Capital Costs, Industrial Mix, and the Composition of Business Investment

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The composition of business investment in the United States changed dramatically during the 1980s. Workplaces were transformed as a result of investments in information processing equipment, such as computers, fax machines, copiers, and sophisticated telephones. Businesses built new office towers and shopping malls, but few industrial facilities.

This article considers the extent to which changes in the cost of capital can account for these shifts. A number of developments occurred in the 1980s that affected the cost of capital more for some industries and assets than others. It is well known, for example, that computer prices fell sharply. Also, policymakers enacted significant revisions to the tax laws in efforts to alter the allocation of investment. The article concludes that changes in the cost of capital have indeed affected investment patterns. These changes are due in large part to movements in real capital goods prices across industries and assets. Surprisingly, while tax incentives have also mattered, they have been a relatively unimportant determinant of shifts in the composition of investment during the 1980s.

Section I confirms the perception that the mix of investment in recent years differs considerably from what it had been in the past. Higher spending on information processing equipment is the single most dramatic change. Section II finds that industrial distribution was important in affecting the asset composition of investment in the 1980s. Thus, explanations for investment patterns should consider incentives across both industries and assets. Section III examines how movements in capital goods and output prices, financing costs, and tax policy have affected industries' investment incentives. Section IV uses regression analysis to analyze whether these economic incentives have actually influenced investment patterns, adjusting also for the effects of industry output and cash flow. Section V offers conclusions.

I. Historical Patterns of Investment Spending

Investment patterns have changed markedly over time. Table 1 summarizes the composition of investment by asset and industry for five-year intervals from 1955 to 1989. Data for five of the 11 assets are also illustrated in Figure 1.

Real expenditures on information processing equipment—which includes computers, communication equipment, scientific and engineering equipment, and photocopying and related equipment—have risen dramatically. This category accounted for only 5 percent of total real business nonresidential investment in the 1955–59 period. By the 1970s, investment in information processing equipment was rising very sharply, accounting for 16 percent of total business nonresidential investment by 1980 and 35 percent by 1989.[1] The share of investment in equipment other than information processing rose through the 1970s, but fell in the 1980s. In particular, industrial equipment dropped from about 19 percent during the 1950s, 1960s, and 1970s to 14 percent in the late 1980s.

Investment in structures has declined as a share of total nonresidential capital expenditures, and its composition has changed. The common perception of rapid growth in office buildings and shopping centers during the 1980s can be attributed in part to their increase from an unusually low investment share in the late 1970s. In comparison with earlier time periods, the 1980s were not marked by an especially high concentration of investment in commercial structures. The share of investment in other structures—notably industrial and farm—was unusually low in the 1980s. Investment in mining structures rose as a share of the total in the early 1980s and fell in the late 1980s.

The bottom half of Table 1 shows the shares of gross investment by different industries. During the 1960s and 1970s, industry shares of real investment were relatively stable. Transportation, communications, and utilities accounted for close to one-quarter of the total. Durable and nondurable goods manufacturing and mining were the other large sources of capital spending.

In the 1980s, industry shares changed noticeably. Most dramatically, the finance and insurance industries accounted for over 15 percent of total investment in the latter half of the 1980s, several times their share in earlier periods. Wholesale and retail trade and services also grew in relative importance,[2] while transportation, communications, and utilities, manufacturing, agriculture, and construction all shrank. Mining was a volatile source of investment.

II. The Importance of Industry Mix in the 1980s

The overall mix of assets can change if individual industries change the composition of their capital spending. Alternatively, because industries vary in the types of capital they use, the composition of investment can change as some industries expand and others contract, even if the relative use of different assets remains unchanged within each industry. Lacking the appropriate data, previous studies have been unable to differentiate these two sources of change in investment patterns. New information indicates that both types of shifts took place in the 1980s.

For example, Table 1 indicates that information processing equipment has accounted for a growing share of investment over time. Simultaneously, the share of investment done by finance and insurance—industries primarily engaged in processing information rather than goods—has also risen. During the period 1985–89, almost 65 percent of real investment by the finance and insurance industries was allocated to information processing equipment, making these firms by far the most intensive purchasers of this type of capital (Table 2). However, the rising demand for information equipment appears to be a general phenomenon as well as industry-specific, since in most industries the share of investment going to information processing equipment was substantially higher than at any time in the past. (For further information

[1] This study considers investment in constant dollars, which is appropriate for comparing quantities of capital goods purchased over time. Another approach would be to examine current dollar figures, to evaluate shares of the investment budget allocated to different items. Because the price of information processing equipment has fallen considerably, its current-dollar share has not risen as much as its constant-dollar share. During the 1955–59 period, spending on information processing in current dollars accounted for 8 percent of total investment spending. It rose to 17 percent in 1980 and 23 percent in 1989.

[2] The shares of investment accounted for by finance and insurance, trade, and services have also risen when expressed in current dollars. Finance and insurance accounted for 10.7 percent of investment in the 1985–89 period, compared to 5.7 percent in 1980–84, and below 5 percent in prior decades. The share for trade was 15.9 percent in 1985–89, 12.0 percent in 1980–84, and about 10 percent in the 1960s and 1970s. The share for services was 13.5 percent in 1985–89, 10.6 percent in 1980–84, and around 9 percent in the 1960s and 1970s (except 1970–74, when it was 10.2 percent).

Table 1
Composition of Real Nonresidential Investment by Asset and Industry, 1955 to 1989
Percent of Total

	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1980	1985	1989	Memo: 1989 with 1980 Industrial Mix
Assets											
Equipment											
Information Processing	4.8	6.2	6.5	8.5	12.1	19.6	31.3	16.3	26.5	35.2	23.6
Industrial	20.3	18.8	20.2	19.8	19.0	16.2	14.2	18.2	14.1	14.8	17.4
Transportation	10.9	11.6	14.4	14.6	14.9	11.3	12.1	12.1	11.8	11.5	10.9
Other	16.6	15.6	15.8	17.4	19.1	15.9	13.6	17.1	13.3	13.7	15.0
Total Equipment	52.6	52.2	56.8	60.2	65.1	63.0	71.2	63.7	65.7	75.3	66.9
Excl. Information Processing	47.8	46.0	50.3	51.7	53.0	43.4	39.9	47.4	39.2	40.1	43.3
Structures											
Industrial Buildings	6.7	6.5	8.6	5.0	4.5	4.0	2.9	4.2	3.3	3.1	3.8
Commercial Buildings	9.0	10.7	9.7	10.7	7.7	9.9	10.5	9.2	11.8	9.3	6.6
Institutional and Other Buildings	6.9	9.4	7.1	5.9	3.6	4.0	4.0	3.5	3.9	3.9	3.7
Farm Structures	2.0	2.0	1.6	1.7	2.1	1.1	.4	1.6	.4	.3	1.0
Public Utility Structures	11.7	9.7	9.6	10.8	9.1	7.4	5.9	8.3	6.3	4.6	6.8
Mining	10.8	8.8	5.9	4.9	7.3	10.2	4.6	9.1	8.0	3.0	10.1
Other	.4	.6	.7	.8	.5	.4	.5	.3	.6	.5	1.1
Total Structures	47.4	47.8	43.2	39.8	34.9	37.0	28.8	36.3	34.3	24.7	33.1
Industries											
Agriculture	8.1	7.6	7.1	7.7	8.2	4.6	2.4	6.3	2.4	2.4	
Mining	14.2	12.4	9.2	7.8	10.9	13.0	5.4	12.5	9.4	3.9	
Construction	3.6	3.5	3.3	3.6	3.3	1.8	1.4	2.6	1.4	1.3	
Durables Manufacturing	12.4	11.3	14.0	11.4	11.9	11.4	10.2	13.1	11.1	10.2	
Nondurables Manufacturing	10.0	10.4	11.5	10.2	10.9	9.2	7.4	9.9	7.8	8.2	
Transportation, Communication, and Utilities	24.8	23.5	23.9	26.3	24.5	22.3	19.8	24.4	20.7	16.1	
Wholesale and Retail Trade	7.5	8.7	9.2	10.0	10.0	11.6	15.6	9.2	14.5	15.8	
Finance and Insurance	2.1	2.4	2.7	3.3	4.0	5.8	15.5	4.4	11.1	19.8	
Nonresidential Real Estate	5.6	6.6	6.7	7.8	5.8	8.0	7.2	7.1	8.2	6.3	
Services	6.9	8.3	8.2	9.2	8.4	10.3	12.9	8.5	11.6	13.9	
Memo: Estimated Nonprofit Real Estate	4.9	5.3	4.1	2.8	2.1	2.1	2.1	2.0	1.8	2.1	

Source: U.S. Bureau of Economic Analysis and authors' calculations (using 1982 dollars).

on the composition of each industry's purchases, see Appendix Table 1.)

Figure 1 shows the results of a more formal analysis for information processing and other assets. Each panel compares the actual share of investment for a given asset in each year with the hypothetical share, assuming that each industry purchased its observed mix of assets but that the industry's share of total investment was equal to its share in 1980. Thus, if the actual asset share is above the fixed-weight share, this would indicate that industries with relatively high purchases of the asset accounted for a greater share of investment than they did in 1980. (The fixed-weight results for 1989 are also reported in the last column of Table 1.)

The rise of finance, insurance, trade, and services boosted sales of information processing equipment. More than one-half of the increased share for information processing equipment between 1980 and 1989 can be attributed to a changing industrial distri-

Table 2
Information Processing Equipment as a Proportion of Real Investment by Industry, 1955 to 1989
Percent

Industry	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89
Agriculture	0	0	0	0	0	.1	.5
Mining	.1	.1	.1	.2	.2	.2	.1
Construction	.7	.9	.7	.5	1.5	5.9	8.8
Durables Manufacturing	3.0	3.2	2.5	3.6	8.3	18.4	27.9
Nondurables Manufacturing	2.8	3.1	2.8	5.4	11.4	15.6	17.8
Transportation, Communication, and Utilities	7.6	13.5	14.5	16.3	22.7	31.1	35.0
Wholesale and Retail Trade	1.6	1.7	2.3	4.0	8.6	18.4	26.6
Finance and Insurance	10.3	7.7	5.3	8.9	17.9	42.6	64.8
Nonresidential Real Estate	15.9	12.7	12.0	11.9	18.4	17.7	18.9
Services	9.3	9.3	10.0	13.6	15.3	24.3	31.1

Source: Authors' calculations described in the Appendix.

bution. Assuming a constant industry mix, the share for information processing equipment would have risen from 16 percent to 24 percent. It actually rose to 35 percent.

