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Anticipatory and Objective Models of Durable Goods Demand

ABSTRACT: One of the less predictable aspects of economic behavior confronting forecasters is the propensity of U.S. households to acquire capital consumer goods such as automobiles and household appliances at varying rates over time. In this study the authors examine the question of whether survey measures of consumer anticipations, including both plans and attitudes, contribute to the economist's ability to predict short-term consumer behavior with reasonable accuracy. This use of data on consumer anticipations in combination with the more traditional information on asset stocks and income flows compose the integral elements of the optimal forecasting model. ¶ In Section 1 the authors develop a nonanticipatory (objective) model of consumer durable-goods demand that relates several aspects of pur-

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chase behavior to stock demand. The model makes provision for the lagged adjustment of the stock of durables to changes in the equilibrium level of stocks, for the expectational basis of stock demand, and for the distinction between transitory and permanent influences on demand. The permanent component depends on long-run expectations and average adjustment lags, while the transitory component represents the immediate reaction to unexpected income flows. ¶ Section 2 investigates the potential contribution of consumer anticipations data to models of durables demand. Several models based largely on anticipatory variables are developed. The authors conclude that the anticipatory models, by themselves, are roughly comparable with their best objective model, and that the residual variance of the objective model is significantly reduced by the anticipatory variables. However, the substitution of the anticipatory model for the fully specified objective model is most effective during periods when both purchase expectations and consumer sentiment can be measured with reasonable precision. During periods when purchase expectations are measured with relatively large sampling errors, a significant part of the objective model continues to warrant inclusion in a consumer demand model if maximum explanatory power is to be derived.

INTRODUCTION

The propensity of U.S. households to acquire tangible assets like automobiles and household appliances at varying rates over time remains one of the less well understood and less predictable aspects of economic behavior. In part, the explanation may be that consumption research has tended to focus on real consumption (use) flows and not on consumer expenditure and investment decisions. A second reason for the present unsatisfactory state of knowledge, and for our inability to predict near-term consumer behavior with reasonable accuracy, may lie in the failure of most model builders to explore seriously the use of data on consumer anticipations as an adjunct to the more traditional information on asset stocks and income flows that models generally tend to emphasize. This paper examines that possibility. First, we develop a nonanticipatory (objective) model of consumer durable goods demand, then we contrast the performance of this objective model with one based largely on the use of survey measures of consumer anticipations, and in the last section we examine the characteristics of an optimal model which combines both types of information.

A commonly used framework for analysis of consumer behavior, the stock adjustment model, views households as attempting to adjust actual to desired stocks of assets. Within this framework, survey measures of consumer purchase expectations can be interpreted as a subjective estimate of the difference between actual and desired stock, with reported purchase expectations reflecting the speed of the adjustment process as well as the underlying determinants of desired stock. And survey measures of consumer attitudes (optimism, pessimism) might be interpreted as one of the arguments in the desired stock function.

Demand models based on survey variables that measure consumer anticipations can be contrasted with models that exclude them and rely wholly on objective variables like income, price, and the stock of durables, as well as with joint models that incorporate both types of variables. Although a number of studies have explored this question, none has done so thoroughly or systematically. Typically, they have focused on examining the usefulness of anticipatory variables in a more or less ad hoc context: that is, objective variables have been introduced into demand models along with anticipations in order to determine whether the anticipations were significantly associated with purchases after accounting for the influence of income, and so on.[1]

Studies concerned with the specification of an objective model have not ordinarily shown much interest in the potential uses of anticipatory data. This is in part because such models have been concerned with the role of basic economic variables like income and prices in the explanation of purchase behavior, and not with the possible forecasting uses of the model.[2] And even where forecasting uses have been an important element in determining the structure of the model, e.g., in the consumer durables equations of econometric models, only rarely have the model builders attempted to incorporate anticipatory data.[3]

For the purpose of explaining consumer behavior, anticipatory variables like intentions or attitudes tend to muddy the coefficients of objective variables like income and prices, because the two sets of variables reflect roughly the same economic phenomena. Thus, to estimate the influence of, income, for example, on purchases in a model that includes both income and buying intentions, it is necessary to estimate the inflence of income on intentions and then add this to the measured influence of income. In models designed for forecasting, the anticipatory variables are often difficult to use, because they tend to cover a limited time span and often have to be extensively processed before they can be effectively utilized. Moreover, simulation of the model requires that future values of the anticipatory variables be predicted. If they could be accurately predicted, one would not need them in the first place; and if the predictions are poor, the simulation is unsatisfactory.[4]

[1] THE OBJECTIVE DEMAND MODEL

Durable goods yield utility to consumers in the form of a flow of services which continues until the product is fully depreciated. The analysis of demand for consumer durables therefore focuses on the demand for durable goods stock, and only indirectly examines purchases. In this section, we develop a model that relates several aspects of purchase behavior to stock demand. The model makes provision for the lagged adjustment of the stock of durables to changes in the equilibrium level of stocks, for the expectational basis of stock demand, and for the distinction between transitory and permanent influences on demand.

Specification of the Model

In general terms, the model views consumers as having a "target" or "desired" value of durables stocks to which they adjust gradually.[5] Net investment is viewed as having a "permanent" or "planned" component and also an "unforeseen" or "transitory" component.[6] The permanent component depends on long-run expectations and average adjustment lags, while the transitory component represents the immediate reaction to unexpected income flows. The transitory component accounts for the volatile behavior of investment, because unforeseen economic phenomena alter the time pattern of stock adjustments.

The partial adjustment model is applied to the planned component of net durables investment, ΔS^p, as in (1) where β represents the average speed at which households move to desired stock levels. S^*, the level of desired stock, is a target set by the household contingent upon its expectations about economic conditions.

(1) $\Delta S^p = \beta(S^* - S_{-1})$

Given expectations, there is some level of stocks that the household would like to hold, and it plans to close some proportion of the gap between existing and desired stocks during the current period.

Desired stock is a function of expected values of a set of economic variables denoted by Z. The specification of variables in the Z function is discussed below; the expectation is shown in (2). The Z function is taken to be linear, and expectations are generated by the uniform application of the adaptive expectations hypothesis to all variables in Z.

(2) $S^* = Z^e$

The adaptive expectation model for the formation of expectations by the household is given in (3).

(3) $Z^e - Z_{-1}^e = \rho(Z - Z_{-1}^e)$

The specification shown here is in the form of a discrete approximation to a continuous revision procedure, rather than a discrete version of the model.[7] This difference determines whether the current or lagged value of Z appears in the model. The interpretation of (3) is that the change in expectations is proportional to the difference between current experience and the previously formed expectation.[8]

The last element of the model is the transitory investment component (4), a function, T, of transitory variables specified below.

(4) $\Delta S^T = T$

Equation (5) defines net investment as the sum of its transitory, ΔS^T, and permanent, ΔS^P, components.

(5) $\Delta S \equiv \Delta S^P + \Delta S^T$

The reduced form of the model given by (1) through (5) is a second-order distributed lag which describes the effect on durables stocks of the change in an economic variable in the Z and T functions.[9] The model, which results from the convolution of two first-order lag models, is shown in difference equation form as (6).

(6) $S = \rho\beta Z + [(1 - \beta) + (1 - \rho)] S_{-1}$
$- (1 - \beta)(1 - \rho) S_{-2} + T - (1 - \rho) T_{-1}$

The lag parameters ρ and β are the coefficient of expectations and the speed of adjustment respectively; however, the full model involves the two lag processes concurrently, and individual estimates have no interpretation even when identified. If expectations are formed instantaneously, $\rho = 1$, and the model reduces to a first-order lag scheme. If adjustments are made instantaneously, $\beta = 1$, and the model reduces to a similar first-order scheme. Thus, a first-order model can be derived from either lag model, each being a special case of the complete model. A first-order model would be suggested if the coefficient on S_{-2} is insignificant; otherwise misspecification would result in sizable biases. Waud's Monte Carlo study indicates that a partial adjustment model that ignores the adaptive formation of expectations produces a downward bias in the speed of adjustment and an exaggeration of the standard errors.

The model actually estimated has net or gross investment rather than stock as the dependent variable, and is obtained by subtracting S_{-1} from both sides of (6) and rearranging terms to yield (7). This is the full objective model, which we call AET (partial adjustment–adaptive expectations–transitory change).

(7) $\Delta S = \rho\beta Z - \rho\beta S_{-1} + (1 - \rho)(1 - \beta)\Delta S_{-1} + T - (1 - \rho) T_{-1}$

A test of this version of the reduced form is that the current and lagged transitory terms are specified to be of opposite sign with the lagged term smaller in absolute value because $(1 - \rho) < 1$.

The model can be readily translated from net to gross investment by using the identity $G = \delta S_{-1} + \Delta S$, where G is purchases and δ is the depreciation rate; this version is shown as equation (7.1).[10]

$$(7.1)\quad G = \rho\beta Z + (\delta - \rho\beta)S_{-1} + (1 - \rho)(1 - \beta)\Delta S_{-1} + T - (1 - \rho)T_{-1}$$

Simplified versions of the model are also tested. The reduced form (8)

$$(8)\quad \Delta S = \rho\beta Z - \rho\beta S_{-1} + (1 - \rho)(1 - \beta)\Delta S_{-1}$$

ignores the distinction between planned and transitory components of net investment. This is the full model without the transitory change component (AE). It can be estimated with permanent, current or both permanent and transitory income as elements of Z.

A first-order adjustment model, derived by setting the coefficient of expectations equal to unity, is also tested (9).

$$(9)\quad \Delta S = \beta Z - \beta S_{-1} + T$$

This is the partial adjustment–transitory change model (AT). In gross investment form (9.1), this is the model most commonly found in the econometric literature. This model, without a transitory term, was introduced by Suits, Chow, and others.

$$(9.1)\quad G = \beta Z + (\delta - \beta)S_{-1} + T$$

Richard Stone and D. A. Rowe, and Hamburger, make use of specific depreciation assumptions to derive a reduced form in lagged purchases without any explicit estimate of the total stock.

Empirical Estimation of the Model

The models outlined in the preceding section are estimated for the period 1949 through 1967, using quarterly data. Equations with both net investment (N) and gross investment (G) as dependent variables are examined; results are shown for total durables, and for automobile and household durables separately (denoted by D, C, and H subscripts, respectively). All variables representing value aggregates are deflated per household magnitudes (1958 prices).[11]

The set Z is composed of the price and income variables that determine the desired stock target. The relevant price variables are all relative prices, the series being the respective implicit price deflators, P, relative to the deflator for total personal consumption expenditure, Q.

For the automobiles and total durables models a measure of credit availability or cost is also used. The measure we use, M, the maturity on instalment credit contracts, has often been found to have a strong influence on purchases. Contract maturity and unit price determine the amount of the monthly instalment payment, which is an important factor in determining the number of credit purchases. The maturity variable also reflects a price effect via its relation to the true marginal borrowing cost for consumers subject to credit rationing. Results using the pure price of credit, the interest rate, as an alternative credit variable are discussed in Appendix B.[12]

The uniform application of adaptive expectations may be unwarranted for the income variable. Therefore, permanent and transitory income variables, Y^* and Y^t, were explicitly estimated.[13] The models are estimated with permanent or current disposable income, Y, as alternative income variables in the Z function.

All regressions are estimated with a set of dummy variables that represent abnormal supply conditions. Panic buying during the Korean War, which resulted from fears of shortages, is treated in this way, as are the three strikes which affected the automobile market. The Korean War dummies (KD) are designed to minimize residuals in 1950-III, 1950-IV, and 1951-I. A uniform strike and poststrike recovery dummy (SD) is used for 1952-III, 1959-IV, and 1964-IV. In the second-order lag models, abnormal supply conditions affect not only the dependent variable but also bias the coefficient of the lagged dependent variable specified by the model: in these equations we adjust the lagged dependent variable for such supply influences.[14]

Alternative specifications of the transitory function, T, are also tested. Unemployed man-hours, U, as a general measure of cyclical conditions, is preferred.[15] An alternative specification is transitory income proper (Y^t), defined as the difference between current and permanent income. However, this variable appears to have only a very gradual impact on investment, which makes it difficult to interpret the lag structure of the model.

Tables 1A, 1B, and 1C present a set of basic regression results for both net and gross investment in total durables, automobiles, and nonauto durables for the 1949–67 period; estimates are by ordinary least squares. The fully specified net investment model (AET, equation 7 above), utilizes the unemployed man-hours variable as the transitory function. The sign and magnitude tests on the transitory and lagged transitory coefficients are satisfactory.[16] The transitory income variable proper (current less permanent income) did not satisfy the tests; the results indicate a lagged rather than immediate influence on stock change. Rather than complicate the lag structure of the model, this variable is used in the simplified function (equation 8) described as AE-2.

