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High-Technology Development
In the Tenth District

Investment in Recession and Recovery:
Lessons from the 1980s

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U.S. Agriculture: The International Dimension

By Mark Drabenstott

U.S. agriculture is passing through troubled times. While the general economy has enjoyed three years of strong expansion, the farm sector has had a much more turbulent passage. Financial problems of considerable magnitude are spread broadly across the sector—from increased farm liquidations, to restructured agribusinesses, to rising farm bank failures. Following the benevolent decade of the 1970s, U.S. agriculture finds itself adjusting to a harsh new market reality.

An important part of agriculture's current adjustment has resulted from U.S. integration into a world market for food and fiber over the past 15 years. That process has proved to be a two-edged sword. Throughout the 1970s, when market conditions were favorable to exports, U.S. agriculture enjoyed a decade of prosperity unparalleled in modern times. But in the 1980s, the United States has learned that declining exports can bring financial hardship and severe adjustments.

The international dimension is a key factor in U.S. agriculture's current financial stress. This article reviews the recent performance of U.S. farm exports, highlighting some causes of deterioration in the 1980s. It then outlines the dimensions of U. S. farm financial stress, considers the international dimension of current farm problems, and explores the critical role international developments will play in restoring farm economic health.

Recent farm export performance

Farm exports were a dream come true in the 1970s. For decades the United States had suffered from chronic oversupply. That condition prompted the farm legislation of the 1930s, which tried to cut back on production and prop up prices. But in the early 1970s, many forces combined to spark a boom in farm exports that, in retrospect, created a halcyon decade for U.S. agriculture.

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The export boom was dramatic. In 1970, the value of farm exports totaled $7 billion. That doubled in 1973, the year of the first big Soviet wheat sale. By 1980, the value of farm exports had increased to $41 billion. Export volume reached 162 million metric tons by 1980, compared with only 64 million in 1970. The rapid expansion was fueled mostly by strong economic growth abroad, readily available world credit, opening of trade with centrally planned economies, and a relatively weak U.S. dollar.

Third World countries became important buyers of U.S. farm products. Relatively rapid economic growth and a tide of developed country credit allowed many developing countries to move up the food ladder. For the decade of the 1970s, the real gross domestic product of all developing countries grew at an average annual rate of 5.2 percent, compared with only 3.0 percent in industrial countries. U.S. farmers supplied a large part of the growing world food trade. By the early 1980s, almost half of U.S. farm exports were destined for developing countries, compared with only 30 percent in 1970.

The export boom had profound effects on U.S. agriculture. The excess capacity problem was pronounced dead by many. A farmland boom was ignited, and with rapid inflation and regulated financial markets, many farmers discovered financial leverage. Marginal lands were brought into production, creating soil erosion problems in many parts of the country. Agribusinesses geared up for what was considered a never-ending growth market. Farm income was the highest it had been in the postwar period.

Producers of major crops grew dependent on export markets. For example, in 1984 U.S. farmers exported 55 percent of the wheat they produced, 25 percent of the corn, 32 percent of the soybeans, and 48 percent of the cotton. Thus, about one out of every three acres in this country goes to the export market.

Macroeconomists discovered the significant contribution agriculture could make to U.S. balance of payments. In the 1950s and 1960s, agriculture's net contribution to the current account was meager, usually less than a few billion dollars. But by 1981, the agricultural trade balance reached a peak of almost $27 billion.

Agriculture now contributes to the current account less than half what it did in 1981.

The farm export boom ended in 1982. The boom had been waning for three or four years, propped up by large loans to Third World buyers. But in 1982, the value of farm exports declined, and the decline has not stopped since. Obviously, farm exports remain very important. But the decline has had profound implications, not the least of which is that agriculture now contributes to the current account less than half what it did in 1981.

Many forces combined to reduce U.S. agricultural exports in the 1980s. The global recession that began in 1981 left many Third World countries with financial problems that most have not overcome. A strong dollar has kept U.S. producers at a significant price disadvantage. Trade barriers remain a problem to entry into foreign markets. Export subsidies by other exporters still are a target for venting farmers' frustration. And export competition is much keener today than when the boom began.

