The Determinants of Business Investment: Has Capital Spending Been Surprisingly Low?

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The volume of capital spending by businesses has long been among the most closely watched elements of the national product accounts. During the past decade, this component of investment seems to have attracted even more attention than usual. In the 1980s, policymakers feared that inadequate investment threatened the future growth of living standards in the United States. Currently, policymakers worry that inadequate investment spending may be slowing the growth of aggregate demand, enervating the economic recovery.

This article compares the volume of aggregate investment spending during the 1980s and early 1990s to projections of spending derived from conventional models that describe investment during the 1960s and 1970s. This comparison, of course, constitutes a test of these conventional models. But, more important, these projections also are yardsticks for measuring the volume of capital spending since 1980. If investment has deviated from its customary course—because of changes in the composition of saving, changes in the leverage of businesses, a reduction in lending by commercial banks, or a recent shift of attention from the long term to a short-term view of business opportunities—then these models can help define the timing, magnitude, and perhaps the causes of investment's divergence.

The conventional models of investment represent the previous historical relationships between capital spending and measures of economic activity. To the degree the projections from these models coincide with the recent course of investment, any apparent deficiency of capital spending may be attributed to familiar causes. In this case, if capital spending is disappointingly low, either the cost of capital is too great or sales, rates of capacity utilization, and profits are uncommonly low. If, however, the models' projections exceed investment, capital spending may have languished for exceptional reasons.

According to this comparison of investment spending with the projections of the conventional models, capital spending has not been surprisingly low during the 1980s and early 1990s. In particular, the correspondence between investment and the cash flow of businesses suggests that aggregate capital spending has not been restrained by financial impediments in an exceptional manner.

Purchases of producers' durable equipment generally corresponded fairly well with the historical relationships incorporated in the models, whereas investment in nonresidential structures was surprisingly great, according to the models, during the late 1970s and early 1980s when the installation of oil rigs and the construction of commercial buildings increased significantly. Although the surge in construction spending has been attributed to changes in the tax laws during the 1980s, the model that best represents the details of these codes anticipated a decline in this component of investment at the time when it first increased significantly.

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The disappointing volume of capital spending by businesses during the early 1990s appears to be a symptom of the slow rate of growth of economic activity in recent years rather than the consequence of exceptional impediments to investment spending. Had the annual rate of growth of real business output since the end of 1988 averaged 2.5 percent rather than 0.5 percent, for example, the current ratio of net investment spending by businesses to real GDP might have nearly doubled.

The first section of this article describes the magnitude and composition of investment in the United States and discusses some of the issues concerning the measurement of that investment. The second section describes the five models of investment spending examined in this article, explaining some of the distinctions among them. The third section describes the abilities of the models to fit the data in the 1960s and 1970s and to forecast the data since the 1970s. The concluding section evaluates potential strategies for fostering capital spending by businesses.

I. The Magnitude and Composition of Investment

The concept of investment comprises many different activities. Generally speaking, investment entails deferring the consumption of resources (or their fruits) in anticipation of enhancing opportunities for consumption in the future. Often the concept of investment is limited to capital formation undertaken by businesses—purchases of producers' durable goods and nonresidential construction spending—but this capital spending constitutes only a portion of national investment. Because the national accounts recognize housing as a productive asset, measures of investment also commonly include residential construction. Recognizing that capital investments undertaken by governments and government enterprises contribute to national output, some measures of investment encompass public capital expenditures (Munnell 1990).

Inasmuch as the national accounts do not measure all productive activity, the accounting for investment becomes more comprehensive when the concept of output is not limited to reported GDP (Nordhaus and Tobin 1972; Eisner 1985). This additional investment may include, for example, expenditures for research or the development of products, purchases of consumer durable goods, education expenditures, the cost of improving the environment, or expenditures for enforcing the law or defending the nation. According to Eisner's total income system of accounts, total gross domestic capital accumulation (which includes intangible investments) may account for approximately one-third of total income. With this more comprehensive accounting, total gross tangible investment may be approximately twice as great as the gross private domestic investment reported in the national accounts (Eisner 1985, Table B, p. 28).

Magnitude of Investment in the National Accounts

Together, gross private domestic investment, government capital spending, and expenditures for education account for about one-third of GDP (Table 1). The share of GDP devoted to this investment has increased approximately 1.5 percentage points since the 1960s. At the same time, the composition of investment has shifted toward consumers' durable goods and, to a lesser degree, toward the capital assets of businesses, away from government investment and residential construction. Currently, purchases of plant and equipment by businesses, repre-

Table 1
Components of Real Investment

As a Percent of Real GDP (1987 Dollars)	Years 61–65	66–70	71–75	76–80	81–85	86–90	91
Gross Domestic Investment	29.7	32.2	32.3	32.1	32.3	33.5	31.1
Business							
Plant and Equipment	9.0	10.2	10.3	10.9	11.6	11.2	10.6
Producer Durable Equipment	4.9	5.9	6.3	7.0	7.1	7.4	7.4
Structures	4.1	4.3	4.0	4.0	4.5	3.8	3.2
Inventory	.7	.9	.6	.6	.5	.4	−.2
Residential Construction	4.1	3.4	4.0	3.4	2.7	2.9	2.1
Consumer Durables	5.9	6.4	7.1	7.6	7.7	9.0	8.6
Government (Non-Education)[a]							
Fixed Non-Defense	3.1	3.0	2.4	2.0	1.9	2.0	2.0
Defense	1.9	1.6	0.8	0.7	1.0	1.2	.8
Inventories	−.1	.1	−.1	−.0	.3	−.0	−.1
Education[b]	5.2	6.6	7.2	6.9	6.7	6.8	7.2
Divided by Civilian Nongovernment Labor Force							
Business Stock of Equipment and Structures	28.9	34.5	37.9	39.4	41.8	43.8	
Divided by Population							
Stock of Total Government Nondefense Capital	8.8	10.3	10.9	10.8	10.6	10.8	
Stock of Residential Capital	16.4	18.1	19.5	20.7	21.6	23.1	
Stock of Consumer Durables	3.9	4.9	5.8	6.8	7.4	9.3	

[a]Does not include investment in educational structures, but investment in educational equipment is included.
[b]Investment in education consists of government and private expenditures on education. Government expenditures were deflated using the GDP deflator since only nominal data are released. Private expenditures include higher education, elementary and secondary schools, fees paid to commercial, business, trade, and correspondence schools, not elsewhere classified, and current expenditures by research organizations and foundations for education and research.
Source: Population and labor force statistics are found in "Current Business Statistics," published in the *Survey of Current Business*. All other data were taken from a data tape from the U.S. Bureau of Economic Analysis in 1987 dollars.

senting almost 40 percent of investment, account for just over one-tenth of GDP.

This comparison of gross investment spending to GDP can misrepresent trends in capital formation. For example, although the *gross* capital spending of businesses has increased since the 1960s, *net* business investment has declined relative to GDP. In the early 1960s, gross investment in equipment virtually equaled that in structures; by the late 1980s, gross investment in equipment had risen to almost twice that in structures. As the composition of the stock of business capital shifted toward equipment, which depreciates comparatively rapidly, and away from structures, which depreciate comparatively slowly, an increasing portion of gross investment represented the replacement of aging capital goods.

Another standard for judging the rate of capital formation compares the stock of capital assets to the number of people who might use that capital or benefit from its services.[1] From the early 1960s to the early 1970s, the stock of business capital increased 31 percent relative to the civilian nongovernment labor force, with two-thirds of this growth occurring in the mid 1960s. This 2.7 percent annual rate of growth of capital per potential laborer fell to approximately 1 percent per year after the early 1970s. The annual rate of growth changed little after the early 1970s even though the net investment of businesses subsided, because the slower growth of the stock of capital assets of businesses coincided with a slower rate of growth of the labor force. Since the late 1960s, the stock of consumer durable goods per capita has grown approximately 3 percent annually, the stock of residences per capita has grown just over 1 percent annually, and the stock of government (nondefense) capital goods per capita has increased about one-quarter of 1 percent annually.

[1] See Box I, "Measuring the Stock of Capital," for a discussion of the estimates of capital used in this article.

Box I: Measuring the Stock of Capital

All measurement of economic variables rests on some theory. As a variable becomes tailored more finely to the characteristics of a specific theory, it becomes more accurate and informative for those who accept that theory, at the risk of becoming less useful to adherents of other theories. The art of measurement, therefore, is to achieve a solid foundation without compromising too greatly a variable's general appeal. The tension between these objectives sometimes produces several different measures of an economic concept, each offering its special advantages (Triplett 1992).

The evidence in the data shapes our theories of economic behavior; yet the variables we choose to measure and the manner in which we measure them presume some theory.[2] Our views of our economic performance spring partly from our measures of the stock of capital and partly from our measures of the productivity of capital and other factors of production. These measures, in turn, depend on the theories that produce the data. (See, for example, Hulten 1992.)

Most of the models of investment presented in this article propose that investors, considering their opportunities for producing goods and services at a profit, conceive of an optimal amount of capital to employ. Investment, then, is the process by which investors alter their stocks of capital to attain this optimum. Therefore, measures of stocks of capital as well as the flow of new investment are essential elements of these models.

Unfortunately, combining disparate capital goods, differing in type, technology, or vintage, into a well-defined aggregate is possible only under implausible circumstances (Fisher 1969; M. Brown 1976; Burmeister 1976; Blackorby and Schworm 1988; Hulten 1991). Consequently, no measure of the stock of capital is theoretically superior to all alternatives; each poses its peculiar biases. This problem, by the way, is not unique to the stock of capital; estimates of investment, GDP, and other aggregates appearing in the national income and wealth accounts pose similar difficulties.

The U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics each publish a measure of capital (BEA 1987; BLS 1983; Oliner 1989). Both the BEA and the BLS begin with estimates of the quantity of capital for distinct types of capital goods. Over time, new investment increases these stocks, and the decay of seasoned capital goods diminishes these stocks. The BEA and BLS differ most in their techniques for combining these elemental stocks of capital into an aggregate stock. The BEA's estimate sums the quantities of the various capital goods. The BLS's estimate essentially weights the investment in each elemental stock by the proportion of the total income of all capital that accrues to that stock.[3] This procedure would yield an accurate measure of capital if production were characterized by constant returns to scale, the economy were in efficient equilibrium, and the return to capital equaled its marginal product—a view which is most consistent with equilibrium (or real) business cycle theories of economic activity.[4] Not only may we question the prevalence of equilibrium, we also may question constant returns (especially in the short run) and businesses' taking prices as given, two common prerequisites for capital to earn its marginal product in equilibrium.

The BLS estimate of capital tries to give more weight to the more productive investments, but by using the earnings of the existing stocks of capital to measure the marginal product of investments, this weighting may represent more than productivity. First, economists and accountants continue to debate the proper method of assigning earnings to the various goods that constitute an enterprise's stock of capital. Furthermore, recognizing that gross returns should be greater for capital goods that decay especially rapidly, that are taxed relatively greatly, or that are riskier investments, the weights for these investments would be too great if they reflected gross returns rather than the even more elusive net returns. Second, if enterprises earn economic rents that change from year to year or if their utilization of capital should change over time, then estimates of the quantity of capital may change in ways that do not represent productivity. The returns to capital and rates of capacity utilization, both for the nation and for companies, have varied substantially from decade to decade and from peaks to troughs of business cycles, suggesting that variations in earnings may reflect much more than changes in the fundamental productivity of capital goods.[5] When all enterprises do not earn the same economic rent, the investments of those earning greater yields receive more weight than those earning lesser yields. For example, the investment in nascent enterprises tends to contribute less to aggregate capital than does the investment in established lines of business if these newer enterprises have not yet achieved a rate of return comparable to those of more mature enterprises. Moreover, this understatement of investment would not be corrected later, when these enterprises eventually report competitive returns. When businesses invest in anticipation of future returns, relatively low earnings do not necessarily imply that capital is less productive.