The AE-1 equation uses current disposable income as an explanatory variable in a second-order model, while the last two rows provide estimates of a first-order (partial adjustment) model with, respectively, current income (A) and a permanent-transitory distribution of current income (AT). The five equations are shown with both net and gross investment as the dependent variable.

The calculated t-ratios for the regression coefficients are well above acceptable levels in virtually every instance, and the lag structure in both first- and second-order models are stable. The lagged stock coefficients in the gross investment equations are at times insignificant, but there is no a priori reason why these coefficients could not be zero—the adjustment coefficients and the depreciation rate could be of approximately equal size. For the first-order models, the Durbin-Watson statistic suggests that there is positive serial correlation in the residuals.[17]

A closer look at some of the coefficients shows that the maturity variable is not consistently significant in the durables equations. For automobiles, which should be most sensitive to credit changes, the variable is always at least twice its standard error. The coefficients of the price variables exhibit some instability, especially when the unemployment variable is included, probably because of common trends in both variables.

The transitory income coefficient is always highly significant, whereas the permanent income coefficient is not, especially for automobiles. The magnitudes of the transitory coefficient in the durables equations are twice that of the permanent one; for automobiles the ratio is higher, and for other durables it is about one. Thus, there appears to be a strong transitory influence on automobile investment, while nonauto durables are less subject to transitory effects. The permanent income coefficients are always higher in the purchase equations than in the corresponding net investment equations. Transitory income, on the other hand, seems to effect only net investment and not replacement demand, as the coefficients are unchanged in net and gross investment equations.

The equilibrium properties of the model can be examined by deriving long-run stock demand elasticities. Equilibrium is defined by unchanging expectations and unchanging stock. The first condition implies that $S^* = Z$ and the second implies that $S = S^*$. The long-run elasticity (evaluated at the mean) with respect to a particular variable Z_i is the proportional effect on desired stock holding and is given by:

$$\epsilon_i = \frac{\partial S^*}{\partial Z_i} \cdot \frac{Z_i}{S}$$

A measure of short-run reaction is given by initial-period purchase elasticities. Using the reduced form for gross investment, the purchase

TABLE 1A Estimates of Regression Coefficients of Models of Net and Gross Investment in Consumer Durables[a] (U.S. quarterly data, 1949-III–67-IV)

Model	Intercept	Y	Y^*	P_D/Q	M_D	S_{D-1}	N_{D-1}	U	U_{-1}	Y^t	SD	KD_D	$\bar{R}^2$
Net Investment, N_D													
AET	1104.0		.0485 (2.1)	−897.0 (−3.8)	.7209 (2.8)	−.1587 (−4.7)	.6416 (9.0)	−34.94 (−6.5)	26.16 (5.0)		37.36 (3.9)	93.05 (6.2)	.934
AE-1	214.8	.1093 (4.6)		−429.5 (−1.7)	.5258 (2.5)	−.1744 (−6.0)	.6289 (9.1)				45.19 (4.1)	103.9 (6.4)	.911
AE-2	581.0		.0836 (3.5)	−577.8 (−2.3)	.3265 (1.6)	−.1466 (−5.0)	.5574 (8.4)			.2675 (5.6)	50.10 (4.7)	111.0 (7.0)	.919
A	969.8	.2311 (8.0)		−1105.0 (−3.1)	.3988 (1.3)	−.3477 (−10.5)					39.60 (2.4)	120.7 (5.0)	.804
AT	1290.0		.1729 (5.0)	−1230.0 (−3.7)	.1376 (.5)	−.2783 (−7.9)				.4329 (6.9)	40.22 (2.7)	128.2 (5.7)	.834
Gross Investment, C_D													
AET	804.1		.1193 (5.2)	−944.2 (−4.1)	.7174 (2.8)	−.0113 (−.3)	.6250 (9.4)	−34.52 (−6.5)	28.43 (5.5)		39.67 (4.1)	96.23 (6.5)	.985
AE-1	187.5	.1718 (7.9)		−584.4 (−2.5)	.5813 (3.0)	−.0294 (−1.1)	.5613 (8.8)				47.13 (4.7)	112.6 (7.5)	.983
AE-2	349.0		.1520 (6.7)	−663.7 (−2.9)	.4791 (2.5)	−.0090 (−.3)	.5367 (8.5)			.2617 (5.8)	41.17 (4.8)	116.4 (7.9)	.984

A	778.9	.2805		−1187.5	.4679	−.1814				42.13	127.7	.963
		(10.8)		(−3.6)	(1.6)	(−6.1)				(2.9)	(5.8)	
AT	1003.0		.2399	−1275.0	.3074	−.1367			.4211	42.57	132.7	.966
			(8.2)	(−4.0)	(1.1)	(−4.1)			(7.1)	(3.0)	(6.3)	

[a] The independent variables in these regressions are as follows:
Y = Disposable income, 1958 dollars per household
Y^* = Permanent income, 1958 dollars per household
P_D/Q = Relative price of consumer durables
M_D = Maturity on all consumer durable contracts
S_{D-1} = Beginning of period stock of consumer durables, 1958 dollars per household
N_{D-1} = Net investment in consumer durables, 1958 dollars per household
U = Unemployed man-hours
Y^T = Transitory income, 1958 dollars per household
SD = Automobile strike dummy
KD_D = Korean War dummy for consumer durables
G_D = Gross investment in consumer durables, 1958 dollars per household

TABLE 1B Estimates of Regression Coefficients of Models of Net and Gross Investment in Automobiles (U.S. quarterly data, 1949-III–67-IV)

Model	Intercept	Y	Y^*	P_c/Q	M_c	S_{c-1}	N_{t-1}	U	U_{-1}	[illegible]	[illegible]	[illegible]	[illegible]
Net Investment, N_t													
AET	283.0		.0091	−259.4	.5796	−.1715	.6752	−25.78	19.57		44.[illegible]	[illegible]	[illegible]
			(.9)	(−2.8)	(3.9)	(−4.0)	(9.9)	(−5.9)	(4.4)		(5.6)	(2.6)	
AE-1	37.79	.0353		−136.3	.3284	−.1795	.7109				50.[illegible]	[illegible]	[illegible]
		(3.2)		(−2.3)	(2.8)	(−4.4)	(9.3)				(5.4)	(2.8)	
AE-2	202.7		.0210	−241.4	.4490	−.1735	.5436			.1926	56.2[illegible]	[illegible]	[illegible]
			(2.0)	(−2.6)	(4.3)	(−4.8)	(8.2)			(5.2)	(6.8)	[illegible]	
A	574.5	.0601		−673.7	.5782	−.3527					45.1[illegible]	[illegible]	[illegible]
		(3.8)		(−4.9)	(3.3)	(−6.4)					(3.2)	(3.4)	
AT	637.1		.0265	−622.9	.5390	−.2503				.3143	46.17	225.9	[illegible]
			(1.8)	(−5.4)	(3.7)	(−5.1)				(6.6)	(3.1)	(4.2)	
Gross Investment, G_t													
AET	198.9		.0384	−301.8	.5097	.0046	.6843	−22.85	18.97		50.68	106.3	.934
			(3.5)	(−3.0)	(3.2)	(.1)	(9.3)	(−5.0)	(4.0)		(6.0)	(2.5)	
AE-1	−1.108	.0594		−197.5	.3198	−.0047	.6891				55.65	131.3	.921
		(5.4)		(−1.8)	(2.7)	(−.1)	(9.0)				(6.0)	(3.0)	
AE-2	85.55		.0488	−239.2	.3319	0167	.6077			.1646	55.49	146.2	.928
			(4.4)	(−2.3)	(2.9)	(.4)	(7.7)			(4.1)	(6.3)	(3.5)	

A	519.1	.0834		−718.4	.5619	−.1726		50.91	223.6	.826
		(5.3)		(−5.3)	(3.3)	(−3.2)		(3.7)	(3.5)	
AT	571.5		.0556	−677.2	.5276	−.0870	.2962	51.74	231.8	.864
			(3.7)	(−5.7)	(3.5)	(−1.7)	(6.0)	(4.3)	(4.2)	

[a] The independent variables Y, Y^*, U, Y^r, and SD are as defined in Table 1A. The others are as follows:

P_c/Q = Relative price of automobiles
M_c = Maturity on automobile installment contracts
S_{c-1} = Beginning of period stock of automobiles and trailers, 1958 dollars per household
N_{c-1} = Net investment in automobiles and trailers, 1958 dollars per household
KD_c = Korean War dummy for automobiles
G_c = Gross investment in automobiles and trailers, 1958 dollars per household

TABLE 1C Estimates of Regression Coefficients of Models of Net and Gross Investment in Other Durables[a] (U.S. quarterly data, 1949-III–67-IV)

Model	Intercept	Y	Y^*	P_H/Q	S_{H-1}	N_{H-1}	U	U_{-1}	Y^t	KD_H	$\bar{R}^2$
Net Investment, N_H											
AET	428.8		.0898 (4.8)	−393.6 (−2.7)	−.2067 (−5.8)	.4301 (4.5)	−9.444 (−3.6)	6.111 (2.3)		92.39	.934
AE-1	91.0	.0944 (7.2)		−181.8 (−2.0)	−.1762 (−7.6)	.4264 (5.4)				99.49 (10.7)	.943
AE-2	91.89		.0941 (5.5)	−182.0 (−2.0)	−.1758 (−6.1)	.4275 (4.9)			.0948 (5.0)	99.51 10.5)	.942
A	−131.4	.1588 (24.7)		−103.1 (−1.0)	−.2627 (−12.8)					101.2 (9.3)	.921
AT	−142.3		.1669 (20.4)	−107.6 (−1.1)	−.2773 (−12.4)				.1276 (6.1)	99.6 (9.2)	.923
Gross Investment, G_H											
AET	738.5		.1003 (5.7)	−715.6 (−5.0)	−.0690 (−2.0)	.4724 (5.0)	−11.24 (−4.4)	8.070 (3.2)		99.0 9.9)	.990
AE-1	435.5	.1045 (8.0,		−526.2 (−6.0)	−.0416 (−1.8)	.4621 (5.9)				107.0 (11.8)	.992
AE-2	429.1		.1070 (6.4)	−525.0 (−6.0)	−.0453 (−1.6)	.4536 (5.3)			.1013 (5.4)	106.8 (9.8)	.992

A	171.5	.1750		−427.1	−.1331		109.1	.987
		(26.6)		(−4.1)	(−6.3)		(9.8)	
AT	156.1		.1863	−433.5	−.1538	.1306	106.9	.988
			(22.6)	(−4.3)	(−6.8)	(6.2)	(9.8)	

[a]The independent variables Y, Y^*, U, Y^T are as defined in Table 1A. The others are as follows:

P_H/Q = Relative price of other durables

S_{H-1} = Beginning of period stock of other durables, 1958 dollars per household

N_{H-1} = Net investment in other durables, 1958 dollars per household

KD_H = Korean War dummy for other durables

G_H = Gross investment in other durables, 1958 dollars per household elasticity, again evaluated at the mean, is defined as the impact effect on purchases of a change in a variable Z_i given by:

$$\eta_i = \frac{\partial G}{\partial Z_i} \cdot \frac{Z_i}{G}$$

Both long-run stock elasticities and short-run purchase elasticities are shown in Table 2. The mean depreciation rate over the sample period must be estimated, then elasticities are evaluated at the mean level of stock holdings.[18] There is no transitory-income elasticity in the long run, since variables in the transitory function do not enter the equilibrium or the desired-stock demand function.

In Panel A of Table 2 elasticities are calculated from fully specified gross-investment equations (the AET model). The long-run permanent income elasticities implied by the model are all about unity, indicating that the household sector aims for a constant ratio of durables stocks to income.

TABLE 2 Elasticities of Durables Demand

	Permanent Income	Transitory Variable	Relative Price	Maturity
Panel A: Unemployment Transitory				
Long Run (equilibrium stock)				
Total durables	1.09		−1.31	.24
Automobiles	.99		−1.14	.57
Other durables	1.11		−1.22	
Short Run (impact on purchases)				
Total durables	.88	.22	−1.05	.20
Automobiles	.74	.39	−.86	.42
Other durables	1.19	.12	−1.31	
Panel B: Transitory Income Proper				
Long Run (equilibrium stock)				
Total durables	1.27		−.84	.15
Automobiles	1.21		−.87	.36
Other durables	1.35		−1.02	
Short Run (impact on purchases)				
Total durables	1.12	1.93	−.74	.13
Automobiles	.95	3.20	−.68	.28
Other durables	1.14	1.08	−1.05	

NOTE: Elasticities are calculated from the AET and AE-2 equations found in the gross-investment section of Tables 1A, 1B, and 1C.