The finance and insurance and trade industries have recently accounted for most of the purchases of commercial structures. Because of the growth of these industries, commercial structures increased from 9 percent of total investment in 1980 to almost 12 percent in 1985; with a constant industrial mix, the share for commercial structures would have fallen slightly. In contrast to the experience for the 1980s, industrial composition did not change the demand for information processing equipment or commercial structures during the 1960s and 1970s.

For several assets, changing industrial mix lowered demand in the 1980s. For example, if manufacturing had maintained its 1980 share of investment, industrial equipment would have fallen only minimally (from 18 percent to 17 percent of total investment in 1989, rather than to under 15 percent).[3] Changes in industry demand also reduced the purchases of farm structures and mining structures.

The shifts in industry shares of investment during the 1980s primarily reflect movements in capital intensity rather than the composition of production. Except for a pronounced decline in mining, industry shares of real gross domestic product (GDP) did not show marked trends (Table 3). The increased share of business investment by finance and insurance reflects greater investment relative to output rather than greater output by these industries relative to national output.

Table 3
Composition of Gross Domestic Product by Industry, 1980 and 1989

Industry	1980	1989
Agriculture	2.8	2.7
Mining	5.2	3.4
Construction	5.6	4.8
Durables Manufacturing	14.9	15.7
Nondurables Manufacturing	9.7	9.3
Transportation, Communication, and Utilities	10.7	10.8
Wholesale and Retail Trade	17.6	19.3
Finance and Insurance	4.9	4.8
Real Estate[a]	12.2	11.4
Services	16.4	17.6

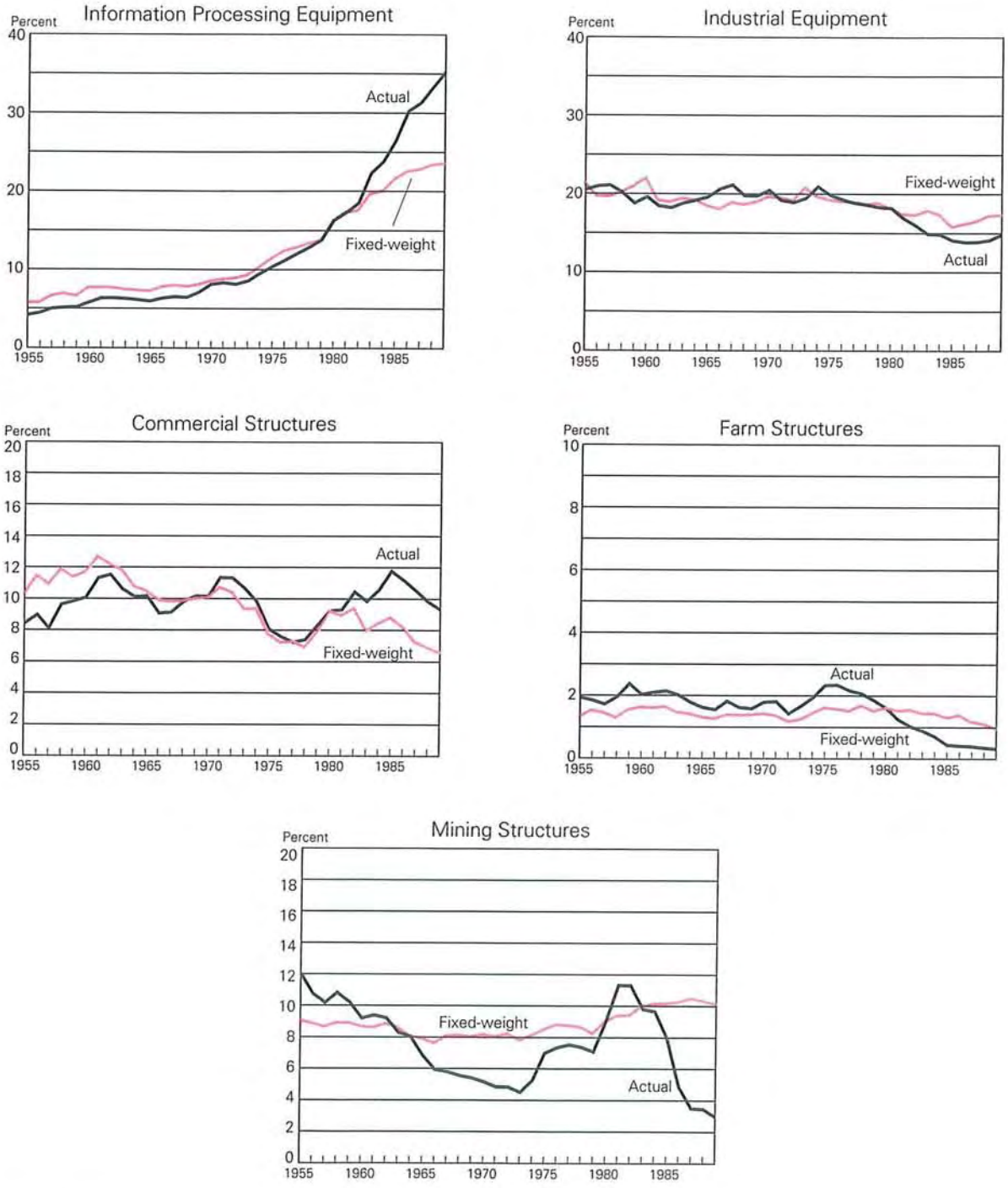
[a]Residential plus nonresidential.
Source: U.S. Bureau of Economic Analysis.

In summary, service-producing sectors accounted for a disproportionately large share of investment in the 1980s compared to their historical shares. This development tended to boost the demand for information processing equipment and commercial buildings. Higher investment by these industries reflected more investment relative to their output—not an overall shift to a more service-based economy. Information processing equipment also increased as a share of total investment because, in general, busi-

[3] Manufacturing industries account for about three-fourths of total investment in industrial equipment (see Appendix Table 1).

Figure 1

Actual versus Fixed-Weight (1980) Investment Shares, 1955 to 1989



Source: U.S. Bureau of Economic Analysis tapes and authors' calculations.

nesses increased their relative purchases of information processing equipment.

III. Economic Incentives for Investment

The previous two sections have noted changes in investment patterns in the 1980s. The study now turns to the underlying economic determinants of these shifts in investment composition. For example, did service-producing sectors increase their investment intensity because of tax policies, price changes, or other factors? What accounts for the growing use of information processing equipment by a variety of industries?

Firms invest when they expect the resulting return to be greater than or equal to the cost of capital. Holding constant assumptions about rates of return, investment would rise (fall) as the cost of capital falls (rises). For example, firms would invest more in an asset if its price fell or if rules governing its tax depreciation were liberalized. Firms in a given industry would tend to invest more in all types of assets if their output prices rose (since this would reduce the real cost of purchasing capital goods), or if interest rates fell.

Firms' expectations about rates of return are unobservable. However, because firms may extrapolate from recent business conditions, current output and profitability can serve as indicators of expected returns, at least in the near future. Output can also reflect the adequacy of current capacity. For example, during a recession, capital is idled, thereby obviating the need for expansion. Expectations about future rates of return may also depend on additional factors that are less susceptible to measurement, such as firms' optimism about the productivity of new technologies.

This section considers how changes in the cost of capital might explain the investment patterns indicated in sections I and II. It then briefly discusses cyclical movements in industry output and cash flow. Some analysts view cash flow as another proxy for expected returns, but others believe that cash flow serves as a refinement in the measurement of investment costs when capital markets are imperfect.

Cost of Capital

Economists have studied the cost of capital for the past three decades, but especially in recent years as a result of changes introduced in the Economic Recovery Tax Act of 1981 and the Tax Reform Act of 1986 (Henderson 1986, 1991). Holding constant macroeconomic factors such as interest rates and expected inflation, the 1981 Tax Act lowered the cost of capital by introducing more accelerated depreciation. In a reversal of this policy, the 1986 Act lengthened tax lives and mandated straight-line recovery for structures. It also eliminated the investment tax credit, which had been available for all equipment and limited categories of structures.

Despite the keen interest in business taxes, tax policy is not necessarily the major factor influencing capital costs. In a much cited article, Bosworth (1985) noted that investment following the 1981–82 recession was strongest in computers and automobiles, two categories not particularly advantaged by the 1981 tax reform. Bosworth concluded that prices of capital goods and movements in the cost of funds played a greater role in determining investment costs than did variations in tax policy during this period. More recently, Auerbach and Hassett (1991a, 1991c) found that investment in equipment was somewhat influenced by the Tax Reform Act of 1986, but that investment in structures appeared to be unrelated to the revised tax provisions.[4]

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The cost of capital by industry and asset. This study constructs separate measures of the cost of capital for each of the 11 assets used by the 10 industries shown in Table 1. (Because not all industries use each type of asset, the study has 59 rather than 110 industry-asset combinations in total.)

The cost of capital is defined as follows:

$$(1)\quad c_{ij} = [pk_{ij}/po_i] * [r + d_{ij}] * [1/(1 - t)] * (1 - k_{ij} - t * z_{ij})$$

where the subscripts i and j refer to industry and asset, respectively. The first term is the real purchase price per unit of capital. It equals the acquisition cost

of the asset, pk, relative to the output price for the industry, po. In this study, the acquisition cost varies by industry because each industry uses a different mix of assets within each of the 11 aggregates. (Most importantly, industries use different ratios of computers and other information processing equipment within the information processing aggregate.)

The second term is the annual economic cost of using the asset. It consists of a real cost of funds, r, plus the rate of economic depreciation for the asset, d.[5] The cost of funds depends both on the risk premium demanded by financial markets and on how businesses finance their capital expenditures.[6] Different studies of the cost of capital have varied greatly with respect to measuring this term, and no consensus has emerged on which method is most appropriate (Bosworth 1985; Poterba 1991b).[7] This study adopts a weighted average of debt and equity costs, with weights varying according to the desired proportions of debt and equity finance.[8] This measure is applied to all assets and industries. The economic depreciation rate is higher for short-lived assets such as computers and automobiles than for long-lived assets such as buildings.

The third term reflects the taxation of returns. As a result of income tax at rate t, to earn one dollar net of tax, capital must earn 1/(1 − t) gross of tax.

The final term indicates the effective reduction of the purchase price resulting from investment incentives. This study will refer to this term as the "tax price" of investing. Some assets are eligible for an investment tax credit at rate k. The variable z represents the present discounted value of depreciation allowances per dollar of purchase price. These allowances are deducted from taxable income, thus saving the firm t * z in tax obligations.[9] Because allowances are specified in current dollars, a nominal discount rate is used to compute z.