Considering the properties of each measure, this article uses the BEA's estimate of the capital stock, primarily because this approach better insulates its measurement of the quantity of capital from the value of the goods and services produced by businesses. If the assumptions behind the BLS's measure of capital do not obtain, then this measure of the quantity of capital would vary with prices in a potentially questionable manner (Steindel 1992). A fundamental feature of the theory of production requires that the quantities of inputs to production be measured independently of both the quantities of outputs and the prices of inputs and outputs (Koopmans 1957). From an engineering point of view, our measure of the quantity of capital in a computer manufacturer's plant last year ought not vary according to the value of the computers that the manufacturer eventually sells. If the analysis of economic aggregates is to correspond to the standard description of production, then the measurement of the aggregate quantity of capital should not depend on the returns to that capital.[6] There is, however, no problem with allowing the valuation of the stock of capital to vary with its returns.

Although the BEA's estimate of the aggregate quantity of capital does not rely on explicit measures of capital's current earnings, it does depend on measures of the prices of capital goods. This reliance on prices poses its own problems (Jorgenson and Landau 1989; Jorgenson 1992; Hulten 1991). The BEA values the stocks of different capital goods according to the prices of these goods in a base year, currently 1987. In this way, for example, the stocks of computers and machine tools may be combined. Although this approach, to a degree, insulates estimates of the quantity of capital from changes in the relative prices of capital goods, it essentially does so by attempting to value capital in all years according to the industrial structure and technology of 1987. Even this approach cannot completely insulate estimates of the quantity of capital from the consequences of changing relative prices. Because the types of capital goods and the technology embedded in these goods change over the years, there is no unimpeachable method for comparing a computer purchased in 1980 or 1992 with a computer purchased in 1987. Such comparisons often depend on the prices of different vintages of capital goods, which may reflect more than differences in their technologies. Here too, the application of more theory may extract more information from the prices of capital goods, but in doing so the measure of capital risks becoming too dependent on the theory's special assumptions.

[2] "No more fiction for us; we calculate; but that we may calculate, we had to make fiction first."—Nietzsche.

[3] Using Törnquist aggregation, the rate of growth of the stock of each capital good is multiplied by its share of the total income of all capital goods period by period. Then the rate of growth of the aggregate stock of capital is the sum of these weighted rates of growth for each capital good. The derived rates of growth of the aggregate stock of capital, along with an estimate of the aggregate stock of capital at any time in the sample period, yield estimates of the stock of capital throughout the sample period. See Diewert (1976).

[4] See, for example, Lucas (1977); Plosser (1989). For criticism of this approach, see, for example, M. Friedman (1964, 1988); Mankiw (1989); Gordon (1990, 1992).

[5] See Gordon (1992, 1990); Morrison (1992); Kopcke (1992b). The variance in earnings and in rents on inframarginal capital appears to be much greater than shareholders' and investors' estimates of the marginal product of capital over the useful lives of investments. If the trends or cycles in business conditions reflect variations in aggregate demand, if the employment of factors adjusts slowly, if seasoned capital is not sufficiently flexible, if prices are set by markups, or if investors are oligopolistic competitors, then earnings may be a poor index of physical productivity. See also the other citations in footnote 4.

[6] For the purposes of this study, adjusting the measurement of the effective quantity of capital to reflect the underemployment of capital is not so important. The models of investment compare the existing stock of capital to investors' demands. When demands subside relative to existing stocks, the need to invest also subsides. If the measure of capital incorporated utilization rates, then the models of investment would need to compensate for the effects of the embedded utilization rates in order to compare properly the demand for capital to the existing stock of capital.

Table 2
Equipment Investment by Type, as a Percent of Total Equipment Investment

Type of Equipment	61–65	66–70	71–75	76–80	81–85	86–90	91
	Years						
Information Processing and Related Equipment	10.8	11.4	13.5	18.7	29.3	36.6	42.4
Office, Computing, and Accounting Machinery	.7	.5	.9	1.9	6.8	14.6	18.3
Communications Equipment	7.3	7.5	7.8	10.8	14.9	14.8	16.8
Instruments	2.0	2.2	2.8	3.3	4.2	4.5	4.8
Photocopy and Related Equipment	.9	1.2	2.1	2.7	3.4	2.8	2.6
Industrial Equipment	36.4	36.3	34.7	30.0	27.4	24.0	21.2
Fabricated Metal Products	2.8	3.5	3.8	4.2	3.5	2.6	3.0
Engines and Turbines	1.6	1.9	2.0	1.2	.9	.7	.6
Metalworking Machinery	7.6	9.1	8.0	7.3	6.1	5.3	4.3
Special Industrial Machinery, n.e.c.	10.2	8.9	8.3	5.8	6.0	5.7	4.4
General Industrial, including Materials Handling Equipment	8.3	7.3	7.2	7.0	6.5	5.9	5.8
Electrical Transmission, Distribution, and Industrial Apparatus	5.9	5.6	5.4	4.5	4.4	3.7	3.2
Transportation and Related Equipment	22.9	24.6	24.0	22.7	18.5	17.0	16.6
Trucks, Buses, and Truck Trailers	11.5	11.9	12.4	11.7	10.2	10.2	7.5
Autos	3.7	3.0	3.2	3.7	3.5	2.9	4.5
Aircraft	2.7	5.1	3.8	3.3	3.0	3.0	3.6
Ships and Boats	1.3	1.4	1.5	1.7	1.0	.4	.4
Railroad Equipment	3.6	3.1	3.0	2.3	.9	.4	.7
Other Equipment	29.9	27.7	29.0	28.6	24.7	22.4	19.7
Furniture and Fixtures	5.2	4.7	4.6	4.2	5.5	5.7	5.1
Tractors	4.4	4.1	4.3	4.3	2.6	1.9	1.7
Agricultural Machinery, except Tractors	4.8	4.7	5.0	4.4	2.4	1.7	1.7
Construction Machinery, except Tractors	5.0	4.9	5.2	5.0	3.2	2.8	2.3
Mining and Oilfield Machinery	2.2	1.7	2.0	2.3	1.6	.6	.4
Service Industry Machinery	3.6	3.6	3.3	2.8	3.0	3.0	2.5
Electrical Equipment, n.e.c.	1.3	1.1	1.3	1.8	2.3	2.6	2.8

Source: See Table 1.

Composition of Investment in Capital Goods by Businesses

The two broad categories of business investment, producers' durable equipment and nonresidential construction spending, each comprise a variety of investments. The volume of total capital spending by businesses is the sum of the outlays for each of these investments undertaken by enterprises in all industries (Bosworth 1985; Auerbach and Hassett 1991; Henderson with Liebman 1992). In principle, a complete description of investment spending could be unwieldy, covering the motives of each investor for purchasing each investment good. But the models of investment analyzed in this article claim that the aggregate volume of investment spending depends on the total sales, profits, and costs of businesses. Although little may be said about the distribution of investment without a detailed census of business conditions, aggregate investment spending corresponds fairly closely with aggregate business conditions. When output is expanding, we may not be able to tell whether automobile manufacturers are purchasing machine tools or mini mills are purchasing computers, but we can predict confidently that investment is increasing.

Since the early 1960s, the composition of the capital budgets of businesses has shifted markedly from industrial equipment toward information processing equipment (Table 2). Computers, communications equipment, instruments, and office equipment represented just over one-tenth of total expenditures on producers' durable goods in the early 1960s. By the late 1980s, this share had quadrupled, with most of the growth occurring since the late 1970s. At the same time, purchases of industrial

Table 3
Structures Investment by Type, as a Percent of Total Structures Investment

	Years						
Type of Structure	61–65	66–70	71–75	76–80	81–85	86–90	91
Nonresidential Building, excluding Farm	62.3	62.6	60.7	57.5	64.1	71.4	70.0
Industrial Buildings	15.4	19.5	15.9	19.6	17.8	16.6	20.9
Commercial Buildings	24.6	24.4	29.0	26.1	33.1	38.3	30.8
Religious Buildings	4.7	3.2	1.7	1.6	1.3	1.7	1.9
Educational Buildings	3.2	3.1	1.8	1.0	1.1	1.9	2.2
Hospital and Institutional Buildings	4.9	5.4	7.0	5.4	5.5	5.7	7.5
Other Nonfarm Buildings	9.4	7.0	5.3	3.8	5.4	7.2	6.6
Public Utilities	19.5	22.3	24.2	21.7	16.6	16.4	17.4
Railroad Structures	2.4	2.4	2.2	2.7	2.0	1.4	1.6
Telecommunications Structures	4.5	5.0	5.1	4.3	3.8	4.5	4.6
Electric Light and Power Structures	8.1	9.8	12.3	10.9	8.7	8.2	7.7
Gas Structures	3.8	4.4	3.4	2.4	1.9	2.1	3.3
Petroleum and Natural Gas	.6	.7	1.3	1.3	.3	.2	.3
Farm Structures	5.9	5.0	5.1	5.8	2.3	1.4	1.6
Mining Exploration, Shafts, and Wells	11.3	8.4	8.0	12.8	13.9	6.9	5.1
Petroleum and Natural Gas	10.6	7.7	7.0	11.2	12.7	6.4	4.5
Other	.7	.7	1.0	1.6	1.2	.5	.6
Other Structures	1.1	1.7	1.9	2.2	3.0	3.9	5.8

Source: See Table 1.

equipment, agricultural machinery, and commercial transportation equipment (except automobiles and aircraft) fell from just over three-fifths of producers' durable equipment to just under two-fifths.

The composition of investment in nonresidential structures has not changed as dramatically as that of equipment over the last 25 years (Table 3). In general, the share of construction devoted to industrial, commercial, hospital, and institutional buildings has increased, while the shares of public utilities, petroleum and gas wells, and farms has declined.

More interesting than these trends are the cycles in spending. After the price of petroleum soared in the 1970s, the investment in rigs rose sharply; after the price of oil fell in the early 1980s, the share of construction represented by petroleum and gas wells fell by two-thirds. Similarly, with the growth of service industries in the 1970s and 1980s the construction of commercial buildings increased significantly, but this investment declined rapidly once the construction boom produced a surfeit of space by the late 1980s.

The composition of investment by industry reflects the cycles in mining and the growth of service and electronics industries as well as the increasing role of financial institutions in leasing structures and equipment to other enterprises (Table 4). From the early 1960s to 1991, the share of investment undertaken by financial institutions rose from 2.3 percent to 12.4 percent of the total capital spending of businesses. Banks, finance companies, and insurance companies, among other financial intermediaries, have supplanted some of their loans with leases; these institutions became investors themselves by purchasing capital goods in order to lease them to other enterprises.[7] This expansion of leasing no doubt accounts for some of the subsidence in the transportation industry's share of investment. Financial institutions also have invested in real estate and office equipment, partly explaining why the real

[7] This investment by financial intermediaries, mostly depository institutions, does not appear to be significantly affected by their recent foreclosures of construction loans. The change in total "other real estate owned" (OREO) appearing in call reports is comparatively small in all years but 1990, when it was 12 percent of the volume of investment by commercial and depository institutions or 7 percent of the investment of all financial institutions. These ratios overstate the potential contribution of foreclosures to investment by financial intermediaries in 1990, because OREO includes foreclosures of existing real estate, while the investment data cover only newly constructed capital goods.

