numerically simulate, respectively, a transactions-cost monetary model and both Lucas (1982) and Svensson (1985)-based CIA models, in order to analyze model predictions for stock and treasury-bill returns. These studies provide some support for the importance of monetary considerations in asset pricing. Those examining multiple asset returns suggest, however, that the associated models do not adequately explain stock and treasury-bill return relationships simultaneously. These empirical findings are borne in mind when discussing the findings of the present study. First, our results are compared to those obtained in other studies for identical asset-pricing

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relationships and similar data sets. Specifically, our barter-model [Lucas (1984)-model] results are compared to the corresponding results in Hansen and Singleton (1984) [Ogaki (1988)]. Second, we examine the various models’ ability to explain stock and treasury-bill returns both on an individual and simultaneous basis.

Section 2 specifies and discusses the stochastic Euler equations which serve as a basis for the empirical work. Section 3 discusses the estimation technique, tests, and the data. Section 4 presents the estimation results and section 5 concludes the paper.

2. Theoretical background

CIA models based on Lucas (1982), Lucas (1984), and Svensson (1985a) are considered in sequence. For each of these models it is assumed that the representative agent has preferences defined over stochastic processes of consumption given by

\[ E_0 \sum_{t=0}^{\infty} \beta^t u(c_t), \]

\[ u(c_t) = c_t^\gamma / \gamma \quad \text{for} \quad \gamma \neq 0, \]

\[ u(c_t) = \log(c_t) \quad \text{for} \quad \gamma = 0, \]

\[ 0 < \beta < 1, \quad \gamma < 1, \]

where \( E_0 \) is the expectations operator conditioned on information at time 0, \( \beta \) is the subjective discount factor, \( u( ) \) is the momentary utility function, \( c_t \) is real consumption at time \( t \), \( \log \) is the natural logarithm, and \( \gamma \) is a preference parameter.

In Lucas (1982) each period is envisaged as comprising of two subperiods. During the first subperiod only asset markets are open and during the second subperiod only goods markets are open. Agents trade money and assets and receive asset payoffs during the asset market subperiod. Shares held at the beginning of this subperiod entitle the owner to dividends from the sale of goods during the previous goods market subperiod. Goods endowments materialize and are traded during the goods market subperiod. Goods must be bought with money acquired in advance. Money that is not currently spent on goods enters as a component of wealth at the beginning of the following period. This assumed sequencing of and restrictions on transactions is re-
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flected in the agent's budget constraint,

\[ a_t s_t + (1 + i_t)^{-1} b_t + M_t = (a_t + d_{t-1}) s_{t-1} + b_{t-1} + M_{t-1} - P_{t-1} c_{t-1}, \tag{2} \]

and CIA constraint,

\[ M_t \geq P_t c_t, \tag{3} \]

where \( s_t \) is the number of shares bought at time \( t \), \( b_t \) is the number of bonds bought at time \( t \) whose payoff is one nominal money unit at time \( t + 1 \), \( M_t \) is nominal money chosen at time \( t \), \( a_t \) is the nominal time-\( t \) price of a share, \((1 + i_t)^{-1}\) is the nominal time-\( t \) price of one unit of the bond, \( d_t \) is the nominal value of the time-\( t \) dividend, and \( P_t \) is the time-\( t \) price level. Assume next that the agent receives full current information at the beginning of time \( t \) and maximizes (1) by choosing \( c_t, s_t, b_t, \) and \( M_t \) subject to (2) and (3). This optimization problem implies the following stochastic Euler equations governing share and bond choices, respectively:

\[
\begin{align*}
    u_c(t) &= \beta \mathbb{E}_t \left[ u_c(t + 1) \frac{P_t}{P_{t+1}} (a_{t+1} + d_{t+1}) \right], \tag{4} \\
    u_c(t) &= \beta \mathbb{E}_t \left[ u_c(t + 1) \frac{P_t}{P_{t+1}} (1 + i_t) \right], \tag{5}
\end{align*}
\]

where \( u_c(t) = c_t^{\gamma - 1} \), the marginal utility of time-\( t \) consumption. Noting the timing convention in Lucas (1982), the following empirical formulations of (4) and (5) are adopted:

\[
\begin{align*}
    u_c(t) &= \beta \mathbb{E}_{\theta_t} \left[ u_c(t + 1) \frac{P_t}{P_{t+1}} (a_t^e + d_t^e) \right], \tag{6} \\
    u_c(t) &= \beta \mathbb{E}_{\theta_t} \left[ u_c(t + 1) \frac{P_t}{P_{t+1}} (1 + i_t^{e-1}) \right], \tag{7}
\end{align*}
\]

where use has been made of \( a_t^e = a_{t-1}^e \) and \( i_t^{e-1} = i_{t-1}^e \), superscript \( e \) denotes a start-of-period (end-of-period) value, and \( \theta_t \) is an information set which includes all information through time \((t - 1), c_t \), and \( P_t \).\footnote{\( \theta_t \) also includes \( d_t^e \) for the Lucas (1982) model. This is ignored for the results reported in the text since \( d_t^e \) turns out to be irrelevant in constructing instruments for estimating and testing the orthogonality conditions implied by (6) and (7).} In Lucas (1982)
positive nominal interest rates emerge as a reflection of and compensation for the absence of currently valued liquidity services from bonds. There is a one-to-one correspondence between currently binding CIA constraints and positive nominal interest rates. Therefore, only equilibria with binding CIA constraints are of interest in this model, even though equilibria with nonbinding CIA constraints may theoretically occur. The former equilibria are characterized by a demand for money that is exclusively a transactions demand, i.e., the quantity theory holds, where the income velocity of money is unity. A discussion of the nonsuperneutrality of money in the Lucas (1982) model is contained in Lucas (1982) and Svensson (1985a, b).