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Historically, asset prices, output prices, financing costs, and tax policy have all influenced the cost of capital, but to varying degrees. (For details regarding the calculations, see the Appendix.)

Prices. Starting in the early 1970s, the price of information processing equipment began falling dramatically, thus encouraging investment in this asset

[4] Auerbach and Hassett (1991a) estimated investment equations for equipment and structures through 1985. They found that equipment investment was consistent with the predictions of their econometric model in 1986 and 1987, but it was weaker than predicted in 1988. Spending on structures was weaker than predicted in each year from 1986 to 1988, indicating either that factors other than capital costs played a role, or that their measure of capital costs was flawed. One acknowledged difficulty of econometric models is measuring business expectations about future tax policy. Another is accounting for the full complexity of changes in tax laws—such as the 1986 expansion of the minimum tax and introduction of tighter accounting provisions. Auerbach and Hassett (1991c) introduced refinements on their methodology on these points, and they examined disaggregated categories of equipment and structures. They found that the 1986 tax law appeared to play a role in reducing equipment spending, but the pattern for different types of structures could not be explained by the provisions of tax reform. A separate study by Poterba (1991a) noted a sharp drop-off in the formation of real estate partnerships after the 1986 tax reform was enacted, but did not specifically examine nonresidential construction.

[5] Some studies add the expected future rate of change in capital goods costs to this term. For example, Auerbach and Hassett (1991b, 1991c) consider the expected change in investment incentives (since this effectively changes the acquisition cost of capital goods). One version of the regressions in section IV of this study added such a term, but it did not improve the results. More experimentation with alternate measures, including the prices of specific assets, is a potential subject for future research. For example, if correctly anticipated, falling output prices over much of the sample period would increase the second term in equation (1), indicating the cost advantage of postponing computer purchases.

[6] The dependence of capital costs on financing methods is based on empirical observations rather than on theory. In theory, firms would pick that leverage ratio at which the marginal costs of financing by debt and equity were equal. However, analysts who have attempted to measure these costs tend to find that the cost of debt finance is lower than the cost of equity finance. Thus, economists still lack an understanding of why companies do not increase their leverage.

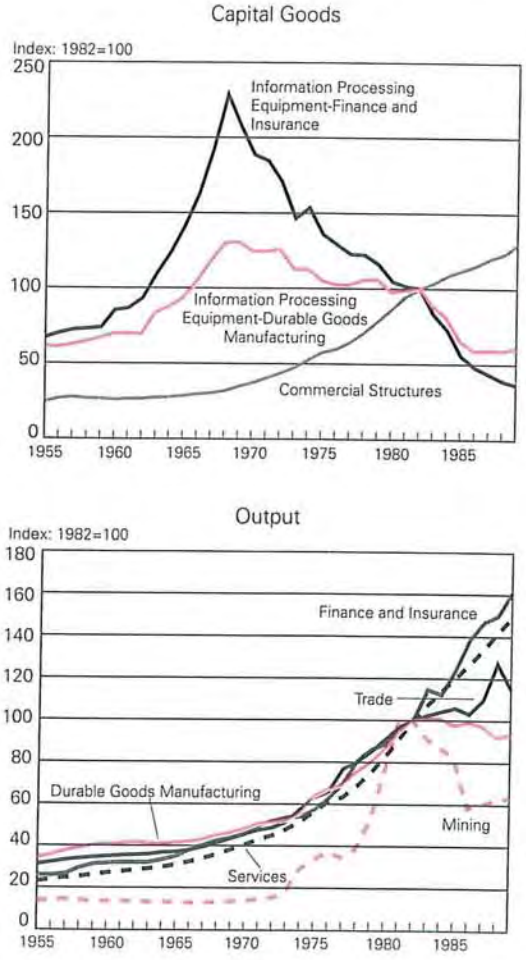
[7] Real interest rates were very low in the mid to late 1970s, and then very high in the mid to late 1980s. Equity costs exhibited the reverse pattern. Therefore the cost of capital can vary enormously depending on the relative roles assigned to debt and equity. The measurement problems become more acute in the context of a disaggregated study, because financing methods and risk premia vary across industries, and possibly across assets. For example, some types of capital can be sold readily in resale markets, and therefore may be amenable to financing by debt, which has a different cost than equity (Bosworth 1985; Gordon, Hines, and Summers 1987).

[8] This cost of capital measure comes from a model of the economy developed at the Federal Reserve Board; see the Appendix.

[9] This study does not account for the tax consequences of churning assets. See Gordon, Hines, and Summers (1987).

Figure 2

Selected Capital Goods and Output Price Deflators, 1955 to 1989



Source: U.S. Bureau of Economics Analysis and authors' calculations.

by all industries. Taking durable goods manufacturing as an illustration, the price deflator for information processing equipment (pk) in the late 1980s was estimated to be one-half of its level in the early 1970s, and the output price deflator (po) for durables more than doubled during this period (Figure 2). Thus, the real price of information processing equipment (pk/po) fell to roughly one-quarter of its early 1970s value. In some other industries—such as finance and insurance—nominal information processing equipment prices fell even more because computers account for a greater share of information processing equipment. The prices of most other capital goods have tended to move roughly in line with general inflation. One notable historical exception is transportation equipment: its price fell considerably between the mid 1950s and the mid 1960s.

During the 1980s, output price inflation was higher in service-producing industries than in goods-producing industries, thereby reducing the real cost of purchasing capital goods for the former industries, compared to the latter (Figure 2, bottom panel). Manufacturing output prices fell slightly during the 1980s, and prices of mining industry output (which includes petroleum) rose almost sixfold between 1973 and 1982, but then fell by over 40 percent between 1982 and 1986. Inflation rates for finance and insurance and for services were higher than general inflation in the 1980s. These price movements discouraged investment by goods-producing industries and encouraged investment by service-producing industries.

Cost of funds. Movement in the cost of funds tended to make investment less costly in the second half of the 1970s and more costly in the 1980s. As indicated in Figure 3, the cost of funds (r) was fairly level from 1960 through the early 1970s. It fell in the mid 1970s as real interest rates declined, and then rose sharply during the early 1980s. The cost of funds remained high in the latter half of the 1980s.

These changes tended to influence overall levels of investment: increases in the cost of funds blunted some of the stimulus to investment associated with the 1981 tax act and reinforced the increased tax costs from the 1986 act. They also may explain some of the shift away from structures observed during the late 1980s, since capital costs for long-lived assets are particularly sensitive to the cost of funds.[10]

Tax rates. Until the substantial reduction under the 1986 Tax Reform Act, movements in the statutory corporate income tax rate were minor, thus having little influence on capital costs. The corporate income tax rate (t) decreased gradually from 52 percent in 1954 to 46 percent in 1979, where it remained through 1986. As a result of the 1986 Tax Reform Act, business profits have been taxed less heavily, as the corporate income tax rate fell to 40 percent in 1987 and 34 percent in 1988.[11] All else equal, these changes reduced the cost of capital for all assets and industries by 18 percent—the rate of change in $[1/(1 - t)]$—between 1986 and 1988.

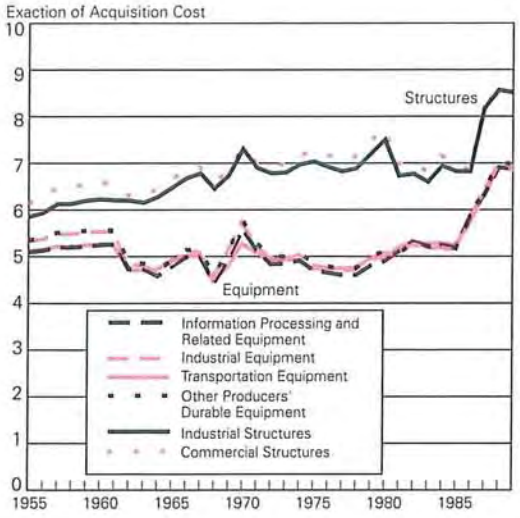
Figure 3

Cost of Funds, 1955 to 1989

Source: Board of Governors of the Federal Reserve System; details in Appendix.

Figure 4

Tax Price by Asset, Durable Goods Manufacturing, 1955 to 1989



Source: Authors' calculations; details in Appendix.

Tax price. The tax price for equipment varied surprisingly little until the Tax Reform Act of 1986. Since tax policy differs more across assets than industries, Figure 4 illustrates the effect of incentives in a representative industry, durable goods manufacturing. The introduction of the investment tax credit in 1962, as well as its reinstatement in 1971 after a suspension in 1969 and 1970, reduced the tax price for equipment somewhat. For industrial equipment, for example, the tax price fell by 8 percent between 1960 and 1980. The acceleration of depreciation in 1981 might have been expected to increase the incentive to invest, but its effect was offset by higher interest rates, leaving the tax price approximately unchanged through the first half of the 1980s.[12]

Because cost recovery periods for structures tend to be relatively long, rising inflation increased the discount rates used in calculating the present discounted value of allowances so as to more than offset successive reforms that shortened allowable tax lives during the 1960s and 1970s.[13] The tax price for industrial structures used by durables manufacturers rose by 20 percent between 1960 and 1980. The more substantial shortening of tax lives in 1981 had a larger effect. Even after accounting for higher interest rates,

[10] For long-lived assets (with low d), the cost of funds is a greater fraction of r + d than it is for short-lived assets (with high d).

This study abstracts from the endogeneity of the cost of funds. For example, when businesses expect a high rate of return on investment, they may choose to invest more and to pay higher yields to their creditors and shareholders. Thus, investment may influence the cost of funds, as well as the other way around (Kopcke 1988). Other elements of the cost of capital may also be endogenous. For example, a higher demand for capital would tend to raise the price of capital. On the other hand, if investment is expected to be weak, policymakers may expand tax incentives for investment. Proper treatment of these linkages would require implementing a simultaneous equations model of the economy.