Table 4
Investment by Industry, as a Percent of Total Investment

Industry	61–65	66–70	71–75	76–80	81–85	86–90	91
	Years						
Mining	8.8	6.6	5.9	8.8	9.8	4.2	2.8
Metal Mining	.6	.5	.6	.8	.4	.2	.2
Coal Mining	.5	.5	.7	1.2	.8	.4	.2
Oil and Gas Extraction	7.2	5.1	4.2	6.3	8.3	3.3	2.0
Durable Goods	11.9	13.7	12.1	12.7	11.4	10.5	10.1
Industrial Machinery and Equipment	1.5	1.8	1.6	2.2	2.1	1.8	1.8
Electronic and Other Electric Equipment	1.1	1.5	1.4	1.6	2.2	2.0	2.2
Motor Vehicles and Equipment	2.0	1.9	1.7	1.8	1.4	1.3	1.0
Other Transportation Equipment	.7	1.1	.7	.8	1.1	1.1	1.1
Instruments and Related Products	.5	.7	.6	.8	1.0	1.1	1.1
Nondurable Goods	11.2	11.7	11.2	11.3	9.8	9.9	10.6
Paper	1.6	1.6	1.4	1.6	1.4	1.7	1.5
Printing and Publishing	.9	1.0	.9	.8	.8	1.2	1.2
Chemicals	3.0	3.3	3.1	3.6	2.6	2.9	3.4
Transportation	7.6	7.9	7.5	6.9	4.3	4.1	3.4
Communications	6.2	6.5	6.9	7.4	6.6	6.2	6.5
Electric, Gas and Sanitary Services	8.8	9.9	10.7	8.5	8.4	9.3	9.2
Finance, Insurance and Real Estate	15.5	14.7	14.4	14.8	20.8	25.7	24.8
Financial Institutions	2.3	2.5	3.5	4.8	7.6	11.5	12.4
Real Estate	12.9	11.9	10.6	9.7	12.6	13.7	12.1
Services	8.4	8.4	9.2	9.3	10.4	12.2	12.8
Hotels and Other Lodging	1.9	1.4	1.2	.8	1.3	1.1	1.2
Business Services	1.1	2.1	2.3	2.8	3.5	3.6	3.3
Auto Repair	1.3	1.5	1.7	2.2	2.0	2.5	2.7
Health Services	1.2	1.1	1.1	1.1	1.5	1.9	2.0
Wholesale Trade	3.4	3.5	4.3	4.2	6.0	5.6	6.2
Retail Trade	6.0	5.9	6.1	5.8	7.3	8.1	9.8

Source: See Table 1.

estate industry as well as the hotel and other service industries, for example, did not account for a greater share of investment in the late 1970s and 1980s.

II. Models of Investment Spending by Businesses

Investments are undertaken in anticipation of profit. Although this theme is common to most models of investment spending, the many distinctions among the leading models rest on their various descriptions of investors' prospective profits or the costs of achieving these profits. We measure production, sales, the cost of production, and the cost of investing in capital goods, but businesses seldom report the opportunities they foresee for production and profits. Even though realized sales and costs will influence the demand for investment goods only insofar as they modify investors' expectations of the future, models of investment spending use realized sales and costs as surrogates for the unobserved expectations. Presumably, investors' views of the future are grounded in their previous experiences. Accordingly, the principal task confronting a theory of investment is describing the influence of experience on investors' expectations, which in turn determine the demand for capital goods.

Even if surveys of businesses' expectations were available for the purpose of forecasting their investment spending, statistical models would remain useful analytical tools for at least three reasons. First, statistical models may forecast investment spending over intervals of time not covered by surveys. Second, the models may help describe the influence of economic conditions on investment spending, so that forecasts may adapt as these conditions change. Third, the models permit policymakers to assess the potential consequences of changing monetary or fiscal policies. The collection of survey data rich enough to satisfy these objectives, even if feasible, is impractical.

This section presents five basic models of investment spending, each representing one of the most common descriptions of the relationship between investment and prior output, sales, and costs. Although many more than five models of investment spending are in use today, most of these models are either modifications or blends of the basic descriptions presented here.

Experience, if anything, has expanded rather than diminished the ranks of models of investment spending. Models, by design, are not comprehensive; they each emphasize only a few determinants of the demand for capital goods, while giving other determinants no explicit role. Because different industries may respond differently to changing economic conditions, and because the response of any specific industry may vary over time, no one approach consistently dominates the others. All models contribute their unique insights into the course of investment spending.

Table 5
The Models of Investment

Accelerator

$$I_t = a + \sum_{i=0}^{n} b_i Q_{t-i} + cK_{t-1}$$

Neoclassical

$$I_t = a + \sum_{i=0}^{n} b_i \frac{Q_{t-i}}{UCC_{t-i-1}} + \sum_{i=0}^{n} c_i \frac{Q_{t-i}}{UCC_{t-i}} + dK_{t-1}$$

q

$$I_t = a + \sum_{i=0}^{n} b_i[(q-1)_{t-i}K_{t-1-i}] + cK_{t-1}$$

Cash Flow

$$I_t = a + \sum_{i=0}^{n} b_i \left(\frac{F}{C}\right)_{t-i}$$

Autoregression

$$I_t = a + \sum_{i-1}^{n} b_i I_{t-i}$$

Explanation of Symbols
C: price index for capital goods
F: cash flow
I: real investment
K: real stock of capital
Q: real output
q: ratio of financial market valuation of assets to the replacement cost of assets
UCC: user cost of capital

The Accelerator Model

Capital goods are a factor of production, and the stock of capital that businesses plan to employ is nearly proportional to their planned rate of output, according to the accelerator model. Consequently, the demand for new capital goods, investment, depends on changes in the rate of production, the *acceleration* of production. The accelerator model proposes that the correspondence between recent output and productive capacity determines investment spending (Clark 1917; Chenery 1952).[8] The greater are output and sales relative to capacity, the greater is investment spending. In this model, prices, wages, taxes, and interest rates have no independent, systematic influence on capital spending.

The equation for the accelerator model is the first entry in Table 5. The terms including current and lagged output represent investment's gradual response to changes in output and sales. Before intentions become expenditures, a demand for greater productive capacity must pass through stages of planning, contracting, and installation. Because these lags vary among projects, greater sales will induce greater investment expenditures during ensuing quarters.

These lags represent more than the requirements of logistics; forecasts of future sales and the attendant demand for productive capacity also adjust gradually to recent experience. Because capital resources are not always liquid investments, businesses wish to avoid overreacting to temporary changes in the demand for their products. This model implicitly proposes that expectations of output in the future are extrapolated from the course of sales in the past.

The lagged stock of capital serves two purposes in the accelerator model. First, because investors wish to maintain an appropriate ratio of output to their stock of capital, the model compares the recent course of output to the existing stock of capital in

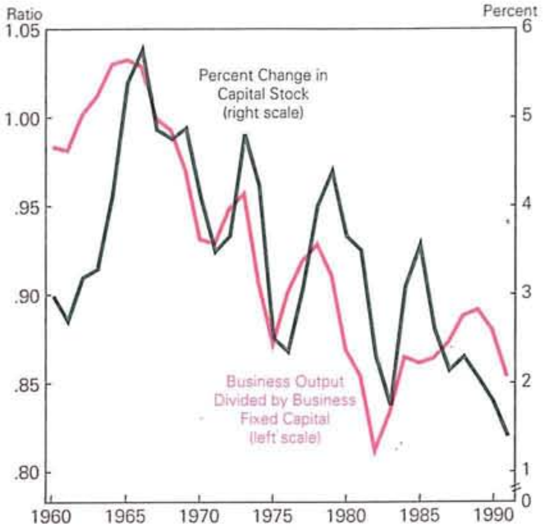
[8] See also the survey by Knox (1952).

order to gauge the need for new capacity. But investment not only expands productive capacity, it also renews and replaces older capital goods as they deteriorate or become obsolete. Because this model assumes that productive capacity decays at a constant rate, the lagged stock of capital also represents the investment required to restore depreciating plant and equipment.

The accelerator model is a simple description of investment spending. Except for the lagged capital stock and a short history of output, no other variables determine the demand for capital goods. This approach implies that the ratio of output to the stock of capital eventually tends toward a constant and that the rate of growth of the stock of capital varies with the ratio of output to the stock of capital (Figure 1). The technology of production may dictate this simple correspondence, or the implicit cost of employing capital goods may change with business conditions to yield this result. Proponents of the accelerator model believe that, despite this rigid description of the demand for capital, other models, which permit the ratio of output to the stock of capital to vary, cannot be specified with the proper precision. Although businesses might economize on their use of capital when interest rates rise, higher interest rates also may accompany a greater demand for capital. In order to distinguish these influences from one another, other assumptions must be imposed on the behavior of investors.

Figure 1

Change in the Stock of Capital and Ratio of Output to the Stock of Capital (Accelerator Model)



Source of data: Data Resources, Inc.

The q Model

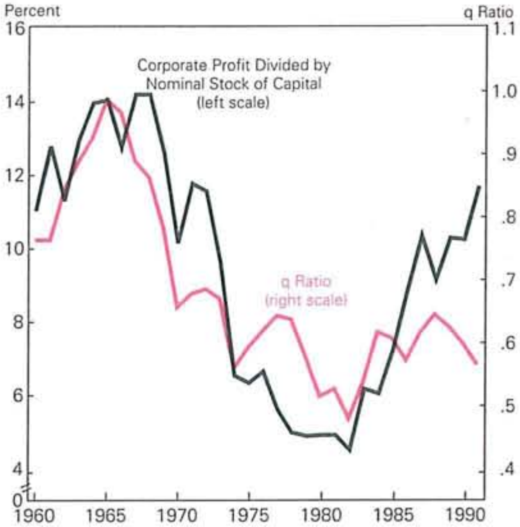
The q model proposes that the demand for capital varies directly with the ratio of the market value of the capital assets of business to the replacement value of those assets. This ratio, known as "q," essentially compares the yield on capital with the rates of return required by those who finance that capital. Values of q exceeding unity foster investment spending, while values of q well below unity discourage capital formation (Tobin 1969, 1982).

The description of the demand for capital behind the q model is as old as financial theories of investment. Investors calculate the demand price of capital assets by discounting their prospective returns. The cost of producing new capital goods is their supply price. Should changes in technology or business conditions create profitable investment opportunities, the demand price for new capital tends to exceed its supply price, fostering investment. As the stock of capital rises, the supply price of capital may rise, and the most profitable investment opportunities are exhausted, depressing the demand price. Eventually, the demand and supply prices of capital will become more nearly equal, reducing the rate of investment spending.

This theory applies to existing plant and equipment as well as new capital goods. The financial markets continually assess the prospective returns to existing capital assets of corporations. The resulting valuation of these enterprises in equity and credit markets is the demand price for these assets. When the prospective return on assets of businesses rises relative to the rates of return required by their shareholders and creditors, then the market value of these financial claims will increase, and the demand price for these assets will rise relative to their supply price. On the other hand, the market value of the assets of businesses declines relative to their replacement value when the prospective returns on these assets are relatively low compared to the costs of acquiring and financing capital goods. Therefore, q is comparatively high when the returns on existing and prospective investments are relatively high, and q is low when these returns are low relative to the

Figure 2

Rate of Return on the Stock of Capital and the q Ratio (q Model)



Source of data: Data Resources, Inc.

rates of return required by shareholders and creditors (Figure 2). The principal exception to this simple correspondence occurred after 1988 when q rose significantly while the yield on capital languished (Kopcke 1992b).

Because q embraces both existing stocks of capital goods and potential investments, it does not isolate incentives for undertaking new investments (Hayashi 1982). For example, should global markets become increasingly competitive, the rate of return on the existing plant and equipment of some domestic manufacturers could fall, depressing q, even though these manufacturers might increase their capital budgets to profit by new opportunities. q also may represent the incentives for investment poorly if existing plant and equipment are designed and installed in a manner that precludes either their being used for other purposes or their adapting to new technologies.[9] Should a new technology diminish the value of existing assets while creating many lucrative opportunities for new investment, q might decline while investment spending rises. Despite these potential problems, this failure to isolate marginal investments may not harm the q model if forecasts of the returns on marginal investments depend on the returns to existing capital.

Though the theory behind the q model is venerable, the model itself is not very popular among forecasters. The difficulties in separating marginal returns from average returns on assets, as described above, can compromise the quality of its forecasts (Abel and Blanchard 1986). Furthermore, projecting stock and bond prices for the next two years in order to forecast investment spending is more daunting than forecasting investment by other means. With the q model, forecasts of investment may be no more accurate than forecasts of stock prices. Nevertheless, the q theory invites analysts to weigh the prospective marginal returns on new capital assets against the cost of acquiring and financing these assets.

The Neoclassical Model

Whereas the accelerator model proposes that the desired stock of capital is nearly proportional to the prospective rate of production, the neoclassical model allows the optimal ratio of output to the stock of capital to vary with prices, interest rates, and tax codes. Unlike the q theory, which imposes no specific structure on the determinants of the ratio of output to capital, the neoclassical model uses a production function to describe the influence of prices, interest rates, and taxes on the ratio of output to capital (Jorgenson 1963; Hall and Jorgenson 1967; Jorgenson 1971).

