THE EFFECTS OF CHANGES IN INTEREST RATES ON DIFFERENT SECTORS OF THE U.S. ECONOMY

Staff Memorandum

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Congressional Budget Office

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SUMMARY

To assess the implications of today's relatively high interest rates, this memorandum reviews the experience of two decades in different sectors of the U.S. economy. Though interest-rate changes can produce many effects--involving saving, investment, exports, and other developments--the Congressional Budget Office has focused in this study on only one: the effects on investment spending in different sectors. One can develop simple rules for predicting the sectoral spending changes that can result from a given change in interest rates. The results of CBO's analysis (shown in Table 1 in the text) must be regarded as highly uncertain, but they suggest that housing is most sensitive to interest rates, followed by nonresidential structures, producers' equipment, and consumer automobiles in that order.

Literature reviewed for the paper suggests that business investment is influenced most strongly by real after-tax interest rates, while consumer investment is affected by all interest-rate changes, whether real or purely nominal. In all cases, however, the effects are indirect; the direct effects of rates are reflected in a measure known as the "rental price" of capital. This measure takes account of all factors affecting the cost of investment. Such factors include tax policy, relative asset prices, and physical depreciation, as well as interest rates themselves.

Because certain of these other provisions cushion the impacts of high interest rates, the current rental prices for certain sectors stand at moderate or even low levels by historical standards, as Figure 1 in the text shows. In particular, the rental price for producers' durable equipment is low by recent historical standards, and that for consumer automobiles is only slightly above its average levels of the 1960s and 1970s. By contrast, quite high rental prices now characterize the housing, nonresidential structures, residential structures, and state and local construction sectors.

A graphic presentation in Figures 2 through 4 separates changes in rental-price measures into those parts caused directly by changes in interest rates, tax policy, and other factors. (There may be interactions among these factors, if, for example, a tax cut helps raise interest rates; but CBO has disregarded these indirect effects in this analysis.) The CBO analysis shows that, in recent years, tax policy and relative prices have overcome the effects of rising interest rates, and these factors have steadily reduced the rental price for producers' equipment. The price for all types of structures, by contrast, has followed the upward course of interest rates.

THE EFFECTS OF CHANGES IN INTEREST RATES ON DIFFERENT SECTORS OF THE U.S. ECONOMY

This brief study responds to three questions about the economic effects of current interest-rate levels:

- Which measures of interest rates (real? nominal? after-tax?) affect different sectors of the U.S. economy most directly?
- How do current levels of these measures compare to those at comparable stages of previous recoveries?
- What are the estimated effects of changes in these rate measures on different U.S. economic sectors?

The discussion is restricted to investment effects and covers four sectors of the domestic economy: business investment in producers' durable equipment, nonresidential structures, and residential structures; investment by households in owner-occupied housing and automobiles; and construction by state and local governments.

The first section briefly describes the findings of the literature on how interest rates affect different sectors. In general, the CBO finds that an overall measure of capital costs--the rental price on capital--is the most direct interest-rate-related determinant of spending in each sector. This measure includes interest costs as well as physical depreciation, the relative prices of capital goods, and various tax provisions.

The second section presents current data on these rental price measures, as well as some perspective on how these measures' current levels compare to those of prior post-War recoveries. Changes in the rental-price measures are broken down into four groups: those components caused by interest-rate changes, those resulting from changes in tax provisions, those following from changes in relative goods prices, and those linked to changes in inflation.

A final section draws evidence from the literature on the responsiveness of spending in each sector to changes in its rental price and in the underlying interest rates.

ECONOMIC EFFECTS OF INTEREST RATE CHANGES

Changes in interest rates may affect the economy in several ways. For example, such changes have strong effects on investment spending decisions in different sectors. Rate increases can also raise the domestic saving rate, and if domestic rates are not matched by rates abroad or by expected exchange-rate developments, they can attract larger inflows of savings from other countries. Such capital inflows can in turn affect exchange rates and the levels of export and import activity.

This study deals with only the first of these effects--the impacts of interest rates on investment decisions. Most evidence suggests that these effects are much stronger than those on domestic savings flows. Though the impacts of interest rates on foreign capital inflows--and hence, on net exports--can be quite strong, they are especially difficult to measure. One must take into account the reactions of foreign interest rates and of expectations about exchange-rate developments, together with the responses of current exchange rates and of demands in other countries for U.S. exports. This problem is complex and has yet to be quantified adequately. Thus with its focus on investment spending impacts, this study considers some but not all of the important effects of interest-rate changes.