Given the preference specification in (1) and assuming full current-period information, Hansen and Singleton (1982) show that the stochastic Euler equations governing share and bond choices implied by a barter economy model are

\[
\frac{c_t}{x_t} = \beta \frac{P_t}{P_{t+1}} \left[ u_c(t+1) \frac{a_{t+1} + d_{t+1}}{a_t} \right],
\]

(8)

\[
\frac{c_t}{x_t} = \beta \frac{P_t}{P_{t+1}} \left[ u_c(t+1) \frac{P_t}{P_{t+1}} (1 + i_t) \right].
\]

(9)

The barter economy model is based on Rubinstein (1976), Lucas (1978), and Breeden (1979). Further assuming that agents consume and invest at the end of the period, their empirical formulation of (8) and (9) is

\[
\frac{c_t}{x_t} = \beta \frac{P_t}{P_{t+1}} \left[ u_c(t+1) \frac{a_{t+1}^* + d_{t+1}^*}{a_t^*} \right],
\]

(10)

\[
\frac{c_t}{x_t} = \beta \frac{P_t}{P_{t+1}} \left[ u_c(t+1) \frac{P_t}{P_{t+1}} (1 + i_t^c) \right].
\]

(11)

Eqs. (10) and (11) will be referred to as the end-of-period barter model or barter-e model. If, instead, agents are assumed to consume and invest at the start of the period, then the empirical formulations of (8) and (9) coincide with (6) and (7), respectively. There is thus an observational equivalence between the Lucas (1982) model and the start-of-period barter model (or barter-s model) in respect to the stochastic Euler equations governing asset choices. This equivalence is ‘observed’ for the first time in this study. Comparison of (6) and (7) with (10) and (11) reveals that the nominal asset

\[^3\]Subsequent empirical studies of the barter economy model also adopted this timing convention.
returns in the former model are one-period-lagged relative to those in the latter model. The barter- model is empirically examined in this study, not only because it is a benchmark barter-economy model but also because it allows an assessment of the empirical significance of this difference in the timing of nominal asset returns.

The Lucas (1984) model differs from the Lucas (1982) model in one fundamental respect—in the former model agents are not assumed to receive full current information at the beginning of time \( t \). Rather, agents are assumed to receive partial current information at the beginning of the time-\( t \) asset market subperiod (consisting of information on current asset prices) and full current information is not received until the beginning of the time-\( t \) goods market subperiod. The Svensson (1985a) model differs from the Lucas (1982) model in one crucial respect also—the sequencing of markets within the period is precisely the reverse. It turns out that the stochastic Euler equations governing asset choices that are implied by the Svensson (1985a) model are identical to those implied by the Lucas (1984) model. Under the Lucas (1984) informational assumption, assume that the representative agent maximizes (1) by choosing \( c_t, s_t, b_t, \) and \( M_t \) subject to (2) and (3). The implied stochastic Euler equations governing share and bond choices are

\[
\begin{align*}
\mathbb{E}_t \left[ \frac{u_c(t)}{P_t} - \beta \frac{u_c(t + 1)}{P_{t+1}} \left( a_{t+1} + d_t \right) \right] &= 0, \tag{12} \\
\mathbb{E}_t \left[ \frac{u_c(t)}{P_t} - \beta \frac{u_c(t + 1)}{P_{t+1}} (1 + i_t) \right] &= 0, \tag{13}
\end{align*}
\]

where \( I_t \) denotes an information set which includes all information through time \( (t - 1) \), \( a_t \) and \( i_t \). Noting the timing convention in Lucas (1984), the following empirical formulations of (12) and (13) are adopted:

\[
\begin{align*}
\mathbb{E}_{t-1} \left[ \frac{u_c(t)}{P_t} - \beta \frac{u_c(t + 1)}{P_{t+1}} \left( a_t^c + d_t^c \right) \right] &= 0, \tag{14} \\
\mathbb{E}_{t-1} \left[ \frac{u_c(t)}{P_t} - \beta \frac{u_c(t + 1)}{P_{t+1}} (1 + i_t^c) \right] &= 0. \tag{15}
\end{align*}
\]

Svensson (1985a) provides an explicit characterization of the equilibrium and shows that the nominal interest rate is always positive. The positive nominal

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4Singleton (1985) also pointed out this timing difference between the barter- and Lucas (1982) models.

5See Svensson (1985a) and/or Finn, Hoffman, and Schlagenauf (1988) for further details.
interest rate is a reflection of and compensation for the absence of expected future valued liquidity services from bonds. Recalling the equivalence between Lucas (1984) and Svensson (1985a), it follows that equilibria with currently nonbinding CIA constraints are of interest in these models since they are consistent with positive nominal interest rates. On this point Lucas (1984) and Svensson (1985a) sharply differ from Lucas (1982). The former models are thus characterized by the possibility of a more reasonable specification of the demand for money, i.e., a combined transactions, precautionary, and state-of-value demand for money or a variable income velocity of money, holding simultaneously with positive nominal interest rates. A discussion of the nonsuperneutrality of money in the Svensson (1985a) model is contained in Svensson (1985a) and Giovannini (1989).

Comparing (6) and (7) with (14) and (15) succinctly shows that the asset-pricing implications differ across the Lucas (1982) and Lucas (1984)/Svensson (1985a) models only in that \( c_t \) and \( P_t \) are assumed to be known in the former when agents undertake their current investment decisions. This, and the earlier discussion of observational equivalence, prompts the statement that if one envisions agents in the barter-s model as choosing their investment plans prior to knowing the current price level and consumption, then (14) and (15) are also implied by such a model. The latter will be referred to as the barter-s model with lagged information. There is thus an observational equivalence between the Lucas (1984)/Svensson (1985a) model and the barter-s model with lagged information. This equivalence is observed for the first time in this study. Correspondingly, a barter-e model with lagged information may also be imagined in which agents choose investment plans prior to knowing the current price level and consumption. The implied stochastic Euler equations governing share and bond choices are

\[
E_{\Omega_t} \left[ \frac{u_c(t)}{P_t} - \beta \frac{u_c(t+1)}{P_{t+1}} \frac{(a_{t+1}^r + d_{t+1}^r)}{a_t^c} \right] = 0, \tag{16}
\]

\[
E_{\Omega_t} \left[ \frac{u_c(t)}{P_t} - \beta \frac{u_c(t+1)}{P_{t+1}} (1 + i_t^c) \right] = 0, \tag{17}
\]