Businesses select production plans to maximize their value to their investors: the return on marginal investments should equal the marginal cost of capital.[10] A production function describes the maximal rate of output that may be produced by any stock of capital combined with specific amounts of other factors of production. This function, consequently, defines the additional returns, net of taxes, that businesses receive when they increase their stock of capital (taking into account any attendant changes in

[9] See, for example, Pindyck (1991). Furthermore, if returns to scale are not constant, capital and other factors of production cannot be adjusted without cost, enterprises do not take prices as given, tax credits and depreciation allowances tend to alter the price of new capital goods relative to the price of existing capital, or not all investors expect an investment to earn the same economic rent, then the simple description of q and its relation to the demand for capital can be misleading. (See, for example, Galeotti and Schiantarelli 1991; Kopcke 1992a.)

[10] Under some circumstances this is equivalent to equating marginal q with unity; see Abel (1980); Hayashi (1982); Pindyck (1991); and Kopcke (1992a).

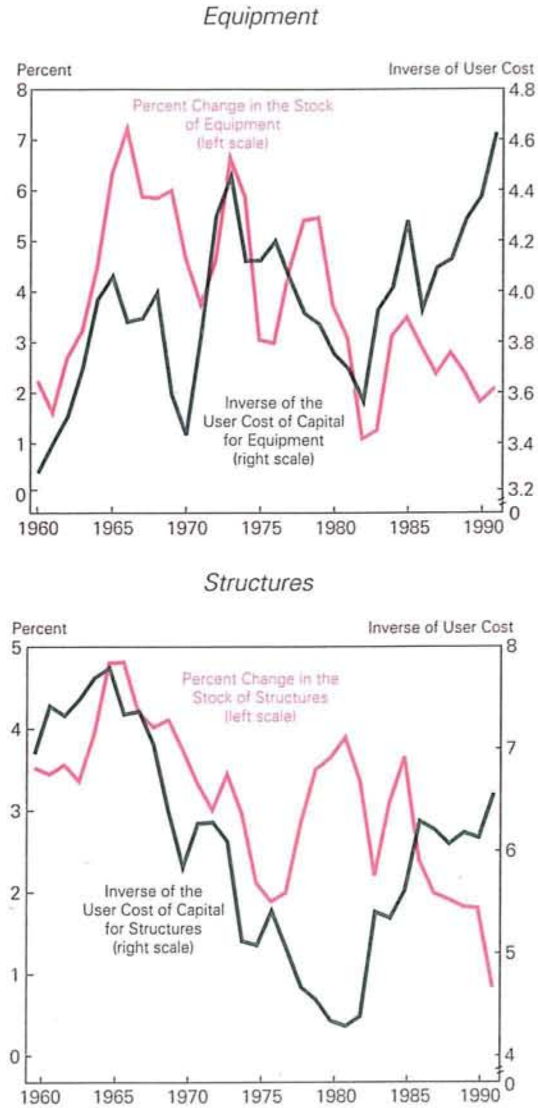
prices of outputs or inputs). The ratio of these additional returns to the change in the stock of capital is the return on marginal investments. The cost of capital comprises the opportunity cost of funds and depreciation charges adjusted for their treatment under the tax codes. (See Box I, "Measuring the Cost of Capital.") Businesses choose their optimal investment programs from their forecasts of sales, their production functions, and the cost of employing capital goods. Increasing sales or rising prices for output foster the demand for plant and equipment, while rising interest rates, diminished investment tax credits, less generous depreciation allowances, or higher corporate income tax rates deter investment spending. These influences, which are implicit in the q model, become explicit in the neoclassical model because it assumes a specific production function and a specific profit-maximizing behavior for businesses.

With common simplifying assumptions regarding the form of the production function, the optimal stock of capital in the neoclassical model is proportional to the rate of output divided by the cost of capital, and investment expenditures depend on lagged values of this ratio.[11] Accordingly, the growth of the stock of capital would tend to vary inversely with the user cost of capital (Figure 3). This proposed correspondence between the user cost and investment appears to be reasonably promising; typically changes in the user cost lead changes in the growth of the capital stock. However, this simple correspondence appears to have been broken during the late 1970s and early 1980s when purchases of nonresidential structures, principally petroleum rigs and commercial buildings, increased significantly (Table 3). As investment surged, the prices of nonresidential structures rose significantly. This break is especially noteworthy in the early 1980s, a time of two recessions and rising unemployment. The simple correspondence between the user cost and the growth of capital appears to break again for both purchases of producers' durable equipment and nonresidential structures after 1988, a break which coincides with a subsidence in the growth of output.

In the accelerator model, for which the optimal stock of capital is proportional only to the rate of output, investment expenditures depend on lagged output alone. Although the neoclassical model allows the demand for capital to vary with both output and the cost of capital, investors may not respond as rapidly to changes in output as they do to changes in the cost of capital. Businesses may also react more quickly to recent changes in sales than they do to

Figure 3

Change in the Stock of Capital and Inverse of the User Cost of Capital (Neoclassical Model)



Source of data: Data Resources, Inc.

[11] These assumptions include a Cobb-Douglas production function, perfectly competitive enterprises that are minimizing the cost of producing a given output, perfectly competitive capital markets with homogeneous expectations, and the linear extrapolation of experience to forecast the demand for capital. See Box II, "The User Cost of Capital and the Cobb-Douglas Production Function."

Box II: The User Cost of Capital and the Cobb-Douglas Production Function

Given a choice between acquiring a security and acquiring capital goods for which the expected returns are equally uncertain, investors expect the yield on the capital to match that on the security.

Suppose investors consider purchasing a quantity of capital, K, at the price of P_K per unit of capital. The expected value of their investment after one period would equal the earnings of the capital plus its resale value:

$$P\ MPK\ K + P_K K(1-\delta)(1+\gamma)(1+\pi).$$

P denotes the price of output, and MPK denotes the marginal product of capital; therefore, the first term denotes the return to the capital if the enterprise is perfectly competitive. The second term denotes the value of the capital after one period, assuming that capital depreciates at rate δ, that prices are inflating at rate π, and that the relative price of capital (P_K/P) appreciates at rate γ.

If, instead of purchasing the capital, investors were to purchase an equally risky security whose expected rate of return for one period were i, after taxes, then the value of their investment after one period would equal

$$P_K K(1+i).$$

For the expected return on the capital to equal its opportunity cost,

$$i \approx \frac{P}{P_K} MPK - \delta - \gamma - \pi,$$

or

$$\frac{P_K}{P}((i-\pi)+\delta-\gamma) \approx MPK.$$

If the earnings of capital ($P\ MPK$) are taxed as corporate profits at rate τ, investors purchasing new capital qualify for an investment tax credit equal to *itc* per dollar of capital spending, investors also qualify for depreciation allowances whose present value equals *pvdep* per dollar of capital spending, and the real discount rate ($i - \pi$) is denoted r, then the expression above defines the user cost of capital, *UCC* (Jorgenson 1963; Hall and Jorgenson 1967):

$$MPK \approx \frac{P_K(1-\tau\ pvdep - itc)}{P(1-\tau)}(r+\delta-\gamma) = UCC.$$

If the production function, which describes the amount of output, Q, that may be produced efficiently by specific amounts of capital and labor inputs, is Cobb-Douglas,

$$Q = AK^{\alpha}L^{\beta},$$

then the marginal product of capital equals

$$MPK = \alpha\frac{Q}{K}.$$

Substituting this description of the marginal product into the expression for *UCC* given above and solving for K, the demand for capital is

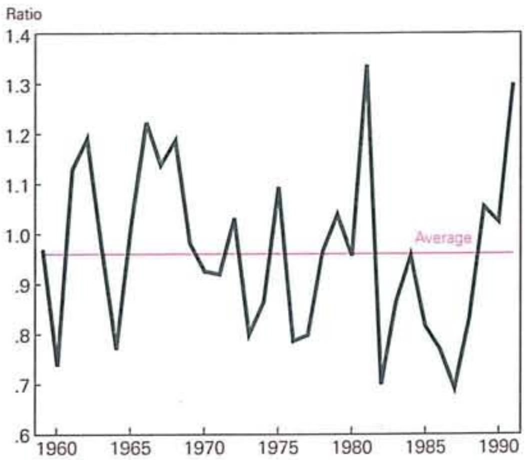
$$K \approx \frac{\alpha Q}{UCC} = \frac{\alpha Q}{\frac{P_K}{P}\frac{(r+\delta-\gamma)(1-\tau\ pvdep - itc)}{(1-\tau)}}.$$

recent changes in the cost of capital if the cost of adjusting technology to changes in the cost of capital are relatively great or if forecasts of future production are relatively sensitive to recent changes in sales. The two sets of lagged variables in the third equation in Table 5 permit investment spending to react differently to a change in output than it does to a change in the cost of capital (Bischoff 1971). If only the first set of lags were included, investment spending would respond in the same way to a 10 percent decrease in output as it does to a 10 percent increase in the cost of capital, because both determinants would be bound together in one variable. The lagged stock of capital accounts for investment needed to renew and replace older capital goods, because this model assumes that productive capacity decays at a constant rate.

The neoclassical model purports to measure the otherwise unobserved but critical return on marginal investments by invoking a specific production function. The specific theoretical assumptions behind this model introduce more variables into the statistical description of investment, but if these fundamental assumptions are sufficiently inaccurate, the resulting equation may be neither more general nor more accurate than apparently simpler equations. For example, if future prices and interest rates are difficult to predict or if businesses recognize that their demand for capital goods and their plans for output influence prices and interest rates, then the neoclassical model may misrepresent the determinants of investment spending. Nonetheless, proponents of the neoclassical model contend that its foundations are more rigorous than those of other models, because it attempts to isolate the return on marginal investments, an important element in most theories of the demand for capital. Furthermore, the presence of output and the cost of capital in the model appeals to many forecasters and policymakers. The accelerator and q models allow tax policy to influence the demand for capital only indirectly, either by altering the demand for output or by altering the valuation of securities or the price of new capital goods.

Figure 4

Gross Investment by Nonfinancial Corporations Divided by Cash Flow (Cash Flow Model)



Source of data: Data Resources, Inc.

The Cash Flow Model

The previous descriptions of investment spending essentially assume that the demand for capital does not depend explicitly on the means of financing investments. Financial considerations are absent from the accelerator model. In the q or neoclassical models, the composition of financing affects the demand for capital only by altering the weighted cost of funds, reflecting the mixture of debt and equity financing that represents the full cost of obtaining financing in these models. The cash flow model differs from these approaches by recognizing that businesses rely on three sources of funds—internal cash flow, new loans and debt issues, and sales of new equity—and that the yields on debt and equity do not represent the full cost of these funds (Meyer and Kuh 1957; Duesenberry 1958; Grundfeld 1960; Lintner 1967).

Cash flow—profit after taxes plus depreciation allowances less payments to shareholders—constitutes the principal source of financing for the capital budgets of businesses. From 1960 to 1989, the purchases of plant and equipment by nonfinancial corporations have essentially equaled their cash flow (Figure 4). This ratio has neither fallen below 0.7 nor exceeded 1.3, and it has tended to revert to its mean after significant deviations.

When capital spending exceeds cash flow, businesses also rely on external funds, comprising debt financing and new issues of equity. Debt financing includes public issues of bonds or commercial paper, private placements, bank loans, leases, and other securities that usually, but not always, offer creditors predetermined yields and claims against the earnings or assets of businesses that take precedence over the claims of shareholders. Since the 1940s, debt financing typically has accounted for more than three-quarters of the external financing for nonfinancial corporations (Kopcke 1989). New issues of equity, which include common and preferred stock or partnership shares, seldom represented a substantial source of funds after 1960.

Not only is external financing often necessary for growth, businesses also may reduce their average cost of capital by relying, to a degree, on debt financing. Both experience and prevailing conventions, however, suggest limits to the profitable use of leverage. For example, should creditors, as "outsiders," be less certain or less optimistic about the enterprise's prospects than are its current shareholders, then the rate of return required by creditors eventually increases with leverage, thereby limiting the appeal of debt financing.[12]

Because the rate of interest on an enterprise's debt increases with leverage when the degree of debt financing is near its optimum, the marginal cost of debt financing exceeds the rate of interest.[13] A desirable degree of leverage balances the advantages of debt financing against its costs. Consequently, businesses whose demand for capital is substantial compared to their cash flow must issue new equity in conjunction with debt in order to maintain a satisfactory degree of leverage. This new equity financing often is sufficiently expensive to be a last resort. Because new shareholders, almost by definition, are less optimistic and less assured than existing shareholders, they may require a greater rate of return than existing shareholders, unless the enterprise had been held privately, the new shares bring more competent management, or the new funds enable the business to realize greater economic rents.