The equilibrium price elasticities all exceed unity, suggesting that the relatively large secular growth in durable stocks over the last two decades has been largely due to their relative cheapening. Other durables appear to be more sensitive than automobiles to both price and income changes. The unemployment response can be converted to a transitory-income response; the transitory-income elasticities implied by this conversion are very large. For these estimates, we converted changes in unemployed man-hours (the transitory variable) into the equivalent change in income by assuming that a 1 per cent change in employment produces a 1 per cent change in income, an assumption that cannot be far wrong.[19] The implied income elasticities are 3.48 for total durables, 6.07 for automobiles, and 1.83 for other durables.

The short-run expenditure elasticities implied by the unemployed man-hours variable are quite large, particularly for automobiles. The response is most easily understood as the effect on expenditures of a one point rise in the unemployment rate: such a rise causes an expenditure decline of 6.86 per cent for automobiles, 2.11 per cent for other durables, and 3.86 per cent for total durables.

In Panel B, somewhat different results are obtained for the AE model, which does not explicitly take account of transitory investment. The direct estimates of the short-run effect of transitory income proper is over three for automobiles and about one for other durables. This specification of the lag structure yields slightly higher permanent-income elasticities than those in Panel A, and price elasticities below unity. We feel that the explicit treatment of unplanned investment in the AET model (Panel A elasticities) is the appropriate specification for estimating long-run or equilibrium effects. In those equations, a solution for desired or planned stock, and the elasticities, are obtained, holding transitory effects constant.

The maturity variable has an elasticity of about one-half in both the long and short run with respect to automobiles. As indicated earlier, it may be appropriate to interpret the maturity effect as a delayed income effect that may explain why the impact elasticities of permanent income on automobile demand is less than unity.

The permanent-income elasticities in Table 2 are, of course, not the same as current-income elasticities although we can approximate the latter by adding together elasticities in the first and second columns. In the short run, our model indicates that the transitory-income effects are substantial. A current-income elasticity comparable to that usually encountered in the literature can be obtained from the AE-1 equation of Tables 1A to 1C, where we show a model with no transitory-income specification. Although this is not the best specification of the model, as the differences in permanent- and transitory-income elasticities in Table 2 indicate, estimates of a current-income elasticity may be useful for comparison. The impact effects of current income on expenditures, and the corresponding price and maturity elasticities. are as follows:

	Income	Prices	Maturity
Durables	1.27	−.65	.16
Automobiles	1.15	−.56	.27
Other durables	1.32	−.96	

The properties of the lag structure of the model are investigated by solving the net investment equations for a distributed lag in stock. If we rewrite (8) as:

$$\Delta S = aZ + bS_{-1} + c\,\Delta S_{-1}$$

then the mean lag[20] is given by:

$$\theta = \frac{1 + b - c}{-b}$$

The mean lag measures the over-all lagged effect of changes in the economic variables (Z) on the stock of durable assets. The mean lag is the time in which half the effect on total stock of a change in a Z variable is registered. Note that the mean lag can be obtained from the coefficients on S_{-1} and ΔS_{-1} and does not require solving for explicit estimates of the lag parameters.

The mean lag and 95 per cent confidence levels for the AET net investment model are given in Table 3. The lags are fairly short but the ranges are wide, the usual result in these analyses. However, a glance at the sampling limits indicates that there is little likelihood that the means differ significantly. This result may be due to the short-run effect of the maturity variable, which is quite large, as credit expectations can be immediately realized through purchases, while income expectations may not be.

As expected, the first-order model yields somewhat higher mean lags: 2.59 for durables, 3.00 for automobiles, and 2.61 for other durables.[21]

TABLE 3 Mean Lags and 95 Per Cent Confidence Intervals in Quarters

	Mean	95 Per Cent Limits	
Durables	1.26	3.73	.39
Automobiles	.89	3.45	.12
Other durables	1.75	4.11	.72

NOTE: Calculated from the AET net investment Section of Tables 1A, 1B, and 1C.

When the first-order model is a misspecification, there is a serious upward bias in the estimated mean lags.

An additional descriptive measure of interest is the path toward equilibrium implied by the shape of the lag pattern. The first-order model yields the familiar exponentially declining lag pattern, which cumulates to a smooth approach to equilibrium. The second-order model yields more interesting patterns, as the lag structure is not constrained to decline exponentially. However, the patterns are the same for all the variables, except the transitory variable.

The lag pattern for the AET net-investment model for total durables indicates that the effect on total stocks of a permanent-income change rises to a peak in the third quarter and then begins to decline. After the eighth quarter, the effects are within 10 per cent of equilibrium as the model overshoots the equilibrium and continues to infinity with oscillations near zero. The cumulative approach to equilibrium is smooth. The overshooting of the equilibrium is small when compared to the standard error of the initial effect. The transitory variable enters the model with a different lag structure, one which yields a pattern that declines from a large initial effect to an insignificant level by the fifth quarter.

[2] MODELS WITH ANTICIPATORY DATA

This section investigates the potential contribution of consumer anticipations data to models of durables demand. Survey data on consumer attitudes and buying intentions are available at approximately quarterly intervals from 1953 on. The attitudes data (Index of Consumer Sentiment) are a consistent series with the same analytical content and sampling error over the entire period; there are some missing quarters prior to 1961, for which values are interpolated. The intentions data, in contrast, are a spliced series. The only source of such data from 1953 to 1959 is the Survey Research Center (SRC) series, which has both relatively large sampling error, and, in published form, some change in the treatment of responses. From 1959 through 1966, either the SRC series or a conceptually comparable series with much smaller sampling error (the Census Bureau's Quarterly Survey of Intentions [QSI]) can be used. After 1966, a conceptually different and presumably improved Census series (Consumer Buying Expectations [CBE]) is available.[22] We have constructed a continuous series from these sources, using SRC data through 1959 and Census data thereafter. The series used and its construction are found in Appendix A.

Two general types of demand models that utilize consumer anticipations data are specified. One model views anticipatory data as either substitutes for, or complements to, the set, Z, of variables in the desired-stock function of the objective model. That is, anticipatory variables can be viewed as additional determinants of desired stock or as substitutes for income, relative price, and so on, as desired-stock determinants. An alternative model views anticipatory variables, plans and attitudes, as a possible substitute, not only for the desired-stock variables, but also for all lag and adjustment processes specified by the model. This suggests the specification of a pure anticipatory model as a replacement for the objective model and will be discussed first.

Anticipatory Models as Substitutes

Purchase intentions are presumably a direct measure of the difference between beginning-of-period stocks and planned end-of-period stocks, hence they could, in principle, substitute fully for the planned investment part of the objective model. The role of the attitude variable is less clear. One interpretation suggests that intentions are an imperfect measure of the difference between planned and actual stocks, and that attitudes serve to modify or correct that measure.[23]

The pure anticipatory model (10.1, a gross investment equation) uses intentions (p) and attitudes (A), and is designated as P. Given the specification of the anticipatory variables, the appropriate dependent variable is gross investment measured in physical units purchased, more precisely, the purchase rate (x). The P model is shown as equation (10.1).

$$(10.1)\quad x = a_0 + a_1 p + a_2 A$$

For the anticipatory model with a transitory component, we add U, the unemployed man-hours variable; the full anticipatory model (11.1) is designated PT.

$$(11.1)\quad x = a_0 + a_1 p + a_2 A + a_3 U$$

Comparison of objective and anticipatory models will be facilitated by including several variations of the former in addition to the partial adjustment–adaptive expectations–transitory change (AET, equation 7.1) model outlined above. As the explanatory power of the AET model may only reflect the existence of serially correlated residuals in an adjustment model, comparisons with the simpler partial adjustment–transitory change model (AT equation 9.1) are also made. Another comparison of interest involves the planned investment part of the objective model, that is, the full model without the transitory change component (AE, equation 9.1), against the comparable anticipatory model (P, equation 10.1). Since the anticipations models use objective purchase plans as one of the major ingredients, this comparison answers the question: How well do subjective purchase plans predict behavior relative to their objective counterpart?

Because the consumer anticipations data cover a shorter span than the objective data, comparisons are not possible over the full 1949–67 period used above. They can be made for two shorter time spans, however. The first, 1953–67, involves the longest period for which we have reasonably consistent measures of both consumer attitudes (A) and consumer buying intentions (p).[24] The second period covers 1960–67, and is used because it covers the only time span for which entirely consistent and statistically reliable measures of both attitudes and buying intentions are available.[25]

The objective model is reestimated for each of the two indicated time spans. The anticipations model uses weighted intentions from current and two past surveys (p) and lagged consumer attitudes (A) to measure planned gross investment; unemployed man-hours (U) are used to measure transitory gross investment. Both models are estimated by ordinary least squares although this procedure may not be entirely satisfactory for purposes of comparison. The objective model includes income and price variables, and the estimates are therefore subject to simultaneous equations bias; the anticipatory model should be largely free of such bias.

The results in Table 4 are interesting, especially where the comparison between objective and anticipations models is unaffected either by large sampling errors in the anticipations variables or conceptual differences between the dependent and independent variables. Both problems are absent in the first two rows of Panel A, where expenditures on automobiles are the dependent variable and the 1960–67 span (when QSI or CBE can be used to measure intentions) is the fit period. The objective (AET) model performs well in explaining a series with the amount of erratic quarterly variation typical of automobile sales: it explains 94 per cent of the variance (adjusted for d.f.); the AE model, which does not contain the transitory investment variable, explains almost 91 per cent of the variance. But the planned investment part of the anticipations model (P), consisting only of buying intentions and lagged attitudes, has a slightly smaller standard error than the comparable (AE) objective model; and the full anticipatory model (PT) has a smaller standard error than the best (AET) objective model and a substantially smaller error than the objective model without the lagged dependent variable (AT). Thus, the much simpler anticipatory models outperform their counterpart objective models.[26] Both intentions and attitudes contribute significantly to the anticipations models, as does unemployed man-hours.

The anticipations models do not fare quite as well in the longer (1953–67) period. For the automobile data, the planned investment objective model is perceptibly better than the anticipations model (cf. AE and P), and the inclusion of transitory stock change improves both models by about the same extent. For the durables equations, the objective model is superior in both periods. The anticipations model is a close substitute in the 1960–67 period, especially when the transitory stock change variable

TABLE 4 Anticipatory Models as Substitutes for Objective Models of Durable Goods Demand

Anticipations Model and Time Period	t-Ratios for Anticipatory Models			Standard Errors				
				Anticipatory Model		Objective Model		
	P	A	U	PT	P	AET	AT	AE
Panel A: Automobile Demand								
P, 1960–67	+11.5	+2.9	—	—	18.3	—	—	19.1
PT, 1960–67	+3.6	+3.9	−3.4	15.5	—	16.5	20.3	—
P, 1953–67	+2.7	+2.6	—	—	49.4	—	—	23.2
PT, 1953–67	+2.4	+1.4	−5.9	38.4	—	19.3	25.9	—
Panel B: Durables Demand								
P, 1960–67	+14.5	+0.8	—	—	34.4	—	—	21.2
PT, 1960–67	+5.2	+1.9	−4.7	25.7	—	19.9	22.1	—
P, 1953–67	+6.1	+2.5	—	—	73.4	—	—	26.0
PT, 1953–67	+7.0	+1.2	−6.6	54.0	—	21.4	29.4	—

NOTE: The strike quarters are excluded from the sample period in order to make the standard errors of the anticipatory and objective models comparable. The standard errors are in constant (1958) dollars per household at annual rates. For the anticipatory models, the dependent variables are the automobile purchase rate and a proxy for the durables purchase rate. The variables are both defined as the respective real per household expenditures divided by the average real car price. The data are shown in Appendix A. The standard errors for the anticipatory models are adjusted to the same basis as the objective model, as discussed in footnote 26.

is included in both models. For the longer period, the objective models are markedly superior. However, the significance of these results is unclear: they are obtained using an intentions variable that is subject to large sampling error during the 1953–59 period, and that measures only automobile, and not total durables, buying intentions. On the whole, given the very high standard implied by the content and empirical fit of the objective models, the much simpler anticipations models provide remarkably powerful competition.

Anticipatory Models as Complements

A different but equally interesting question is whether the anticipations variables improve a fully specified objective model, i.e., constitute a significant subset of the desired-stock function. The answer, from Table 5, is unambiguously yes: both buying intentions and lagged attitudes clearly add to the explanatory power of the fully specified AET model in the shorter (1960–67) period, both for automobiles and total durables; for the

TABLE 5 Anticipatory Variables as Complements to Durable Goods Demand Models

	Standard Errors						
	Objective Model	Objective Model Plus	Objective Model Plus		t-Ratios for Anticipatory Variables		
Model and Time Period	(*AET*)	*p, A*	*p, WDA*	*p*	*A*	*p*	*WDA*
Automobiles 1960–67	16.5	13.6	13.7	2.2	2.3	2.9	2.2
Automobiles 1953–67	19.3	19.4	18.2	0.9	0.6	1.9	2.5
Durables 1960–67	19.9	16.1	17.6	2.5	2.1	2.8	0.8
Durables 1953–67	21.4	21.1	19.9	1.3	0.7	2.1	2.5

NOTE: See note to Table 4; standard errors are in 1958 dollars per household.

longer (1953–67) period, the joint contribution of the two anticipatory variables is not significant although intentions would be if considered by itself.

