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2 Consumer Spending and the After-Tax Real Interest Rate

N. Gregory Mankiw

2.1 Introduction

The responsiveness of consumer spending to the after-tax real interest rate has important implications for a variety of policy questions.[1] The more highly interest elastic consumer spending is, the smaller is the impact of persistent government deficits on the capital stock and the more effective are savings incentives such as Individual Retirement Accounts. Despite its importance, there is little agreement among economists regarding the interest elasticity of consumer spending. This paper examines two issues relevant to the theoretical and empirical debate.

The paper first examines the interaction between consumer durable goods and consumer nondurable goods in determining the responsiveness of total expenditure to the after-tax interest rate. I show how the introduction of durables into the consumer's decision affects the interest elasticity of total spending. The channel highlighted here might be called the "user cost effect," in that the after-tax interest rate enters the implicit user cost of consumer durable goods.

This user cost effect may be one of the most important ways in which interest rates affect consumer spending. Previous studies of this interest elasticity, such as Summers (1981), examine nondurable consumption in life cycle models. Such analyses thus emphasize intertemporal substitution and human wealth effects. Some recent empirical work, how-

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ever, has cast doubt on the life cycle (permanent income) hypothesis and has suggested that borrowing constraints play an important role in determining consumer spending.[2] A borrowing constraint effectively makes a consumer face a one-period planning problem and thus reduces the importance of the intertemporal substitution and human wealth effects. In contrast, I show that even if an individual has a one-period planning horizon, the user cost effect nonetheless makes his spending highly interest sensitive.

The second goal of this paper is to examine the response of various categories of consumer spending to the events of the 1980s. The 1980s provide a natural test of the responsiveness of saving to the after-tax interest rate. I show that these events are consistent with the view that the interest elasticity of consumer spending is substantial. In particular, the evidence is consistent with the view that, because of the user cost effect, spending on consumer durables and residential construction is more highly interest sensitive than spending on nondurables and services.

2.2 Durables, Nondurables, and the Rate of Interest

In this section I examine the decision of a consumer that must choose in each period both an amount of a nondurable good to consume and an amount of a durable good to purchase. My goal in particular is to examine the long-run response of consumption decisions to the interest rate. Of course, the relevant interest rate for the consumer is the after-tax real interest rate.

The analysis here is partial equilibrium in nature. I consider an individual facing a given path of labor income and a given constant after-tax real interest rate that chooses a path of spending on the two goods. I examine how his optimal levels of spending are affected by a permanent change in the after-tax interest rate he faces. In particular, the effect of the after-tax real interest on the user cost of durable goods is highlighted.

2.2.1 A Simple Model

Let us begin with the consumer's budget constraint. Each period he spends C on the non-durable good, which equals his consumption of it, and he spends X on the durable good, which is added to his stock. The present value of his purchases must equal his "wealth." That is,

$$W = \sum_{t=0}^{T} \left(\frac{1}{1 + r}\right)^t (C_t + X_t). \tag{1}$$

where "wealth" is defined as the present value of labor income, his initial non-human wealth A_0, and the value of the terminal stock of durables K_T. That is, if δ is the depreciation rate for the durable,

$$(2) \qquad W = \sum_{t=0}^{T} \left(\frac{1}{1+r}\right)^t Y_t + A_0 + \frac{(1-\delta)K_T}{(1+r)^{T+1}}$$

The third term ensures that the consumer can borrow against the terminal value of his stock of the durable good.

I assume that the durable depreciates at a constant rate, that is, exponentially. The relation between the stock K and the flow X is

$$(3) \qquad K_t = X_t + (1-\delta)K_{t-1}$$

Using the stock-flow identity we can rewrite the budget constraint in terms of the stock rather than the flow. It becomes

$$(4) \qquad \tilde{W} = \sum_{t=0}^{T} \left(\frac{1}{1+r}\right)^t [C_t + ((r+\delta)/(1+r))\, K_t]$$

where the now relevant notion of wealth[3] is

$$(5) \qquad \tilde{W} = \sum_{t=0}^{T} \left(\frac{1}{1+r}\right)^t Y_t + A_0 + (1-\delta)K_{-1}$$

Equation (4) is useful because it expresses the budget constraint in terms of the stock of the durable K rather than the flow X.

The consumer maximizes an additively separable utility function:

$$(6) \qquad V = \sum_{t=0}^{T} \beta^t\, U(C_t, K_t).$$

The consumer receives utility in each period from his consumption of the nondurable good and his stock of the durable good.