Cash flow serves two purposes in this model. A greater cash flow not only permits an expansion of capital budgets, it also reflects a greater return on assets, which, in turn, may foster the demand for capital by increasing expected yields. The terms containing lagged cash flow in the cash flow model represent both the adjustment of capital budgets to recent experience and the projection of future earnings from past earnings. These lags also may represent the consequences of changes in the desired degree of leverage. When business conditions are promising, entrepreneurs expect relatively attractive returns on capital, and, if creditors concur, the optimum degree of leverage is comparatively great. Accordingly, investment, for a time, may be substantial relative to cash flow until leverage has increased sufficiently. When conditions are less promising and creditors become much more wary than shareholders, the optimal degree of leverage falls. In this case, investment, for a time, may be slight compared to cash flow until leverage has fallen sufficiently.

The Autoregression Model

Unlike the other approaches discussed in this article, the autoregression model does not use output, prices, profits, or taxes to describe investment spending. Instead, capital spending depends only on its history: the trends and cyclical dynamics evident in recent experience are sufficiently stable to describe the course of spending in the future. The autoregression approach may be regarded as a model in its own right, or it may be regarded as a standard against which models that feature more variables might be judged.

The autoregression model's simple appearance belies the sophisticated reasoning that often justifies this approach. Investment may depend on many economic variables, all of which are embedded in a larger model of the economy. If, according to this model, these variables mutually depend on their lagged values, then an autoregression may represent investment spending. For example, if the model of the economy is linear and if the covariances among any exogenous variables do not change over time, then investment spending is described by an autoregression. For models that are sufficiently close to

The autoregression model uses the trends and cyclical dynamics of recent capital spending to describe the course of spending in the future.

[12] When creditors and shareholders have identical discount rates and regard an enterprise's prospects identically, when corporate income is not taxed, and when bankruptcy costs are negligible, then the enterprise's cost of funds is independent of its leverage. Should these assumptions not obtain, the cost of funds may first fall and then rise with increasing leverage (Modigliani and Miller 1958, 1963; Duesenberry 1958; Lintner 1967; Myers 1989; Kopcke 1992a).

[13] The difference between the marginal cost of debt and the rate of interest also may increase with leverage, especially if "marginal creditors" are more wary or less optimistic about the enterprise's return on its capital. Furthermore, borrowers assume commitments and constraints that inherently increase the cost of their funds as leverage increases. Debt contracts entitle creditors to a senior claim against the borrower's resources. These contracts protect creditors' claims, either explicitly or implicitly, by imposing minimum loan to value ratios (debt relative to the value of the assets of the business), minimum coverage ratios (earnings divided by debt service obligations), minimum working capital ratios (current assets less current liabilities all divided by outstanding long-term debt), and other restrictions on borrowers. When enterprises fail to meet these standards, they cede some control over their financial or business planning to their creditors' interests.

being linear for decades at a time, the autoregression model may closely approximate the course of investment spending.

Although autoregression models invoke their own identifying assumptions (such as linearity in models of the economy or constant correlations among exogenous variables), proponents of this approach believe that alternative models generally rest on even stronger assumptions. To what degree does output determine investment or does investment determine output? Coping with these distinctions is not feasible without invoking many assumptions about the behavior of businesses, the structure of markets, and other potentially controversial aspects of the economy. If output and the cost of capital are not exogenous determinants of investment spending, for example, the accelerator and neoclassical models are misspecified. The autoregression model attempts to avoid pitfalls such as these by analyzing the dynamics embedded in investment alone.

Critics contend that autoregression models are not as useful as others because they do not allow forecasters or policymakers to assess the consequences of a prospective change in business conditions or of a change in policy on investment spending. These models can break down when new fiscal or monetary policies alter the correlations among exogenous variables. Autoregression models forecast investment, but they tell no stories. Often, knowing that investment may increase 4 percent may not be as important as knowing the motives that may be influencing investors. Forecasts frequently are judged by these details. Although the correlation between investment spending and output may change when policy changes, perhaps undermining the apparent value of policy analysis in models other than the autoregression model, these alternative approaches are, in principle, no more vulnerable than autoregressions to such structural changes.[14] Indeed, models other than autoregression models often attempt to avoid structural changes by incorporating descriptions of the consequences of policy in the model itself.

III. The Performance of the Models

The five models of investment spending in Table 5 were estimated from 1962 to 1979. (See the Appendix.) Each model was applied to each of the two major components of investment by businesses, purchases of producers' durable equipment (1962 to 1979) and nonresidential construction spending (1962 to 1977), all measured in constant (1987) dollars.[15] The estimated models were then used to predict investment in equipment from 1980 to 1992 and in nonresidential structures from 1978 to 1992.

No model dominates the others. All generally fit the data before 1979 (1977 for structures) well, especially considering the substantial differences among their characteristics (Table 6). They also describe purchases of producers' durable equipment during the 1980s and early 1990s fairly accurately (Table 7), suggesting that this component of investment has conformed to historical patterns despite recent concerns about the rising leverage of businesses, about the consequences of a novel credit crunch in banking, or about the increasing tendency of investors to shun a long-term view in favor of a short-term view of business prospects. The models, however, failed to predict the surge in nonresidential construction during the early 1980s. Since the mid 1980s, the models' forecasts have coincided more closely with nonresidential construction spending.

Estimating the Models

The estimates of each model reflect the historical correspondences between capital spending and other macroeconomic variables. For example, the coefficients on the lagged stocks of capital in the neoclassical equations, which represent the rate of depreciation of capital, match very closely the average rate of depreciation implied in the measures of the U.S. Bureau of Economic Analysis. The steady-state ratio of investment by all businesses to the cash flow of nonfinancial corporations implied by the cash flow model is very near its historical average of 1.5. According to the q model, the rate of growth of the stock of capital, when q equals unity, essentially

[14] See Lucas (1976). Correlation coefficients between variables ordinarily are not stable, because they depend on values assumed by other variables or because variables may be bound by nonlinear relationships. To assist policy analysis, the strategy of modelling is to uncover more stable statistical relationships by taking into account nonlinearities or the values of related variables. See, for example, Haavelmo (1944); Duesenberry (1948); B. Friedman (1978); and Sims (1982).

[15] The surge in both the price of and investment in structures, beginning in the late 1970s and ending in the early 1980s, failed to correspond to "fundamentals" as described by the models. Shifts in the constant term appeared to be neither frequent nor random when the structures equation was modeled by first differencing. Because of this experience, the equations for structures were modeled through 1977:IV, unlike those for equipment, modeled through 1979:IV.

Table 6
Selected Statistics for the Quarterly Estimation Periods of the Investment Models

Model	Mean Absolute Error	Root Mean Squared Error	Percent of Absolute Errors Exceeding $8 Billion	Percent of Absolute Errors Exceeding $13 Billion	Autocorrelation Coefficient	Number of Lags
		Producers' Durable Equipment: Estimation Period 1962:I–1979:IV				
Accelerator	5.8	7.1	30.6	6.9	.73	3
Neoclassical[a]	3.0	3.6	1.5	.0	.14	16
q Model	11.7	13.7	65.3	43.1	.85	5
Cash Flow	9.4	10.9	51.4	23.6	.88	4
Autoregression						
without output	3.5	4.7	11.1	1.4	n.a.	4
with output	2.7	3.2	.0	.0	n.a.	4
		Nonresidential Structures: Estimation Period 1962:I–1977:IV				
Accelerator	4.8	5.6	14.1	1.6	.86	11
Neoclassical[b]	2.8	3.2	.0	.0	.67	12
q Model	3.3	4.1	4.7	.0	.72	8
Cash Flow	6.6	7.4	34.4	4.7	.90	12
Autoregression						
without output	1.8	2.4	.0	.0	n.a.	4
with output	1.5	1.9	.0	.0	n.a.	4

[a]Period of fit is 1963:II–1979:IV
[b]Period of fit is 1962:II–1977:IV

equals the sum of the rate of depreciation of capital, the growth of the labor force, and the growth of the ratio of capital to labor for the 1960s and 1970s. The steady-state ratio of the stock of capital to output entailed by the accelerator model also matches its historical average, 1.4.

This article estimates each model without allowing for the possibility that its error in explaining investment in one quarter may be correlated with its errors in subsequent quarters. The autocorrelation coefficients reported in Table 6 indicate that the equations' errors during the period of estimation are positively correlated: Once an equation overstates investment, for example, it tends to overstate investment in the following quarters. By taking this dependence among errors into account when estimating the equations, the models would conform to the data much more closely, and the statistics describing the magnitude of the models' errors would tend to be smaller than those reported in the table.

This allowance for dependence among the errors is not adopted here for several reasons. Including such a correction essentially converts the errors into other (constructed) explanatory variables for describing the course of investment spending. In some cases, especially for the equations describing structures, this adjustment appears to assign too much weight to this implicit explanatory variable at the expense of the other variables. (See the discussion in the Appendix.) Some evidence, again strongest for structures, implies that the correlation among the errors varies with time. This suggests either that the equations have omitted some persistent determinants of investment spending or that the equations might need to allow for nonlinearities.

The objective is to examine the ability of the models, as specified above, to describe investment spending, without allowing them to use their past errors to mold their projections to the course of spending. If omitted variables or nonlinearities are sufficiently important, the models will tend to stray from the course of investment spending. The characteristics of any such divergence could highlight either deficiencies in the model or the presence of extraordinary influences. Therefore, in both the estimation and forecast periods, the models do not take into account their previous errors.

The structure of each model corresponds to that shown in Table 5. The autoregression model also assumes an alternative form that includes lagged values of output as well as lagged values of investment spending. If the pure autoregression used the actual value of investment spending to forecast investment after 1979 for equipment and 1977 for

Table 7
Selected Statistics for the Quarterly Forecasts of the Investment Models

Model	Mean Error	Mean Absolute Error	Root Mean Squared Error	Percent of Absolute Errors Exceeding $8 Billion	Percent of Absolute Errors Exceeding $13 Billion
		Producers' Durable Equipment: Forecast Period 1980:I–1992:I			
Accelerator	−8.7	13.8	16.8	67.3	49.0
Neoclassical	3.7	11.6	13.7	67.3	34.7
q Model	−16.7	18.8	22.6	75.5	63.3
Cash Flow	16.4	18.9	26.9	65.3	46.9
Autoregression					
without output	40.5	49.8	58.6	89.8	83.7
with output	−6.6	9.9	11.8	55.1	32.7
		Nonresidential Structures: Forecast Period 1978:I–1992:I			
Accelerator	17.0	25.4	32.0	77.2	61.4
Neoclassical	10.9	32.6	36.6	89.5	84.2
q Model	12.2	31.0	34.9	94.7	84.2
Cash Flow	20.8	21.9	27.3	70.2	56.1
Autoregression					
without output	46.7	46.7	49.2	98.2	96.5
with output	30.2	30.2	35.0	91.2	87.7

nonresidential structures, this model would benefit implicitly from taking its past errors into account. Accordingly, this model's forecasts depend on its predictions of investment from past quarters. In this case, the autoregression's forecasts, unlike those of the other models, tend to settle upon a simple trend line, because the pure autoregression cannot respond to changes in variables other than investment spending. The version of this equation that includes output may be considered one equation in a two-variable autoregression that is able to take into account recent changes in business conditions.

The Forecasts

The forecasts of the five models generally correspond well to both the trends and the cycles in purchases of producers' durable equipment since 1980. For nonresidential structures, however, the performance of the models is much worse. The investment in structures during much of the 1980s greatly exceeded the predictions of the models. This divergence was especially remarkable before 1983, when purchases of structures were rising sharply and the accelerator, neoclassical, and cash flow models were predicting a significant decline in spending. Since then, these three models tended to predict much more accurately the pattern of investment in structures, if not the amount of that investment.