Moreover, a modified version of the consumer attitude variable gives better marks to the anticipatory data. Elsewhere, Juster and Wachtel show that a filtered version of A appears to provide a better specification of the role of consumer attitudes in forecasting models. The filtered variable, designated *WDA*, uses the weighted change in consumer attitude only when it shows either large or persistent change. The results in Table 5 indicate that the *WDA* formulation is generally superior to A, and that both *p* and *WDA*, with one exception, make a statistically significant contribution to the fully specified objective (AET) model.

Joint Objective-Anticipatory Models

The data in Table 5 suggest that the anticipatory variables make a significant contribution to a fully specified objective model, both in the 1960–67 and 1953–67 periods, and for both automobile and total durables expenditure models. Examination of the regression coefficients in a model which simply adds the anticipatory variables to the objective AET model suggest that even stronger conclusions may be warranted.

In the shorter (1960–67) period, the only variables in the AET model which retain a *t*-ratio in excess of unity, other than the two anticipations variables, are unemployed man-hours and relative price; this finding holds for both automobile and total durables equations. For the longer (1953–67) period, the results are markedly different, possibly because expected purchases are a linked variable containing a great deal of erratic variability in the earlier (1953–59) part of the period. Here, both lagged stock change and permanent income retain statistically significant coefficients in both the automobiles and durables models, while lagged unemployed man-hours is significant in some of the models. As was true of estimates for the shorter period, the relative price variable lowers the standard error of the model although its coefficient is never significant at conventional levels.

Although the relative brevity of the 1960–67 period makes it difficult to draw firm conclusions on the matter, it is plausible to conjecture that the optimum specification for a durable goods demand model might well include only the two anticipatory variables, unemployed man-hours, and relative prices. The other two variables that retain explanatory power in the 1953–67 period, permanent income and lagged stock change, are both clearly known to the household at the beginning of the purchase period. Hence, a precise measure of purchase expectations would, in principle, be expected to eliminate the statistical influence of these two, since purchase expectations should be capable of taking full account of both expected income and all the expectational and adjustment lags specified by the objective model. On the other hand, unemployed man-hours is an integral part of the anticipatory model itself, since it reflects transitory investment, and relative price might plausibly be included as part of the model as well.

The question is whether relative price movements are foreseen or unforeseen at the start of the purchase period. Since the model involves the demand for a class of items that are infrequently purchased, households considering purchase might well be unaware of any recent change in market prices until they begin an active search for the product. Thus, if prices have been changing, households may generally tend to be "surprised" at discovering what prices actually are compared to what they had been expecting.

Table 6 presents some regressions which incorporate only those variables which are the best candidates for inclusion in an optimally specified model that combines anticipatory and objective variables.[27] Three equations are presented in each of the four panels: the first two equations are basically partial adjustment–transitory change models (like AT, equation 9.1) with the anticipatory variables included in the desired-stock function; the third assumes that all adjustment processes are represented by the expected purchase variable, as in the PT model, equation 11.1, and an additional objective variable is added to the transitory function. The first and second equations differ only in that permanent income is included as a desired-stock determinant in the second equation but not in the first. The third equation includes only the anticipatory variables, with relative price and unemployment as the transitory function.

The results support the view that relative prices warrant inclusion in the fully specified model. The best specification for a combined model seems to consist either of eliminating all the adjustment lags and letting expected purchases carry the burden of the adjustment process, or including both expected income and a partial adjustment process in the model; it is not clear which alternative is better. When beginning-of-period stock is included but expected income is not, the former usually has a positive coefficient: the estimated adjustment coefficient, obtained by the subtraction of depreciation rates from the coefficient of beginning stock, implies a very slow adjustment process. Inclusion of permanent income lowers the beginning stock coefficient and therefore speeds up the adjustment to a more plausible pattern. In the automobile equations, elimination of an explicit adjustment process as well as the expected income variable seems to produce more sensible results than retaining both, while the reverse appears to be true in the durables equations. Needless to say, these conclusions are highly tentative and are in need of much more exploration.

TABLE 6 Demand Models Combining Anticipatory and Objective Variables

Equation	Constant	p	WDA	Y^*	P/Q	U	S_{t-1}	Standard Error	R^2
	Regression Coefficients (t-Ratios)								
	Panel A: 1953–67 Period, Durables Expenditures Dependent								
1	218.5 (6.8)	26.39 (3.6)	7.037 (4.2)		−1660 (6.7)	−35.24 (12.1)	+.0856 (4.4)	23.85	.9808
2	121.4 (2.1)	31.47 (4.1)	7.154 (4.4)	.1289 (2.0)	−1132 (3.2)	−26.79 (5.2)	−.0401 (.6)	23.15	.9823
3	323.4 (12.9)	31.19 (3.6)	5.674 (3.0)		−2453 (12.4)	−32.58 (9.8)		27.95	.9731
	Panel B: 1953–67 Period, Automobile Expenditures Dependent								
1	605.0 (6.2)	23.02 (4.1)	6.953 (4.7)		−480.4 (5.0)	−15.82 (5.4)	+.0892 (2.9)	19.85	.9242
2	582.2 (3.7)	22.90 (4.0)	6.903 (4.5)	.0046 (.2)	−468.4 (4.0)	−15.78 (5.4)	+.0742 (.9)	20.06	.9243
3	568.5 (5.5)	36.25 (10.3)	4.906 (3.5)		−426.3 (4.2)	−17.12 (5.5)		21.30	.9109
	Panel C: 1960–67 Period, Durables Expenditures Dependent								
1	174.8 (1.6)	55.43 (4.5)	5.844 (2.2)		−1307 (1.7)	−44.06 (5.4)	+.0627 (.8)	16.67	.9912
2	120.5 (.9)	52.47 (4.0)	3.872 (1.1)	.1571 (.8)	−1034 (1.2)	−37.03 (3.1)	−.1360 (.5)	16.79	.9916
3	266.8 (9.9)	49.81 (4.8)	6.061 (2.3)		−1936 (7.3)	−46.61 (6.1)		16.57	.9911
	Panel D: 1960–67 Period, Automobile Expenditures Dependent								
1	897.7 (1.6)	34.77 (4.1)	5.465 (2.4)		−544.4 (1.3)	−29.17 (4.2)	−.0980 (.8)	13.85	.9684
2	105.1 (1.8)	36.12 (4.3)	7.077 (2.6)	−.0783 (1.1)	−548.4 (1.3)	−31.83 (4.3)	+.2044 (.7)	13.80	.9700
3	482.7 (2.6)	35.25 (4.2)	5.447 (2.5)		−258.0 (1.4)	−27.87 (4.2)		13.74	.9676

NOTE: The strike quarters are eliminated from all the regressions.

SUMMARY

On the whole, the evidence suggests that during periods when both purchase expectations and consumer sentiment can be measured with reasonable precision, the anticipatory model is virtually a perfect substitute for a fully specified objective model, and that as good results can be achieved with a simple two-variable anticipations model as with a much more complex model with a fully specified lag structure. In effect, survey measurements of purchase expectations combined with systematic changes in consumer sentiment seem able to replace the influence of income and all the adjustment lags in a complex objective model although it does not appear that the anticipatory variables reflect the influence on purchases of movements in relative prices of durables—possibly because these are largely unforeseen.

The evidence is markedly less convincing during periods when purchase expectations are measured with relatively large sampling errors. Here a significant part of the objective model continues to warrant inclusion in a consumer demand model, and the simple anticipatory model falls considerably short of the fully specified objective model in explanatory power. One clear-cut need for additional research lies in the influence of relative prices on purchase decisions in the context of the model which uses anticipatory variables as the major determinant of desired stock. While most of the evidence seems to suggest that the anticipations variables need to be augmented with a relative price measure, the coefficients of the price variables are erratic and the specification can undoubtedly be improved.

APPENDIX A: SOURCES OF DATA

Expenditure and Stock Data

The data series for real durables stocks used in this study were based on annual estimates for the household sector prepared by Raymond Goldsmith. In *The National Wealth of the United States in the Postwar Period*, Goldsmith estimates stocks through 1962 by applying straight-line depreciation to the expected useful life of each group of durable goods, except automobiles, for which an assumed depreciation schedule was applied. From these data, annual depreciation ratios were calculated for the aggregate category total durables and for autos. Ratios for the post-1962 period were extrapolated by regression. The change in the depreciation ratio was regressed on the change in expenditures, a procedure suggested by the fact that the depreciation ratio is a function of the age distribution of the stock, tastes, and style. The depreciation ratios were applied to a benchmark stock figure for the end of 1948 (Goldsmith) converted to a 1958 price base, and to purchase data from the National Income Accounts.

For durables, the gross investment data are Personal Consumption Expenditures on Durables (Table 1.2, *Survey of Current Business* [*SCB*]). For automobiles, the personal consumption expenditures on new and net used autos (Table 2.6, *SCB*) is published quarterly, but the trailer component is not. A quarterly estimate is obtained by adding an interpolated estimate of expenditures on trailers to the gross auto product–personal consumption expenditure data (Table 1.16, *SCB*).

A two-stage procedure was used to calculate the quarterly stock data. In the first stage, purchases less depreciation (one-quarter of the annual ratio times the last period stock) were added to the initial stock figure for each year. In this way, depreciation on the last quarter's stock additions is included. In the second stage, the quarterly depreciation figures are adjusted proportionately so that they total the figure implied by the annual depreciation rate, in order to insure consistency of the data.

Other household or nonauto durables are defined as total durables less automobiles. Data for stocks and for gross and net investment were derived in the same manner as for automobiles. All stock and purchase data are in 1958 prices and are on a per household basis. Real per household gross investment, seasonally adjusted at annual rates, and real per household end-of-quarter stocks of automobiles and total durables are found in Table A-1.

The net investment series used in the regressions are the first differences in real stocks deflated by the average number of households during the quarter. These will differ from the first differences in the real per household stocks, which are shown in Table A-1. The number of households was interpolated quarterly from annual data in the *Statistical Abstract of the United States*. The number of households in millions (*H*) is shown in Table A-5.

Anticipatory Variables

The survey variables are of two basic kinds. The first variable, (*A*), is the familiar Survey Research Center (SRC) Index of Consumer Sentiment lagged one quarter. The data are published in *Business Conditions Digest* (Series Number C1, 435). The survey was not taken in every quarter prior to 1962, and missing quarters are interpolated linearly. Since the survey is taken at various times during the quarter, the index is always used in lagged form. The other survey variable, (*p*), the index of expected purchases of automobiles, is a weighted variable constructed from SRC data,

TABLE A-1 **Gross Investment and Stock of Durables and Autos**

	G_D	S_D	G_C	S_C
1949-II		2285.9		569.2
1949-III	689.5	2342.1	265.0	596.9
1949-IV	709.5	2401.1	265.2	624.3
1950-I	731.6	2456.7	286.2	653.1
1950-II	733.8	2517.6	297.2	685.1
1950-III	908.6	2619.6	358.9	730.4
1950-IV	792.3	2687.3	334.0	766.9
1951-I	798.5	2762.5	307.3	799.6
1951-II	686.1	2803.5	270.4	819.6
1951-III	665.0	2837.5	242.4	831.6
1951-IV	657.4	2868.6	221.3	837.5
1952-I	660.8	2897.9	224.6	843.9
1952-II	673.1	2929.2	234.6	853.1
1952-III	628.5	2948.1	185.5	849.6
1952-IV	729.9	2991.9	269.3	866.9
1953-I	763.3	3042.2	304.9	892.6
1953-II	760.2	3092.5	305.8	918.2
1953-III	755.7	3139.9	307.0	942.6
1953-IV	755.5	3185.8	312.4	966.8
1954-I	723.3	3216.7	285.9	981.5
1954-II	741.9	3247.1	299.7	997.9
1954-III	746.8	3277.4	294.0	1012.1
1954-IV	785.3	3316.7	315.8	1030.9
1955-I	852.8	3367.6	368.8	1060.7
1955-II	904.9	3427.9	410.7	1099.2
1955-III	929.1	3491.4	421.0	1138.1
1955-IV	901.5	3546.6	391.9	1167.4
1956-I	847.5	3581.2	338.6	1183.1
1956-II	836.2	3619.1	314.0	1194.5
1956-III	816.6	3650.8	298.6	1201.6
1956-IV	841.8	3686.6	319.7	1213.0
1957-I	856.6	3721.9	340.6	1227.1
1957-II	833.2	3750.0	327.2	1237.0
1957-III	819.8	3773.3	309.9	1242.0
1957-IV	814.6	3794.8	320.6	1249.0
1958-I	755.8	3796.8	261.8	1240.2
1958-II	730.7	3791.6	244.8	1227.5
1958-III	741.0	3789.4	241.7	1214.7
1958-IV	759.0	3792.4	250.4	1205.5
1959-I	821.7	3803.8	303.7	1208.4
1959-II	857.4	3821.6	321.3	1214.9