where \( \Omega_t \) denotes an information set including all information through time \( (t - 1), a_t^r, d_t^r, \) and \( i_t^c \). Consideration of this barter-e model with lagged information is new. It is empirically explored here in order to serve as an additional benchmark barter economy model and to enrich the attempt of discerning the empirical significance of differences in both the timing of nominal asset returns and the timing of information flows across models.
The MIUF model is based on Dixit and Goldman (1970), Fama and Farber (1979), LeRoy (1986a,b), and Stulz (1983). The representative agent is assumed to have preferences defined over stochastic processes of consumption and real money balances given by

$$E \sum_{t=0}^{\infty} \beta^t u(c_t, M_t/P_t),$$

$$u(c_t, M_t/P_t) = \left[ c_t^{\delta}(M_t/P_t)^{(1-\delta)} \right]^{\gamma}/\gamma \quad \text{for} \quad \gamma \neq 0,$$

$$u(c_t, M_t/P_t) = \delta \log(c_t) + (1-\delta) \log(M_t/P_t) \quad \text{for} \quad \gamma = 0,$$

$$0 < \beta < 1, \quad 0 < \delta < 1, \quad \gamma < 1,$$

where $\delta$ is a preference parameter capturing the relative importance of consumption and real money balances in the utility function. Assume next that the agent has full current information and maximizes (18) by choosing $c_t$, $s_t$, $h_t$, and $M_t$ subject to the budget constraint:

$$P_t c_t + a_t s_t + (1 + i_t)^{-1} b_t + M_t = (a_{t+1} + \delta) s_{t-1} + b_{t-1} + M_{t-1}. \quad (19)$$

This problem implies the following stochastic Euler equations, respectively, governing share, bond, and money choices:

$$u_s(t) = \beta E_{t} \left[ u_s(t+1) \frac{P_t}{P_{t+1}} \left( \frac{a_{t+1} + d_{t+1}}{a_t} \right) \right], \quad (20)$$

$$u_s(t) = \beta E_{t} \left[ u_s(t+1) \frac{P_t}{P_{t+1}} (1 + i_t) \right], \quad (21)$$

$$u_s(t) = u_{M/P}(t) + \beta E_{t} \left[ u_s(t+1) \frac{P_t}{P_{t+1}} \right], \quad (22)$$

where $u_c(t) = \delta c_t^{\delta \gamma} (M_t/P_t)^{(1-\delta)\gamma}$ is the marginal utility of time-$t$ consumption and $u_{M/P}(t) = (1-\delta) c_t^{\delta \gamma} (M_t/P_t)^{(1-\delta)\gamma} - 1$ is the marginal utility of time-$t$ real money balances. For the MIUF model it is assumed that agents consume and invest at the end of each period. Accordingly, set $a_{t+1} = a_{t+1}'$, $d_{t+1} = d_{t+1}'$, $i_t = i_t'$, and measure $M_t$ by the money stock at the end of time $t$. With this timing convention for choices, it follows that when $\delta = 1$ the share and

A MIUF model, based on Danthine and Donaldson (1986), in which it is assumed that agents' current choices of money yield future utility, was also estimated and tested. The findings for this model were very similar to those for the MIUF model discussed in the text. See Finn, Hoffman, and Schlagenhauf (1989) for details.
bond asset-pricing equations of the MIUF model collapse to those of the barter-e model. By placing real money balances directly in the utility function, the MIUF model is consistent with a combined transactions, precautionary and store-of-value demand for money. The marginal value of liquidity services is directly given by the current marginal utility of nominal money, and positive nominal interest rates reflect the absence of this value from nominal bonds. A discussion of nonsuperneutrality of money in MIUF models is contained in Sargent (1987).

3. Data, estimation technique, and tests

The sample period for the estimation is April 1959 through December 1986. U.S. monthly data on per-capita real consumption, per-capita money supply, prices, stock and treasury-bill returns are employed. Appendix 1 provides details of the data and their sources.

The generalized-method-of-moments (GMM) estimation technique and associated J-test proposed by Hansen (1982) and Hansen and Singleton (1982) are used. These studies provide conditions under which the GMM estimator is consistent, asymptotically normal and ‘optimal’ in the sense of having the smallest asymptotic covariance matrix among the class of GMM estimators employing alternative choices of weighting matrices and a given set of instruments. The J-test is a test of the overidentifying restrictions implied by the model. The C-test, proposed by Eichenbaum, Hansen, and Singleton (1988), is used to test a unit-value restriction on the δ parameter of the MIUF model. The conditions ensuring that the GMM estimator has the aforementioned properties include that the stochastic Euler equations are functions of stationary variables and that the instrumental variables are stationary. Appendix 2 notes the stationary form of each Euler equation and associated instrument set for each of the models.

Alternative timing conventions for choices and/or alternative assumptions with regard to information flows are not investigated in the context of the MIUF model. The effects of these alternatives have been isolated in examining the various barter models.

Diagnostic testing supports the stationarity of all variables entering these equations and instrument sets except for the ratio of real money balances to consumption. This velocity measure is nonstationary [which is consistent with the evidence in Marshall (1989)]. It follows that no stationarity-inducing transformation of the money Euler equation is possible. Estimation techniques appropriate for Euler equations involving both stationary and nonstationary variables await development. Here, the problem of nonstationary velocity is controlled for by estimating the MIUF model both with and without the money Euler equation.

The chosen instrument set for each Euler equation comprises a constant and the most recently observed values in agents’ information sets of the variables entering into that Euler equation. One exception to this rule arises in the case of the MIUF model. The Euler equation governing money holdings includes \( \frac{M_t}{P_t} \frac{c_t}{c_{t+1}} \), while the associated instrument set excludes its one-period lag. This exclusion is immaterial for the results due to the inclusion of \( \frac{M_t}{P_t} \frac{c_t}{c_{t+1}} \).
The reported estimation results are qualitatively robust to choices over a number of alternative instrument sets, starting guesses for the models' parameters, starting guesses for the weighting matrices and to further iterations over these matrices. The estimation results for the lagged-information versions of the barter-e and barter-s models obtain having used the Hansen and Singleton (1982) autocorrelation correction procedure to adjust for first-order serial correlation in the residuals of these models.