It is a common claim that spending on consumer durables is a form of saving. While it is true that (like saving) buying durables today increases future utility, it is not accurate to view durables in this model as merely one form of saving. The "durables as savings" model suggests that transitory income should affect spending on durables. This conclusion, however, does not arise from this formulation of the consumer's decision. Consider an increase in current income and a decrease in future income that does not change the present value of income in (4). Such a change alters neither the objective nor the constraint of the consumer. Hence, it affects neither the optimal level of nondurable consumption nor the optimal stock of the consumer durable. Such an increase in current income does, however, increase saving. In this natural model of the consumer, spending on both the nondurable and the durable depends on permanent income and is unaffected by transitory income. The decision to save and the decision to buy durables are conceptually distinct.

We can see from the budget constraint (4) that the consumption decision here is analogous to a consumption decision with two nondurable goods in which $(r + \delta)/(1 + r)$ plays the role of the relative price. The first-order condition necessary for an optimum is therefore

$$\text{(7)} \qquad \frac{U_K(C,K)}{U_C(C,K)} = \frac{r + \delta}{1 + r}.$$

The marginal rate of substitution between durables and nondurables must equal the marginal rate of transformation, which depends on the real interest rate.

Suppose $U(C,K)$ has a constant elasticity of substitution:

$$\text{(8)} \qquad U(C,K) = \frac{1}{1 - (1/\Theta)} [C^{1-(1/\epsilon)} + \phi\, K^{1-(1/\epsilon)}]^{\frac{1-(1/\Theta)}{1-(1/\epsilon)}}$$

where ϵ is the elasticity of substitution between durables and nondurables, and Θ is the intertemporal elasticity of substitution. The first-order condition (7) becomes

$$\text{(9)} \qquad \phi\left(\frac{K}{C}\right)^{-1/\epsilon} = \frac{r + \delta}{1 + r}$$

which implies

$$\text{(10)} \qquad \log K = \log C - \epsilon \log\left(\frac{r + \delta}{1 + r}\right) + \epsilon \log\phi.$$

Differentiating equation (10) with respect to the interest rate yields

$$\text{(11)} \qquad \frac{d \log K}{d\, r} = \frac{d \log C}{d\, r} - \epsilon \left(\frac{1 - \delta}{(r + \delta)\,(1 + r)}\right)$$

The responsiveness of the durable stock to the interest rate equals the responsiveness of the nondurable minus a term that depends on the depreciation rate and, most important, on the elasticity of substitution between the durable and the nondurable. Note that the intertemporal elasticity of substitution Θ, which Hall (1985) argues is very small, does not enter this first-order condition.

The relation between the durable and the nondurable expressed in equation (9) is very general. First, it holds for all planning horizons T. That is, it holds for both young and old consumers. It also holds for consumers that have long horizons because they are linked to some future generations through intergenerational altruism (Barro 1974).

Second, the utility function can be complicated in a variety of ways without affecting equation (9). Other arguments, such as leisure or public goods, can be entered additively separably, multiplicatively separably, or additively within the brackets in (8). None of these changes would affect the first-order condition (9).

Third, expression (9) also holds for consumers who cannot borrow on future labor income because of some capital market imperfection. A person facing a binding borrowing constraint is like a person with a one-period planning horizon ($T = 0$). Because the intertemporal Kuhn-Tucker conditions hold with strict inequality, the trade-off between utility today and utility tomorrow is not relevant at the margin; because he is at a corner with regard to borrowing on future labor income, the existence of that income is not relevant for today's budget constraint. Hence, positing a binding borrowing constraint is equivalent to setting $T = 0$.

It is important to realize that even if $T = 0$, the interest rate plays a role in the consumption decision. In this case the budget constraint, equations (1) and (2), becomes

$$C_0 + X_0 = Y_0 + \frac{(1 - \delta)K_0}{(1 + r)} . \tag{12}$$

The interest rate affects the present value of terminal stock of the durable. The interest rate can affect consumer spending through this channel. In the case of a borrowing-constrained consumer, I am assuming he can borrow to the extent that the depreciated value of his durables can cover the debt; that is, his net wealth, including his stock of durables but not including his future labor income, cannot be negative. Given that consumer durable goods are commonly used as collateral for consumer loans, this assumption about borrowing constraints seems the most plausible.