Declining farm exports have had numerous negative effects on the farm sector. Net farm income peaked at $32 billion in 1979, and while the expensive Payment In Kind (PIK) program boosted 1984's result, real farm

income has been low throughout the 1980s. Soft exports have been a primary cause. With slumping foreign demand, U.S. grain surpluses have grown larger and crop prices have moved lower. Agribusinesses have felt the effect of declining farm exports in both lower sales of farm equipment and reduced grain shipments. Grain companies, for example, are currently using only about 40 percent of peak export capacity.

The prolonged decline in farm exports is a major cause of agriculture's bleak outlook for 1986. Farm exports have weakened markedly in 1985. The value of U.S. agricultural exports is expected to total $32 billion, 15 percent below 1984 and more than a fourth less than the 1981 peak. World crop supplies remain large, competitors are anxious to market their stocks, and world demand is weak. As a result of the export decline, and due to a record U.S. harvest in 1985, U.S. grain stocks are rapidly approaching the large levels of 1982 that spawned the PIK program.

U.S. agriculture is adjusting to new market realities with an extremely heavy debt burden accumulated when expectations were much brighter and real interest rates much lower.

Depressed crop prices will contribute significantly to an anticipated 30 percent reduction in 1985 net farm income. And the persistence of huge stocks and low prices will keep farm income low in 1986.

Dimensions of financial stress

The decline in export markets is one major cause of the problems now facing U.S. agriculture. Deregulation of financial markets and a return to lower inflation are the other major causes. Not unlike the debt problem of less developed countries, U.S. agriculture is adjusting to new market realities with an extremely heavy debt burden accumulated when expectations were much brighter and real interest rates much lower.

U.S. agriculture suffers from a serious debt service problem. As a sector, agriculture still carries a low debt-asset ratio—about 21 percent. But the problem is one of distribution—too much debt in too few hands. And the relationship between debt and income has become a crushing one. In the last 15 years, net farm income has not changed a great deal, while farm debt has quadrupled. The result has been a debt-income ratio that suggests one dollar of farm income must now support nearly ten dollars of debt.

Farm financial stress is concentrated among the nation's heavily leveraged commercial farmers—farms with annual sales greater than $40,000. About 129,000 farms—20 percent of the 634,000 commercial farms—have a debt-asset ratio greater than 40 percent and a negative cash flow.[1] Together, these farms owe $46 billion to all farm lenders. If the farm economy does not improve in the next few years, many farmers in this category will have great difficulty servicing their debt.

The most serious debt service problems are found on farms with a negative cash flow and a debt-asset ratio greater than 70 percent. These farms number about 54,000—9 percent of all commercial farms. These farms likely are in danger of failing in the next year or two. They owe about $23 billion to all commercial lenders, or put in perspective, an amount equal to one-third of all U.S. commercial bank loans to Argentina, Brazil, and Mex-

[1] U.S. Department of Agriculture, *Financial Characteristics of U.S. Farms, January 1985*, Agriculture Information Bulletin No. 495.

ico. Thus, we see a farm debt problem of significant dimensions. A substantial portion of farm assets must move from weak to stronger hands.

Financial stress has been exacerbated by the sharp decline in farmland values. Farm asset values have declined more in the 1980s than any time since the Great Depression. For the nation, farmland values peaked in 1982 and have declined 18 percent since then. Declines have been even steeper in many parts of the country. Land values in some areas have fallen more than 50 percent. In the Tenth Federal Reserve District, land values are nearly 45 percent below their 1981 peak. And the pace of asset value decline quickened over the last 18 months. District land values fell 22 percent between October 1984 and October 1985.

The decline in values has added to the financial strain of farmers who borrowed against rising collateral values in the 1970s. As land values have continued to decline, more and more borrowers find themselves unable to service existing obligations without restructuring their debts or selling their assets. Either is increasingly difficult in a declining market. For lenders, the deterioration in the credit quality of farm borrowers has led to higher loan losses and mounting numbers of past due and nonperforming loans.

Commercial banks have witnessed a substantial increase in their farm loan losses. Agricultural banks had much smaller loan losses than nonagricultural banks during the 1970s. But the tables have turned. Agricultural bank loan losses are more than four times what they were in 1980. And the rate of failure among agricultural banks has risen sharply. In 1983, only 7 of 44 bank closings in the United States were agricultural banks. In 1984, that increased to 25 out of 79. And thus far in 1985, 48 out of 95 bank failures have been agricultural banks.