Table 7 and Figures 5 and 6 describe the forecasts of the five models of investment, showing investment in equipment from 1980:I to 1992:I and investment in nonresidential structures from 1978:I to 1992:I. These forecasts use the actual values of the variables shown on the right side of the equations in Table 5 combined with the estimates of the coefficients derived from the data for the 1960s and 1970s. The statistics in Table 7 are not intended to separate the bad models from the good. Rather than seeking the best description of investment spending, we should appreciate that each model provides its unique insights. No single model or fixed blend of models is likely to be the best description of investment for long, because each casts investment as a simple function of relatively few variables. As the concerns of investors shift with changing business conditions, each model, for a time, may describe especially well the level, trend, or cycle of investment.[16]

The statistics in Table 7 indicate that models' errors after 1979 (1977 for structures) are greater than their errors during the period of estimation. Statistical theory advises some tolerance: models' errors ordinarily increase as these models are applied to new data that differ substantially from the data of the period of estimation. Although the forecast errors for equipment spending are not especially great compared to the errors from the period of estimation, the comparatively large forecast errors for structures suggest that these equations do not describe investment spending after 1977 as well as they did during the previous two decades.[17] For this failing, either we may fault the models or we may examine the timing and nature of these extraordinary errors, seeking some insight from the models.

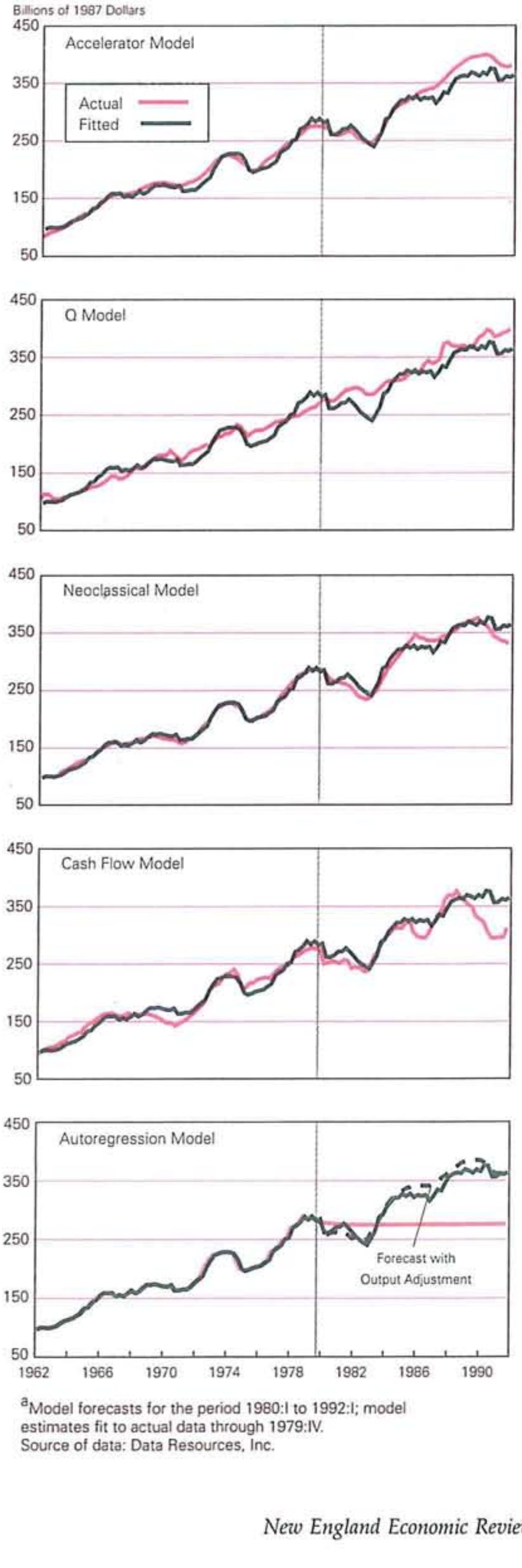
Forecasts of Investment in Producers' Durable Equipment

The performance of the models suggests that purchases of producers' durable equipment, when compared to the customary explanatory variables, were neither surprisingly great nor surprisingly low since 1980 (Figure 5). According to the models, if investment spending has been unacceptably low in the 1980s or the early 1990s, analysts need not seek extraordinary culprits; rounding up the usual suspects appears to suffice.

The cash flow model suggests that investors' optimism has been running sufficiently high since the 1980s to not depress purchases of equipment in an extraordinary manner. However great debt burdens might be, however deep is the credit crunch, however greatly businesses may have shifted their attention from long-term to short-term opportunities, equipment spending has generally exceeded the forecasts of the cash flow model. The ratio of capital

Figure 5

Actual Expenditures and Forecasts[a] of Investment in Equipment



[a]Model forecasts for the period 1980:I to 1992:I; model estimates fit to actual data through 1979:IV.
Source of data: Data Resources, Inc.

[16] The validity of the models cannot be compared very rigorously. Each model relies on a unique form of exogenous information, which, in turn, shapes the interpretation of the statistical properties of the data. The statistical properties of the models may be checked conditionally: assuming one model is "true," what are the implied specification errors of the others? These conditional tests, for which the analysis and results depend on the model assumed to be "true," are not comparable because they rest on contradictory assumptions and specifications. Moreover, the relative statistical properties of these models will change with time. When investors fervently wish to maintain their enterprise's market shares, the accelerator or neoclassical models may appear to be specified best; at other times when financial concerns loom larger in capital budgeting, the performance of these models may be compromised. Because the topological atlas of the investment model may have many distinct pages (and associated projections), there may be no model for all seasons. See also Balasko (1984).

[17] Assuming that the error terms in these models are normal random variables, a formal F-test of structural stability comparing the period before 1980 to the period after 1979 finds that the equations for structures from the 1960s and 1970s do not describe this component of investment during the 1980s. For equipment, there is evidence of a shift after 1979 for the neoclassical and accelerator equations. Nevertheless, these two models appear to explain the course of investment comparatively well during the past twelve years. Their F-tests suffer because these models fit the data so very closely before 1980, a feat that was unlikely to be repeated.

spending by all businesses to the cash flow of nonfinancial corporations was almost 1.7 in 1991, a comparatively high value by post-World War II standards. The managers of enterprises apparently anticipate profits and cash flows that are sufficiently attractive to overcome any prevailing financial deterrents.

Shareholders and creditors also have exhibited their customary optimism. The forecasts of the q model have exceeded investment spending during the 1990s by a margin that is not surprisingly large for a business cycle recovery. These investors, too, apparently anticipate a substantial recovery in the rate of return on capital (Figure 2 and Kopcke 1992b).

In general, the correspondence between purchases of producers' durable equipment and the course of business output since 1979 seems to match patterns established before 1980. Although equipment spending had fallen noticeably below the forecasts of the accelerator model by 1990, the forecasts of the neoclassical model and the autoregression model (adjusted for GDP) correspond more closely to the course of equipment spending.

Forecasts of Investment in Nonresidential Structures

The forecasts of nonresidential construction spending deviated greatly from experience after 1977. The models generally suggest that investment in nonresidential structures was driven by a mania during the late 1970s and the early 1980s. The accelerator, cash flow, and neoclassical models imply that, according to historical patterns, the weak economic fundamentals of these years warranted less construction spending; instead, spending increased substantially. This surge in spending also appears substantial when compared to the forecasts of the q model, even though this model, driven by falling rates of interest and capitalization rates, predicted greater purchases of structures during the early 1980s. Investment in structures exceeded the forecasts of the autoregression model (adjusted for output) during the entire forecast period from the late 1970s to the early 1990s.

The models generally suggest that investment in nonresidential structures was driven by a mania during the late 1970s and the early 1980s.

The patterns of the forecasts of the neoclassical, cash flow, and accelerator models are particularly interesting. After diverging substantially from the course of investment from 1978 to 1981, the forecasts of these models tended to fall and rise with investment between 1982 and 1986, essentially preserving or diminishing the gap between investment and forecasts that had emerged by 1981. This performance suggests that the models had not broken down, but failed to predict a shift in demand favoring nonresidential structures—a shift, lasting nearly a decade, unrelated to output, profits, taxes, cash flow, and other traditional determinants of investment spending. By the late 1980s, the forecasts of the cash flow and accelerator models coincided with the course of investment. Since then, the cash flow model predicted the subsidence of construction spending, while the accelerator model understated the decline in investment.

The forecasts of the neoclassical and q models, which had substantially underestimated investment before 1986, exceeded investment by a wide margin in the 1990s. A falling capacity utilization rate for structures, combined with a subsidence in economic growth, greatly depressed the relative prices of both new and used structures after the mid 1980s. Ironically, these falling prices induced both models to predict more investment in structures.

Although some attribute the boom and bust in the construction of nonresidential structures during the 1980s to changes in tax laws, this story does not correspond to the performance of the neoclassical model, the description of investment spending that devotes the most attention to details in the tax codes. Investment in structures and the price of structures began to rise considerably in 1978, well before the favorable Economic Recovery Tax Act became law in 1981. The construction of nonresidential structures most exceeded the forecast of the neoclassical model at the beginning of 1981. During the course of that year, the construction of nonresidential structures fell sharply, reducing the magnitude of the neoclassical model's forecast error. In 1982, this error continued to shrink as the forecast of investment increased even more rapidly than did investment after the new tax code took effect. Although the Tax Reform Act of 1986 revoked accelerated depreciation allowances for nonresidential structures, thereby reducing the neoclassical model's forecast of investment, construction spending continued to rise until the recession of 1990.

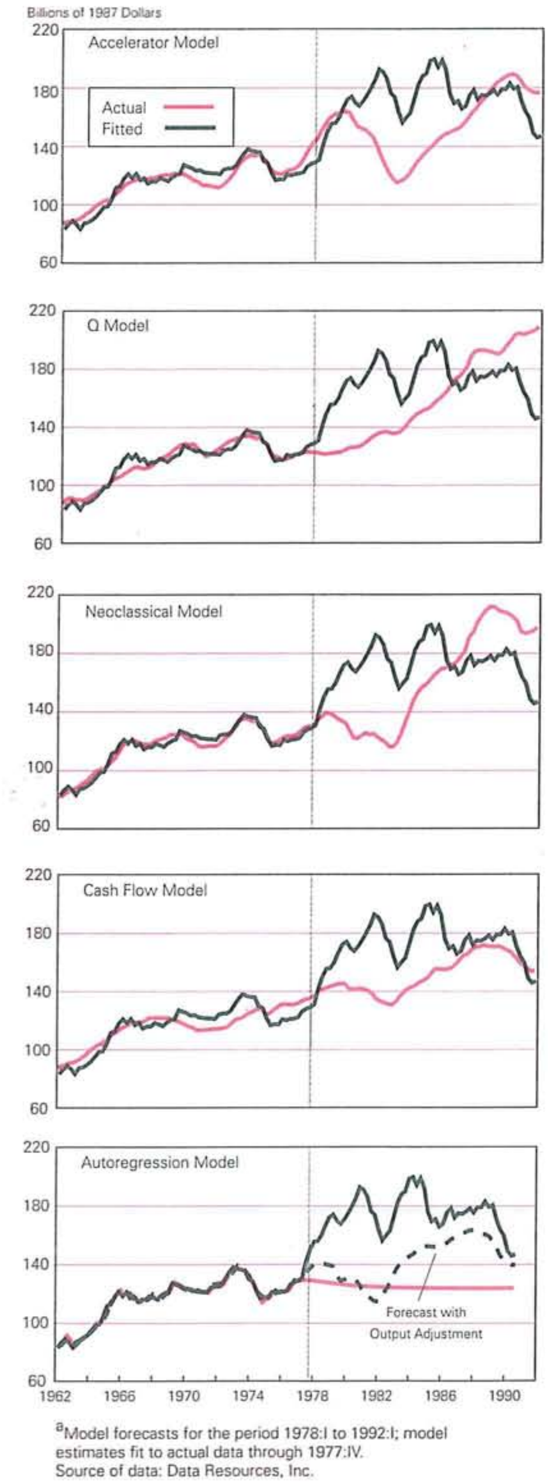
Whatever mania overtook the demand for nonresidential structures in the late 1970s had deflated by the 1990s. The existence of such a bubble is suggested not only by the forecasts of the models of investment spending, but also by the deflator for nonresidential structures. Both the deflator and construction spending rose significantly in the early 1980s; both fell after 1985. The measure of the user cost of capital used in the neoclassical model in this article assumes that the expected rate of change of the relative price of structures generally is negligible. (See Box II, "The User Cost of Capital . . . .") If, during the late 1970s and early 1980s, investors consistently expected the relative price of structures to rise, then the pattern of the neoclassical model's errors would tend to resemble those shown in Figure 6. (See the Appendix.) As expectations of real capital gains increased, the model's forecasts (which do not incorporate these expected capital gains) would fall below actual investment. When these expectations stopped rising and remained constant, the pattern of the model's forecasts would resemble that of actual spending, but the forecasts would tend to remain too low. Should expectations of real capital gains fall, the difference between actual investment and the forecasts would diminish. Should the expected rate of real capital gains eventually fall below zero, the forecasts would tend to exceed the investment in structures. According to this interpretation of the neoclassical model, investment in structures will remain below "normal" until investors no longer expect the relative prices of nonresidential structures to fall very greatly and economic activity increases sufficiently to absorb existing excess capacity.