2.2.2 Redefining the Consumer's Problem

It is instructive to reexpress the consumer's optimization problem given the relation between the durable and the nondurable in equation (9). By solving out for the durable stock, the consumer's problem becomes:

$$\text{Max } V = \Psi(r) \sum_{t=0}^{T} \beta^t \frac{C^{1-(1/\Theta)}}{1 - (1/\Theta)}$$

subject to

$$\tilde{W} [1 + \phi^{\epsilon} \left(\frac{r + \delta}{1 + r}\right)^{1-\epsilon}]^{-1} = \sum_{t=0}^{T} \left(\frac{1}{1 + r}\right)^t C_t$$

where $\Psi(r) = [1 + \phi^{\epsilon}\left(\frac{r + \delta}{1 + r}\right)^{1-\epsilon}]^{\frac{1-(1/\Theta)}{1-(1/\epsilon)}}$ does not affect the consumer's decision.

With one difference, the consumer's problem expressed above is identical to the standard problem without durable goods. In addition to the standard effects, a change in the real interest rate changes the factor multiplying wealth in the budget constraint. Depending on the elasticity of substitution between the durable and the nondurable, an increase in the interest rate could be effectively either wealth-diminishing or wealth-augmenting. For example, if the elasticity of substitution is less than 1, then an increase in the interest rate reduces the factor multiplying wealth; thus, nondurable spending will fall more in response to the higher interest rate than a model that ignores durables would predict.

In the special case in which the elasticity of substitution is unity, this additional factor becomes a constant. Hence, in this case, the responsiveness of nondurables to the interest rate is not affected by the presence of durable goods. The response of nondurables spending to the interest rate can therefore be taken from standard models without durables, and the response of durables spending can be inferred from equation (11).

2.2.3 Evidence on the Elasticity of Substitution Between Durables and Nondurables

In Mankiw (1985), I provide some evidence on the elasticity of substitution between consumer durables and consumer nondurables. Since this elasticity plays a key role in the interest elasticity of consumer spending, I briefly summarize that evidence here.

The technique of the previous paper, used similarly in Hansen and Singleton (1983) and Mankiw, Rotemberg, and Summers (1985), is to estimate the first-order condition, equation (10). Equation (10) states that

$$\log(\text{user cost}) = \text{constant} - (1/\epsilon)\log(K_t/C_t) \tag{13}$$

where the relative price is the implicit rental price of the durable, which depends on the real interest rate and (although suppressed in the previous discussion) on the relative purchase price of the durable good. The model implies a simple bivariate relation between the relative price and the relative quantity K/C.[4] I use expenditure on nondurables and services as C and the net stock of consumer durables as K.[5]

Estimation of equation (13) yields

$$\log(\text{user cost}) = \underset{(0.06)}{-1.95} \ \underset{(0.11)}{-0.81}\log(K_t/C_t)$$

$$s.e.e. = 0.10 \qquad D.W. = 1.39 \qquad \bar{R}^2 = 0.62$$

Standard errors are in parentheses.

Thus, the data yields the predicted negative relation between the relative price and K/C. The coefficient implies that ϵ is about 1.

Although this result supports the model, it is possibly spurious. One might suspect that the regression is only picking up a trend in both variables. Alternatively, one might suspect that we have found merely a business cycle correlation without any deeper structural interpretation. To test these possibilities, I include a time trend and the rate of unemployment (RU_t) in the above regression. If the correlation found above is indeed spurious, then we might expect the significant relation to disappear when these additional variables are included. In fact, I find

$$\begin{aligned}\log(\text{user cost}) = &\underset{(0.41)}{-2.11} \ \underset{(0.43)}{-1.00} \log(K_t/C_t)\\ &+ \underset{(0.007)}{0.004} \text{ Time} - \underset{(0.0182)}{0.0007} RU_t\end{aligned}$$

$$s.e.e. = 0.11 \qquad D.W. = 1.40 \qquad \bar{R}^2 = 0.59$$

The time trend and the unemployment rate are insignificant; I cannot reject the null hypothesis that both coefficients are zero at even the 10% level. Perhaps more striking, the relation between the relative price and K/C remains statistically and substantively significant.