TABLE A-1 (concluded)

	G_D	S_D	G_C	S_C
1959-III	867.2	3841.2	324.9	1221.8
1959-IV	825.2	3849.6	278.9	1216.2
1960-I	861.7	3874.0	326.4	1225.8
1960-II	861.8	3901.5	325.0	1235.9
1960-III	847.8	3924.4	324.0	1245.2
1960-IV	817.0	3939.4	298.6	1247.9
1961-I	780.7	3936.1	267.7	1240.9
1961-II	805.0	3935.9	272.0	1234.4
1961-III	824.7	3940.9	285.4	1231.7
1961-IV	853.3	3951.9	298.5	1232.2
1962-I	881.7	3976.1	324.4	1241.0
1962-II	878.6	4002.6	330.6	1252.8
1962-III	905.6	4034.7	338.9	1265.9
1962-IV	923.4	4070.6	350.8	1281.3
1963-I	946.6	4104.5	362.6	1297.4
1963-II	957.9	4138.2	363.3	1312.7
1963-III	979.7	4176.0	369.1	1328.6
1963-IV	992.3	4215.1	369.6	1344.2
1964-I	1029.8	4255.0	380.8	1359.4
1964-II	1055.0	4294.3	384.3	1374.2
1964-III	1068.6	4335.3	398.0	1391.4
1964-IV	1032.8	4365.7	353.6	1397.4
1965-I	1139.1	4422.8	477.7	1427.4
1965-II	1120.3	4475.1	461.7	1453.2
1965-III	1164.9	4536.2	477.7	1480.1
1965-IV	1207.3	4604.8	473.9	1505.9
1966-I	1256.4	4679.4	498.0	1535.6
1966-II	1188.6	4734.2	446.6	1551.7
1966-III	1229.3	4796.7	467.4	1572.0
1966-IV	1218.5	4853.4	464.2	1590.2
1967-I	1197.6	4885.8	425.2	1591.5
1967-II	1246.7	4924.5	471.9	1603.7
1967-III	1219.9	4954.7	453.6	1610.5
1967-IV	1218.4	—	445.6	—

NOTE: G_D = Gross investment in consumer durables, 1958 dollars deflated by number of households.
S_D = End of period stock of consumer durables, 1958 dollars deflated by number of households.
G_C = Gross investment in automobiles and trailers, 1958 dollars deflated by number of households.
S_C = End period stock of automobiles and trailers, 1958 dollars deflated by number of households.

TABLE A-2 Anticipations Data

	p	A	WDA
1953-III	6.27	87.3	0.0
1953-IV	5.66	84.1	0.0
1954-I	6.17	80.8	−1.65
1954-II	6.89	82.0	−1.65
1954-III	7.56	82.9	0.0
1954-IV	8.14	84.9	1.0
1955-I	7.79	87.0	2.05
1955-II	7.60	93.1	4.10
1955-III	7.50	99.1	6.05
1955-IV	7.48	99.4	3.15
1956-I	7.32	99.7	0.30
1956-II	7.42	99.1	0.15
1956-III	7.64	98.2	0.0
1956-IV	7.91	99.2	0.0
1957-I	7.77	100.2	0.0
1957-II	7.74	96.6	0.0
1957-III	7.44	92.9	−1.85
1957-IV	7.03	88.6	4.00
1958-I	6.79	83.7	−4.60
1958-II	6.55	78.5	−5.05
1958-III	6.52	80.9	−2.60
1958-IV	6.53	85.9	2.50
1959-I	7.07	90.8	4.95
1959-II	7.37	93.1	3.60
1959-III	7.36	95.3	2.25
1959-IV	7.20	94.5	1.10
1960-I	7.74	93.8	0.0
1960-II	7.74	98.9	0.0
1960-III	7.60	92.9	0.0
1960-IV	7.52	91.5	−0.70
1961-I	7.63	90.1	−1.40
1961-II	7.60	91.1	−0.20
1961-III	7.86	92.3	0.0
1961-IV	7.96	93.3	0.50
1962-I	8.04	94.4	1.05
1962-II	8.29	97.2	1.95
1962-III	8.21	95.4	1.40
1962-IV	8.34	91.6	0.0
1963-I	8.39	95.0	0.0
1963-II	8.64	94.8	0.0

TABLE A-2 (concluded)

	p	A	WDA
1963-III	8.84	91.4	0.0
1963-IV	8.81	96.2	0.0
1964-I	8.97	96.9	0.0
1964-II	9.15	99.0	1.05
1964-III	9.05	98.1	1.05
1964-IV	9.40	100.2	1.05
1965-I	9.55	99.4	1.05
1965-II	9.57	101.5	1.05
1965-III	9.62	102.2	1.40
1965-IV	9.60	103.2	0.85
1966-I	9.58	102.9	0.50
1966-II	9.46	100.0	0.0
1966-III	9.47	95.7	−2.15
1966-IV	9.58	91.2	−4.40
1967-I	9.35	88.3	−3.70
1967-II	9.13	92.2	−1.45
1967-III	9.09	94.9	0.0
1967-IV	8.00	96.5	0.80

NOTE: p is the weighted proportion of households expecting to purchase a new car; A is the SRC Index of Consumer Sentiment lagged one quarter; and WDA is the filtered charge in A.

and from the Census Bureau's Quarterly Survey of Intentions (QSI), and Consumer Buying Expectations (CBE) data as described below.

From 1953 through 1959 the only source is data on buying intentions from the Survey Research Center. The data are taken from several published sources and are not available in a consistent form nor, as has been noted, for every quarter. Therefore, some processing is necessary to put the raw data in useful form. The basic sources used are Arthur Okun, p. 446, and various issues of the *Survey of Consumer Finances*.

From 1953-I to 1956-I Okun provides data for eight of thirteen quarters in the form of intentions (measured by the sum of "will buy," "will probably buy," and one-half of the "maybe" responses) for new and used cars. The new- and used-car intentions are assigned weights of .6 and .3 respectively. From 1956 on, second- and fourth-quarter surveys are available with the data classified by "will buy," "will probably buy," and "may buy" new autos. Weights of .7, .5, and .3, respectively, were assigned as well as a .3 weight for used-car purchase plans and a .4 weight for "don't know" responses. The first quarter data are available in a new-used classification with "don't know" responses allocated. Consistent weights for these classifications, based on the mean size of each category, were

TABLE A-3 Disposable and Permanent Income

	Y	Y*		Y	Y*
1949-III	5419.9209	5514.0664	1959-I	6412.2295	6424.0273
1949-IV	5413.8945	5495.2246	1959-II	6482.3955	6464.9033
1950-I	5740.3349	5565.5214	1959-III	6395.6621	6473.0742
1950-II	5640.0175	5592.3740	1959-IV	6407.4892	6483.0703
1950-III	5685.9228	5627.4404	1960-I	6430.5517	6495.2724
1950-IV	5708.8037	5656.7353	1960-II	6448.8086	6510.9277
1951-I	5634.8144	5611.5478	1960-III	6439.8222	6520.2793
1951-II	5728.0146	5689.2480	1960-IV	6376.4257	6511.2539
1951-III	5727.1865	5709.5312	1961-I	6399.6709	6510.7822
1951-IV	5704.2304	5720.1748	1961-II	6479.4463	6531.0996
1952-I	5670.3535	5718.7890	1961-III	6538.2978	6562.7724
1952-II	5705.1396	5726.7207	1961-IV	6627.8388	6610.9472
1952-III	5803.1435	5758.2529	1962-I	6646.7480	6652.2041
1952-IV	5854.6230	5796.3408	1962-II	6700.5234	6697.4775
1953-I	5903.4687	5838.4892	1962-III	6715.1396	6734.8730
1953-II	5963.4316	5885.6113	1962-IV	6746.0468	6771.4873
1953-III	5923.5254	5910.9209	1963-I	6813.0713	6816.2461
1953-IV	5909.5488	5925.7939	1963-II	6832.4785	6855.5459
1954-I	5882.7304	5929.8964	1963-III	6899.4707	6903.1152
1954-II	5848.4638	5924.4922	1963-IV	6964.3086	6955.5937
1954-III	5892.1855	5931.9355	1964-I	7091.1338	7028.6796
1954-IV	5986.0195	5962.2343	1964-II	7226.9873	7119.2402
1955-I	6022.3798	5994.9238	1964-III	7300.2002	7207.2021
1955-II	6138.5771	6050.2998	1964-IV	7337.2871	7283.2099
1955-III	6226.1494	6114.3935	1965-I	7372.2207	7348.9560
1955-IV	6281.8476	6177.8691	1965-II	7441.9306	7416.3154
1956-I	6277.4472	6224.3437	1965-III	7657.7207	7523.2089
1956-II	6287.8593	6261.7060	1965-IV	7780.3906	7635.7422
1956-III	6281.4892	6287.7314	1966-I	7826.3408	7733.4170
1956-IV	6354.2177	6326.3642	1966-II	7808.5800	7801.6679
1957-I	6333.5283	6349.8857	1966-III	7899.8701	7876.4463
1957-II	6342.4824	6370.9726	1966-IV	7963.2705	7948.6025
1957-III	6353.1113	6389.2343	1967-I	8027.8300	8020.6845
1957-IV	6303.9023	6390.8066	1967-II	8057.5908	8082.4453
1958-I	6219.2509	6370.5781	1967-III	8057.2002	8128.8281
1958-II	6211.2422	6353.2226	1967-IV	8073.5107	8167.6298
1958-III	6319.4111	6368.0498			
1958-IV	6371.9072	6393.5107			

TABLE A-4 Dependent Variables for Anticipatory Models

	X_p	X_c	ACP
1953-III	29.15	11.84	2593
1953-IV	29.42	12.17	2568
1954-I	27.34	10.81	2646
1954-II	27.74	11.21	2675
1954-III	27.47	10.82	2719
1954-IV	28.91	11.62	2717
1955-I	34.50	14.92	2472
1955-II	36.76	16.68	2462
1955-III	37.92	17.18	2450
1955-IV	35.83	15.58	2516
1956-I	33.79	13.50	2508
1956-II	32.75	12.30	2553
1956-III	31.42	11.49	2599
1956-IV	30.58	11.61	2753
1957-I	30.04	11.94	2852
1957-II	29.04	11.41	2869
1957-III	28.83	10.90	2844
1957-IV	28.61	11.26	2847
1958-I	26.36	9.13	2867
1958-II	25.36	8.50	2881
1958-III	25.49	8.32	2907
1958-IV	25.95	8.56	2925
1959-I	27.75	10.26	2961
1959-II	28.69	10.75	2989
1959-III	28.94	10.34	2997
1959-IV	27.35	9.24	3017
1960-I	29.77	11.28	2895
1960-II	29.97	11.30	2876
1960-III	29.61	11.32	2863
1960-IV	29.05	10.62	2812
1961-I	27.80	9.53	2809
1961-II	28.43	9.61	2832
1961-III	28.92	10.01	2852
1961-IV	29.40	10.29	2903
1962-I	30.52	11.23	2889
1962-II	30.10	11.33	2919
1962-III	30.95	11.58	2926
1962-IV	31.25	11.87	2955
1963-I	32.04	12.28	2954
1963-II	32.39	12.28	2958

TABLE A-4 (concluded)

	X_D	X_C	ACP
1963-III	32.81	12.36	2986
1963-IV	33.06	12.31	3002
1964-I	34.31	12.69	3002
1964-II	35.25	12.84	2993
1964-III	35.33	13.16	3025
1964-IV	35.06	12.01	2946
1965-I	36.72	15.40	3102
1965-II	36.27	14.95	3089
1965-III	38.01	15.59	3065
1965-IV	39.38	15.46	3066
1966-I	40.85	16.19	3076
1966-II	38.29	14.39	3104
1966-III	39.05	14.85	3148
1966-IV	37.85	14.42	3219
1967-I	36.69	13.03	3264
1967-II	37.76	14.29	3302
1967-III	35.88	13.34	3400
1967-IV	35.16	12.86	3465

calculated (.32 for used cars, .54 for new cars). The two sections of the SRC data were then linked on the basis of an overlap period.

Missing quarters were interpolated, and the series were seasonally adjusted with the X-11 moving seasonal program. After adjustment, the missing quarters were corrected to be interpolations of the seasonally adjusted data. The SRC portion (1953–60) of the basic intentions series was then linked to the level of the QSI-CBE portion based on an overlap period. The derivation of the QSI-CBE portion follows.