EFFECTS OF INTEREST RATES ON INVESTMENT DECISIONS

Seldom does economic theory suggest that either nominal or real interest rates in themselves exert a direct effect on the level of spending. Rather, interest costs are grouped with several other cost elements such as physical depreciation, relative prices of actual investment goods, and various tax provisions. All these factors interact to determine the marginal costs of investment in a measure termed the rental price of capital. 1/

1/ The original formulation of the rental price, applied to business investment, is in Hall and Jorgenson (1967). More recent treatments include Clark (1979), and Chirinko and Eisner (1981). The rental price measures for owner-occupied and rental housing are discussed in detail in Rosen and Rosen (1980) and in Hendershott and Shilling (1980), and their empirical importance is developed in Hendershott (1980). The rental price is used to analyze spending on other consumer durables in Mishkin (1976). An alternative approach related to the rental-price analysis is 'q theory'; see Abel (1980), Clark (1979), and Summers (1981). References are given in full at the back of this memorandum.

In most formulations of the rental price for business investment, the particular interest-rate measure that enters the calculation is the real rate before personal taxes but after corporate taxes. 2/ Nominal before-tax rate changes also affect business investment through their role in discounting tax deductions for depreciation and the tax deductibility of nominal interest, but their influence is much less strong than those of real rates, as the discussion below shows. For consumer investments such as housing and consumer durables, by contrast, statistical studies suggest overwhelmingly that nominal, rather than real, rates determine spending decisions. 3/ Thus the following discussion develops measures of the rental price of capital based on estimated real interest rates for business investment and on nominal rates for consumer investment.

CURRENT LEVELS OF RENTAL PRICES AND THEIR CAUSES

Figure 1 shows rental prices for each of the sectors described above over the 1962-1983 period, together with the underlying measures of real and nominal interest rates. The computer routine with which the figures were calculated is described briefly in the appendix. All rental prices in Figure 1 are indexed to their 1962 values; periods of economic recession are set off in bands.

In the calculations of real interest rates, inflationary expectations are represented as a function of past inflation rates only. Since the assets treated here are assumed to be held indefinitely by their initial purchasers, a long-term inflation forecast is needed. An implicit long-term inflation

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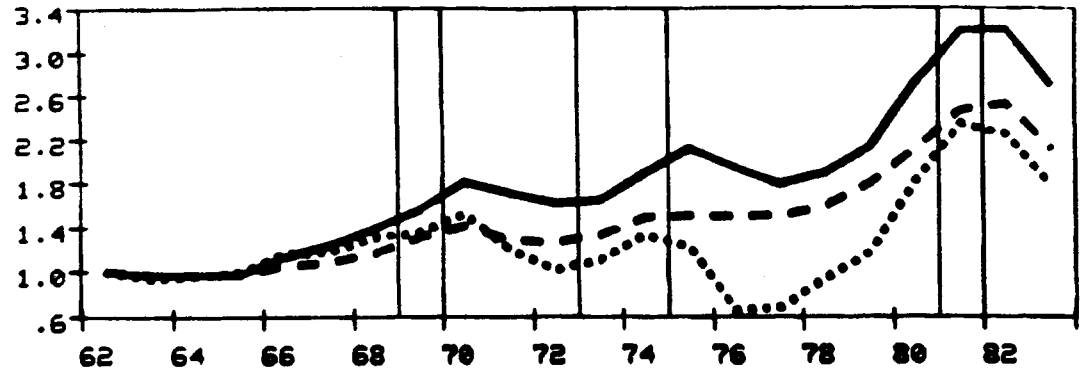
2/ Chirinko and King (1981) and others argue for the after-personal-tax real rate, but this is not yet a widely held view.

3/ Jaffee and Rosen (1979) and most studies surveyed in Kearl, Rosen, and Swan (1975) find that nominal rather than real mortgage rates perform well in equations explaining housing. Mishkin (1976) finds that a rental-price measure based on a nominal rather than a real pre-tax interest rate does better than the real-rate-based measure in explaining purchases of other durables. Most investigators attribute this result to cash-flow constraints faced by households, variations in uncertainty associated with changes in inflation, and to other factors.