The analysis so far has assumed that the only error in the relation is an expectation error. If there are shocks to tastes, however, then the error includes these taste shocks and identification requires more careful attention. In particular, ordinary least squares does not produce consistent estimates, as K/C is likely to be correlated with these taste shocks. To investigate whether taste shocks are important here, I estimate equation (13) using instrumental variables. The instruments must be orthogonal to the shocks to consumer tastes. One variable that may be exogenous is federal government purchases of durable goods per capita. Fluctuations in government purchases are largely attributable to wars, making it an almost ideal instrumental variable for many purposes. This variable is a valid instrument here if it shifts the supply curve of consumer durables but not the demand curve. It shifts the supply curve if, for example, the production of military equipment takes resources away from the production of consumer durables. Using $\log(G_t)$ and $\log(G_{t-1})$ as the instruments, I obtain

$$\log(\text{user cost}) = \underset{(0.15)}{-2.21} \ \underset{(0.28)}{-1.30} \log(K_t/C_t)$$

$$s.e.e. = 0.13$$

The relation found using IV is similar to that found using OLS. Both estimation methods yield a negative and significant relation. In addition, both estimates suggest ϵ is about one.

2.2.4 Some Implications of the Evidence

The evidence above suggests that the elasticity of substitution between durables and nondurables is approximately unity. This finding has important implications for the interest elasticity of consumer spending. As indicated above, a unit elasticity of substitution implies that the interest elasticity of nondurables spending is not affected by the presence of durable goods. Hence, the responsiveness of nondurables spending to the interest rate can be taken from simulations that ignore durable goods, and the responsiveness of durables spending can be inferred using equation (11).

I highlight here the implications of this finding for the case in which the planning horizon for the consumer is only one period ($T = 0$), either because of myopia or because of a binding borrowing constraint. This extreme case provides perhaps the worst circumstances to find interest sensitivity, since the human wealth and intertemporal substitution effects emphasized in previous work are absent.

The consumer's optimization problem outlined above becomes

$$\text{Max } V = \log(C) + \phi \log(K) \tag{14}$$

subject to

$$Y = C + \left(\frac{r + \delta}{1 + r}\right) K \tag{15}$$

I am assuming here that the initial wealth and the initial stock of the durable is zero. In subsequent periods, this consumer will carry forward both a depreciated stock of the durable and a debt; since these are equal, the problem will remain essentially the same.

The solution to the consumer's optimization is:

$$C = (1/(1 + \phi))\, Y \tag{16}$$

and

$$K = \frac{(\phi/(1 + \phi))\, Y}{(r + \delta)/(1 + r)} \tag{17}$$

In steady state, spending on the durable X is δK.

The responsiveness of spending to the interest rate should be apparent. Nondurable spending is a constant fraction of income and is not affected by the interest rate. (This is an implication of the unit elasticity of substitution.) Durable spending, however, is responsive to the interest rate. A higher interest rate raises the user cost of the durable and thus reduces K.

To gauge the magnitude of this user cost effect, it is necessary to calibrate the model. The after-tax real interest rate has historically averaged about zero, and durable goods as defined in the National Income Accounts depreciate at about 20% per year. I therefore use $r = 0.0$ and $\delta = 0.2$, as well as the estimated value of ϵ of 1.0. From equation (11) (or 17), we see that the interest semi-elasticity of durables is 4.0. That is, a one percentage point increase in the real interest rate reduces the stock of durables (and thus in steady state durables spending) by 4%.

The responsiveness of total spending, $C + X$, to the after-tax real interest rate depends on the relative importance of durables and nondurables. Since durable spending is approximately one-eighth of the total, a one-percentage-point increase in the interest rate reduces total spending of the consumer by 0.5%.

2.3 The Evidence from the 1980s

The events of the early 1980s provide a natural test of the proposition that consumer spending is sensitive to the after-tax real interest rate. In this section I present an analysis of this episode. I find that the level and composition of consumer spending during the 1980s is consistent with a high degree of interest sensitivity.

2.3.1 The After-Tax Real Interest Rate

Three related developments starting in approximately 1980 make the past half decade a useful period in which to examine the response of consumers to the after-tax real interest rate. First, monetary and fiscal policy combined to make interest rates skyrocket. In October 1979, the Federal Reserve announced a new disinflationary stance and a greater emphasis on targeting monetary aggregates over stabilizing interest rates. In November 1980, Ronald Reagan was elected committed to large-scale tax reduction. This tax reduction occurred in 1981, and was followed by deficits that were unprecedented in peacetime. As one might have expected from these changes in macroeconomic policy, interest rates rose.