For 1960 through 1966, the Census Bureau's Quarterly Survey of Intentions is used; for 1967 on, CBE purchase probability data are used. First, we construct a weighted measure of the basic QSI intentions data: six-month definite, probable, or possible new-car plans are assigned weights of .7, .5, and .3, respectively, twelve-month plans are assigned a weight of .3, used-car plans a weight of .2, and "don't know" responses a weight of .3. For CBE data, six- and twelve-month car-purchase probabilities were given equal weights. The resulting variable was then regressed on the purchase rate, seasonal dummy variables, and dummies for the effect of interviewer training session and survey type (QSI vs. CBE). The coefficients on the last two dummies were used to adjust the weighted plan

TABLE A-5 Explanatory Variables for Objective Models

	M_c	M_p	U	H
1949-III	20.900	18.521	8.0100	42.639
1949-IV	20.900	18.638	8.3648	42.982
1950-I	20.900	18.755	7.6847	43.325
1950-II	20.900	18.872	6.6860	43.741
1950-III	20.900	18.872	5.6632	44.021
1950-IV	15.300	15.339	5.0702	44.300
1951-I	14.000	14.429	4.2691	44.580
1951-II	14.000	14.312	3.7889	44.745
1951-III	15.700	15.349	3.8793	44.961
1951-IV	16.500	15.954	4.1302	45.177
1952-I	16.500	16.071	3.7375	45.394
1952-II	19.300	17.896	3.6559	45.608
1952-III	20.900	18.989	3.9749	45.820
1952-IV	20.900	19.106	3.4099	46.032
1953-I	22.000	19.894	3.2072	46.244
1953-II	22.200	20.133	3.1743	46.433
1953-III	22.200	20.172	3.3127	46.577
1953-IV	22.600	20.377	4.5005	46.721
1954-I	23.400	20.865	6.2932	46.866
1954-II	25.000	21.802	6.9299	47.038
1954-III	25.600	22.168	7.1959	47.266
1954-IV	26.000	22.412	6.4781	47.494
1955-I	26.000	22.373	5.6937	47.722
1955-II	26.900	22.922	5.2823	47.959
1955-III	27.800	23.510	5.0133	48.216
1955-IV	27.900	23.610	5.0260	48.473
1956-I	28.500	24.015	4.8925	48.730
1956-II	29.000	24.359	5.1617	49.031
1956-III	29.400	24.603	5.0221	49.224
1956-IV	28.800	24.237	4.9927	49.416
1957-I	28.600	24.115	4.9600	49.609
1957-II	29.800	24.847	5.1637	49.807
1957-III	30.400	25.252	5.2611	50.007
1957-IV	30.100	25.147	5.9605	50.207
1958-I	29.800	25.003	7.6909	50.408
1958-II	30.400	25.369	8.6640	50.634
1958-III	31.000	25.774	8.3153	50.875
1958-IV	30.600	25.608	7.3975	51.115
1959-I	30.800	25.730	7.0080	51.355
1959-II	31.300	26.074	6.1823	51.663

TABLE A-5 (concluded)

	M_C	M_D	U	H
1959-III	32.000	26.579	6.4160	52.004
1959-IV	31.600	26.374	6.6476	52.345
1960-I	31.500	26.391	6.2527	52.686
1960-II	31.800	26.613	6.4456	52.909
1960-III	32.200	26.896	6.6435	53.076
1960-IV	31.600	26.530	7.4331	53.243
1961-I	31.300	26.386	8.0904	53.409
1961-II	31.700	26.630	8.2443	53.662
1961-III	32.100	26.874	7.9389	53.959
1961-IV	31.600	26.569	7.2341	54.256
1962-I	32.100	26.835	6.7813	54.553
1962-II	32.300	26.957	6.5847	54.742
1962-III	32.800	27.301	6.6735	54.876
1962-IV	32.100	26.913	6.5992	55.010
1963-I	32.400	27.135	6.4714	55.144
1963-II	32.600	27.296	6.3846	55.324
1963-III	33.100	27.601	6.2166	55.526
1963-IV	32.500	27.235	6.1497	55.727
1964-I	32.700	27.318	5.9893	55.929
1964-II	33.000	27.501	5.8577	56.206
1964-III	33.300	27.723	5.6678	56.519
1964-IV	32.800	27.496	5.3975	56.833
1965-I	32.800	27.535	5.2571	57.147
1965-II	33.100	27.796	5.2193	57.391
1965-III	33.400	28.057	4.9619	57.602
1965-IV	32.800	27.730	4.4702	57.812
1966-I	32.900	27.830	4.0945	58.022
1966-II	33.900	28.479	4.4029	58.218
1966-III	33.900	28.557	4.3310	58.406
1966-IV	33.900	28.600	3.9669	58.594
1967-I	34.100	28.600	4.0995	58.783
1967-II	33.700	28.700	4.0724	59.112
1967-III	34.100	28.300	4.3685	59.370
1967-IV	33.900	28.200	4.3330	59.640

variable for those net effects. The entire series was then seasonally adjusted with the Census X-11 moving seasonal program.

The resultant intentions variable is always used in weighted form and draws upon three surveys of expected purchases. The current-quarter survey value and two lagged surveys are weighted .6, .3, and .1, respectively. The current survey is included because the Census Bureau surveys are taken at the beginning of the quarter although they do not become available until the middle of each one.

The sentiment index is used in two forms. The first is a filtered change variable and the second is the lagged attitude index itself. The filtered variable is based on a dummy, (D), which is assigned a value of 1 when there is a systematic change in A and assigned a value of 0 otherwise. The decision rule is that the sentiment index must move in the same direction for three consecutive quarters before the move is considered persistent. Interpolated quarters are counted in applying the rule, and a break in a series of upward or downward movements does not necessarily mean that three more quarterly movements are needed to reintroduce the series. The criterion is whether the next quarter after the break continues the previous pattern by registering a new local high (or low) value. If it does, the series will only be interrupted by the quarter break; if it does not, the basic decision rule applies. The rule is relaxed in the case of two consecutive changes that are both quantitatively large (defined to be at least 7 percentage points in the SRC index, which has a base of 1963 = 100). The decision rule can be summarized as follows: the filtered attitude variable is given by

$$WDA_t = .5D_t\,(\Delta A_t) + .5D_{t-1}\,(\Delta A_{t-1})$$

where

$$
\begin{aligned}
D_t = 1 \quad & \text{if } \Delta A_{t-i} \text{ for } i = 0, 1, 2 \text{ are of the same sign} \\
& \text{or if } |\Delta A_t + \Delta A_{t-1}| \geq 7 \\
& \text{or if } D_{t-2} = 1 \text{ and } D_{t-1} = 0 \text{ and } |\Delta A_t| > |\Delta A_{t-1}|; \\
D_t = 0 \quad & \text{otherwise.}
\end{aligned}
$$

The anticipations data are shown in Table A-2.

The dependent variables for the anticipatory models are deflated expenditures divided by unit price, or the purchase rate. The respective expenditure variables (G_C and G_D) are divided by the average car price in 1958 dollars (ACP). The average car price, a weighted average of foreign and domestic car prices divided by the Consumer Price Index for new cars, is shown in Table A-2. The basic data were obtained from the Office of Business Economics. The average car price is used as a proxy for the unit price of durables, as discussed in the text. The purchase rate for automobiles, x_C, and for durables, x_D, are multiplied by 100 and are shown in Table A-4.

Prices, Maturities, Interest Rates, and Unemployed Man-hours

The price series are all estimated as P_i/Q, where Q is the implicit price deflator for personal consumption expenditures. The implicit price deflators for personal consumption expenditures on durables and for gross auto product are found in Tables 8.1 and 8.2, *SCB*. For nonauto durables the implied deflator is calculated from the ratio of current- to constant-dollar purchases.

The mean maturity, seasonally adjusted, for new auto contracts was obtained for 1947–62 from unpublished material provided by Robert Shay, and for 1963–65 from J. Craig of the Brookings Institution. From 1966 on, the data were estimated by formula from Federal Reserve Board seasonally adjusted data on credit outstanding and repayments. For nonauto durables, annual data from Juster, *Household Capital Formation and Financing*, were updated and interpolated quarterly. The maturity variable for total durables is a weighted average of auto and nonauto maturities. The weights of .39 and .61, respectively, represent average shares of total durables expenditures. The maturity variable for automobiles (M_C) and total durables (M_D) are shown in Table A-5.

Two interest-rate series are also utilized as explanatory variables—a general interest rate (the return on AAA corporate bonds) and the return on household savings accounts. The latter series is a weighted average of various time and savings deposits, and was obtained through correspondence with M. Hamburger of the Federal Reserve Bank of New York.

Unemployed man-hours, U, used as a transitory variable in both the objective and anticipatory models, is shown in Table A-5. The variable is defined as the number unemployed times the average number of hours worked plus hours lost due to involuntary part-time work as a per cent of the total man-hours of the potential labor force. The basic data are seasonally adjusted Bureau of Labor Statistics (BLS) series and are adjusted for changes in the definition of the labor force which exclude fourteen and fifteen year olds. After 1955 the BLS series, labor-force time lost as a per cent of total potential man-hours, is the basic source. The earlier data are constructed from the basic definition and are adjusted to this series.

Dummy Variables

Dummy variables are included in the regressions in order to explain two types of supply restrictions. First of all, auto strikes in 1952-III and 1964-IV and a steel strike in 1959-IV distorted the observed demand patterns. For the Korean War period (1950–51) panic-buying patterns were treated with a dummy system. The design of the respective dummy variables is discussed in Appendix C. It is also necessary to adjust the lagged dependent variables for the influence of the dummy variable. The adjustment procedure is discussed in Appendix C.

Income Variables

Two income variables are used: Y is real per household disposable income and $\dot{Y}^*$ is a constructed permanent-income variable.

The permanent income series is based on a discrete approximation to the continuous adaptive-revision model originally suggested by Friedman. Estimates were constructed with various values of the coefficient of expectations, using postwar quarterly data. In addition, a trend correction that increases linearly with time was estimated by regression. This last step is necessary because of the unusual growth pattern on income in the sample (1949–67) period. A constant trend correction, using the compound growth rate, yields consistently negative transitory income in the early years and consistently positive transitories in later years.

The series used has a coefficient of expectations of .3. This series seems, on balance, to yield the highest explained variance in different specifications of the objective model. Real per household disposable and permanent income are shown in Table A-3. Transitory income is defined as disposable income less permanent income.

The quarterly coefficient of expectation of .3 implies a mean adjustment lag of 3.3 quarters. This contrasts with Friedman's estimate of an annual coefficient of expectations of .4 and a mean lag of 10 quarters. However, Mundlak has shown that the coefficient of expectations increases with the length of the observation period. If adjustments are made quarterly, Friedman's estimate implies a mean lag of 5.2 quarters.

APPENDIX B: ANALYSIS OF THE OBJECTIVE MODEL

In this appendix, some extensions of the objective model described in section 1 of the text are discussed. First, alternative specifications of the desired demand function that utilize interest rates are examined. This is followed by a comparison of the results with the durables equations used in various econometric models. Next, the possibility of serial correlation problems are examined, and comparisons are presented using an estimation procedure that corrects for first-order serial correlation. The final section of this appendix presents a reformulation of the model in which the transitory variable affects the speed of adjustment rather than affecting investment directly. An estimation procedure is suggested and estimates of the magnitude of the effect are shown.

Additional Specifications

Several other variables were tested in alternative specifications of the desired-stock function. First of all, interest rates may enter the model in two ways: as the cost of credit, and as the return on substitute financial assets.[28] No loan-rate series is available so the corporate-bond rate was used as a proxy. The bond rate is related to the rate paid by finance companies to obtain funds and, thus, will affect the rate charged although with a lag. The bond rate lagged five quarters is, therefore, used as a measure of credit costs, and as a possible substitute for the maturity variable. An interest-rate series that measures the return on savings deposits is used as an estimate of the return on substitute assets. An increase in the interest return makes other assets more attractive and should have a negative effect on the demand for durables stocks.

For total durables the interest-rate series all have negative signs. For autos, however, the coefficients are insignificant and positive, even though the credit-cost effect should be stronger for automobiles. The permanent-income and transitory-income variables are not sensitive to changes in the interest rate and credit specifications. The relative-price variables are unstable, indicating some collinearity with interest rates and a common trend. Real rates of interest, estimated by correcting nominal rates for the rate of inflation,[29] were not significant in any regressions.

The interest-rate tests show fairly small long-run stock elasticities on durables, as would be expected. For the lagged bond rate, the interest elasticities are $-.25$ in the second-order model and $-.27$ in the first-order model; for the savings rate, the elasticities are $-.09$ and $-.32$, respectively. The addition of interest-rate variables tends to increase the price elasticity to between -1.5 and -2.0. The permanent-income elasticity remains just under 1, and a positive maturity effect of less than .5 is still found in equations that contain the savings-return variable along with maturity. For total durables, the results support the contention that there is a small negative (nominal) interest-rate effect on durables stocks. For automobiles, the results are less clear, possibly because there is less trend correlation between interest rates and net investment. In the first-order model, interest-rate coefficients are significant and have an elasticity of about $-.3$; the associated price elasticity, however, is about -2.