FIGURE 1. INTEREST RATES AND RENTAL PRICES ON DIFFERENT INVESTMENTS, 1962-1983 (Ratio to 1962 Level)

Interest Rates

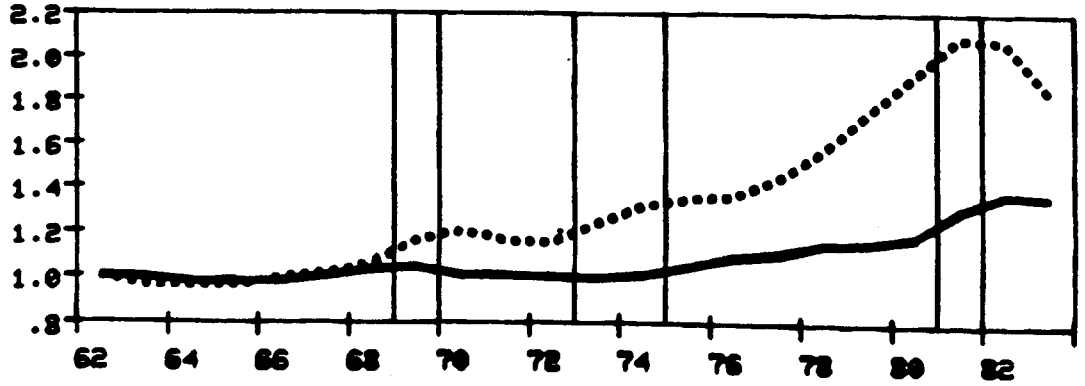
Moody's BAA Corporate Bond Rate, Nominal (line)
Moody's BAA Corporate Bond Rate, Real (dot)
Mortgage Commitment Rate, Nominal (dash)



Rental Prices

Producers' Durable Equipment (line)
Nonresidential Structures (dot)

Consumer Automobiles (line)
Owner-Occupied Housing (dot)



forecast is derived from an estimated equation designed to forecast only one year ahead using a method presented by Modigliani and Shiller (1973). 4/

As the top panel of Figure 1 shows, interest rates--both real and nominal--are quite high by recent historical standards. Certain of the rental-price measures are correspondingly high, including those for owner-occupied housing (bottom panel), nonresidential structures (middle panel), and both residential structures and state and local construction (not shown; these follow patterns quite similar to that of nonresidential structures). By contrast, the rental price for consumer automobiles (bottom panel) is only moderately high, and the price for producers' durable equipment (middle panel) is low by recent standards.

Several factors together explain why rental prices for automobiles and producers' equipment are now lower relative to those in the recent past than are the prices for various structures. Because these assets have shorter lives, their depreciation rates are higher, so a particular increase in interest rates causes a smaller percentage increase in the overall cost than for an asset with a lower depreciation rate, such as structures. In the case of producers' equipment, moreover, the downward trend in the rental price reflects the effects of federal tax policy and the behavior of the relative prices of equipment goods themselves.

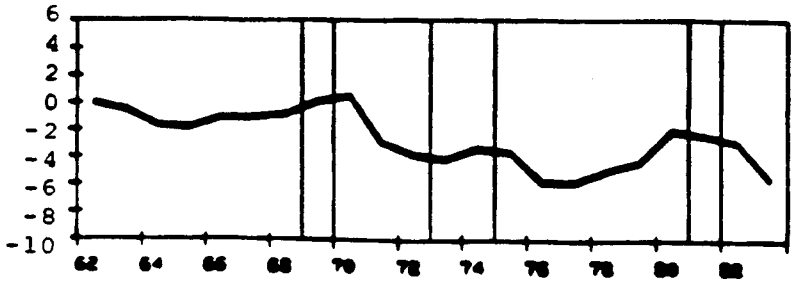
The roles of relative asset prices, real interest rates, and other factors in changing the rental price of capital are illuminated more precisely in Figures 2 through 4. Figure 2 breaks down the changes in the price for producers' durable equipment since 1962 into components caused directly by changes in relative asset prices, real interest rates, inflationary expectations, and federal tax policy. These components are calculated using a linear approximation to the rental price. (The CBO rental-price model is described in the appendix. Other methods of making such "decompositions" exist, and they might give different results.)

The downward trend in the rental price over this period is caused by the relative price of producers' equipment goods, whose contribution is shown in the second panel, and by tax policy, shown in the bottom panel.

4/ Feige and Pearce (1976) have helped justify this procedure, showing evidence that little relevant information is lost when the information set conditioning inflation forecasts is limited to the past values of inflation alone. Other approaches to determining the real cost of funds are, of course, available; see, for example, Corcoran and Sahling (1982).