The cooperative Farm Credit System (FCS) is under even greater pressure since all its loans are agricultural. The system already has reported a loss of $426 million in the first nine months of 1985 on its $74 billion farm loan portfolio. And the system will almost certainly record its first annual loss in 1985. Surprisingly, the system's problems have only recently had any sharp impact on Wall Street. The yield spread on FCS bonds over Treasury securities widened noticeably only after the governor of the Farm Credit Administration in September announced a need for public assistance. Since that time, the spread has widened to around 80 to 100 basis points, well above the normal 15 to 30 basis points.

Farm solutions: the international dimension

Solutions to agriculture's fundamental problems will not come easily. Because agriculture is no longer a domestic industry, farm policy cannot solve farm problems. Macroeconomic forces and international trade and economic forces also will be critical to restoring farm economic health.

A weaker dollar by itself is no panacea for U.S. farm exports.

International trade is a critical dimension of agriculture's current adjustment. Agriculture, along with the rest of the economy, has become more dependent on trade. And the opening of the U.S. economy to international trade carries with it two substantial implications for agriculture.

The first is that U.S. macroeconomic policy, through its international effects, has

become much more important to agriculture. The combination of U.S. fiscal and monetary policy has direct effects on U.S. interest rates and the exchange value of the dollar. And U.S. interest rates influence world interest rate levels. In the 1980s, agriculture has learned that it is greatly affected when U.S. economic policies keep real interest rates high and thereby contribute to slower economic growth in trading partner developing countries.

The second implication for agriculture is the competitiveness that is brought by a more open economy. The world food market has become keenly competitive since the U.S. export boom began. Many countries—such as Argentina, Australia, Canada, and the European Community—now vie for market share along with the United States in the stagnant world food market.

U.S. agriculture, therefore, must be extremely price competitive, which requires trimming costs. For producers, this has meant a secular decline in farmland values, the major part of crop production costs. Cost reduction is exactly as international trade theory demands. When a country is exposed to a world market, input prices must move toward a common equilibrium across borders. For agribusinesses, greater competition has meant restructuring the industry to eliminate excess capacity. Thus, the past few years have witnessed the merger and acquisition of some hallmarks in the agribusiness world—International Harvestor, Allis Chalmers, and Far-Mar-Co, for example.

A more open economy, then, is a critical cause of U.S. agriculture's current adjustment. U.S. agriculture cannot ignore international competitive pressures, nor should an agricultural policy be implemented that impairs the United States' competitive position in a global food market. Moreover, agriculture has a great stake in U.S. economic and international policies that foster economic growth abroad.

International factors can contribute to an improved farm economy in two fundamental ways. The first is obvious—a weaker dollar. A weaker dollar would be of considerable help in boosting farm exports. But a weaker dollar by itself is no panacea for U.S. farm exports.

Agriculture would also benefit greatly from lower federal budget deficits and the attendant lowering of real interest rates. Direct benefits would include reduced agricultural production costs and an early halt to declines in farm asset values. But the indirect benefits would be even greater. In addition to further possible declines in the U.S. dollar, lower interest rates would help lower interest rates worldwide. That would facilitate business investment abroad, especially in developing countries where capital formation is key to their economic vitality.

Stronger income growth in the Third World is the second international factor of critical importance to U.S. agriculture. While U.S. producers like to complain about subsidized production by other countries, the reality is that unless world food demand grows, the United States and other exporters will simply engage in a costly battle over market share. Growth in world food trade is a vital prerequisite for U.S. agriculture's return to economic and financial health. And the economic performance of middle-income and developing countries will be the linchpin to any expansion in trade. While agricultural development is crucial in many recipient countries, their own food production gains are unlikely to be great enough to meet the increases in food demand brought about by rising incomes.

Improved economic performance in these countries will depend on two developments. The first is continued strength in U.S. and western economies to allow Third World countries to generate foreign exchange. And

the second is renewed emphasis on economic development assistance to those countries. It is essential that such assistance be targeted to countries where funds could materially improve economic performance and that assistance be long term in character.