IV. Conclusion

According to the conventional models of investment examined in this article, the volume of capital spending by businesses poses few mysteries since the 1970s. Apart from an exceptional surge in the construction of nonresidential structures (especially oil rigs and commercial buildings) in the late 1970s and early 1980s, the course of investment has adhered fairly well to its historical correspondence with output, profits, and the cost of capital. If the volume of capital spending is insufficient, we need not attribute

Figure 6

Actual Expenditures and Forecasts[a] of Investment in Structures



[a]Model forecasts for the period 1978:I to 1992:I; model estimates fit to actual data through 1977:IV.
Source of data: Data Resources, Inc.

this disappointment to the extraordinary consequences of changes in the composition of saving, changes in the leverage of businesses, a reduction in lending by commercial banks, or a shift of attention from the long term to the short term. If these forces have affected capital spending, their gravity has not increased since the 1960s and 1970s. Investment in producers' durable equipment appears to be responding in the customary manner to changing business conditions, and the principal impediment to a renaissance of construction spending is the surfeit of nonresidential structures, a legacy of the 1980s that will endure well into the 1990s.

This finding suggests that, lacking novel challenges, novel remedies are not necessarily required to foster investment. The familiar incentives—including stimulating aggregate demand, accelerating depreciation allowances, restoring investment tax credits, or reducing income tax rates—retain their traditional appeal. This traditional appeal, however, often depends on the viewpoint of the observer.

Because all the models, either implicitly or explicitly, stress that investment is undertaken in anticipation of profit, the prospect of a greater demand for output is a principal spur for capital spending. When the existing capacity for producing output significantly exceeds sales, a greater rate of growth of demand for goods and services may be an essential foundation upon which other incentives might build. If, for example, the annual rate of growth of real business output since 1988 had averaged 2.5 percent instead of 0.5 percent, then, according to the accelerator, neoclassical, and cash flow models, the rate of net investment spending by businesses would have been almost twice as great in 1992. Gross investment represented about 10.8 percent of real GDP in 1992:II; 7.8 percent for equipment, and 3.0 percent for nonresidential structures (Table 8). If the rate of growth of economic activity had matched the economy's potential, then this ratio might have exceeded 12.3 percent, an increase of 1.5 percentage points. Because capital consumption for businesses has been approximately 9 percent of real GDP recently, this additional investment would have increased net investment from 1.8 percent to 3.3 percent of real GDP. As a result of greater net investment in every year after 1988, the rate of growth of the stock of capital per member of the labor force might have nearly tripled, rising from 0.5 percent to 1.4 percent per year since 1988.

Many adherents of the neoclassical model favor investment tax credits and accelerated depreciation

Table 8
Economic Policy and Business Investment

Policy Option	Real Net Investment (percent of real GDP) 1988:IV	1992:II	Real Stock of Capital (relative to civilian labor force) 1988:IV	1992:II
Producers' Durable Equipment				
Actual	7.6	7.8	17.1	17.7
2.5 percent average annual GDP growth				
Accelerator Model		8.9		18.5
Neoclassical Model		9.2		18.4
Cash Flow Model		9.8		19.0
2.5 percent average annual GDP growth plus 10 percent investment tax credit				
Neoclassical Model		9.9		19.1
Cash Flow Model		10.2		19.7
2.5 percent average annual GDP growth plus corporate income tax rate of 23 percent				
Neoclassical Model		9.5		18.7
Cash Flow Model		10.2		19.7
2.5 percent average annual GDP growth plus SOYD depreciation				
Neoclassical Model		9.2		18.5
Cash Flow Model		9.9		20.9
Nonresidential Structures				
Actual	3.7	3.0	20.2	20.3
2.5 percent average annual GDP growth				
Accelerator Model		3.7		20.8
Neoclassical Model		3.4		20.7
Cash Flow Model		3.5		20.7
2.5 percent average annual GDP growth plus 10 percent investment tax credit				
Cash Flow Model		3.9		20.9
2.5 percent average annual GDP growth plus corporate income tax rate of 23 percent				
Neoclassical Model		4.0		21.7
Cash Flow Model		3.9		20.9
2.5 percent average annual GDP growth plus ACRS depreciation				
Neoclassical Model		3.8		20.8
Cash Flow Model		3.7		20.9

Note: The simulations of investment using the cash flow model with the 23 percent corporate income tax rate and the 10 percent investment tax credit are equal since the model does not distinguish between differing policies that increase cash flow equally. SOYD = sum of the year's digits; ACRS = accelerated cost recovery system.

allowances to foster the demand for capital.[18] Only enduring investment tax credits and a lasting acceleration of depreciation allowances increase the demand for capital significantly within the neoclassical model. If temporary increases in credits or allowances increase investment spending, they do so principally by reducing investment spending commensurately in subsequent years. If, in addition to achieving 2.5 percent growth, a 10 percent investment tax credit had been reinstated for equipment in 1989, the share of GDP devoted to investment by businesses might have risen by another 0.7 of a percentage point by 1992 according to the neoclassical model, as purchases of equipment would have risen from 9.2 percent of real GDP to 9.9 percent. Accelerating depreciation allowances for equipment would have increased investment only slightly, because the prevailing tax lives for equipment already were comparatively short. And with the reinstatement of the accelerated-cost-recovery depreciation allowances, new construction would have risen from 3.4 percent of real GDP to 3.8 percent.

Businesses do not necessarily regard investment tax credits or accelerated depreciation allowances as "rebates" against the prices of specific capital goods; instead, they may regard these incentives as "tax cuts" that increase the net yield on the entire stock of capital. In this case, the consequences of investment tax credits and accelerated depreciation allowances are similar to the consequences of reductions in the rate of corporate income taxation. For example, cash flow would have increased by essentially the same amount whether a 10 percent investment tax credit had been reinstated in 1989 or the corporate income tax rate had been reduced from 34 percent to 23 percent. In both cases, according to the cash flow model, investment would have increased by 0.9 percent of real GDP, 0.5 percent for equipment and 0.4 percent for structures (Table 8). Although this reduction in the rate of corporate income taxation also would increase investment by 0.9 percent of real GDP in the neoclassical model, construction spending would account for more of this additional investment. In both models, a tax reduction of this magnitude accompanied by a 2.5 percent rate of growth of aggregate demand since 1988 might have increased the rate of growth of the stock of business capital per member of the labor force to almost 2.5 percent per year.

Since the introduction of investment tax credits in the early 1960s, some have advocated a marginal tax credit, applying only to capital spending that exceeds the investment of the previous year, in order to foster capital spending without reducing the government's revenues substantially. Such marginal credits, however, may not necessarily increase the demand for capital very greatly. In the cash flow model, the increase in capital spending depends on the size of the tax cut; a marginal credit increases capital spending only marginally.

In the neoclassical model, the consequences of an investment tax credit depend on its ability to increase the stock of capital assets demanded by businesses. In some familiar circumstances, a marginal credit may increase this demand only negligibly, at best. For example, with constant returns to scale, a common assumption behind the neoclassical model, a marginal credit merely bestows a windfall on some investments instead of increasing the demand for capital.[19] An unrestricted credit increases the demand for capital, because all investors are willing to accept a lower yield from all of their investments, while paying savers a greater rate of return in order to obtain and maintain more capital. If a marginal credit also increases the demand for capital, then, in this case too, the yield on *all* capital falls relative to the rate of return *all* investors must pay to savers. Because those investments that do not qualify for the marginal credit no longer would be attractive, they would be prone to be displaced by those that qualify for the marginal credit. Ultimately, the equilibrium stock of capital would be no greater than it was before the introduction of the marginal investment tax credit; only in this case does the yield on the least profitable investments (after taxes) equal the return required by savers.

Adherents of the accelerator model are skeptical of the efficacy of any tax incentives for businesses, because lower tax burdens do not necessarily increase

[18] Some who, in principle, would favor the elimination of the deadweight loss of the corporate income tax on marginal investments, might favor defining depreciation allowances so that their present value always equals unity. Consequently, the cost of capital would be independent of the rate of corporate income tax, provided the rate of tax credit were zero. (See Box II, "The User Cost of Capital.") In this case, corporations earning normal returns on their capital essentially would pay no corporate tax on those profits, while corporations earning economic rents (profits in excess of normal returns) would be taxed on those rents at a rate equal to the corporate income tax rate. See E. C. Brown (1962) and Samuelson (1964).

[19] This conclusion may remain much the same even if returns are not constant, provided the return to any specific capital good depends on the overall quantity of capital.

the demand for capital assets if the prospect for sales is no better. According to the accelerator model, if lower corporate taxes were combined with either less consumption spending (due to greater personal taxes, in order to avoid greater budget deficits) or less spending by government, then capital spending might fall despite the tax incentives for businesses.

Finally, recalling that capital spending by businesses accounts for less than half of total national investment, a comprehensive plan to improve living standards should not slight investments in research, product development, education, job training, households' capital, and public capital. The merits of these investments, which may increase the productivity of the capital assets of businesses, could be judged partly by their contributions to domestic product. But, these investments frequently also increase "national income" and living standards in ways that are not reflected fully in wages, salaries, profits, and GDP as they are reported in the national accounts.

Appendix

Sources of Data

All data are from the U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts (NIPA) except where otherwise noted. Measures of stocks of assets and flows of goods or services are expressed in 1987 dollars.

IS, IE: Investment in nonresidential structures and investment in producers' durable equipment, respectively, for all private businesses. The quarterly investment data are expressed at an annual rate.

KS, KE: Capital stock of structures and equipment, respectively. Quarterly estimates of the stock of capital were derived from year-end stocks by a nonlinear interpolation assuming the perpetual inventory method and assuming a constant quarterly rate of depreciation throughout the year that is consistent with published data for the end of each year.

RGDPBUS: Real gross domestic product for businesses; quarterly data expressed at an annual rate.

F: Cash flow for businesses, using data from the Board of Governors of the Federal Reserve System, Flow of Funds Section, for the nonfinancial corporate business sector. Cash flow is defined as profits less taxes and dividends, with capital consumption adjustment and depreciation allowances plus capital consumption allowances.

CS, CE: Implicit price deflators for nonresidential structures and producers' durable equipment.

NYSEBOND: Market value as a percent of par value for all New York Stock Exchange listed bonds. Annual data come from the NYSE *Fact Book* for various years. Quarterly data were derived using a nonlinear interpolation based on the pattern of new Aa utility bond yields.

q: The ratio of the market value of nonfinancial corporations to the replacement value of their net assets. Market value equals equity less farm net worth plus net interest-bearing debt, which is the sum of bank loans, commercial paper, acceptances, finance company loans, U.S. government loans, and adjusted bonds (AB).

$$AB = .5 * MTG + NYSEBOND * (.5 * MTG + TEB + CB)$$

MTG = commercial mortgages
TEB = tax-exempt bonds
CB = corporate bonds

The replacement value of net nonfinancial corporate assets equals total assets less profit taxes payable, trade debt, and foreign direct investment in the United States. Except for NYSEBOND, all data are taken from the Board of Governors of the Federal Reserve System, *Flow of Funds*.