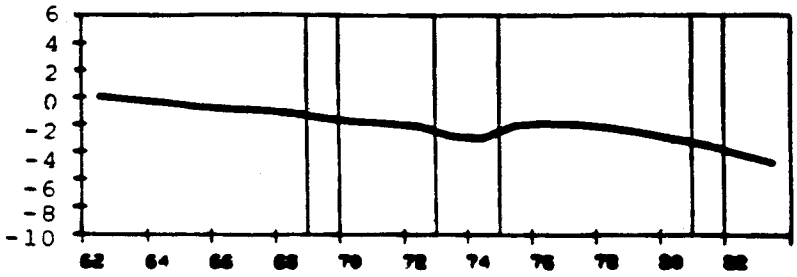
FIGURE 2. CHANGES FROM 1962 LEVEL OF RENTAL PRICE FOR PRODUCERS' DURABLE EQUIPMENT CAUSED BY VARIATIONS IN PARTICULAR UNDERLYING FACTORS, 1962-1983 (In percentage points)

Overall Change in Rental Price

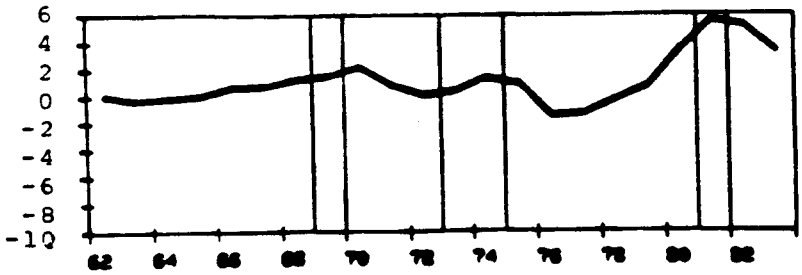


Components of Change Caused by Variations in:

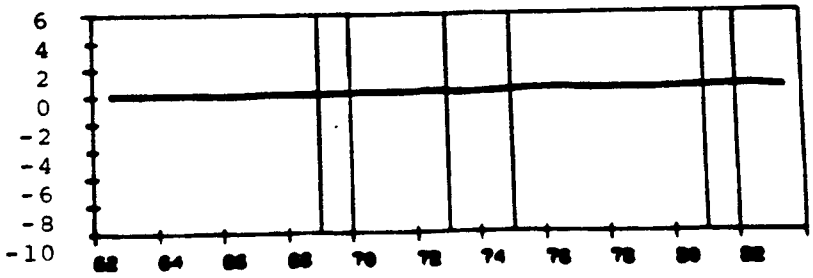
Relative Price of Equipment Goods



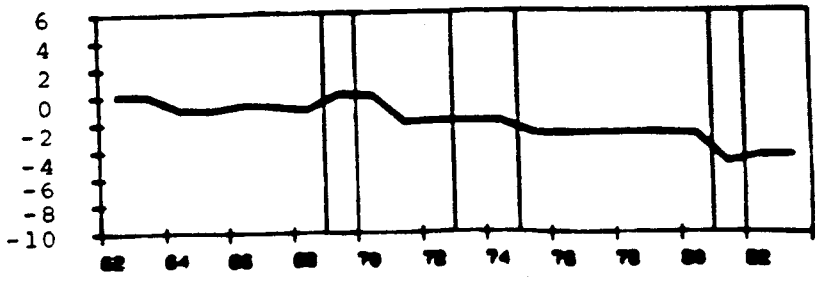
Real Interest Rate



Inflationary Expectations



Federal Tax Policy



Real interest rates, in contrast, contributed no trend (just a series of sharp upward ticks), and inflationary expectations contributed only a slight upward trend. 5/

The direct effect federal tax policy has worked consistently--and with some success--since 1962 to reduce the rental price of equipment as demonstrated in Figure 2. The effects of particular policy measures are distinguished in Figure 3. Measures that worked to reduce the rental price were repeal of the basis adjustment in 1964, the liberalization of the investement tax credit in 1975, and acceleration of depreciation in 1971 and 1981. (A basis adjustment is a modification of tax depreciation guidelines to take account of, and partially offset, changes in the investment tax credit.) The only contrary moves were the temporary repeal of the investment tax credit in 1969-1970 and the partial restoration of the basis adjustment under the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA). Of course, liberalization of the tax code could have had indirect effects tending to increase the rental price, but these are not taken into account here. For example, tax cuts may have helped raise interest rates by stimulating output, thereby increasing the demand for credit.

What factors account for the behavior of the rental price of nonresidential structures? Figure 4 shows a decomposition like that presented earlier for equipment. The rental price, shown in the top panel,

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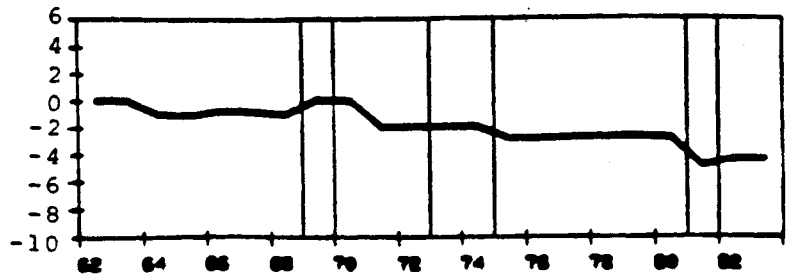
5/ The essentially neutral effect of inflationary expectations on the rental price for equipment conceals two offsetting effects. Inflationary expectations as measured in this study rose sharply throughout the period. One partial result was, ceteris paribus, to reduce the rental price of equipment. This is because the inflation premium in nominal interest payments is deductible under the corporate and personal income taxes. Thus real after-tax interest rates decline when inflationary expectations rise, holding all other factors the same, and this reduces the rental price.