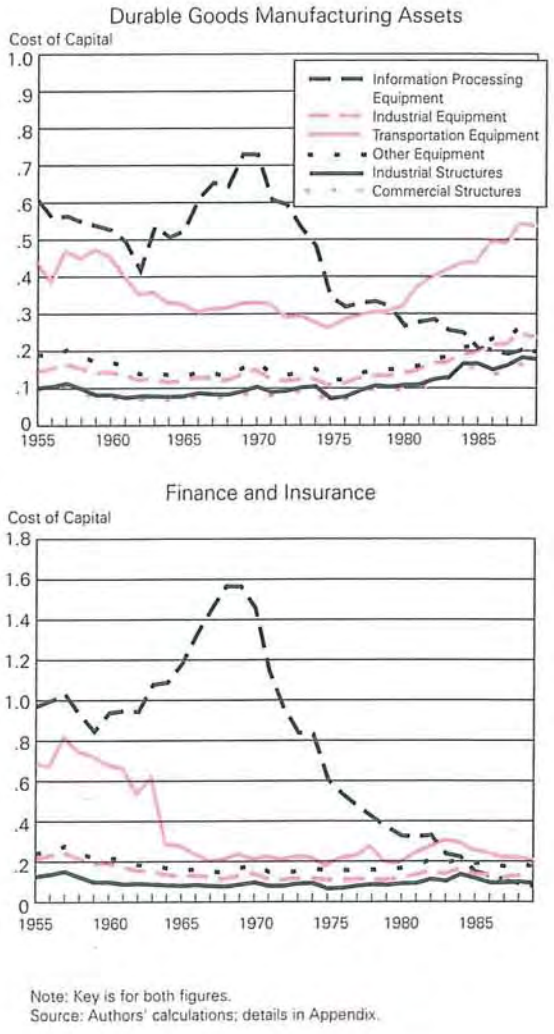
[11] Following standard practice, this study uses the corporate income tax rate even though noncorporate businesses account for some investment. Personal income tax rates were also reduced as a result of the 1986 tax reform.

[12] As noted in the Appendix, depreciation allowances are discounted by the Moody's Baa rate times the quantity one minus the corporate income tax rate. The Moody's Baa rate rose from 13.67 percent in 1980 to over 16 percent in 1981 and 1982. Auerbach and Hassett (1991a) find an increased incentive to invest during the early 1980s because they use the six-month commercial paper rate to discount allowances. This rate also rose between 1980 and 1981, but it fell in 1982.

[13] The estimated discount rate was 2.5 percent in 1960, 4.6 percent in 1970, and 7.4 percent in 1980.

Figure 5

Cost of Capital, 1955 to 1989



Note: Key is for both figures.
Source: Authors' calculations; details in Appendix.

the tax price for structures investment fell by about 5 percent between 1981 and 1985 (Figure 4). This may help to explain the falling share of investment in structures during the 1960s and 1970s, and the rising share in the early 1980s.

By eliminating the investment tax credit and altering depreciation allowances, the Tax Reform Act of 1986 reduced investment incentives, especially for equipment (Figure 4). As a result of the elimination of the investment tax credit in 1986 and the longer tax lives starting in 1987, the tax price for equipment categories used by durable goods manufacturers rose by over 30 percent from 1985 to 1988.[14] The tax reform also eliminated accelerated depreciation for structures. For durable goods manufacturers, the result was an increase in the tax price of 22 percent for commercial buildings and 26 percent for industrial buildings. However, the reduction in the corporate tax rate offset more than half of the tax price increase for equipment and most of the increase for structures. In light of these changes, many analysts expected equipment to be affected more adversely than structures by the 1986 tax reform. But, as is clear in Table 1, such a shift did not occur.

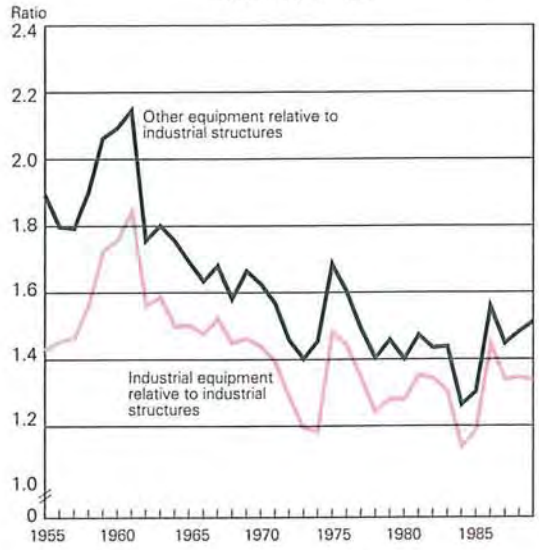
Summary. The results for the cost of capital are illustrated in Figure 5 for durables manufacturing and finance and insurance. (Data for additional industries are presented in Appendix Table 3.) Largely because of falling prices (shown in Figure 2), the cost of investing in information processing equipment declined from the early 1970s until the mid 1980s, and then stabilized as a result of the higher costs imposed by the Tax Reform Act of 1986.

For other assets, the cost of capital rose in the 1980s, as a result of a high cost of funds (shown in Figure 3) and also as a result of reduced incentives for investment under the 1986 tax reform (shown in Figure 4). The repeal of the investment tax credit in 1986 increased the cost of capital for equipment. Longer tax lives and the mandated use of straight-line depreciation increased the cost of capital for structures starting in 1987, but this was largely offset by a lower corporate income tax rate.

Policymakers justified the sharp tax increase for equipment in 1986 by noting that they were "leveling the playing field" by introducing more similar tax treatment for equipment and structures.[15] Some opponents countered that discouraging equipment investment was particularly harmful to economic growth.[16] In the wake of this debate, it is somewhat surprising that the change in the relative cost of capital for equipment versus structures was not all that large from an historical perspective (Figure 6). The steady erosion in the value of depreciation allowances for structures because of rising inflation during the 1960s and 1970s (shown in Figure 4) created far greater incentives for businesses to alter the composition of their capital expenditures than did the 1986 tax reform.[17] Once non-tax elements of the cost of capital—particularly the cost of funds—are considered, the cost of equipment relative to the cost of structures was only slightly higher in the 1987–89 period than it had been from 1981–84.

Movement in industry output prices during the

Figure 6 *Cost-of-Capital Ratios in Durable Goods Manufacturing, 1955 to 1989*



Source: Authors' calculations; details in the Appendix.

1980s also affected capital costs. Services prices generally rose more than goods prices (shown in Figure 2). Therefore, services-producing industries faced lower capital costs than goods-producing industries, even when comparing assets with similar tax treatment (compare top and bottom panels of Figure 5).

Taken together, these changes appear consistent with investment patterns seen in sections I and II. The declining cost of information processing equipment contributed to its greater share of investment in the 1970s and 1980s. Movements in relative costs indicate why other equipment increased while structures fell as a share of investment through the 1970s, and why shares of both categories decreased during the 1980s. Relatively high increases in prices of finance and insurance and services products contributed positively to the demand for information processing equipment and commercial buildings. Meanwhile, weak prices for manufactured products depressed demand for industrial buildings.

Other Determinants of Investment: Output and Cash Flow

The evidence on capital costs seems to accord well with changes in the composition of investment, but a statistical test of these results requires controlling for other influences. As noted above, firms may use current output in determining the desirability of adding new capacity.[18] Even though section II noted no pronounced secular changes in output shares by industry during the 1980s (except for mining), for some industries output has varied significantly over business cycles. In manufacturing industries, especially the durables sector, output turned down sharply in recessions, such as the period 1980–82. Construction is also highly cyclical. Service-producing sectors have been more stable. Output is entered as a separate influence on investment in the regressions in section IV.

Economists have long observed a positive relationship between business investment and internal cash flow. Cash flow equals profits plus write-offs that provide cash but are not included in industry profits. Although some observers view cash flow as a general indicator of industry conditions, a recent literature has stressed its importance in light of imperfections in capital markets. In evaluating new issues of stock, potential shareholders may feel that they have poorer information about the firm's prospects than does the firm's management, and therefore may be unwilling to purchase stock without receiving a discount from the going price. Accordingly, corporations find it expensive to issue new shares because they must give up a large ownership stake per dollar raised. Thus, internal funds may effectively constrain capital spending if information is asymmetric. Additionally, companies with a volatile cash flow may incur sizable interest rate premia when they borrow because potential debtholders are concerned with bankruptcy risk. This extra cost may cause companies to defer some investment projects if internal funds are unavailable. Some recent evidence

[14] The discount rate changed only slightly between these two years.

[15] The studies reviewed in Henderson (1991) indicate that effective tax rates for equipment and structures did become more nearly equal as a result of the 1986 tax reform.

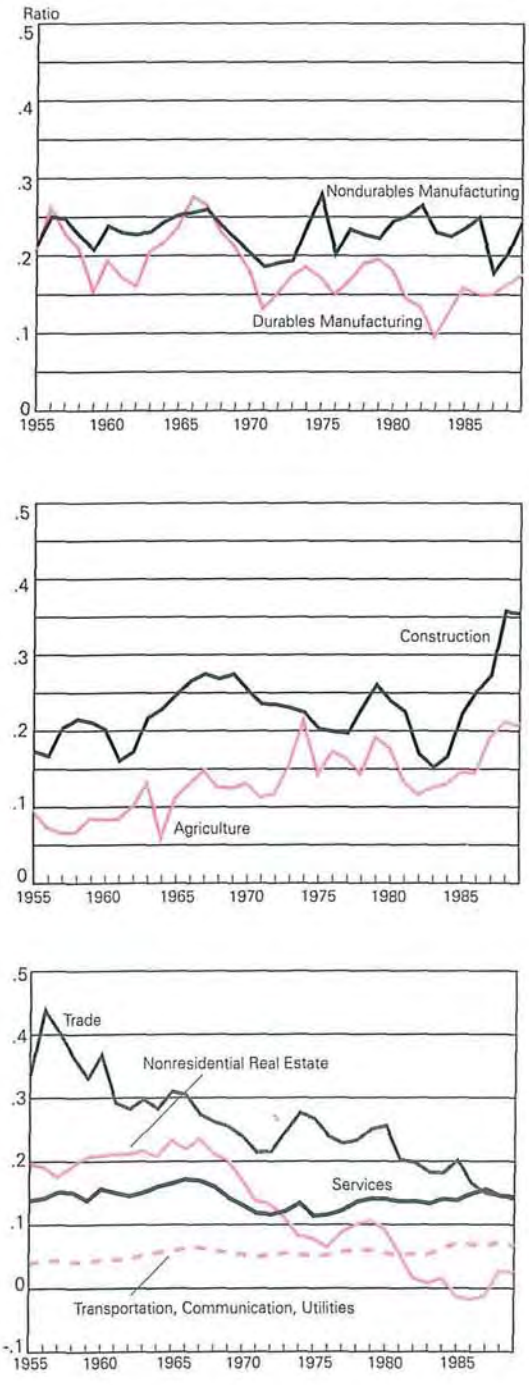
[16] See DeLong and Summers (1990) for a cross-country comparison of equipment investment and economic growth rates.

[17] The economic depreciation rate for equipment is higher than that for structures, causing the cost of capital for equipment to be higher than that for structures in all time periods. Figure 6 also reflects changes in the cost of funds over time.