The model was also estimated with the price of substitute goods as an additional determinant of desired stock. Consumers can substitute service expenditures for most durable-goods investments. Thus the relative price of services should enter with a positive coefficient. The estimated coefficients were positive but small, and the t-ratios never exceeded 1.5. A clearer picture of this effect would require a better measure of the price of substitute goods than the one that we used—the aggregate deflator for service expenditures.

Comparisons with Earlier Studies

Several of the durable-goods demand studies mentioned earlier provide results that can be compared to those presented here. Although there are differences among these studies in time period and in the gross-investment series, the standard errors of estimate should be roughly comparable. For this purpose our model was reestimated over the 1953–67 period. This is the period used by Hamburger, and it is close to the fit periods for the OBE model (1953–66) and the Brookings model (1954–65). The standard-error comparisons are in billions of 1958 dollars, thus requiring multiplication of the Brookings results by the average population over the fit period, and multiplication of our results by the average number of households. Table B-1 shows that the results of the various studies are very close to one another.

Previous studies of the demand for automobiles (e.g. Chow and Suits), have yielded considerably larger estimates of income elasticities. The differences are due to a number of factors. First, the Chow and Suits studies are based on first-order adjustment models and, therefore, if the present model is correct, contain misspecification bias. Waud shows that the misspecification bias in a partial-adjustment model, when the expectational structure is part of the appropriate specification, will lead to the overestimation of elasticities. Secondly, earlier studies were estimated over the initial period of diffusion of many durables, in which a very high income elasticity might be found. Also, as noted above, the treatment of the maturity variable may tend to reduce the estimated income elasticity.[30]

Serial Correlation Bias

The possibility of serially correlated residuals suggests that the least-squares error specification is inadequate. In addition, if a disturbance term had been specified prior to estimation, the reduced form would have a serially

TABLE B-1 Standard Errors of Estimate (billions of 1958 dollars)

	Gross Investment	
	Autos	Other Durables
OBE model	1.0	.6
Brookings model	.9476	.5006
Hamburger model	.9249	.2913
AET model	.9402	.4867
PT model	1.2839	.5649

correlated residual. The model was reestimated by generalized least squares with the assumption of first-order serial correlation in the disturbance. The reestimated model does exhibit a great deal of positive serial correlation, but the coefficient estimates are largely unchanged and appear to be more stable.

In the second-order models, the major effect of reestimation is to reduce the lagged net-investment coefficient. The estimated parameter of serial correlation is very small, except for other durables. The first-order models exhibit a great deal of serial correlation and largely reduced standard errors when reestimated. When reestimated, the AT models (Tables 1A to 1C, net investment, show the originals) are respectively:

$$N_D = .900 + .2217\,Y^* - 1012\,P_D/Q - .0445\,M_D - .3056\,S_{D\text{-}1} + .2022\,Y^t$$
$$(1.4) \quad (4.0) \quad (2.3) \quad (.1) \quad (5.0) \quad (3.4)$$
$$\text{S.E.E.} = 24.29 \quad \omega = .77$$

$$N_C = 214 + .0706\,Y^* - 328\,P_C/Q + .1545\,M_C - .2834\,S_{C\text{-}1} + .1461\,Y^t$$
$$(.9) \quad (2.2) \quad (2.0) \quad (.7) \quad (3.0) \quad (2.9)$$
$$\text{S.E.E.} = 20.83 \quad \omega = .74$$

$$N_H = 14.8 + .1695\,Y^* - 221.2\,P_H/Q - .3014\,S_{H\text{-}1} + .0847\,Y^t$$
$$(.1) \quad (12.2) \quad (1.5) \quad (9.1) \quad (3.6)$$
$$\text{S.E.E.} = 9.70 \quad \omega = .56$$

The dummy variables are omitted and ω is the estimated coefficient of serial correlation.

Variable Adjustment Lags

The transitory term, a distinctive feature of the objective model, can enter in either of two ways. In the objective model in the text, an additive transitory term was used.

(1) $\Delta S = \beta(S^* - S_{-1}) + T$

In this formulation, the speed of adjustment (β) is constant and independent of the transitory term.

An alternative formulation is to specify that transitory investment has an influence on the speed-of-adjustment coefficient. In the AT net-investment model, for example, the alternative hypothesis would be that the speed of adjustment in (2) is not constant but is a linear function of the transitory term (3). In both models the transitory phenomena effect the speed of adjustment.

(2) $\Delta S = \beta(S^* - S_{-1})$

(3) $\beta = a + bT$

It is therefore not possible to test one model against the other. If the true model is given by the reduced form of (2) and (3) with an interactive transitory effect, the original objective model can still show a significant linear effect and vice versa. However, it is of interest to examine the magnitude of the effect of the transitory term on the speed of adjustment in (2).

The revised model is estimated by a two-step procedure. First of all, (2) is estimated by ordinary least squares and the coefficient estimates are used to generate an estimate of desired stock, and consequently an estimate of $(S^* - S_{-1})$, which is entered into a second-stage regression. In the second

TABLE B-2 The Speed of Adjustment in Partial-Adjustment Models

	β	R^2
Durables (N_D)		
AT model	.2783 (7.9)	.8497
Revised model, first stage	.3407 (7.6)	.7387
Revised model, second stage	.2980 + .006Y' (12.3) (6.1)	.8287
	.4154 − .0160U (11.4) (3.1)	.7702
Automobiles (N_A)		
AT model	.2503 (5.1	.7564
Revised model, first stage	.3126 (5.0)	.5969
Revised model, second stage	.2833 + .0010Y' (8.8) (5.6)	.7237
	.4146 − .0176U (6.2) (1.8)	.6154
Other Durables (N_H)		
AT model	.2773 (12.4)	.9278
Revised model, first stage	.3137 (11.8)	.8887
Revised model, second stage	.2921 +.0001Y' (17.9) (2.2)	.8477
	.3343 − .0102U (19.5) (3.7)	.8640

NOTE: Numbers in parentheses are t-ratios.

stage, net investment is regressed on the estimated difference between desired and actual stock and an interaction term with the transitory variable as implied by (3).

Table B-2 summarizes the results for both standard and revised partial-adjustment models. The first stage of the revised model is an adjustment model without a transitory term, which is clearly an unsatisfactory equation. The second-stage estimates utilize the estimated difference between desired and actual stock and an interaction with either transitory income or unemployed man-hours. The table presents the various estimates of the speed of adjustment and the coefficient of determination for each regression. Although the two-stage revised model yields highly significant results, as measured by the t-ratio of the interaction terms, the proportion of variance explained is not as high as in the standard model with an additive transitory term. The results do serve as an indication of the magnitude of transitory effects on the speed of adjustment, even if the additive transitory term is a more satisfactory explanatory model.

The largest effects on the speed of adjustment are those exerted on automobiles. At the mean level of transitory income and unemployed man-hours, the second-stage estimates of the speed of adjustment are .2833 and .3145, respectively. An increase of transitory income, or a decrease of unemployed man-hours, equal to one standard deviation in each series would imply adjustment speeds of .3508 and .3397, respectively. A two standard-deviation change would bring the estimates to .4183 and .3649. The response in the adjustment for total durables would not be as large.

APPENDIX C: DISTRIBUTED LAG EQUATIONS AND DUMMY VARIABLES

Equation systems in which one or more lagged values of the dependent variable appear as independent variables are used extensively in estimating econometric models. Such equations are conceptually appropriate whenever there is reason to suppose that past as well as present values of the independent variables have an influence on the observed values of the dependent variable. In this appendix, we examine the statistical consequences of using a common type of distributed lag formulation in equation systems where, for one reason or another, the dependent variable contains one or more abnormal values which can be handled by use of a dummy (1, 0) variable.

A standard case in point is an equation designed to explain either purchases of automobiles or change in automobile stocks in the household sector. On several occasions during the past fifteen years, strikes have curtailed the supply of automobiles for periods ranging from one to several months. These effects usually spill over from one quarter to the next, inasmuch as the below-normal supply resulting from a strike during one quarter is balanced by an above-normal supply during subsequent quarters. Thus, the dependent variable is apt to be abnormally low during the strike quarter,[31] abnormally high during the quarter immediately following and, perhaps, also during the second quarter following. If the desired stock of automobiles is taken to be a function of current and past levels of income and relative prices, for example, it will ordinarily be necessary either to exclude quarters in which strike and poststrike effects show up strongly or to insert a dummy variable designed to measure the net influence of this supply disruption on each of the quarters in question. Failure to do so will give biased estimates of the parameters in the demand function, and exaggerate the residual variance as well. Eliminating the offending quarters is, in principle, less desirable than permitting them to remain and allowing for their special influence by means of one or more dummy variables.

In models where the lagged value of the dependent variable appears, use of a dummy variable to reflect supply disruptions will inevitably distort estimates of regression parameters, of residual variance, and possibly of serial correlation. Troubles arise because the dummy is designed to handle abnormal values of the *dependent* variable only. In practice, if the dependent variable proper has an abnormal value, it necessarily follows that at least one of the lagged dependent variables will also be abnormal. If the model contains more than one lagged dependent variable, the problem is magnified.

It is easy to see that dummy variables which reflect abnormalities like strikes will bias the regression coefficients of both the dummy variable and any lagged dependent variable, and will exaggerate the residual variance. Take the simplest case: an unforeseen strike occurs in quarter t, reducing supply, and this effect is fully made up in quarter $t + 1$. In quarter t the model will function effectively: the variables reflecting demand, including the lagged dependent variable, will all have normal values. On the customary assumption that demand and supply are in balance, the dummy variable for quarter t will have a negative regression coefficient equal to the difference between normal supply (= demand) and the below-normal supply due to the strike. In quarter $t + 1$, substantive demand variables will again have normal values: the dummy variable will have a positive regression coefficient which reflects the difference between normal demand and the above-normal demand (= supply) resulting from producers having made up the supply shortfall in t. But the lagged dependent variable, because it reflects the influence of the strike in t, will have an abnormally low value and, hence, predicted demand will tend to be low.

Moreover, demand in the next quarter, $t + 2$, will also be poorly predicted despite the fact that the strike no longer has any effect whatsoever on either current demand or current supply. The reason is that the lagged dependent variable in $t + 2$ is the (abnormally high) level of purchases in $t + 1$. Furthermore, if the lag structure involves not one but two lagged terms, this adverse effect will carry over to one additional quarter, since the bias will not be eliminated from the regression estimates until all lagged dependent variables have ceased to be influenced by the temporary effects of the strike.

There are a number of relatively simple solutions to this problem though it is not entirely clear which one is optimal. One could estimate the model without lag terms, but with all of the substantive independent variables, including the dummy. The regression coefficients of the dummy variable could then be used to compute a "corrected" dependent variable series. Finally, the equation could be reestimated with the distributed lag structure, using the corrected dependent variable both as the dependent variable proper and as the lagged variable, but not using the dummy variable(s).

Alternatively, one could estimate the model without lags in order to obtain the regression coefficients for all dummy variables, and these regression coefficients could then be used to estimate corrected values for the dependent variable *only* when the latter appear as lag terms. Thus, no adjustment would be made in the dependent variable proper, but the dependent variable would appear in corrected form when it constitutes a lagged independent variable. Using the first procedure, the final equation will not contain the dummy variable; the full effect of the supply situation reflected by the dummy will already have been accounted for by the corrected dependent variable series. If the alternative procedure is used, the dummy variable will be included in the final model, since no correction will be applied to the dependent variable itself. Thus, the estimated effect of the supply stringency, as reflected by the coefficient of the dummy, will be different in the final equation from what it was in the equation from which correction factors were taken. Presumably, the final estimate will be better, since any association between the dummy variable and the lagged dependent variable will be permitted to influence the regression coefficients in the final version. Intuitively, it would seem that if there were zero correlation between the dummy variable and the lagged dependent variable, both procedures would yield the same parameter estimates and the same estimates of explained variance.[32]

The following procedure is used by us to correct lagged dependent variables. Corrected equations are obtained by (a) estimating the model without lags to get a first approximation to the regression coefficients for dummy variables; (b) using these estimated regression coefficients to correct the dependent variable for any quarter in which the dummy variables have a nonzero value; (c) reestimating the model with substantive demand variables, dummy variables, and corrected values for the lagged dependent variable. Corrected values are used only when the dependent variable appears as a lag term on the right-hand side of the equation. Thus, the corrected equation fits all variables in their original form except for lagged dependent variables with abnormal values.