4. Estimation results

The estimation results for the barter-e model are presented in table 1. The discount parameter estimate, $\hat{\beta}$, is slightly less than unity, precise, and significantly greater than zero. The estimated coefficient of relative risk aversion, $\hat{\alpha}$, is in the concave region of parameter space, imprecise, and significantly greater than zero in all cases but those of the individual estimation of the stock Euler equation. The $J$-test indicates strong rejection of the model, at most at the 3.17 percent significance level, in all cases except those of the individual estimation of the stock Euler equation when value-weighted stock returns are used. The $J$-test in the latter cases easily indicates nonrejection at the 5 percent significance level. Hansen and Singleton (1982/1984) also estimated the barter-e model using some comparable data sets to those used here. Their findings closely compare to those corresponding findings reported here – not only in terms of parameter estimates but also in terms of the patterns and strength of rejections of the overidentifying restrictions of the model.

Table 2 presents the estimation results for the barter-e model with lagged information. Sharp differences between these results and those for the barter-e model emerge in the case of the individual estimation of the stock Euler equation. In particular, for this case in table 2, estimates of $\alpha$ are in the nonconcave region and are much more imprecise, while the $J$-test

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10 Finn, Hoffman, and Schlagenhauf (1989) provide exact details of the alternative instrument sets.
11 The reported estimation results use the following starting guesses for model parameters: $\beta = 1$, $\gamma = -1$, $\delta = 0.9$. These parameter guesses were also used to construct the initial weighting matrix for the reported estimation results. The associated estimate of the weighting matrix generally converged after two iterations.
12 Statements of significant differences pertaining to parameter estimates mean significant differences from the value indicated based on a one-tail $t$-test at the 5 percent significance level.
13 The marginal significance level (MSL) is one minus the probability that a $\chi^2$(df) random variable has a smaller value than the computed value of the test statistic under the null hypothesis that the overidentifying restrictions implied by the model are true.
14 For the comparable data sets, the present study uses a longer sample period and different data sources than Hansen and Singleton (1982/1984).
Table 1
Estimation results for barter-e model (1959:4–1986:12).\textsuperscript{a}

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Return</th>
<th>$\hat{\beta}$</th>
<th>$\hat{SE}(\beta)$</th>
<th>$\hat{\alpha} = 1 - \gamma$</th>
<th>$\hat{SE}(\hat{\alpha})$</th>
<th>J(df)</th>
<th>MSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Stock and bond Euler equations: (10) and (11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9998</td>
<td>0.0003</td>
<td>0.5593</td>
<td>0.1829</td>
<td>32.23(4)</td>
<td>0.0001</td>
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<tr>
<td>NDS</td>
<td>VWR</td>
<td>0.9999</td>
<td>0.0003</td>
<td>0.4925</td>
<td>0.1629</td>
<td>24.74(4)</td>
<td>0.0001</td>
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<tr>
<td>ND</td>
<td>EWR</td>
<td>0.9989</td>
<td>0.0003</td>
<td>0.2539</td>
<td>0.0955</td>
<td>30.68(4)</td>
<td>0.0001</td>
</tr>
<tr>
<td>ND</td>
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<td>0.9991</td>
<td>0.0003</td>
<td>0.2273</td>
<td>0.0919</td>
<td>19.56(4)</td>
<td>0.0006</td>
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<td>B. Stock Euler equation: (10)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9917</td>
<td>0.0042</td>
<td>1.2912</td>
<td>2.4458</td>
<td>4.61(1)</td>
<td>0.0317</td>
</tr>
<tr>
<td>NDS</td>
<td>VWR</td>
<td>0.9949</td>
<td>0.0032</td>
<td>0.1463</td>
<td>1.9177</td>
<td>0.49(1)</td>
<td>0.4857</td>
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<tr>
<td>ND</td>
<td>EWR</td>
<td>0.9904</td>
<td>0.0026</td>
<td>1.5842</td>
<td>1.0471</td>
<td>6.05(1)</td>
<td>0.0138</td>
</tr>
<tr>
<td>ND</td>
<td>VWR</td>
<td>0.9947</td>
<td>0.0022</td>
<td>0.7798</td>
<td>0.7821</td>
<td>0.76(1)</td>
<td>0.3837</td>
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<tr>
<td>C. Bond Euler equation: (11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td></td>
<td>0.9999</td>
<td>0.0003</td>
<td>0.4984</td>
<td>0.1609</td>
<td>20.20(1)</td>
<td>0.0001</td>
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<tr>
<td>ND</td>
<td></td>
<td>0.9990</td>
<td>0.0003</td>
<td>0.2343</td>
<td>0.0913</td>
<td>13.92(1)</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

\textsuperscript{a}(1) NDS (ND) denotes the nondurables-plus-services (nondurables) measure of real per-capita consumption. EWR (VWR) denotes the equally-(value)-weighted stock return measure.

(2) $\hat{\beta}$ denotes an estimate. $\hat{SE}$ is the standard error of the corresponding parameter estimate. J(df) is the J-statistic whose degrees of freedom are indicated in parentheses. MSL is the marginal significance level of the J-statistic.

(3) Sample size is 333.

indicates nonrejection of the model at the 5 percent significance level – even when equally-weighted returns are used. Since for the barter-e model with lagged information the higher marginal significance values of the J-statistic go hand-in-hand with nonconcave estimates of $\alpha$, it is not regarded as being in better accord with the data than is the barter-e model. Therefore, the lagged-information assumption does not result in improved explanation of the data.