There is, however, a second channel through which rising inflation expectations affect the rental price, and in this case they increase it. The present value of firms' tax deductions for depreciation is computed using a nominal interest rate, which, other things being equal, rises when inflationary expectations rise. The resulting decline in the present value of depreciation deductions increases the rental price. In the case of producers' equipment, this increase has slightly more than offset the decrease working through the tax deductibility of interest, causing the rental price to rise slightly on trend.

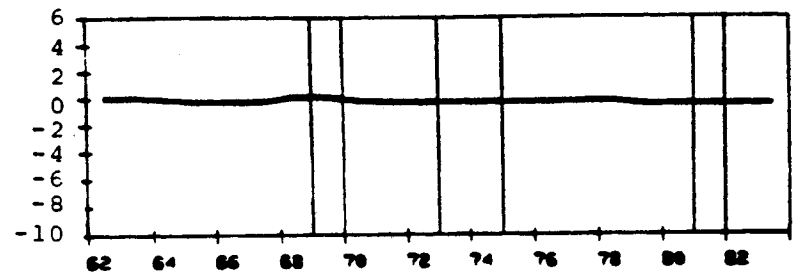
FIGURE 3. CHANGES FROM 1962 LEVEL OF RENTAL PRICE FOR PRODUCERS' DURABLE EQUIPMENT CAUSED BY VARIATIONS IN FEDERAL TAX POLICY, 1962-1983 (In percentage points)

Overall Change in Rental Price Caused by Changes in Tax Provisions



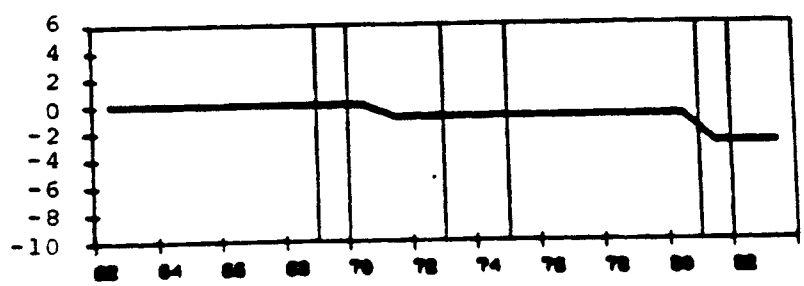
Components of Change Caused by Variations In:

Statutory Tax Rate

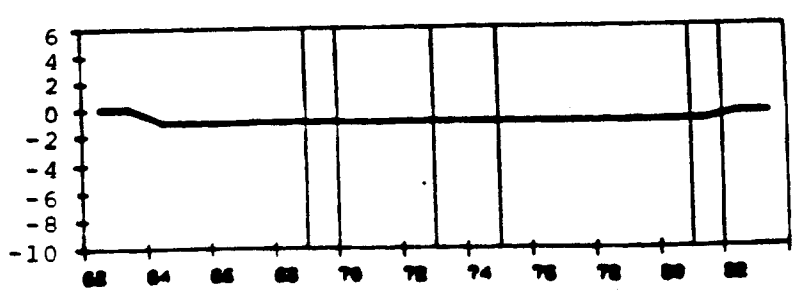


Investment Tax Credit

Depreciation Policy



Basis Adjustment



has closely followed the behavior of the real interest rate (middle panel of Figure 4). Tax policy (bottom panel) had little impact until the liberalization of depreciation under The Economic Recovery Tax Act of 1981 (ERTA), chiefly because structures were not eligible for the 1971 depreciation changes, and they are also mostly ineligible for the investment tax credit. 6/ The relative price of nonresidential buildings has grown on trend since 1962, imparting a positive trend to the rental price, as the second panel shows. A partial offset to this effect has come from inflationary expectations, as demonstrated in the middle panel of Figure 4. Unlike the case of producers' equipment, the rising trend in inflationary expectations served on balance to reduce the rental price for structures.