[18] They may also be guided by current returns to capital. One alternative to the specifications in section IV considered interest plus pre-tax profits instead of output. Another entered this variable in the denominator of the cost of capital, as in the Auerbach-Hassett studies. Neither approach helped to explain investment patterns.

Figure 7

Cash Flow Relative to Capital Stock, by Industry, 1955 to 1989



Source: Authors' calculations; details in Appendix.

has supported this view, although most of the research concentrates on manufacturing.[19]

Figure 7 shows cash flow (measured as retained earnings plus capital consumption allowances) relative to the value of each industry's capital stock.[20] (See the Appendix for further details.) The durable goods manufacturing industry has experienced high variation in cash flow, as well as some secular deterioration starting in the 1970s. Cash flow was relatively strong in good economic times—such as the mid to late 1980s—but it dropped considerably in recessionary periods. In fact, the recessions of the early 1980s caused profits to fall by enough to offset the boost to cash flow accorded by the liberalization of depreciation allowances in the 1981 tax act. Cash flow in nondurables manufacturing industries is somewhat less volatile, and it has not deteriorated over time.

Among the remaining industries, cash flows are relatively volatile in agriculture and in construction. For both industries, cash flow fell in the early 1980s, and recovered in the second half of the decade. These industries also have many small firms, thus suggesting possible binding constraints on investment. By

[19] Fazzari, Hubbard, and Petersen (1989) found that cash flow was an important determinant of investment, especially for firms that retain nearly all of their income and therefore cannot alter dividend payments to raise funds. Petersen and Strauss (1991) found that investment by durable goods manufacturing industries, which tend to be highly cyclical, is more sensitive to cash flow than investment by nondurable manufacturing industries, which tend to be less cyclical. Petersen and Strauss found no independent role for the cost of capital. In addition to these industry studies, Kopcke (1985) and Auerbach and Hassett (1991a) found that economy-wide cash flow was a determinant of aggregate investment. Comparatively little work has focused on specific nonmanufacturing industries. However, a recent study found that cash flow affected investment by small hospitals and unaffiliated hospitals, but not large or affiliated hospitals (Calem and Rizzo 1991).

[20] Retained earnings are calculated net of dividends but gross of share repurchases. In recent years, total share repurchases have increased as a proportion of total payouts, and are estimated to have exceeded dividends in 1988 and 1989 (Gordon and Mackie-Mason 1991). (Data on share repurchases are not available by industry.) Because it is based on retained earnings, the cash flow measure used in this study (and many other studies) treats payouts to shareholders inconsistently. This asymmetry may be justified if dividends are viewed as much less discretionary than share repurchases: companies tend to maintain fairly constant ratios of dividends to after-tax earnings, perhaps indicating that they feel constrained by past practices. As an alternative to the usual measure of cash flow, this study also investigated after-tax profits gross of dividends and share repurchases, as in Auerbach-Hassett (1991a). One weakness of this alternative approach is that the dividend data in the national income and product accounts refer to dividend payments by the industry net of dividends received from other industries. Conceptually, dividends received should be included in the industry's cash flow (as in retained earnings), not excluded (as in the after-tax profits measure).

contrast, cash flow for the transportation, communications, and utilities industry and for services has been extremely stable.

For two nonmanufacturing industries, the available data do not provide a good measure of internal funds. Mining firms are able to deduct intangible drilling expenses and depletion allowances, and finance and insurance companies are allowed specialized reserves (such as for bad debts). Thus, cash flows for these industries are not included in the analysis.

IV. Econometric Estimates

Section III has discussed incentives for investment; this section investigates the significance of the cost of capital, controlling for cash flow and output. The specification is parsimonious in order to focus on fundamental hypotheses about cost and demand factors.[21] The following annual time series equation is estimated by industry and asset for the period 1955 to 1989:

$$(2) \quad I_{ij}K_{ij} = a + b1 * c_{ij} + b2 * CF_i/K_i + b3 * O_i/K_i$$

where i refers to the industry, j refers to the asset, and the variables are defined as follows:

- I gross investment (in constant dollars)
- K beginning-of-period net capital stock (in constant dollars)
- c cost of capital
- CF cash flow (in constant dollars), lagged one period
- O output (in constant dollars).

The expected sign for b1 is negative. If cash flow is a significant constraint on investment, or if it indicates expected returns to investing, then b2 would be positive. If output influences investment, then b3 would be positive. Because the model is relatively simple and omits lagged values of the explanatory variables, the errors are likely to be serially correlated. Accordingly, the equations are estimated assuming a first-order autoregressive process in order to capture adjustment lags.

The equations for each industry are estimated as a system, using the Zellner "seemingly unrelated regressions" procedure. Under this method, information about the contemporaneous correlations between the error for one asset demand equation and the error for each of the other asset demand equations is used in determining the coefficients. In effect, this procedure uses information on capital costs for all assets used by the industry to estimate each equation.

Regression Results

For six industries, the results indicate that increases in the cost of capital discourage investment. These are agriculture, mining, construction, durables manufacturing, nondurables manufacturing, and finance and insurance. (Table 4 shows regression results for these six industries for all assets that accounted for over 3 percent of industry investment during the 1985–89 period.[22] Data for the dependent variable (I/K) are summarized in Appendix Table 2. The results for the remaining industries are presented in Appendix Table 4; neither the cost of capital nor the other variables accounted for the investment behavior of these industries.)

Section III had noted that changes in capital goods and output prices seemed to account for some recent shifts in investment patterns; these factors are often excluded from studies focusing on tax policy. The following exercise confirms their importance. Capital costs were recomputed using aggregate price deflators for equipment and structures in place of pk and the implicit GNP price deflator in place of po. With these changes, the cost of capital is a significant factor only for three construction assets and one asset in each manufacturing industry—and no assets in agriculture, mining, and finance and insurance.

The findings for cash flow and output vary across industries.[23] Cash flow has mattered in agriculture (which was expected given the importance of small firms), but output has not. As discussed in section III, measures of cash flow are unavailable for mining and finance and insurance. Output is highly significant in mining—where it is very variable—but not in finance and insurance. For the remaining industries—construction, durables manufacturing, and nondurables manufacturing, the evidence indicates some significance for both cash flow and out-

[21] For simplicity, this study does not consider non-capital inputs and environmental regulations that may affect the demand for capital (Jorgenson and Wilcoxen 1989; Shapiro 1986; Tannenwald 1981).

[22] Equations for the remaining assets were included in the estimation procedure (if investment was generally above $100 million).

[23] A separate set of regressions investigated cash flow gross of dividends (see footnote 20). These results were similar to those using the original measure, and are not reported separately.

Table 4
Regression Results

Industry Asset	Constant	Cost of Capital	Cash Flow	Output	Autoregressive Parameter	Adjusted $\bar{R}^2$	Memo: Share of Industry Investment, 1985–89
Agriculture							
TRNEQ	.147	.086	.510***	−.178	.812***	.559	.07
OTHEQ	.217***	−.704***	.153*	.094	.603***	.849	.71
FRMST	.054	−.232**	.078*	−.049	.964***	.899	.16
Mining							
OTHEQ	−.097	−.161**		.545***	.695***	.886	.11
MINST	−.002	−.535***		.313***	.915***	.817	.83
Construction							
INFEQ	−.380	−.389*	2.585*	.097	.529***	.107	.09
INDEQ	.012	−.157	.421**	.015	.213*	.104	.12
TRNEQ	.055	−.316***	.137	.062***	.352***	.461	.13
OTHEQ	.144**	−.797***	.229	.053***	.387**	.619	.55
COMST	.052	−.552***	−.190	.050***	.509***	.710	.12
Durables Manufacturing							
INFEQ	.250***	−.373***	1.123***		.701***	.537	.28
INDEQ	.063***	−.139*	.438***		.480***	.789	.51
TRNEQ	.237***	−.296***	.264			.330	.04
INDST	.011	−.220	.555***		.686***	.780	.15
INFEQ	.406***	−.323***		.022	.525***	.434	.28
INDEQ	.007	−.152*		.112***	.601***	.733	.51
TRNEQ	.050	−.359***		.209***	.320**	.584	.04
INDST	−.038	−.251*		.125***	.615***	.661	.15
Nondurables Manufacturing							
INFEQ	1.014***	−.435**	.545	−.763***	.787***	.502	.18
INDEQ	−.080	−.068	.248***	.152***	.880***	.722	.59
TRNEQ	.242**	−.511***	−.210	.166**	.166**	.477	.04
INDST	−.108	.014	.294***	.121*	.835***	.694	.16
Finance and Insurance							
INFEQ	.578***	−.220***		.005	.651***	.761	.65
INDEQ	.262***	−.937**		.055*	.506***	.442	.04
TRNEQ	.139***	−.517***		.134***	.327***	.671	.09
OTHEQ	.454***	−1.087***		.003	.661***	.430	.10
COMST	.076*	.048		.019	.833***	.717	.12

*Significant at the .10 level. **Significant at the .05 level. ***Significant at the .01 level.

Note: Period of estimation = 1955 to 1989. INFEQ = information processing and related equipment. INDEQ = industrial equipment. TRNEQ = transportation and related equipment. OTHEQ = other producers durable equipment. INDST = industrial structures. COMST = commercial structures. FRMST = farm structures. MINST = mining exploration, shafts and wells.

put. (In durables manufacturing, the correlation between cash flow and output is very high, so separate equations were estimated with these variables.)

Regression Fit since the 1986 Tax Reform Act

Table 5 indicates how these equations fit the data in the period since the 1986 tax reform. To present the results more concisely, equipment and structures are aggregated for each industry. On the whole, actual values for the investment-to-capital ratio are somewhat lower than the fitted values, as in the Auerbach-Hassett (1991a) study. Thus, the economic conditions for investment were less favorable than accounted for in the model during this period. However, in contrast to most studies that find structures investment rela-

Table 5
Actual versus Fitted Investment Data, 1987–89 Average

Industry Asset	Investment-to-Capital Ratio		Fraction of Investment in Equipment	
	Actual	Fitted	Actual	Fitted
Agriculture				
Equipment	.125	.131	.811	.805
Structures	.025	.027		
Mining				
Equipment	.083	.099	.151	.151
Structures	.076	.093		
Construction				
Equipment	.182	.234	.881	.848
Structures	.041	.071		
Durables Manufacturing				
Equipment	.153	.165 (.173)	.806	.819 (.807)
Structures	.062	.063 (.070)		
Nondurables Manufacturing				
Equipment	.132	.127	.831	.826
Structures	.055	.056		
Finance and Insurance				
Equipment	.386	.410	.899	.907
Structures	.135	.131		

Note: The two entries for durables manufacturing represent the results of the specifications using cash flow and output, respectively.
Source: Regressions summarized in Table 4. Calculations use actual capital stocks for investment weights.

tively difficult to explain, the fitted values for structures are as accurate as those for equipment. Therefore, even though the estimated levels for both equipment and structures are too high, the shares of equipment and structures in total investment are estimated quite precisely.