The estimation findings for the Lucas (1982)/barter-s model are contained in table 3. There is one crucial difference between these findings and those for the barter-e model. It concerns the individual estimation of the stock Euler equation. Specifically, for this case in table 3, estimates of $\alpha$ are more imprecise and not only outside the concave region but significantly so. Therefore, the Lucas (1982)/barter-s model is not viewed as being more consistent with the data than is the barter-e model; nor does it seem that the monetary effects, as captured in the former model, are important. Alternatively expressed, the one-period lagging of nominal asset returns, relative to the barter-e model, does not permit improved explanation of the data. Furthermore, the Lucas (1982)/barter-s model does not perform well either when stock and treasury-bill returns are considered individually or when they are considered jointly.
Table 2
Estimation results for barter-e model with lagged information (1959:4–1986:12).\(^a\)

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Return</th>
<th>(\hat{\beta})</th>
<th>(\hat{SE}(\hat{\beta}))</th>
<th>(\hat{\alpha} = 1 - \hat{\gamma})</th>
<th>(\hat{SE}(\hat{\alpha}))</th>
<th>(J(df))</th>
<th>(MSL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(NDS)</td>
<td>(EWR)</td>
<td>0.9999</td>
<td>0.0003</td>
<td>0.3599</td>
<td>0.1603</td>
<td>24.94(6)</td>
<td>0.0004</td>
</tr>
<tr>
<td>(NDS)</td>
<td>(VWR)</td>
<td>0.9999</td>
<td>0.0003</td>
<td>0.3684</td>
<td>0.1631</td>
<td>23.85(6)</td>
<td>0.0006</td>
</tr>
<tr>
<td>(ND)</td>
<td>(EWR)</td>
<td>0.9994</td>
<td>0.0003</td>
<td>0.4189</td>
<td>0.2506</td>
<td>19.16(6)</td>
<td>0.0039</td>
</tr>
<tr>
<td>(ND)</td>
<td>(VWR)</td>
<td>0.9994</td>
<td>0.0003</td>
<td>0.4894</td>
<td>0.2692</td>
<td>16.94(6)</td>
<td>0.0095</td>
</tr>
</tbody>
</table>

A. Stock and bond Euler equations: (16) and (17)

B. Stock Euler equation: (16)

C. Bond Euler equation: (17)

\(\hat{\beta}\) and \(\hat{\alpha}\) are estimated parameters.

| \(NDS\) | \(EWR\) | 0.9874 | 0.0070 | -3.8713 | 4.6528 | 0.04(2) | 0.9824 |
| \(NDS\) | \(VWR\) | 0.9929 | 0.0052 | -1.8666 | 3.4954 | 0.10(2) | 0.9526 |
| \(ND\) | \(EWR\) | 0.9904 | 0.0037 | -2.1656 | 2.5061 | 0.83(2) | 0.6597 |
| \(ND\) | \(VWR\) | 0.9942 | 0.0029 | -0.9894 | 1.9819 | 0.59(2) | 0.7446 |

Table 3
Estimation results for Lucas (1982)/barter-s model (1959:4–1986:12).\(^a\)

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Return</th>
<th>(\hat{\beta})</th>
<th>(\hat{SE}(\hat{\beta}))</th>
<th>(\hat{\alpha} = 1 - \hat{\gamma})</th>
<th>(\hat{SE}(\hat{\alpha}))</th>
<th>(J(df))</th>
<th>(MSL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(NDS)</td>
<td>(EWR)</td>
<td>1.0002</td>
<td>0.0004</td>
<td>0.7127</td>
<td>0.2242</td>
<td>37.98(4)</td>
<td>0.0001</td>
</tr>
<tr>
<td>(NDS)</td>
<td>(VWR)</td>
<td>1.0002</td>
<td>0.0003</td>
<td>0.6071</td>
<td>0.1993</td>
<td>31.99(4)</td>
<td>0.0001</td>
</tr>
<tr>
<td>(ND)</td>
<td>(EWR)</td>
<td>0.9992</td>
<td>0.0003</td>
<td>0.2842</td>
<td>0.1102</td>
<td>35.37(4)</td>
<td>0.0001</td>
</tr>
<tr>
<td>(ND)</td>
<td>(VWR)</td>
<td>0.9991</td>
<td>0.0003</td>
<td>0.2404</td>
<td>0.0987</td>
<td>25.47(4)</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

A. Stock and bond Euler equations: (6) and (7)

B. Stock Euler equation: (6)

C. Bond Euler equation: (7)

\(\hat{\beta}\) and \(\hat{\alpha}\) are estimated parameters.

| \(NDS\) | \(EWR\) | 0.9801 | 0.0048 | -6.9243 | 2.5850 | 5.95(1) | 0.015 |
| \(NDS\) | \(VWR\) | 0.9867 | 0.0040 | -5.9484 | 2.1691 | 1.35(1) | 0.245 |
| \(ND\) | \(EWR\) | 0.9875 | 0.0031 | -3.0566 | 1.0490 | 5.56(1) | 0.018 |
| \(ND\) | \(VWR\) | 0.9927 | 0.0025 | -2.1211 | 0.8317 | 0.83(1) | 0.360 |

\(\hat{\beta}\) and \(\hat{\alpha}\) are estimated parameters.

\(^a\)Notes as for table 1.
Consider next the estimation results for the Lucas (1984)/Svensson (1985a)/barter-s model with lagged information, presented in table 4.15 There are two striking points of difference between these findings and those for the barter-e model. Again the differences in the question concern the individual estimation of the stock Euler equation. In particular, for this case in table 4, the point estimates and standard errors of \( \alpha \) as well as the marginal significance levels of the \( J \)-statistic are much larger – so much so that the model is easily not rejected at the 5 percent level even when equally-weighted returns are used. This is evidence suggesting that the Lucas (1984) model is in better accord with the data than is the barter-e model, and that the monetary effects, as captured in the former model, are important for asset pricing. Viewed alternatively, the simultaneous lagging of information and nominal asset returns relative to the barter-e model does permit improved explanation of the data. However, the Lucas (1984) model falls short of complete success. Specifically, estimates of \( \alpha \) remain imprecise (and are mostly insignificantly different from zero); while the \( J \)-test continues to reject the model, at most at the 0.68 percent significance level, both for the individual estimation of the bond Euler equation and the joint estimation of the stock and bond Euler equations. This suggests that the inconsistency of the Lucas (1984) model with the empirical behavior of treasury-bill returns is the source of its inconsistency with the joint empirical behavior of stock and treasury-bill returns. Ogaki (1988) also estimated the Lucas (1984) model using some comparable data sets to those used here.16 His findings, for the joint estimation of the stock and bond Euler equations and the individual estimation of the bond Euler equation, are consistent with those corresponding findings reported here – in terms of the strong rejection of the overidentifying restrictions implied by the model.17