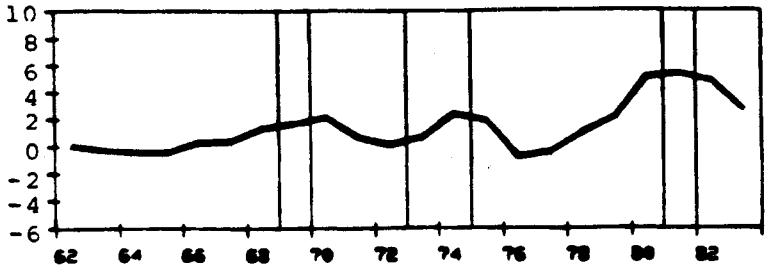
IMPACTS OF CHANGES IN INTEREST RATES ON SPENDING IN DIFFERENT SECTORS

How is actual spending in a given sector affected by changes in that sector's rental price? This is not easy to tell, because other factors, such as changes in output, also have strong effects on investment. To disentangle the effects of changes in rental prices from those of changes in output and other relevant variables, statistical techniques must be applied to historical data. This study uses estimates of the responsiveness of spending to rental-price changes drawn from published statistical studies designed to isolate such sensitivities. The CBO results should be understood to represent the estimated sensitivity on the assumption that all other relevant factors are held constant. (CBO has not attempted a complete survey of the wide statistical literature concerning the impacts of interest rates on spending. Instead, only certain relatively recent and widely cited studies were reviewed. Thus the references that were used may not be representative of the wider literature--indeed, some ambiquity creeps in, even with the small sample used here, as Table 1 shows. The issue of spending response to interest rates is as uncertain as most empirical issues in economics.)

6/ Ineligibility for the investment tax credit implies that the basis adjustment is also largely irrelevant to structures. Nonresidential structures in the National Income Accounts (NIA), the category used here, are not wholly unaffected by the investment tax credit because public utility structures, which are eligible for the credit, are included among nonresidential structures in the NIA. The sensitivity of NIA nonresidential structures to the investment tax credit may have been greater during the period before 1981 than is represented in this study because the tax law allowed "component depreciation" during that period. Under that system, certain integral components of structures, such as elevators, were treated as equipment for tax purposes.

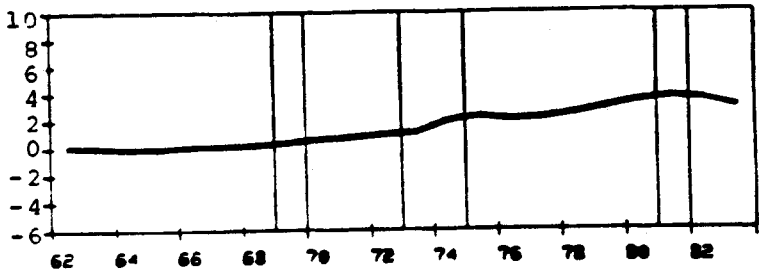
FIGURE 4. CHANGES IN RENTAL PRICES FOR NONRESIDENTIAL STRUCTURES CAUSED BY VARIATIONS IN PARTICULAR UNDERLYING FACTORS, 1962-1983 (In percentage points)

Overall Change in Rental Price

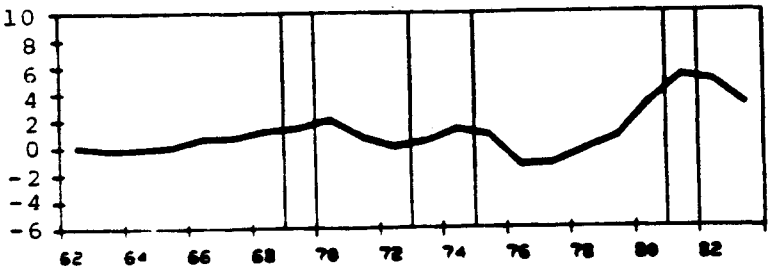


Components of Change Caused by Variations in:

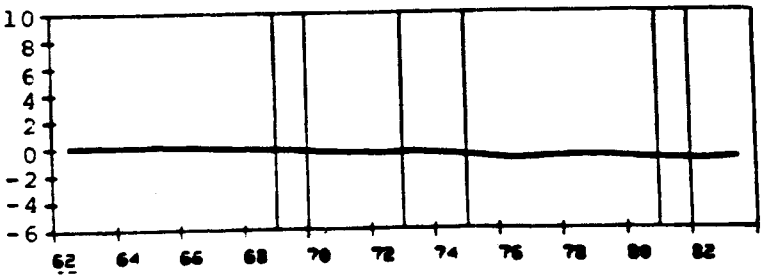
Relative Price of Nonresidential Structures