V. Conclusions

As a fraction of total investment, information processing equipment has risen tremendously since the early 1970s. This category, which includes computers, now accounts for about one-third of total real nonresidential investment. Despite the perception that investment in commercial structures (such as office buildings and stores) grew rapidly during the 1980s, their share of total business investment was similar to what it had been in most earlier periods. However, their perceived importance can be explained by their unusually low share of total investment in the late 1970s, as well as the fact that they now account for about one-third of structures investment. Most other assets have declined as a share of business capital spending over the past decade. Industrial plant and equipment decreased markedly.

The declining price of information processing equipment has caused the cost of investing in this asset to fall. This dramatic price decrease since about 1970, reflective of enormous technological advances, swamps the variations observed in financial costs or taxes. Thus, all industries have had an incentive to increase the intensity with which they use information processing equipment. This result extends the findings of Bosworth (1985) for the early 1980s.

In addition, industrial composition has mattered in the 1980s. Shifts in industry demand—most notably higher investment by finance and insurance—boosted purchases of information processing and commercial structures. With the exception of a pronounced swing in mining, however, changes in the industrial composition of national output were minor and cannot explain the investment trends by industry. Instead, investment became relatively more affordable for some industries, and less affordable for others. The service-producing sectors—such as finance and insurance, trade, and services—enjoyed above-average increases in the price of their output during the 1980s, which lowered their real cost of acquiring capital goods. By contrast, mining and manufacturing output prices were weak, making capital goods purchases effectively expensive, thereby lowering demand for industrial plant and equipment. Durable goods manufacturing, agriculture, and construction were also hurt by lowered cash flows in the early 1980s, as a result of low profits. Cyclical swings in output have also affected investment demand by manufacturers and construction firms.

Tax policy, combined with the effects of inflation and interest rates, was responsible for greater changes in the relative costs of equipment and structures during the 1960s and 1970s than in the 1980s. In the 1960s and early 1970s, the introduction of the investment tax credit and the interaction of unindexed depreciation rules with higher interest rates increasingly favored equipment over structures. As noted in previous studies, tax law changes in the 1980s did have differential effects on equipment and

structure costs. However, these law changes did not tilt incentives to purchase one type of asset over another as much as had occurred in earlier periods.[24]

Econometric evidence confirms that historical variations in capital costs have affected business investment. Although they are often ignored, shifts in capital goods and industry output prices have been important elements in this link.

Appendix

Investment and Capital

The data for investment and capital stocks in constant 1982 dollars were obtained in machine-readable form from the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. They are consistent with more aggregated information in the National Income and Product Accounts (NIPA) except that the BEA data record investment in the year that a structure is completed rather than as it is being constructed. In general, the numerical differences between the two series tend to be quite small.

The disaggregated data have two notable drawbacks for this study. First, investment is recorded in the industry owning the asset rather than the industry using the asset. Therefore leased assets are attributed to the industry of the lessor. Systematic information about the extent of leasing could not be obtained. Second, investment is measured as purchases of new and used assets less sales of used assets. No separate information was available on gross purchases and gross sales.

The BEA data were for 61 industries and 50 nonresidential assets, and they were aggregated to the 10-industry and 11-asset specification used for this study. One of the BEA industries, real estate, has a large component of investment by nonprofit businesses. Because the nonprofit sector faces different costs and incentives than the for-profit sector, this component of investment and capital was deleted from the real estate industry here (in effect forming an eleventh industry, nonprofit real estate) using unpublished estimates of investment shares from the U.S. Treasury Department. Investment by industry and asset is presented in Appendix Table 1.

Following the Auerbach-Hassett studies, the dependent variable in the regressions was defined as gross investment (that is, including investment for replacement purposes) divided by the net capital stock at the beginning of the period. Appendix Table 2 indicates these investment-to-capital ratios for five-year periods for each of the 59 industry-asset combinations. (Of the 64 combinations shown in Appendix Table 1, five categories where investment is usually less than $100 million were omitted.) All else equal, the investment-to-capital ratio will be higher for short-lived assets than for long-lived assets because short-lived assets must be replaced more frequently. However, the investment-to-capital ratios for each asset may be compared to their own history and to those for similar assets in other industries.

Prices

The capital goods price index was derived by dividing investment in current dollars by investment in constant 1982 dollars from the BEA data. In general, this price index equals one in 1982. (However, the price deflator for transportation equipment is greater than one in 1982 because of the treatment of used automobiles. In addition, the deflator for electric light and power buildings equals one in 1983, not 1982, because the investment is measured when the asset is put in service, rather than with the NIPA convention of when it is put in place.)

The price of a given asset may vary across industries in this study because each asset consists of an industry-specific aggregation of the more detailed BEA asset categories. The greatest variation arises for information processing and related equipment; for most industries, this series is dominated in recent years by the falling price of computers; but for the transportation, communication, and utilities industry, the price of communication equipment is a large component.

The price of output is taken from output price deflators by industry published by BEA (Mohr 1991).

The price deflators for aggregated equipment and structures, and for GNP, are taken from the NIPA, as published in the 1991 *Economic Report of the President.*

Cost of Funds

Economists have taken a variety of approaches to measuring the cost of funds. A typical method is to use a weighted average of the cost of debt and equity. The cost of debt is relatively straightforward because bond yields are observable, but the cost of equity is more elusive. One measure is the inverse of the price-earnings ratio. However, stock prices are probably too volatile a measure for the vast majority of companies that do not issue new shares. An alternative approach is to use the dividend yield, or the dividend yield plus an expected capital gain. Another issue is the appropriate weight for debt and equity costs. Most analysts use existing debt-equity ratios, even though the financing of marginal investments may be quite different. They also attempt to adjust book figures to reflect market values. For the current study, which requires time series data by industry, it would be difficult to obtain the required information on stock prices, bond yields, and debt-equity ratios to implement these methods.

Because of these difficulties (and the uncertain payoffs to a more sophisticated method), this study adopts an

[24] One important caveat regarding these results is that they do not take into account the specific effects of tax shelter opportunities. This is a topic deserving of further research.

approach that provides a single rate in each time period for all assets and industries. The variable r (in equation 1) is taken from an econometric model developed at the Federal Reserve Board, and equals a variable-weighted average of a real after-tax corporate bond rate and a dividend-price ratio. The weights reflect the estimated financing of marginal investments in order to move toward a target leverage ratio determined by the current differential between debt and equity costs. For a further description and comparison with other measures of the cost of funds, see Bosworth (1985).

Economic Depreciation

The economic depreciation rates were aggregated from the estimates for 51 assets provided in table 13B of Jorgenson-Yun (1989) using investment weights for each of the industry-asset combinations. The data from Jorgenson and Yun do not vary over time, but in the data set for this study the investment weights change over time. For example, within information processing equipment, computers (with an economic depreciation rate of 0.2729) rise relative to the other assets, whose depreciation rates are lower. Thus, all else equal, investment in information processing equipment requires a greater threshold rate of return. However, the available information does not provide a faster rate of obsolescence for computers over time—as might in fact be expected during periods of rapid technological advance.

Investment Incentives

To estimate the rate of investment tax credit, this study began with information on the statutory investment tax credit rate. For years during which the rate was changed, the statutory rate was set equal to the fraction of months for which the credit was applicable. The investment tax credit was initiated at a 7 percent rate in 1962, repealed in 1966, reinstated in 1967, repealed in 1969, reinstated in 1971, and increased to 10 percent in 1975. The Tax Reform Act of 1986 rescinded the investment tax credit retroactively to the beginning of 1986.

Some assets received the full credit, while others (primarily shorter-lived equipment) were eligible only for a partial credit, and most structures other than public utility property were not eligible for a credit at all. Using Table 5.2 in Fullerton, Gillette, and Mackie (1987), the eligibility was estimated for each of the 50 BEA asset categories and these fractions applied, in order to derive an effective rate of investment tax credit for each year. Investment weights were used to derive a rate for each of the industry-asset combinations. However, a zero weight was assigned to those industry-asset categories where investment was negative (because sales of used assets were greater than purchases of assets).

The calculation of the value of depreciation allowances took account of five tax regimes: 1954–61, 1962–70, 1971–80, 1981–86, and 1987–89. In each period, a variety of sources were consulted to determine the most accelerated method commonly available for each of the BEA industry-asset combinations. The main sources were Jorgenson and Sullivan (1981), Pechman (1987), and U.S. Joint Committee on Taxation (1987). (As a consequence, some of the results differ from studies such as that of Jorgenson and Yun, which attempts to use information on the fraction of investment depreciated under the most accelerated method possible. However, this study's calculations attempt to make use of information on how tax lifetimes for similar assets may vary across industries, which other studies have typically ignored.)

The stream of allowances was discounted at the Moody's Baa corporate bond rate times the quantity one minus the statutory corporate tax rate for the year in which the investment was made. The resulting present discounted values of allowances were then aggregated to the desired industry-asset combinations using the same investment weights as for the investment tax credit.

Finally, in 1962–63, the law specified that the basis for depreciation allowances had to be decreased by the investment tax credit rate, and in 1982–85 by half the investment tax credit rate. Accordingly, the computed values for z were multiplied by $(1 - k)$ and $(1 - .5k)$, respectively, during these two periods.

The simplest specifications for depreciation allowances applied during the 1981–86 period as a result of the Economic Recovery Tax Act. All assets were divided into five categories. Equipment was depreciated over three or five years and public utility property over 10 or 15 years, according to schedules published in the law. Structures (termed "real property") was depreciated over 15 years (19 years starting in 1984) using the 175 percent of declining balance method, switching to straight line.

For all the other periods, depreciation policy was considerably more complicated because of a multiplicity of rules. Generally, depreciation schedules (such as double declining balance, 150 percent of declining balance, and straight line) differed between equipment and structures. However, the greater complication arose from tax lives. The laws specified some tax life guidelines applicable to general-purpose assets (such as trucks), other guidelines applicable to assets used in a particular industry, and some default guidelines by industry. These guidelines were revised periodically by the Internal Revenue Service. The IRS publications included numerous categories of assets—for example, the 1962 guidelines included over 150 industries, some of which had guidelines for over 100 types of assets. Alternatively, taxpayers could use lives based on their own experience if they could provide sufficient documentation.