Table 5 shows the estimation results for the MIUF model. \( \hat{\beta} \) is almost always less than unity, precise, and significantly greater than zero. The point estimates of \( \alpha \) and \( \delta \) imply concave preferences. The estimate of \( \alpha \) is imprecise, mostly significantly greater than zero, and significantly different from unity except for some cases involving the individual estimation of the stock Euler equation. Significant differences between \( \alpha \) and unity is tantamount to a rejection of logarithmic separability of the utility function across consumption and real money balances. The estimate of \( \delta \) is very precise and is significantly greater (smaller) than zero (unity). This latter significance result is consistent with the emphatic rejection of the restriction, \( \delta = 1 \) (in

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15 Henceforth in this section this model will be referred to as the Lucas (1984) model.
16 For the comparable data sets, the present study uses a longer sample period and different data sources than Ogaki (1988).
17 The joint estimation by Ogaki (1988) that is referred to there is a restricted estimation, where \( \beta \) is restricted to values at or below unity.
Table 4

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Return</th>
<th>(\hat{\beta})</th>
<th>(\hat{SE}(\hat{\beta}))</th>
<th>(\hat{\alpha} \equiv 1 - \hat{\gamma})</th>
<th>(\hat{SE}(\hat{\alpha}))</th>
<th>(J(df))</th>
<th>MSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9998</td>
<td>0.0003</td>
<td>0.2793</td>
<td>0.1963</td>
<td>25.17(6)</td>
<td>0.0003</td>
</tr>
<tr>
<td>NDS</td>
<td>VWR</td>
<td>0.9998</td>
<td>0.0003</td>
<td>0.2640</td>
<td>0.1869</td>
<td>23.96(6)</td>
<td>0.0005</td>
</tr>
<tr>
<td>ND</td>
<td>EWR</td>
<td>0.9993</td>
<td>0.0003</td>
<td>0.5722</td>
<td>0.3123</td>
<td>18.35(6)</td>
<td>0.0054</td>
</tr>
<tr>
<td>ND</td>
<td>VWR</td>
<td>0.9992</td>
<td>0.0003</td>
<td>0.5261</td>
<td>0.2985</td>
<td>18.21(6)</td>
<td>0.0057</td>
</tr>
</tbody>
</table>

A. Stock and bond Euler equations: (14) and (15)

B. Stock Euler equation: (14)

| NDS         | EWR    | 0.9980          | 0.0062          | 5.0821          | 4.6301          | 0.57(2)   | 0.7513 |
| NDS         | VWR    | 1.0007          | 0.0046          | 4.2877          | 3.5651          | 0.44(2)   | 0.8041 |
| ND          | EWR    | 0.9938          | 0.0032          | 2.3634          | 2.2184          | 0.94(2)   | 0.6248 |
| ND          | VWR    | 0.9964          | 0.0024          | 1.9262          | 1.6472          | 1.27(2)   | 0.5291 |

C. Bond Euler equation: (15)

| NDS         |        | 1.0003          | 0.0005          | 0.6277          | 0.4225          | 13.50(2)  | 0.0012 |
| ND          |        | 0.9995          | 0.0003          | 0.9516          | 0.4142          | 9.97(2)   | 0.0068 |

Notes as for table 1.

For the joint and individual estimations of the stock and bond Euler equations implied by the MIUF model it was necessary to fix the value of \(\delta\). Even though \(\delta\) is formally identified in each of these equations, in practice it is largely identified by the intratemporal condition governing consumption and real money balances that is implied by the money Euler equation and either of the stock or bond Euler equations. This was evident from attempts to estimate \(\delta\) without the money Euler equation – the estimate of \(\delta\) was very imprecise and wildly fluctuated as the instrument set was varied; the estimation-minimization algorithm exhibited slow or no convergence. The value of \(\delta = 0.95\) was chosen in view of the \(\delta\) estimates in panels A–C of table 5.
Table 5