The second development increasing after-tax real interest rates was a reduction in marginal tax rates on capital income. The 1981 tax cut lowered marginal tax rates across the board, reducing the top rate from 70% to 50%. (While some of the tax reduction was offset by already-scheduled Social Security tax increases, these increases are not relevant here because the Social Security tax falls only on labor income.) In addition, the introduction of Individual Retirement Accounts reduced the marginal tax rate on capital income to zero for those individuals not at the maximum contribution level. Both of these changes in the tax law raise the after-tax real interest rate.

The third development was the increased availability of market interest rates to consumers. The spread of money market mutual funds and the deregulation of banking has allowed small savers to earn rates much higher than those on passbook savings accounts. To the extent that marginal saving is now earning the Treasury bill rate rather than the passbook rate, this financial development increases the real interest rate relevant for saving decisions.

While it is difficult to measure the importance of these latter two developments, the increase in market interest rates is easy to document. Table 2.1 shows that the nominal three-month Treasury bill rate averaged 6.3% in the 1970s and rose to 10.9% in the early 1980s. Meanwhile, inflation as measured by the consumer price index fell from 7.2% to 6.1%.

To compute the after-tax real interest rate, I use a marginal tax rate of 0.3. Since there is ample reason to believe that the marginal rate on interest income fell during this period, using a constant marginal rate underestimates the increase in after-tax real interest rates. Table 2.1 shows that the ex post after-tax rate measured this way rose from −2.8% in the 1970s to 1.6% in the early 1980s.

Of course, consumer decisions are based not on ex post rates but on ex ante rates. Since the 1970s was a period of positive inflation surprises and the early 1980s was a period of negative inflation surprises, the increase in the ex post rate of 4.4 percentage points is overstated. A rough measure of ex ante rates can be found using the technique pioneered by Mishkin (1980) of regressing ex post rates on lagged information and using the fitted values as ex ante rates. A regression of the ex post real rate (*eprr*) on its own lag for the period 1970:1 to 1984:4 yields:

$$\begin{aligned} eprr_t = \underset{(0.38)}{-0.39} + \underset{(0.10)}{0.66}\, eprr_{t-1} \end{aligned}$$

$$s.e.e. = 2.67 \quad D.W. = 2.46 \qquad \bar{R}^2 = 0.41$$

Table 2.1 **Interest Rates in the 1970s and 1980s**

	Nominal Three-Month Treasury Bill Rate	Inflation	After-Tax Real Interest Rates: Ex post	After-Tax Real Interest Rates: Ex ante
1970:1–1979:4	6.3	7.2	−2.8	−2.2
1980:1–1984:4	10.9	6.1	1.6	0.3

Note: After-tax rate is computed assuming a marginal tax rate of 0.3. Ex ante real rates are computed as the fitted value from the first-order autoregression of ex post real rates estimated 1970:1 to 1984:4.

This equation implies an increase in the ex ante rate from −2.2% in the 1970s to 0.3% in the early 1980s.

One problem with using this equation is that consumers have more information than the lagged ex post rate when forming their expectations implicit in the ex ante rate. If this additional information is useful, then this equation underestimates the variation in the ex ante rate, since forecasts based on greater information vary more than forecasts based on more limited information. Hence, the increase in the ex ante rate of 2.5 percentage points implied by this equation is likely to understate the true increase.

2.3.2 Consumer Spending in the 1980s

For a variety of reasons, the after-tax real interest rate rose substantially from the 1970s to the 1980s. If consumer spending is sensitive to this interest rate, consumer spending in the 1980s should be lower than it otherwise would have been. My purpose in this section is to examine whether consumer spending responded to the dramatic increase in the after-tax real interest rate.

Rather than attempt to estimate a structural model relating consumer decisions to interest rates, as has been done elsewhere (Hansen and Singleton 1983; Mankiw 1985; Hall 1985), I examine the following relation

$$C_t = \text{constant} + A(L)\, C_{t-1} + B(L)\, Y_t \tag{18}$$

where C is the log of some category of consumer spending,
Y is the log of personal disposable income, and
$A(L)$ and $B(L)$ are distributed lags.

This equation is not intended to be structural. Its purpose is merely to summarize the time series co-movements of income and consumer spending.