Two kinds of dummy variables appear in the model. First, there is a Korean War dummy (KD) designed to reflect the fact that changes in durable-goods stocks were abnormally high from the third quarter of 1950 to the first quarter of 1951. The above-normal volume of durable-goods demand during both periods could presumably have been reflected by some kind of anticipated price variable, rather than being treated as an exogenous disturbance. This is not a practical alternative because no expected price variable exists. The KD dummy variable does not specify that the abnormally high level of demand from 1950-III through 1951-I is associated with a specific pattern of abnormally low demand in following periods. The stock variable in the equation is permitted to carry the full weight of the reaction; that is, abnormally high demand results in the building up of an abnormally high stock of durables, and purchases in future periods tend to be lower because of this high level of stocks.[33]

The quantitative scaling of the dummy is essentially arbitrary and must be decided largely on empirical grounds. The following system satisfactorily reduces prediction errors in the indicated quarters and is used throughout.

	Autos *(AKD)*	Household Durables *(HKD)*	Total Durables *(DKD)*
1950-III	.40	1.00	1.40
1950-IV	.20	0	.20
1951-I	.30	.50	.80

A different treatment is accorded the dummy variables for strike periods and poststrike influence (*SD*). Here, it is specifically assumed that strikes cause only a displacement of purchases and have no net impact: a value of −1 is assigned to the period during which the strike took place, and values of +0.75 and +0.25 are assigned to the two following quarters. In general, strikes in the automobile industry have taken place around model changeover time, and have had their major influence during the fourth quarter of the current year and the first quarter of the following one. The strikes treated in this manner occurred in 1952-III and 1964-IV. In addition, the steel strike of 1959-IV is given the same dummy treatment.

The fact that part of the dummy-variable structure in these equations is designed to reflect not only an abnormal change during a particular period due to a specified cause, but also the reaction (opposite in sign) to the abnormality, means that the equation itself is more sensitive to the sharp up and down movements found around such periods. Thus, the period around an automobile strike probably tends to be better fitted than the average quarter in the period, and a large part of the burden for this better fit is carried by the dummy variable in the absence of a "normal" value for any lagged dependent variable.

The impact of the adjustments of the lagged dependent variables are shown in Table C-1. Estimates of the AET model for total durables are shown. The first equation is the fully specified AET model without any adjustment of the lagged dependent variable in the poststrike and postwar periods. The estimated coefficients of the dummy variables from this first stage regression are then used to adjust the lagged dependent variable. The model is then reestimated and these second-stage results are the second equation shown.[34]

The most important difference between the first- and second-stage estimates are in the coefficients of the distributed lag terms. The coefficient of the lagged dependent variable rises by .12. Correspondingly, the coefficients of the determinants of desired stock decline. The coefficients of the dummy variables themselves change slightly, but the transitory variables are hardly affected by the adjustment.

It is expected that the explanatory power of the model should be increased by the adjustment, which is the case. An examination of the residuals shows very little change except in the periods in which the dummy variable has nonzero values. The serial correlation in the residuals is reduced for the corrected equation.

TABLE C-1 Effect of Lagged Dependent Variable Correction in AET model

	Constant	Y^*	P_D/Q	M_D	S_{D-1}	N_{D-1}	U	U^{-1}	SD	KD_D	R^2	DW
				Net Investment in Durables, N_D								
No adjustment	1,264	.0797	−1,064	1.4863	−.2430	.4877	−36.5	20.5	41.8	99.3	.9356	1.66
	(3.7)	(3.5)	(4.4)	(5.7)	(8.1)	(8.8)	(6.5)	(3.8)	(4.1)	(6.4)		
With adjustment	1,164	.0543	−948	.9978	−.1836	.6069	−35.7	24.3	35.9	94.5	.9415	1.91
	(3.5)	(2.4)	(4.1)	(3.9)	(5.7)	(9.6)	(6.6)	(4.7)	(3.7)	(6.4)		

NOTES

1. Eva Mueller, E. Scott Maynes, and F. Thomas Juster (1969a) fit into this general framework, in that the main focus is on the performance of anticipatory variables in a demand model. All pay only incidental attention to the structure of an objective model.
2. Examples of demand studies of this type are those by Gregory Chow, Daniel Suits, and Michael Hamburger.
3. The current versions of the Brookings, Wharton, FMP, and OBE models use some form of the stock adjustment process, and none contain anticipatory variables. Earlier versions of the Brookings and Wharton models included the Index of Consumer Sentiment as an explanatory variable.
4. A recent paper by Saul Hymans uses the Index of Consumer Sentiment in a model designed to be simulated, with an auxiliary prediction equation for the Index itself.
5. Adjustments are not made instantaneously partly because of decision and purchasing lags, partly because the level of desired stock represents a target demand about which there exists some uncertainty, and partly because of transactions costs. Household investment decisions are sensitive to uncertainty because resale markets are imperfect; a decision to invest represents a commitment to consume a certain level of services well into the future. Increasing marginal costs of investment are usually cited in the capital investment literature as the source of adjustment lags.
6. In our model, the disctinction between permanent and transitory investment is the length of the planning horizon that precedes the investment decision. Thus, "transitory" investment may come from an unexpected but permanent income change which alters the rate of consumption and therefore the level of durable stock held.
7. The discrete model, in contrast, states that the current expectation differs from the previous expectation by some proportion of the error made in the last period. The correct specification of this model is the continuous form (3'), as expectations are being continually revised. The approximation to (3') is (3), which is the form used above.

$$(3')\quad \frac{dZ^e}{dt} = \rho(Z - Z^e)$$

Its only drawback is that it is not an ex ante explanation, since it requires current observations to explain current expectations. When a pure forecast form is required the discrete error revision version (3") of the model can be substituted:

$$(3'')\quad Z^e - Z_{-1}^e = \rho(Z_{-1} - Z_{-1}^e)$$

8. The symmetry of the partial adjustment and adaptive explanations first-order lag models has been discussed by Roger Waud.
9. The reduced form is derived by writing the model in terms of lag operators. We can rewrite the identity in (5) in terms of stock, then substitute (1) and (4), all expressed with the lag operator L to yield:

$$S - LS = \beta S^* - \beta LS + T$$

Using (2), substitute for S^* and solve for S:

$$S = \frac{1}{1-(1-\beta)L}\,[\beta Z^e + T]$$

Similarly, (3) can be solved for Z^e and substituted above to yield the reduced form:

$$S = \frac{\beta}{1-(1-\beta)L}\cdot\frac{\rho}{1-(1-\rho)L}Z + \frac{T}{1-(1-\beta)L}$$

10. An alternative formulation of the gross investment model specifies that a partial adjustment to depreciated stock determines planned purchases (1').

(1') $C^p = \beta[S^* - (1 - \delta)S_{-1}]$

The reduced form of the model specified by (1'), (2), (3), (4'), and (5') is given by (8')

(4') $C^r = I$

(5') $C = C^p + C^r$

(8') $C = \beta\rho Z + [(1 - \rho)\delta - \beta\rho(1 - \delta)]S_{-1} + (1 - \rho)(1 - \delta)\Delta S_{-1} + I - (1 - \rho)I_{-1}$

which is identical to (8) except that the coefficients have a different interpretation. This form would be preferred if supply restrictions or an absolute decline in wealth led the household sector to delay replacment demand. There is no evidence that this occurs in the sample period. Net investment in total durables is never negative and the automobile component is less than zero in only five quarters of the twenty-year period examined.

11. The constructed data are discussed in Appendix A.
12. Consumer purchases are not ordinarily thought to be sensitive to changes in interest rates per se, which often are not adequately reflective of conditions in credit markets. In terms of financial flows, an increased interest cost is readily balanced out by a longer maturity. This can be seen by looking at the value of a loan. $V = \pi[1 - (1 + i)^{-M}/i]$, where π is the monthly payment, i the loan rate and M the maturity. The elasticity of V with respect to M exceeds the elasticity with respect to i for the observed ranges. A discrete approximation to the elasticities can be calculated with the use of an annuity table. The interest elasticity increases in absolute value with both maturity and interest rates, and the maturity elasticity does the opposite. Thus, the comparison of a maturity elasticity of .79 and an interest elasticity of −.21 at a maturity of thirty-six months and a loan rate of 16 per cent does not overstate the case for using the maturity variable. See also, Juster and Shay.
13. Adaptive expectations with a trend correction and the Permanent Income Hypothesis were used to generate the series.
14. A discussion of the adjustment procedure is found in Appendix C.
15. Unemployed man-hours are defined as the number unemployed times the average number of hours worked plus hours lost due to involuntary part-time work, divided by the total man-hours of the potential labor force.
16. An alternative hypothesis—that the first difference in unemployed man-hours is the correct explanatory variable in a model without an explicit transitory component—may be equally plausible.
17. This result is common in a quarterly model without a lagged dependent model. For the second-order models, although the Durbin-Watson is biased towards 2, the results do not preclude the possibility of positive serial dependence. The model was reestimated with the additional assumption that the residuals follow a pattern of first-order serial correlation. The results, which are basically the same as those shown above, are examined in Appendix B.
18. The mean depreciation rates are .2225 for automobiles, .1626 for other durables, and .1814 for total durables.
19. Edwin Kuh estimates the elasticity of output with respect to employment as 1.81 in the current quarter, 1.27 after two quarters, and .82 in the long run
20. The mean lags are derived in Zvi Griliches' article. A procedure for deriving confidence intervals for θ was adapted from W. Fuller.
21. These results are calculated from the AT model, net investment. Tables 1A to 1C.
22. The differences among these series are described in Juster (1969b).
23. In previous research, it has been found that attitudes and lagged intentions were the best predictor of purchase rates or households classed as nonintenders. Hence both intentions and attitudes made significant contributions to an explanation of aggregate purchase rates: intentions presumably reflected variations in intender purchase rates.

while attitudes picked up variations in the purchase rates of nonintenders. See Juster (1969a).

24. The intentions variable refers only to automobiles although it is also used in the total durables function.
25. As noted above, the available intentions series have differential sampling reliability before and after 1960, while attitudes are not available for every quarter prior to 1961.
26. The standard errors shown in Table 4 for the anticipations models are actually obtained from a two-step procedure. Buying intentions are conceptually designed to explain unit sales rather than deflated per household expenditures, hence we estimated the anticipations model with the dependent variable defined as deflated expenditures divided by deflated unit price. This variable is the equivalent of the population purchase rate. The proportion of explained variance and the standard error estimates in the table are not the ones derived from this equation but, rather, statistics estimated by multiplying the predicted values from the equation by the deflated price variable. This procedure insures that the standard error estimates for the anticipations models are comparable with those estimated for the objective model.

    The durable goods equations are also estimated in the same way, even though the only deflated unit price variable that can be constructed is for automobiles. Thus, it is assumed that movements in the deflated unit price of automobiles are identical to those in the deflated unit prices of some weighted average of all durable goods—an extreme assumption but not necessarily a totally unrealistic one.
27. The joint models are estimated with gross expenditures as the dependent variable. When anticipatory variables are used, the appropriate dependent variable is the purchase rate; hence, the models may contain specification bias.
28. The tests of interest rates draw heavily on Hamburger. The use of the lagged corporate-bond rate and the savings rate follow his discussion.
29. An eight-quarter weighted average of the lagged rate of increase in the consumption-expenditures deflator is used.
30. The effect of a change in the specification on elasticity estimates is not small. For example, an expenditure equation for a partial-adjustment model without the maturity variables yields current-income-impact elasticities of 1.91 for durables and 1.65 for automobiles.
31. If the strike is widely anticipated, the above-normal supply period may precede rather than follow the strike period.
32. Other procedures appear to be distinctly inferior to either of the above. For example, one could estimate the regression coefficients of the dummy variables from an equation which includes lagged dependent variables. In this case, the coefficients of the lag terms will be biased, and the bias is bound to influence the estimated regression coefficients of the dummy because the lag term will be negatively correlated with the dummy. Thus, the correction factor applied to the dependent variable series will be nonoptimal. Alternatively, one could estimate the regression coefficients of dummy variables from an equation which includes only the dummy and no other substantive demand variables. This also seems inappropriate, since in principle, one wants to isolate the effects of supply shortages, taking account of whatever demand influences are present in that particular quarter or set of quarters. Thus, it appears that in estimating the regression coefficients of dummy variables, the model should be completely specified, except for the distributed-lag terms.
33. An alternative treatment is to account for periods of abnormally high demand by a positive dummy variable, allowing the dummy to take on negative values in later periods to reflect the reaction. Such an assumption is made for periods in which supply shortages are caused by strikes. The best way to handle this problem hinges on whether it is plausible to suppose that the pattern of reduced (increased) demand in the aftermath of an abnormal increase (decrease) is the same as the "typical" relation between stocks

and flows. If it is supposed that there is a change in flows over and above any influence due to larger (or smaller) stocks, the appropriate dummy variables must have a series of negative (or positive) values which wholly or partly offset the positive (negative) values representing the abnormal periods.

34. These results differ slightly from the estimates of the AFT model in the text of the paper. Those estimates utilize adjustments based on first-stage equations with unrevised data and an earlier specification of the model and used a different computational routine.

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