INFLATN: Rate of inflation expected over the coming five years. For 1980:IV–1992:I, INFLATN is the average of monthly surveys done by Richard Hoey, available from the Board of Governors of the Federal Reserve System, FAME Database. Hoey's survey data were regressed on lagged values of the annual rate of change in the CPI for 1980:IV–1992:I; this equation was used to obtain expectations for the period 1959:I–1980:III.

RE, RS: User cost of capital for equipment and nonresidential structures.

$$RE = (CE/CT)(.15 + D)(1 - ITC - TAX * WE - .3 * (1 - DEBTE))/(1 - TAX)$$

$$RS = (CS/CT)(.05 + D)(1 - TAX * WS - .3 * (1 - DEBTS))/(1 - TAX)$$

The economic rate of depreciation is estimated at 0.15 for equipment and 0.05 for structures. D, the discount rate for corporate profits after corporate income taxes, equals the Standard & Poor's dividend/price ratio for common stocks plus an estimate of the real rate of growth of nonfinancial corporate enterprises, a constant 4 percent. This definition of D is inspired by the Gordon growth model for valuing equities.

ITC, the investment tax credit for equipment, and TAX, the statutory effective tax rate paid by U.S. corporations, are taken from the DRI Model of the U.S. Economy. ITC is the weighted average of investment tax credits for autos, office equipment, and other equipment.

WE is the present value of depreciation allowances for equipment using the most "accelerated" formula permitted by law. From 1959:I through 1981:II, equipment was depreciated using Sum of the Year's Digits; from 1981:III through 1986:IV, equipment was depreciated using the Accelerated Cost Recovery System; from 1987:I through 1992:I, equipment was depreciated using the Modified Accelerated Cost Recovery System. Tax life for equipment is the weighted average of the tax lives for different classes of equipment taken from the DRI Model of the U.S. Economy. The nominal discount rate used equals INFLATN times (1 + 0.015); 0.015 represents the assumed real rate of discount (after taxes).

WS is similarly defined for structures. Structures were depreciated according to Sum of the Year's Digits from 1959:I through 1969:II; from 1969:III through 1981:II, structures were depreciated according to the 150% Declining Balance Method; from 1981:III through 1986:IV, buildings were depreciated according to the Accelerated Cost Recovery System, and the Modified Accelerated Cost Recovery System was used thereafter. The discount rate used equals INFLATN times (1 + 0.015).

DEBTE and DEBTS are the present value of debt service charges after taxes per dollar borrowed, for equipment and for structures. The interest rate on debt equals the prevailing Aa new utility rate. The maturity of the loan equals the tax life of the capital good. The discount rate is the same as that for WE and WS. DEBT equals unity when the Aa utility rate, after taxes, equals the discount rate; DEBT exceeds unity when the after-tax interest rate exceeds the discount rate.

Unless otherwise noted, all regressions for equipment were run from 1962:I to 1979:IV, while those for structures were run from 1962:I to 1977:IV. Lag coefficients in all models other than the autoregression were constrained to a third-degree polynomial when the lags were sufficiently long. The last lag coefficients for the cash flow structures equation were constrained to equal zero. Otherwise, the lag coefficients were not constrained.

The regressions were estimated by ordinary least squares with no allowance for autocorrelation of the errors. Inasmuch as the estimated first-order autocorrelation coefficients for the residuals from these equations could be as large as 0.9, the estimates of the variance of the errors (the root mean squared errors in Table 6) are biased toward zero (Kiviet and Krämer 1992). When a first-order autocorrelation coefficient for the errors is estimated with the other coefficients, the procedure essentially constructs the errors and their harmonics to obtain the best fit. Because the harmonic of the constructed error is likely to resemble those of the other variables, the estimates of the coefficients for the explanatory variables may be biased (Yule 1926). This bias appeared to be especially great in the equations for structures. In some cases, the linear combination of the regressors in the regression bore little resemblance to investment. In this sample of data, the bias in the estimates of the coefficients of the regressors appeared to be least with ordinary least squares.

The surge in both the price of and investment in structures beginning in the late 1970s and ending in the early 1980s, which failed to correspond to "fundamentals" as described by these models, could be interpreted as an unstable constant term in the structures equation. This type of bubble might be modeled by first differencing the structures equation. Though this random-walk description might accommodate the bubble during the 1970s and 1980s, the performance of the equation before the mid 1970s and the profile of forecasts during the later 1980s and early 1990s suggest that this description is not entirely warranted: the shifts in the constant term seem to be neither frequent nor random. Because of this experience, the equations for structures, unlike those for equipment, were estimated through 1977:IV.

Investors may have expected that the relative prices of nonresidential structures, which had been rising during the 1970s, would continue to rise, thereby reducing the cost of capital during the late 1970s and early 1980s. (See Box II, "The User Cost of Capital.") This variable is assumed to be zero in the empirical measure of the cost of capital used in the regressions and in the forecasts reported below and in the text. Setting γ equal to the annual rate of change of CS/CT over the ensuing year for each quarter during the forecast period (this one-year "forecast" of the change in the deflator shrinks to one quarter by the end of the period) reduces the model's errors from 1980 to 1982 and in 1991 and 1992:I; otherwise, the errors typically are as great as those shown in the text. Setting γ equal to the annual rate of change of CS/CT over the ensuing three years for each quarter during the forecast period (this three-year "forecast" of the change in the deflator also shrinks to one quarter by the end of the period) reduces the model's errors after 1985; otherwise, the errors typically are greater than those shown in the text. Reestimating the neoclassical equations for structures with γ included in the cost of capital (both a one-year and a three-year version), yields forecasts of investment after 1984 that are substantially below those reported in the text. From 1978 to 1983, these alternative forecasts resemble the reported forecasts. After 1986, the pattern of these alternative forecasts resembles that of actual investment spending, but the alternative forecasts lie well below actual spending.

A bubble and its collapse not only may arise because of a surge and slump in expected capital gains, they also may arise because of changes in the outlook of "outsiders." If lenders and other outsiders became more optimistic about the prospects for investments in nonresidential real estate during the late 1970s and early 1980s, the supply of financing and terms of financing would have improved, thereby fostering investment even if the outlook of "insiders" had not changed (Lintner 1967, Kopcke 1992a). If the outlook of outsiders had deteriorated by the late 1980s, both the terms of financing and the volume of investment would have deteriorated as well. Consequently, the dimensions of a bubble may not be reflected fully in the price of the asset (even presuming perfect foresight) or in γ; changes in the marginal cost of financing also may be driving the cost of capital.

Quarterly Models of Investment in Equipment and Structures

Autoregression

$$IS = 6.00 + \sum_{i=1}^{4} b_i IS_{t-i}$$

b_1 = 1.1227
b_2 = .0587
b_3 = −.1832
b_4 = −.0516
Sum = .9516

$$IE = 2.68 + \sum_{i=1}^{4} b_i IE_{t-i}$$

b_1 = 1.2674
b_2 = .0369
b_3 = −.3013
b_4 = −.0128
Sum = .9902

$$IS = 2.70 + \sum_{i=1}^{4} b_i IS_{t-1} + \sum_{i=0}^{2} c_i RGDPBUS_{t-i}$$

b_1 = .9455
b_2 = .2529
b_3 = −.0821
b_4 = −.1622
Sum = .9541

c_0 = .0451
c_1 = −.0206
c_2 = −.0239
Sum = .0006

$$IE = -20.50 + \sum_{i=1}^{4} b_i IS_{t-i} + \sum_{i=0}^{2} c_i RGDPBUS_{t-i}$$

b_1 = .7969
b_2 = .2165
b_3 = .1723
b_4 = −.3711
Sum = .8146

c_0 = .1049
c_1 = −.0631
c_2 = −.0205
Sum = .0213

Accelerator

$$IS = 21.61 + \sum_{i=0}^{11} b_i RGDPBUS_{t-i} - .21KS_{t-1}$$

b_0 = .0371
b_1 = .0271
b_2 = .0203
b_3 = .0161
b_4 = .0137
b_5 = .0127
b_6 = .0122
b_7 = .0118
b_8 = .0106
b_9 = .0082
b_{10} = .0038
b_{11} = −.0033
Sum = .1703

$$IE = -167.33 + \sum_{i=0}^{3} b_i RGDPBUS_{t-i} - .11KE_{t-1}$$

b_0 = .0531
b_1 = .0572
b_2 = .0375
b_3 = .0459
Sum = .1937

Cash Flow

$$IS = 25.14 + \sum_{i=0}^{12} b_i (F/CS)_{t-i}$$

b_0 = .0853
b_1 = .0566
b_2 = .0369
b_3 = .0246
b_4 = .0184
b_5 = .0168
b_6 = .0185
b_7 = .0219
b_8 = .0256
b_9 = .0283
b_{10} = .0285
b_{11} = .0248
b_{12} = .0158
Sum = .4020

$$IE = -28.28 + \sum_{i=0}^{4} b_i (F/CE)_{t-i}$$

b_0 = .5051
b_1 = .1693
b_2 = .1104
b_3 = .1421
b_4 = .0784
Sum = 1.0053

Neoclassical (period of fit for equipment: 1963:II–1979:IV; period of fit for structures: 1962:II–1977:IV)

$$IS = -25.07 + \sum_{i=0}^{12} b_i (RGDPBUS/RS)_{t-i}$$

$$+ \sum_{i=0}^{12} C_i (RGDPBUS_{t-i}/RS_{t-1-i}) + .03KS_{t-1}$$

$b_0 = -.0013$
$b_1 = -.0076$
$b_2 = -.0117$
$b_3 = -.0139$
$b_4 = -.0144$
$b_5 = -.0137$
$b_6 = -.0120$
$b_7 = -.0097$
$b_8 = -.0071$
$b_9 = -.0045$
$b_{10} = -.0022$
$b_{11} = -.0006$
$b_{12} = -.0000$
Sum = −.0987

$c_0 = .0080$
$c_1 = .0119$
$c_2 = .0140$
$c_3 = .0146$
$c_4 = .0140$
$c_5 = .0125$
$c_6 = .0103$
$c_7 = .0079$
$c_8 = .0053$
$c_9 = .0031$
$c_{10} = .0013$
$c_{11} = .0004$
$c_{12} = .0007$
Sum = .1040

$$IE = -31.16 + \sum_{i=0}^{16} b_i (RGDPBUS/RE)_{t-i}$$

$$+ \sum_{i=0}^{16} C_i (RGDPBUS_{t-i}/RE_{t-1-i}) + .11KE_{t-1}$$

$b_0 = -.0021$
$b_1 = -.0124$
$b_2 = -.0209$
$b_3 = -.0278$
$b_4 = -.0331$
$b_5 = -.0370$
$b_6 = -.0396$
$b_7 = -.0409$
$b_8 = -.0410$
$b_9 = -.0401$
$b_{10} = -.0382$
$b_{11} = -.0355$
$b_{12} = -.0320$
$b_{13} = -.0278$
$b_{14} = -.0230$
$b_{15} = -.0178$
$b_{16} = -.0122$
Sum = −.4812

$c_0 = .0149$
$c_1 = .0226$
$c_2 = .0288$
$c_3 = .0336$
$c_4 = .0371$
$c_5 = .0394$
$c_6 = .0406$
$c_7 = .0406$
$c_8 = .0397$
$c_9 = .0379$
$c_{10} = .0352$
$c_{11} = .0318$
$c_{12} = .0276$
$c_{13} = .0229$
$c_{14} = .0176$
$c_{15} = .0118$
$c_{16} = .0057$
Sum = .4878

q Model

$$IS = 2.70 + \sum_{i=0}^{8} b_i (q-1)_{t-i} KS_{t-1-i} + .09KS_{t-1}$$

$b_0 = -.0065$
$b_1 = .0037$
$b_2 = .0092$
$b_3 = .0112$
$b_4 = .0106$
$b_5 = .0084$
$b_6 = .0056$
$b_7 = .0033$
$b_8 = .0025$
Sum = .0480

$$IE = -24.89 + \sum_{i=0}^{5} b_i (q-1)_{t-i} KE_{t-1-i} + .20KE_{t-1}$$

$b_0 = -.0528$
$b_1 = .0101$
$b_2 = .0328$
$b_3 = .0298$
$b_4 = .0151$
$b_5 = .0028$
Sum = .0378

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