The equation is estimated for the period 1970:1 to 1979:4, during which real interest rates were very low. The equation is then used to forecast consumer spending from 1980:1 to 1984:4 *using the actual path of disposable income*. Since the forecast is conditional on disposable income, it controls for the effect of the deep recession in 1982 and the subsequent rapid recovery. If consumer spending is not sensitive to the interest rate and instead obeys a simple Keynesian consumption function, then this equation should forecast accurately.

In contrast, if consumer spending is sensitive to the real interest rate, a major change in the interest rate should cause this equation to forecast badly. Since the equation is estimated under a low interest rate regime, it should overpredict consumer spending in the 1980s. The forecast error can be viewed as a rough guide to the effect of omitted variables on consumer spending during this period. Since interest rates are prob-

Table 2.2 Conditional Forecast Errors for Consumption

	Actual Level Relative to Predicted (percent)						
Category of Consumer Spending	80:1	80:4	81:4	82:4	83:4	84:4	Average
Total Consumer Expenditure	−0.8	−2.4	−5.3	−5.0	−4.2	−5.3	−4.0
Nondurables	−1.0	−2.5	−3.0	−3.1	−1.5	−2.0	−2.2
Services	−0.6	−1.2	−4.0	−5.3	−6.6	−7.4	−4.6
Durables	−2.2	−7.5	−16.9	−9.7	−5.4	−5.7	−8.4
Residential Construction	−3.1	−2.4	−31.6	−25.9	+2.0	−6.1	−13.1

Note: A reduced-form equation is estimated by regressing consumption on its own two lags, current personal disposable income, and two lags of income using data from 1970:1 to 1979:4. This equation is used dynamically to forecast consumption given the observed path of disposable income. The figure reported is the difference in log of actual spending and the log of predicted spending, times 100, which is approximately the percentage difference.

ably the most important of the omitted variables, it seems reasonable to attribute the forecast error to the effects of interest rates.[6]

Table 2.2 summarizes the results from this experiment. Total consumer spending was on average 4.0% lower than one would have expected from the experience of the 1970s.[7] The breakdown into the various categories is plausible. Nondurables are 2.2% lower than forecast and services 4.6% lower. The largest forecast error is for durables spending, which is 8.4% lower than forecast. This differential impact is consistent with the hypothesis that the forecast error is attributable to the high real interest rates.[8]

While the National Income Accounts treat residential construction as investment, it seems conceptually most similar to spending on consumer durables. If one performs the same experiment as above with residential construction, the results confirm the above findings. In particular, residential construction was 13.1% below the conditional forecast.

2.4 Summary

The major conclusions of this paper are as follows:

1. Spending on durables should be substantially more sensitive to the after-tax real interest rate than spending on nondurables and services. The reason is that the interest rate affects the implicit user cost of durables. The difference in interest sensitivity can be simply expressed in terms of the interest rate, the depreciation rate, and the elasticity of substitution between durables and nondurables.

2. The elasticity of substitution between durables and nondurables can be easily estimated by examining the first-order condition of the consumer. This method avoids the problems of solving for the consumer's decision rule and of obtaining proxies for future income and relative prices that would enter that decision rule. Aggregate data for the United States suggest an elasticity of substitution of about unity with a very small standard error.

3. Even if a consumer faces a one-period planning horizon, possibly because of a binding borrowing constraint, his spending should be highly interest sensitive. With an elasticity of substitution of unity, a 1% increase in the after-tax real interest rate reduces his spending on durables by 4% while not affecting his spending on nondurables.

4. After-tax real interest rates were substantially higher in the early 1980s than in the 1970s, suggesting that this episode is an ideal natural experiment to examine the interest sensitivity of consumer spending. It appears that spending on all categories of consumer spending was substantially lower in the early 1980s than one would have forecast conditional on the path of disposable income. Moreover, the forecast

error is greater for durable goods than for nondurable goods. This experience thus appears consistent with the hypothesis that real interest rates have an important impact on the level and composition of consumer spending.