This study relied on unpublished U.S. Treasury Department estimates of tax lives for the 61 industries and 50 assets for the Asset Depreciation Range (ADR) system that applied prior to the introduction of the Accelerated Cost Recovery System. For the 1972–80 period, it was assumed that companies used lifetimes equal to 80 percent of ADR midpoints, the most accelerated method allowed. For the 1962–71 period, it was assumed that they used ADR midpoint lives. Because the Tax Reform Act of 1986 assigned assets to categories based on their ADR midpoints, these rules could be applied in assigning lives for the 1987–89 period. For the 1954–61 period, no comparable information was available. Instead, this study used the estimated Bulletin F lifetimes for 34 assets by Jorgenson and Sullivan (1981), and extrapolated these to the remaining assets. Thus, for this period, the estimates of z vary by asset but not by industry.

Cost of Capital

The resulting cost of capital described in equation 1 is summarized in Appendix Table 3.

Cash Flow

Cash flow for each industry is measured as the sum of undistributed corporate profits plus corporate capital consumption allowances, deflated by the GNP implicit price deflator. Profits and capital consumption allowances are taken from the NIPA. Cash flow is then expressed as a rate relative to the value of the corporate capital stock in the industry. The corporate capital stock was obtained by multiplying the total capital stock from the BEA tape by the industry ratios of corporate to noncorporate capital stocks from unpublished BEA data. For the alternative gross cash flow measure, after-tax profits (also from the NIPA) replace profits net of taxes and dividends.

Output

Output is measured as the gross domestic product by industry in 1982 dollars from the BEA. In the regressions, it is expressed as a rate relative to the capital stock from the BEA tape.

Regression Results for Other Industries

For four industries, the regression results did not point to any consistent economic effects. These findings are summarized in Appendix Table 4. The cost of capital did not have a significant, negative effect on investment. For three of these industries, cash flow and output were very highly correlated (the correlation coefficients exceeded 0.85), preventing an assessment of their individual effects. In these cases, cash flow and output were entered in separate regressions.

For transportation, communication, and utilities, the lack of robust findings may be due to several factors. Regulators may require the industry to purchase a mix of assets different from what would be purchased in the absence of regulation. Also, the existence of nonprofit cooperatives may blunt the effects of tax incentives. According to unpublished U.S. Treasury Department estimates, between 13 and 20 percent of electric power investment in the 1980s was done by cooperatives. Finally, as explained above, in the data set used here, investment is recorded when it is completed. Given the long lags in the construction of power plants, the tax parameters used in this study may not appropriately reflect conditions at the start of the project. One commentator for the Auerbach-Hassett (1991a) study indicated that public utilities often feel the effect of new tax laws only with a delay because of pre-existing binding contracts specifying prior law.

For trade, the poor results may arise because the study does not consider inventories, which form a large component of investment spending for this industry and help to determine the demand for warehouses, retail space, shelving, and other types of capital. The increased use of computers to some extent probably reflects innovations in inventory management. Also, as noted above, the data refer to the industries that own the assets. The lack of information on leased retail and wholesale space may be a problem.

For nonresidential real estate, the regressions indicate a negative effect from the cost of capital for equipment categories, but not for structures, which account for the bulk of purchases. Problems in these estimates probably result from poor estimates of the capital stock due to nonprofit organizations. In recent years, about one-third of investment in real estate was due to nonprofits, and in the absence of other information this percentage was also applied to the capital stock. Finally, business decisions to lease or own their structures could have affected the estimates.

Finally, the services industry has undergone a transformation over the last several decades that has probably influenced the types of capital goods purchased. Business services and health services grew from about one-quarter of the industry capital stock in 1955 to about one-half in 1989. Disaggregation of services may be necessary to detect a relationship between demand for particular capital goods and their costs.

Appendix Table 1

Average Annual Investment by Industry and Asset

Millions of 1982 Dollars

Industry / Asset	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89
Agriculture							
INFEQ	1	1	2	6	11	26	53
INDEQ	520	444	347	322	247	139	149
TRNEQ	1789	1891	2505	2300	2802	1296	737
OTHEQ	6824	7021	10273	14010	16190	11540	7762
INSST	23	17	16	17	21	23	63
FRMST	2975	3405	4001	4906	6894	4137	1755
OTHST	88	114	158	207	190	193	360
Mining							
INFEQ	17	24	14	46	68	77	28
INDEQ	344	623	743	562	993	553	131
TRNEQ	172	309	517	654	818	442	371
OTHEQ	3152	3025	4445	5607	8685	7172	2789
INDST	1318	1659	1908	706	712	1057	507
COMST	108	191	115	236	413	1030	423
MINST	16360	14924	14377	13941	23591	38686	20820
OTHST	39	191	288	295	220	102	59
Construction							
INFEQ	38	53	56	49	157	393	571
INDEQ	358	448	601	861	1097	812	752
TRNEQ	725	1162	1216	1695	1316	686	827
OTHEQ	4121	3938	5323	6138	6359	3844	3532
COMST	148	446	843	1513	1739	982	771
Durables Manufacturing							
INFEQ	571	612	858	1173	3210	7982	13136
INDEQ	11827	11625	20629	21495	24770	24720	23811
TRNEQ	715	782	1323	1581	2410	1670	1897
OTHEQ	363	372	603	591	550	681	518
INDST	4824	4900	10121	6699	7190	7608	7301
COMST	656	950	494	857	553	642	459
Nondurables Manufacturing							
INFEQ	427	553	793	1561	3994	5411	6096
INDEQ	9244	10652	16343	17877	21120	19991	20212
TRNEQ	460	582	870	1117	1738	1322	1520
OTHEQ	539	545	797	725	714	668	405
INDST	4032	4496	8804	6611	6615	6599	5612
COMST	523	843	424	885	662	646	419
OTHST	12	33	30	96	98	13	5
Transportation, Communication, and Utilities							
INFEQ	2857	5366	8469	12164	18078	26158	31868
INDEQ	6417	6095	7167	10648	8505	8907	11313
TRNEQ	9029	10039	17078	18598	21350	18613	17712
OTHEQ	398	499	584	507	747	964	1059
COMST	744	699	869	1202	842	781	869
INSST	169	316	349	326	373	424	441
UTLST	17702	16389	23476	30420	29177	28079	27131
OTHST	322	387	525	614	469	270	534
Wholesale and Retail Trade							
INFEQ	176	258	516	1137	2814	8093	19101
INDEQ	889	1048	1537	1448	1325	1773	2651
TRNEQ	1533	2230	4492	6796	6962	6404	11900
OTHEQ	3894	4917	6800	7722	10275	13367	19686
COMST	4800	6355	9030	11201	11160	14278	18591

Appendix Table 1 continued

Average Annual Investment by Industry and Asset

Millions of 1982 Dollars

Industry / Asset	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89
Finance and Insurance							
INFEQ	323	318	356	834	2316	9361	46615
INDEQ	109	122	398	958	1549	1969	2783
TRNEQ	265	382	1571	2068	3308	3201	6267
OTHEQ	276	303	667	2083	3302	4004	7491
COMST	2171	2998	3734	3407	2435	3432	8802
Nonresidential Real Estate							
INFEQ	1350	1413	1978	2614	3532	5371	6276
TRNEQ	179	158	469	707	866	692	890
OTHEQ	2045	1954	3133	3621	4975	5109	4288
COMST	2313	2847	4823	6744	4172	12950	14672
INSST	2446	4459	5530	7351	4972	5383	5679
OTHST	132	308	558	884	728	833	890
Services							
INFEQ	973	1320	2022	3543	4178	9469	18601
INDEQ	1100	954	1459	1928	1760	2337	3600
TRNEQ	1671	2200	5166	5951	7173	8268	13638
OTHEQ	2695	3180	4621	6679	8501	10744	13492
COMST	2146	2856	3302	4077	3105	2681	3406
INSST	1806	3651	3441	3812	2510	5485	7070
OTHST	53	28	88	83	47	20	38

Note: INFEQ = information processing and related equipment. INDEQ = industrial equipment. TRNEQ = transportation and related equipment. OTHEQ = other producers durable equipment. INDST = industrial structures. COMST = commercial structures. INSST = institutional and other buildings. FRMST = farm structures. UTLST = public utility structures. MINST = mining exploration, shafts and wells. OTHST = other nonresidential structures.

Source: U.S. Bureau of Economic Analysis. See text of Appendix for description.

Appendix Table 2

Investment to Capital Ratios (I/K) by Industry and Asset

Industry Asset	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89
Agriculture							
INDEQ	.139	.115	.096	.104	.101	.069	.101
TRNEQ	.164	.184	.205	.171	.199	.094	.088
OTHEQ	.159	.169	.214	.229	.195	.127	.114
FRMST	.071	.072	.074	.078	.091	.047	.021
OTHST	.090	.097	.103	.100	.073	.065	.100
Mining							
INDEQ	.200	.195	.145	.090	.140	.064	.022
TRNEQ	.146	.203	.219	.197	.180	.087	.081
OTHEQ	.204	.193	.235	.238	.263	.163	.093
INDST	.123	.115	.100	.034	.041	.063	.032
COMST	.155	.168	.075	.129	.153	.207	.054
MINST	.165	.128	.120	.122	.189	.224	.104
OTHST	.063	.233	.175	.106	.062	.028	.017
Construction							
INFEQ	.345	.290	.236	.215	.571	.366	.292
INDEQ	.144	.146	.158	.171	.160	.094	.100
TRNEQ	.193	.266	.212	.250	.177	.106	.179
OTHEQ	.235	.232	.256	.250	.226	.137	.195
COMST	.111	.213	.195	.180	.121	.053	.041
Durables Manufacturing							
INFEQ	.251	.228	.254	.262	.373	.374	.307
INDEQ	.131	.112	.161	.128	.124	.105	.099
TRNEQ	.158	.169	.214	.191	.215	.127	.145
OTHEQ	.180	.159	.205	.160	.141	.158	.120
INDST	.113	.091	.142	.072	.072	.070	.065
COMST	.120	.122	.052	.083	.047	.056	.040
Nondurables Manufacturing							
INFEQ	.190	.239	.253	.342	.370	.266	.235
INDEQ	.118	.128	.163	.142	.140	.115	.113
TRNEQ	.129	.170	.191	.183	.202	.127	.131
OTHEQ	.163	.188	.221	.168	.163	.149	.108
INDST	.084	.084	.131	.076	.071	.066	.057
COMST	.083	.109	.048	.092	.059	.056	.036
Transportation, Communication and Utilities							
INFEQ	.208	.245	.226	.205	.208	.198	.176
INDEQ	.146	.102	.102	.122	.080	.079	.092
TRNEQ	.105	.109	.156	.137	.138	.107	.108
OTHEQ	.196	.200	.184	.157	.218	.203	.192
COMST	.076	.064	.074	.087	.053	.049	.054
INSTT	.107	.137	.106	.080	.080	.079	.075
UTLST	.058	.051	.069	.078	.066	.059	.054
OTHST	.075	.079	.090	.083	.055	.031	.063
Wholesale and Retail Trade							
INFEQ	.311	.350	.405	.432	.413	.459	.390
INDEQ	.146	.149	.171	.130	.116	.149	.174
TRNEQ	.175	.241	.306	.275	.208	.175	.236
OTHEQ	.185	.198	.215	.224	.204	.222	.225
COMST	.122	.117	.118	.106	.083	.088	.092