Estimation results for the MIUF model (1959:4–1986:12).a

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Return</th>
<th>( \hat{\beta} )</th>
<th>( \overline{SE}(\hat{\beta}) )</th>
<th>( \delta = 1 - \gamma )</th>
<th>( \overline{SE}(\hat{\delta}) )</th>
<th>( \hat{\delta} )</th>
<th>( \overline{SE}(\hat{\delta}) )</th>
<th>J(df)</th>
<th>MSL</th>
<th>C(df)b</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Stock, bond, and money Euler equations: (20), (21), and (22)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9999</td>
<td>0.0002</td>
<td>0.5143</td>
<td>0.1058</td>
<td>0.9792</td>
<td>0.0004</td>
<td>51.95(9)</td>
<td>0.0001</td>
<td>2674.05(1)</td>
</tr>
<tr>
<td>NDS</td>
<td>VWR</td>
<td>1.0000</td>
<td>0.0002</td>
<td>0.4823</td>
<td>0.1104</td>
<td>0.9806</td>
<td>0.0003</td>
<td>38.59(9)</td>
<td>0.0001</td>
<td>4762.97(1)</td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9999</td>
<td>0.0002</td>
<td>0.2465</td>
<td>0.0889</td>
<td>0.9578</td>
<td>0.0007</td>
<td>41.22(9)</td>
<td>0.0001</td>
<td>3256.22(1)</td>
</tr>
<tr>
<td>ND</td>
<td>VWR</td>
<td>0.9991</td>
<td>0.0003</td>
<td>0.2196</td>
<td>0.0835</td>
<td>0.9588</td>
<td>0.0007</td>
<td>29.54(9)</td>
<td>0.0005</td>
<td>3500.36(1)</td>
</tr>
<tr>
<td><strong>B. Stock and money Euler equations: (20) and (22)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9979</td>
<td>0.0008</td>
<td>0.2775</td>
<td>0.1176</td>
<td>0.9730</td>
<td>0.0034</td>
<td>21.13(5)</td>
<td>0.0007</td>
<td>70.5596(1)</td>
</tr>
<tr>
<td>NDS</td>
<td>VWR</td>
<td>0.9991</td>
<td>0.0008</td>
<td>0.2570</td>
<td>0.1147</td>
<td>0.9741</td>
<td>0.0029</td>
<td>12.01(5)</td>
<td>0.0346</td>
<td>71.8896(1)</td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9947</td>
<td>0.0014</td>
<td>0.0552</td>
<td>0.1013</td>
<td>0.9246</td>
<td>0.0107</td>
<td>19.97(5)</td>
<td>0.0018</td>
<td>42.9904(1)</td>
</tr>
<tr>
<td>NDS</td>
<td>VWR</td>
<td>0.9959</td>
<td>0.0013</td>
<td>0.0625</td>
<td>0.0973</td>
<td>0.9345</td>
<td>0.0101</td>
<td>10.09(5)</td>
<td>0.0720</td>
<td>36.8388(1)</td>
</tr>
<tr>
<td><strong>C. Bond and money Euler equations: (21) and (22)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>1.0000</td>
<td>0.0002</td>
<td>0.4849</td>
<td>0.1105</td>
<td>0.9808</td>
<td>0.0003</td>
<td>32.73(5)</td>
<td>0.0001</td>
<td>4429.32(1)</td>
</tr>
<tr>
<td>NDS</td>
<td>VWR</td>
<td>0.9991</td>
<td>0.0003</td>
<td>0.2266</td>
<td>0.0853</td>
<td>0.9593</td>
<td>0.0007</td>
<td>21.79(5)</td>
<td>0.0001</td>
<td>3205.35(1)</td>
</tr>
<tr>
<td><strong>D. Stock and bond Euler equations: (20) and (21) [( \delta = 0.95 )]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9991</td>
<td>0.0002</td>
<td>0.3537</td>
<td>0.1301</td>
<td></td>
<td></td>
<td>40.35(6)</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>VWR</td>
<td>0.9998</td>
<td>0.0002</td>
<td>0.3261</td>
<td>0.1293</td>
<td></td>
<td></td>
<td>29.58(6)</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>ND</td>
<td>EWR</td>
<td>0.9991</td>
<td>0.0003</td>
<td>0.1887</td>
<td>0.0999</td>
<td></td>
<td></td>
<td>34.04(6)</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>ND</td>
<td>VWR</td>
<td>0.9991</td>
<td>0.0003</td>
<td>0.1566</td>
<td>0.0930</td>
<td></td>
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<td>22.89(6)</td>
<td>0.0001</td>
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<tr>
<td><strong>E. Stock Euler equation: (20) [( \delta = 0.95 )]</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9911</td>
<td>0.0038</td>
<td>0.6586</td>
<td>2.0520</td>
<td></td>
<td></td>
<td>4.75(2)</td>
<td>0.0047</td>
<td></td>
</tr>
<tr>
<td>NDS</td>
<td>VWR</td>
<td>0.9954</td>
<td>0.0029</td>
<td>0.6116</td>
<td>1.7095</td>
<td></td>
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<td>0.69(2)</td>
<td>0.7069</td>
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</tr>
<tr>
<td>ND</td>
<td>EWR</td>
<td>0.9904</td>
<td>0.0026</td>
<td>1.6428</td>
<td>0.9697</td>
<td></td>
<td></td>
<td>5.97(2)</td>
<td>0.0506</td>
<td></td>
</tr>
<tr>
<td>ND</td>
<td>VWR</td>
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<td>0.0022</td>
<td>1.0428</td>
<td>0.7608</td>
<td></td>
<td></td>
<td>1.55(2)</td>
<td>0.4598</td>
<td></td>
</tr>
<tr>
<td><strong>F. Bond Euler equation: (21) [( \delta = 0.95 )]</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>NDS</td>
<td>EWR</td>
<td>0.9998</td>
<td>0.0002</td>
<td>0.3313</td>
<td>0.1296</td>
<td></td>
<td></td>
<td>24.05(2)</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>ND</td>
<td>VWR</td>
<td>0.9991</td>
<td>0.0002</td>
<td>0.1661</td>
<td>0.0951</td>
<td></td>
<td></td>
<td>16.33(2)</td>
<td>0.0002</td>
<td></td>
</tr>
</tbody>
</table>

Notes as for table 1.

C(df) is the C-statistic whose degrees of freedom are indicated in parentheses. The C-test tests the restriction \( \delta = 1 \) for the sets of equations listed in panels A, B, and C.
5. Conclusion

This paper makes the following contributions. First, two observational equivalence results are established for the stochastic Euler equations governing agents' optimal asset choices. The Lucas (1982) cash-in-advance model is indistinguishable from a barter model embodying a start-of-period timing convention for consumption and investment decisions. The Lucas (1984)/Svensson (1985a) cash-in-advance model is indistinguishable from a barter model embodying both a start-of-period timing convention and a lagged information assumption. Second, the following empirical results are established.

(i) The empirical findings in Hansen and Singleton (1984) for the conventional barter-economy model, embodying an end-of-period timing convention for consumption and investment choices, are reaffirmed. The overidentifying restrictions implied by this model are emphatically rejected when they are both jointly and individually applied to stock and treasury-bill returns, except when they are individually applied to value-weighted stock return measures.

(ii) A barter model embodying an end-of-period timing convention and a lagged-information assumption; the Lucas (1982) cash-in-advance model and a money-in-the-utility function model do not accord any better with the data than the conventional barter model. The conclusions are as follows. The lagged-information assumption does not promote the explanatory power of the conventional barter model. Since the Lucas (1982) model has a cash-in-advance interpretation, it seems that the monetary influences it embodies are not important for asset pricing. Even though real money balances enter significantly into the utility function, so that they are in turn significant for asset pricing, their consideration does not result in improved explanation.

(iii) The overidentifying restrictions implied by the Lucas (1984)/Svensson (1985a) cash-in-advance model are easily not rejected when individually applied to stock returns — both equally- and valued-weighted measures. They are strongly rejected when individually (jointly) applied to treasury-bill (stock and treasury-bill) returns. Since the Lucas (1984)/Svensson (1985a) model has a cash-in-advance interpretation, it seems that the monetary effects it captures are important for and permit improved explanation of stock returns only.