Notes

1. For a discussion of the importance of this issue, see Boskin (1978).
2. See, for example, Hall and Mishkin (1982) and Zeldes (1985).
3. This concept probably corresponds best to what is normally meant by the term "wealth."
4. The error term in this equation is an expectation error attributable to the fact that the real interest rate in the relative price is not known at time t when the consumption decisions are made. Since K/C is known at time t, it is orthogonal to the error, implying that *OLS* leads to consistent estimates of $1/\epsilon$.
5. Consumer durables as defined in the National Income and Product Accounts excludes residential housing. In Mankiw (1985) I examined only the NIPA's category of consumer durables, which includes primarily motor vehicles, furniture, and household equipment. The technique could be extended to residential housing, however.
6. Alternatively, one could attribute any conditional forecast error to the direct effect of deficits on saving through anticipated future tax liabilities (Barro 1974). Note that this Ricardian view implicitly assumes that the long-run interest elasticity of saving is infinite, since in steady state the after-tax real interest rate must equal the subjective rate of time preference. It therefore appears inconsistent to maintain both (1) consumption is interest insensitive, and (2) consumers effectively have infinite horizons and thus foresee their future tax liabilities.
7. This result stands in contrast to the conclusion one would reach by a simple comparison of savings rates through time. That is, the dynamic comparison in table 2.2 gives a very different picture of the 1980s than would a static comparison. Reconciling these results would appear to require a structural model of some sort.
8. While these results are broadly consistent with the model, it is difficult to judge whether the magnitudes are comparable to what theory would predict. The theory discussed above applies to steady states, while the experience of the past few years is necessarily temporary or one of transition. To examine this period in detail using a structural model, the adjustment process, possibly including adjustment costs, should be modeled explicitly.

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Comment Laurence J. Kotlikoff

Greg Mankiw's paper usefully redraws attention to the fact that the after-tax interest rate determines not only intertemporal relative prices, but also the relative price of durables and nondurables at a point in time. With the exception of the recent work of Poterba (1980) and Gahvari (1985) on housing, relatively little attention has been given to the affect of changes in capital income taxation on the ratio of durables to nondurables expenditures.

Mankiw's chief point is that even if nondurable expenditures do not respond to interest rate changes, durables expenditures most likely will. While I accept this point, I'm not sure why this should alter my view of the effectiveness of government policy for changing national saving or for the elasticity of saving with respect to the interest rate. If one properly defines consumption to include imputed rent on durables, rather than expenditures on durables, and properly defines national income to include imputed rent on durables, then in the unitary elasticity case he is considering, the effect on total national wealth of changing the tax on capital income is zero.

To see this, consider the two period utility function, $U_t = \log C_{y,t} + \log C_{o,t} + \log D_{t+1}$, where D_{t+1} is the durables stock at time $t+1$, $C_{y,t}$ is consumption when young at time t, and $C_{o,t}$ is consumption when

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old at time $t + 1$. Assume individuals are retired when old, but work full time when young, earning $W_t(1 - \tau_{wt})$, where τ_{wt} is the wage tax rate at time t. Let K_{t+1} stand for nondurable assets at time $t + 1$. It is easy to show that total assets at $t + 1$, $K_{t+1} + D_{t+1}$ are given by:

$$K_{t+1} + D_{t+1} = \frac{W_t(1 - \tau_{wt})}{3}$$

From this equation it is clear that the elasticity of savings as well as saving to the tax rate on capital income is zero. Total wealth is, however, very sensitive to the after tax wage. Indeed, the elasticity of savings with respect to $(1 - \tau_{w,t})$ is unity. Parenthetically, I've always been puzzled about the strong professional interest in the interest elasticity of saving and the entire lack of interest in the wage elasticity of saving.

Now including durables in this way in the model, while not altering one's views about the interest elasticity of saving, does influence one's view about the elasticity of the ratio of K_{t+1} to D_{t+1} with respect to the rate of capital income taxation. As Mankiw points out, and as Gahvari's simulation studies strongly demonstrate, the composition of national wealth as between durables and other assets can be highly sensitive to the rate of capital income taxation.

Another bit of grumbling involves Mankiw's estimation of the first order condition relating the marginal utility of durables to the marginal utility of nondurables consumption. While Mankiw states that the error term in his regression is on expectation error, I believe this is incorrect. At the point when spending occurs the two marginal utilities are known with certainty. Hence, it is not clear that a regression, rather than a calculation, is appropriate.

Finally, while I believe that the interest rate increases in the early 1980s may have played some role in reduced expenditures, I don't find convincing the procedure of running a vector autoregression, leaving out the interest rate, and then attributing the residual to the interest rate. I would find a structural model much more persuasive.

References

Gahvari, Firouz. 1985. Taxation of housing, capital accumulation, and welfare: A study in dynamic tax reform. *Public Finance Quarterly* 13, no. 2 (April).

Poterba, James. 1980. Inflation, income taxes, and owner occupied housing. NBER Working Paper no. 553 (September).