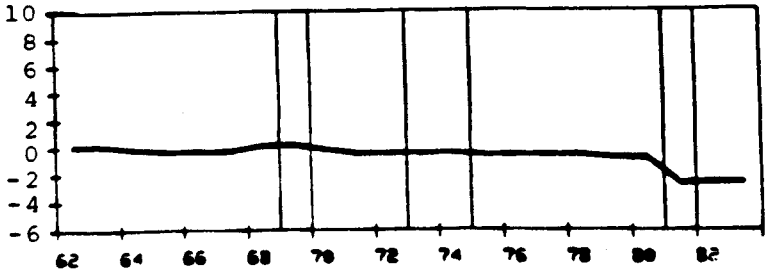
Real Interest Rate



Inflationary Expectations



Federal Tax Policy



The results of the CBO analysis are presented in Table 1. The first column shows estimates or ranges of estimates from the literature on the sensitivity of investment to changes in its rental price caused by changes in real interest rates. The second column displays calculations from CBO's rental-price model of the responsiveness of rental prices to changes in the underlying real interest rate. The product of these two estimates, shown in the third column, is the estimated responsiveness of spending to real interest rates.

Even the qualitative story told by the data in Table 1 is garbled by a persistent controversy, reflected in the first two lines, over the sensitivity of business investment to changes in its rental price. The higher figures given for producers' durable equipment and for nonresidential structures is based on the widely held view associated with Professor Dale Jorgenson which implies a relatively high degree of sensitivity. If these views are accepted, then the implication of the table is that housing is the most sensitive sector, followed by nonresidential structures, producers' equipment, and automobiles. In quantitative terms, housing starts are estimated to change by nearly 9 percent for every 10 percent change in the real interest rate, while at the opposite extreme consumer purchases of automobiles change by about 1 percent for the same change in rates. The main factor explaining this ordering is the relative importance of depreciation in the total annual cost of holding a given asset. The longer-lived an asset, the lower its annual depreciation cost and the larger the percentage by which its total cost (rental price) changes with a given change in rates. Taking account of the sensitivity of spending to rental prices does not alter this ordering.

TABLE 1. ESTIMATED RESPONSIVENESS OF SECTORAL SPENDING TO CHANGES IN REAL INTEREST RATES

Sector	Elasticity of Spending to Rental Price (1)	Elasticity of Rental Price to Interest Rate (2)	Elasticity of Spending to Interest Rate (1) x (2) (3)
Producers' Durable Equipment	0.2 to 1.0 a/	0.2	0 to 0.2 a/
Nonresidential Structures	0.2 to 1.0 a/	0.6	0.1 to 0.6 a/
Owner-Occupied Housing			0.9 b/
Consumer Automobiles	1.0 c/	0.1	0.1

a/ Higher figure is based on estimates by Jorgenson (1974). Lower figure is based on estimates by Chirinko and Eisner (1981, p. 151). Figures refer to long-run impacts.

b/ Based on estimated elasticity of demand for housing starts to nominal mortgage rate of 1.5 developed by James Kearl and Kenneth Rosen and reported in Kearl, Rosen, and Swan (1975, p. 103). Similar estimates are reported in many other studies also surveyed in the Kearl-Rosen-Swan paper. To promote comparability with other elasticities shown in this table, the elasticity has been converted to one with respect to real rather than nominal rates by multiplying it by 0.6, CBO's estimate of the average ratio of the real to the nominal mortgage rate over Kearl and Rosen sample period.

c/ Based on results reported in Mishkin (1976, p. 651). This figure is consistent with those reported in other studies of the demand for automobiles; see Gomez-Ibanez, Leone, and O'Connell (1983), p. 200.

APPENDIX. CBO'S RENTAL PRICE MODEL

The procedure CBO uses for computing rental prices for business capital is based on the following expression for the price, c:

$$c = \frac{P_i}{P(1-u)} (r+d)(1-k-uZ(1-dum\ k)) \qquad (1)$$

where

$$r = i(1-Lu)-inf \qquad (1a)$$

where P_i is the price index for the particular asset concerned; P is a general price index; r is the after-corporate-tax real cost of capital; d is a depreciation rate; u is the marginal corporate tax rate (consisting of both federal and state and local taxes); Z is the present value of tax allowances for depreciation discounted with a before-tax nominal interest rate; k is the investment tax credit rate; dum is a dummy variable accounting for the presence, absence, or (as in the post-1982 period) partial presence of a basis adjustment; i is the nominal interest rate; inf is inflationary expectations; and L is the leverage ratio, taken to be the current ratio of corporate debt to the sum of corporate debt and equity.

This measure differs only slightly from the formulation originally proposed by Hall and Jorgenson (1967). It departs from their expression only in that depreciation allowances are discounted using a nominal interest rate.