The upshot of the study is that more work needs to be done before we have a theory of asset pricing that is fully consistent with the data. The above results provide some guidance. It is precisely those monetary models which are simultaneously consistent with positive nominal interest rates and the possibility of a combined transactions, precautionary and store-of-value de-
mand for money that lead to asset-pricing relationships in which monetary effects are significant. Within this set, the cash-in-advance model of Lucas (1984)/Svensson (1985a) seems to offer the most promise – since it is, additionally, consistent with stock return behavior. Perhaps this is because it models the transactions demand for money more specifically without placing restrictions on the interactions between the marginal utilities of consumption and real money balances. At an econometric level, it may be because it does not rely on accurate measurement of the money stock held by consumers. Further explorations of the monetary transactions technology in the Lucas (1984)/Svensson (1985a) model therefore seem exciting.

This optimistic note seems in sharp contrast to the conclusion in Hodrick, Koche!akota, and Lucas (1988). These authors calibrate a version of the Lucas (1984)/Svensson (1985a) model, using U.S. time series data on consumption and money growth processes, to find that the model, in practice, implies that the cash-in-advance constraint almost always binds. In their words: 'We conclude that there is little practical gain in using these more complicated informational specifications [than the Lucas (1982)-type model] in future applications of a cash-in-advance technology' [Hodrick, Koche!akota, and Lucas (1988), abstract]. Of course there is no necessary inconsistency. Our conclusion is predicated on evidence that the monetary effects as captured by the Lucas (1984)/Svensson (1985a) and Lucas (1982) models are, at an empirical level, significantly different for asset-pricing relationships. The Hodrick, Koche!akota, and Lucas (1988) conclusion is based on evidence that the two models have the same (and implausible) empirical implications for monetary velocity. Further exploration of the Lucas (1984)/Svensson (1985a) model which simultaneously improves on its predictions for asset pricing and velocity constitutes an ambitious and interesting agenda.

Appendix 1

The data set consists of monthly observations on U.S. variables from 1958:01 through 1986:12 (estimation begins in 1959:4). Data sources are indicated in parentheses. CB denotes Citibase.

(i) Two measures of seasonally-adjusted real consumption expenditure (at 1982 prices) are used: real purchases of nondurable goods and real purchases of nondurable goods plus services. [CB]
(ii) Prices are the implicit deflators of the corresponding consumption series, calculated from real and nominal consumption series. [CB]
(iii) The population is total population aged sixteen and over. [CB]
(iv) The money supply is end-of-period, seasonally-adjusted M1. [Citibank]
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(v) Stock returns are value-weighted or equally-weighted returns on stocks traded on the New York Stock Exchange. [Center for Research in Security Prices]

(vi) The treasury-bill return is the one-month treasury-bill return. [Fama (1984)]

Appendix 2

This appendix notes the stationary forms of the stochastic Euler equations governing stock and (when relevant) money choices and the associated instrument sets. Those relevant for bonds are identical to the corresponding stock equations and instrument sets except that \([1 + i_t^e']\) replaces \([(a_{t+1}^e + d_{t+1}^e)/a_t^e]\). \(Z_x\) denotes the instrument set used in the estimation and testing of eq. (x).

(a) Barter-e model

\[
E_t \left[ \beta \left( \frac{c_{t+1}}{c_t} \right)^{\gamma-1} \frac{P_t}{P_{t+1}} \frac{(a_{t+1}^e + d_{t+1}^e)}{a_t^e} - 1 \right] = 0, \tag{10'}
\]

\[
Z_{10'} = \left\{ 1, \frac{c_t}{c_{t-1}} - 1, \frac{P_{t-1}(a_t^e + d_t^e)}{P_t a_{t-1}^e} - 1 \right\}.
\]

(b) Barter-e model with lagged information

\[
E_{\Omega_t} \left[ \left( \frac{c_t}{c_{t-1}} \right)^{\gamma-1} \frac{(P_{t-1}/P_t)}{(P_{t-2}/P_{t-1})} \right] \times \left\{ 1 - \beta \left( \frac{c_{t+1}}{c_t} \right)^{\gamma-1} \frac{P_t}{P_{t+1}} \frac{(a_{t+1}^e + d_{t+1}^e)}{a_t^e} \right\} = 0, \tag{16'}
\]

\[
Z_{16'} = \left\{ 1, \frac{c_{t-1}}{c_{t-2}} - 1, \frac{(P_{t-2}/P_{t-1})}{(P_{t-3}/P_{t-2})} - 1, \frac{P_{t-2}(a_{t-1}^e + d_{t-1}^e)}{P_{t-1} a_{t-2}^e} - 1 \right\}.
\]
(c) Lucas (1982) / barter-s model

Same as for barter-e model except that nominal asset returns are lagged one period relative to those for the latter model (and the notation for the conditioning information set is \( \theta_t \) instead of \( t \)).

(d) Lucas (1984) / Svensson (1985a) / barter-s model with lagged information

Same as for barter-e model with lagged information except that nominal asset returns are lagged one period relative to those for the latter model [and the notation for the conditioning information set is \( (t - 1) \) instead of \( \Omega_t \)].

(e) MIUF model

\[
E \left[ \beta \left( \frac{c_{t+1}}{c_t} \right)^{\delta \gamma - 1} \left( \frac{M_{t+1}/P_{t+1}}{M_t/P_t} \right)^{(1-\delta)\gamma} \frac{P_t(a_{t+1}^e + d_{t+1}^e)}{P_{t+1}a_t^e} - 1 \right] = 0,
\]

(20')

\[
Z_{20'} = \left\{ 1, \frac{c_t}{c_{t-1}} - 1, \frac{M_t/P_t}{(M_{t-1}/P_{t-1}) - 1}, \frac{P_{t-1}(a_t^e + d_t^e)}{P_t a_{t-1}^e} - 1 \right\},
\]

\[
E \left[ \beta \left( \frac{c_{t+1}}{c_t} \right)^{\delta \gamma} \left( \frac{M_{t+1}/P_{t+1}}{M_t/P_t} \right)^{(1-\delta)\gamma} \frac{M_t/P_{t+1}}{c_{t+1}} \right]
+ \frac{(1 - \delta)}{\delta} - \frac{(M_t/P_t)}{c_t}
\right] = 0,
\]

(22')

\[
Z_{22'} = \left\{ 1, \frac{c_t}{c_{t-1}} - 1, \frac{M_t/P_t}{(M_{t-1}/P_{t-1}) - 1}, \frac{M_t/P_t}{c_t} - 1 \right\}.
\]

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