Appendix Table 2 continued

Investment to Capital Ratios (I/K) by Industry and Asset

Industry / Asset	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89
Finance and Insurance							
INFEQ	.364	.245	.268	.434	.455	.563	.590
INDEQ	.207	.154	.294	.285	.219	.166	.170
TRNEQ	.115	.147	.303	.179	.172	.116	.168
OTHEQ	.219	.181	.275	.376	.255	.217	.277
COMST	.140	.130	.112	.079	.051	.070	.140
Nonresidential Real Estate							
INFEQ	.224	.179	.214	.216	.232	.236	.205
TRNEQ	.180	.173	.329	.228	.171	.109	.111
OTHEQ	.267	.205	.265	.229	.253	.196	.169
COMST	.159	.129	.145	.130	.064	.147	.110
INSST	.091	.121	.103	.099	.053	.053	.052
OTHST	.081	.150	.165	.150	.084	.077	.104
Services							
INFEQ	.269	.244	.258	.285	.231	.338	.330
INDEQ	.256	.153	.189	.176	.130	.158	.184
TRNEQ	.192	.191	.280	.187	.176	.168	.201
OTHEQ	.252	.213	.234	.244	.228	.222	.219
COMST	.154	.130	.105	.978	.061	.051	.063
INSST	.117	.162	.102	.090	.053	.104	.103

Note: INFEQ = information processing and related equipment. INDEQ = industrial equipment. TRNEQ = transportation and related equipment. OTHEQ = other producers durable equipment. INDST = industrial structures. COMST = commercial structures. INSST = institutional and other buildings. FRMST = farm structures. UTLST = public utility structures. MINST = mining exploration, shafts and wells. OTHST = other nonresidential structures.

Source: U.S. Bureau of Economic Analysis. See text of Appendix for description.

Appendix Table 3

Average Annual Cost of Capital by Industry and Asset

Industry Asset	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89
Agriculture							
INDEQ	.170	.152	.136	.116	.099	.155	.217
TRNEQ	.420	.365	.270	.216	.189	.278	.371
OTHEQ	.191	.169	.145	.122	.108	.173	.233
FRMST	.112	.084	.076	.073	.059	.095	.117
OTHST	.106	.085	.079	.075	.065	.107	.131
Mining							
INDEQ	.427	.396	.386	.386	.254	.193	.334
TRNEQ	1.145	.991	.937	.870	.493	.433	.902
OTHEQ	.365	.378	.433	.406	.266	.215	.374
INDST	.267	.227	.261	.282	.156	.135	.233
COMST	.446	.299	.360	.292	.158	.131	.236
MINST	.149	.128	.134	.137	.098	.093	.142
OTHST	.226	.208	.241	.252	.147	.122	.206
Construction							
INFEQ	1.481	1.538	1.271	.836	.397	.216	.184
INDEQ	.397	.345	.250	.168	.138	.167	.174
TRNEQ	.889	.766	.526	.345	.291	.354	.350
OTHEQ	.369	.362	.280	.204	.174	.212	.223
COMST	.344	.221	.168	.119	.090	.114	.117
Durables Manufacturing							
INFEQ	.562	.496	.632	.589	.329	.267	.200
INDEQ	.151	.128	.125	.127	.121	.161	.222
TRNEQ	.444	.379	.317	.303	.289	.388	.500
OTHEQ	.187	.149	.140	.147	.136	.176	.244
INDST	.100	.078	.084	.098	.090	.127	.167
COMST	.094	.071	.075	.086	.079	.115	.150
Nondurables Manufacturing							
INFEQ	.384	.366	.417	.361	.234	.241	.196
INDEQ	.118	.107	.104	.112	.114	.155	.185
TRNEQ	.409	.357	.306	.316	.313	.410	.444
OTHEQ	.186	.162	.150	.161	.148	.186	.213
INDST	.085	.069	.070	.086	.081	.123	.134
COMST	.080	.064	.067	.082	.077	.113	.125
Transportation, Communication, and Utilities							
INFEQ	.288	.231	.221	.228	.179	.175	.206
INDEQ	.152	.130	.125	.120	.116	.137	.164
TRNEQ	.220	.202	.184	.200	.200	.253	.309
OTHEQ	.216	.184	.169	.181	.170	.205	.237
COMST	.099	.075	.080	.091	.080	.112	.124
INSST	.116	.091	.096	.112	.100	.129	.148
UTLST	.097	.074	.074	.087	.083	.106	.114
OTHST	.094	.074	.080	.093	.087	.112	.116
Wholesale and Retail Trade							
INFEQ	.790	.820	.833	.579	.304	.265	.177
INDEQ	.178	.150	.132	.132	.112	.150	.185
TRNEQ	.457	.382	.302	.274	.271	.353	.384
OTHEQ	.265	.216	.192	.185	.153	.197	.234
COMST	.106	.075	.068	.075	.061	.105	.120

Appendix Table 3 continued

Average Annual Cost of Capital by Industry and Asset

Industry / Asset	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89
Finance and Insurance							
INFEQ	.955	.999	1.418	1.045	.479	.288	.110
INDEQ	.219	.162	.123	.118	.108	.138	.128
TRNEQ	.729	.557	.232	.215	.217	.259	.227
OTHEQ	.246	.191	.156	.158	.156	.192	.184
COMST	.128	.090	.081	.087	.075	.106	.100
Nonresidential Real Estate							
INFEQ	.274	.251	.257	.241	.191	.192	.180
TRNEQ	.418	.395	.442	.418	.443	.512	.441
OTHEQ	.247	.211	.192	.187	.171	.204	.201
COMST	.099	.076	.077	.088	.081	.109	.109
INSST	.104	.080	.080	.089	.083	.111	.109
OTHST	.092	.073	.077	.087	.086	.110	.101
Services							
INFEQ	.546	.469	.469	.358	.254	.228	.165
INDEQ	.255	.204	.169	.155	.142	.168	.163
TRNEQ	.555	.424	.334	.296	.287	.306	.280
OTHEQ	.336	.266	.218	.198	.174	.202	.194
COMST	.142	.101	.094	.097	.084	.111	.107
INSST	.147	.104	.096	.098	.087	.113	.110

Note: INFEQ = information processing and related equipment. INDEQ = industrial equipment. TRNEQ = transportation and related equipment. OTHEQ = other producers durable equipment. INDST = industrial structures. COMST = commercial structures. INSST = institutional and other buildings. FRMST = farm structures. UTLST = public utility structures. MINST = mining exploration, shafts, and wells. OTHST = other nonresidential structures.

Source: See Appendix text.

Appendix Table 4
Additional Regression Results

Industry Asset	Constant	Cost of Capital	Cash Flow	Output	Autoregressive Parameter	Adjusted $\bar{R}^2$	Memo: Share of Industry Investment, 1985–89
Transportation, Communication, and Utilities							
INFEQ	.108*	−.011	1.649*		.826***	.356	.35
INDEQ	.035	−.095	1.179**		.762***	.634	.12
TRNEQ	.081***	−.337***	2.108***		.216*	.528	.19
UTLST	.023	−.036	.677***		.848***	.740	.30
INFEQ	.391***	−.162		−.469**	.551***	.332	.35
INDEQ	.158***	.016		−.201	.651***	.663	.12
TRNEQ	.078***	−.388***		.426***	.251**	.602	.19
UTLST	.062**	−.019		−.001	.844***	.698	.30
Wholesale and Retail Trade							
INFEQ	.440***	−.089	−.010		.536***	.145	.27
INDEQ	.150***	.352	−.233*		.476***	.204	.04
TRNEQ	.323***	−.187	−.123		.477***	.316	.16
OTHEQ	.226***	.040	−.062		.654***	.361	.27
COMST	.058***	.121	.136***		.515***	.561	.26
INFEQ	.351***	−.051		.031	.552***	.132	.27
INDEQ	.063	.421*		.010	.474***	.148	.04
TRNEQ	.188*	−.238		.055	.500***	.338	.16
OTHEQ	.209***	.065		−.001	.648***	.310	.27
COMST	.019	.134		.032***	.441***	.668	.26
Nonresidential Real Estate							
INFEQ	.244***	−.132	−.023		.324***	.105	.19
OTHEQ	.193***	−.056	.322***		.231**	.291	.13
COMST	.080	.188	.161		.628***	.293	.44
INSST	.020	.136	−.058		.982***	.870	.17
OTHST	.064	.192	.309**		.428***	.399	.04
INFEQ	.255***	−.387*		.029	.161	.002	.19
OTHEQ	.206***	−.834***		.113***	.192*	.269	.13
COMST	−.082	.735		.086**	.433***	.278	.44
INSST	−.040	.281*		.057**	.796***	.834	.17
OTHST	−.014	.243		.068	.548***	.409	.04
Services							
INFEQ	.346***	−.127	.262	−.028	.453***	.478	.31
INDEQ	.077	.236	.505	−.010	.398***	.335	.06
TRNEQ	-.084	−.588**	1.145**	.152**		.268	.23
OTHEQ	.213***	−.075	−.295	.035	.375***	.086	.23
COMST	.033	.199	.091	−.028	.965***	.920	.06
INSST	−.103	−.192	.060	.110***	.788***	.841	.12

*Significant at the .10 level. **Significant at the .05 level. ***Significant at the .01 level.

Note: Period of estimation = 1955 to 1989. INFEQ = information processing and related equipment. INDEQ = industrial equipment. TRNEQ = transportation and related equipment. OTHEQ = other producers durable equipment. INDST = industrial structures. COMST = commercial structures. INSST = institutional and other buildings. UTLST = public utility structure. OTHST = other nonresidential structures.

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