The nominal interest rate, i, used for business assets is Moody's BAA corporate bond rate average. The expression (1a) for the real after-tax cost of capital takes account of the fact that nominal interest (but not dividend) payments are deductible. This treatment avoids complications in measuring the equity cost of capital by assuming that the before-tax nominal returns to debt and equity are equated by arbitrage. The expected rate of inflation, inf, is estimated using the procedure described in Footnote 5 on page 9.

The real depreciation rate estimates are weighted averages of the rates estimated by Hulten and Wykoff (1981), in which the weights are lagged real investment flows from the National Income Accounts (NIA). The investment tax credit rates are weighted averages of the statutory rates, with the weights also derived from the NIA investment flows. The federal component of the marginal corporate tax rate is the statutory rate. The state and local component is taken to be the average effective rate. The deductibility of federal taxes under state and local income taxes is taken into account.

The streams of depreciation deductions allowed for assets with given useful lifespans are calculated using a program that accounts precisely for the half-year convention, for the particular depreciation methods available to a given asset, and for the optimal time to switch from one method to another. This algorithm is applied separately during the 1962 to 1980 period to nonresidential structures, utilities, residential structures, and producers' durable equipment, in each case using a tax lifetime computed as a weighted average of those available to the subcomponents, with the weights again derived from NIA real investment flows. After 1980, the depreciation deduction streams are taken directly from the two recent pieces of tax legislation, ERTA and TEFRA. In all years, the streams are discounted using the before-tax nominal rate and then, using NIA investment flows as weights, combined into aggregates corresponding to the NIA categories--producers' durable equipment, nonresidential structures, and residential structures.

For state and local construction, the rental price expression is equivalent but with all tax-related terms dropped:

$$c = \frac{P_i\,(i\text{-}inf + d)}{P}$$

For consumer automobiles and owner-occupied housing, a simpler expression is used:

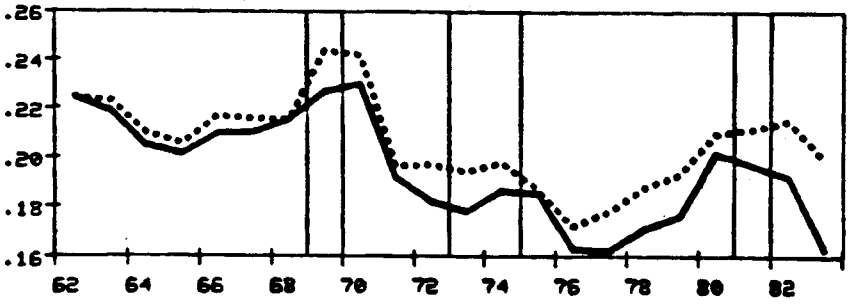
$$c = \frac{P_i\,(i(1\text{-}t) - inf + d + t_p)}{P}$$

Here, t is a DRI estimate of the marginal personal tax rate (accounting for both federal and state and local taxes); i is the mortgage commitment rate; and d is an estimate of the depreciation rate. For housing, the depreciation-rate estimate is taken from the MPS model, and for automobiles it is taken from Hulten and Wykoff (1981). A rough estimate of 2 percent, expressed as tp, represents the average property tax rate. For calculations based on nominal rather than real rates the expected inflation rate, inf, is dropped.

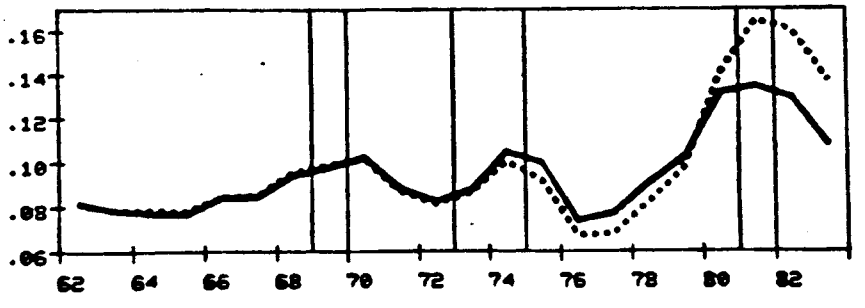
The linear approximation of the rental prices for producers' durable equipment and nonresidential structures used in the calculations shown in Figures 2 through 4 is a first-order expansion of equation (1) in Taylor series. The quality of the Taylor approximation to the rental price is better for nonresidential structures than for producers' equipment, as Figure 5 shows, but in both cases it is close enough to permit conclusions to be drawn with confidence.

FIGURE 5. COMPARISON OF LINEAR APPROXIMATIONS TO ACTUAL VALUES OF RENTAL PRICES, 1962-1983.

Producers' Durable Equipment
Linear Approximation (line)
Actual Value (dot)



Nonresidential Structures
Linear Approximation (Line)
Actual Value (dot)



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