Conclusions

The international dimension has been a fundamental force in U.S. agriculture for the past 15 years. In the 1970s, a farm export boom brought prosperity, encouraged investment, and nurtured lofty expectations. But in the 1980s, declining world trade and reduced U.S. farm exports ushered in great financial stress for U.S. agriculture. Despite the vagaries of competing in a world food market, the painful lessons of recent years suggest that increasing farm exports will be a key part of restoring farm prosperity. Until that growth returns, agriculture's passage through the current period of adjustment promises to remain turbulent.

High-Technology Development In the Tenth District

By Tim R. Smith and Marla Borowski

Economic development resources in many parts of the Tenth Federal Reserve District have been directed in recent years to attracting high-technology industries. These efforts have been largely reactions to weakness in the agriculture and energy sectors, traditional sources of strength throughout most of the district. The belief that high-technology industries can provide growth and stability to local and regional economies has been widespread. Recently, however, some of these industries have had setbacks leading to layoffs and plant closings. Nevertheless, high-technology industries have been important in recent economic development in the district, and they promise to continue to be important.

This article examines high-technology development in the Tenth District. In the article, emphasis is given to identifying the characteristics of high-technology manufacturing firms, their location decisions, and to the outlook for high-technology development in the district. The article is divided into two main parts. The first part provides an overview of high-technology manufacturing in the district, wherein high-technology is defined and its significance to district employment is discussed. The second part presents the results of a survey of high-technology manufacturers conducted by the Federal Reserve Bank of Kansas City. These results provide additional information about the characteristics of high-technology manufacturers, their location decisions, and the outlook for high-technology development in the Tenth District.

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Overview of high-technology manufacturing in the Tenth District

What is high technology?

High technology is used in this article to mean manufacturing industries that share the common characteristics of substantial scientific activity and technological innovation. Two measures of scientific activity and techni-

cal innovation are used: spending on research and development relative to sales, and employment of scientific, engineering, and technical workers relative to the total work force.[1] Using both criteria, high-technology industries were identified to include the following classification of manufacturing firms: the manufacturers of chemicals, ordnance, office and computing machines, electrical and electronic equipment, aircraft, guided missiles and space vehicles, miscellaneous transportation equipment, and instruments.[2] Nearly all of these industries have a ratio of research and development expenditures to sales higher than the 3.1 percent average for all industries. Likewise, the proportion of technology-related workers in these industries is also above the average of 6.3 percent for all manufacturing industries.[3]

The definition of high technology used here is not intended to be an exhaustive listing of the district's high-technology industries.[4] For example, no effort has been made to include services, some of which may be related to high technology. There are also other industries in the district that are not included, yet use high-technology processes in manufacturing.

High-technology industries are not all alike, even though they share the characteristics of scientific activity and technological innovation. Innovation and manufacturing processes differ across industries, resulting in differences in the proportion of firms' work forces devoted to research and development and in the skill levels of manufacturing workers. These differences affect the location decisions of firms and the subsequent economic impact registered on different areas.

Employment growth in high-technology industries

Employment growth in high-technology industries has been strong in the Tenth District (Table 1). High-technology employment increased 18.9 percent from the first quarter of 1978 (the earliest period for which data are available at the state level) to the second quarter of 1984, compared with growth of 2.5 percent for all manufacturing employment and 13.9 percent growth for total nonagricultural employment. For the nation as a whole, employment in high-technology industries grew 13.6 percent during the 1978-84 period, while total manufacturing employment declined 3.1 percent and total nonagricultural employment grew 12.5 percent.

District growth in high-technology manufacturing has been unevenly distributed across industries during the 1978-84 period (Table 1). Employment in office and computing machine firms and in guided missile and space vehicle firms more than doubled. Manufacturers of instruments and ordnance also made substantial gains. Employment growth in the chemical and electrical and electronic equip-

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[1] For expanded discussions of high-technology definitions, see *Technology, Innovation, and Regional Economic Development*, U.S. Congress, Office of Technology Assessment, OTA-STI-238, Washington, D.C., July 1984, and Lynn E. Browne, "High Technology and Regional Economic Development," *Economic Indicators*, Federal Reserve Bank of Boston, April 1984.

[2] This definition is based on the Standard Industrial Classification (SIC) codes. It includes all firms in SIC categories 28, 36, 38, 348, 357, 372, 376, and 379.

[3] Richard Riche, Daniel E. Hecker, and John U. Burgan, "High Technology Today and Tomorrow: A Small Slice of the Employment Pie," *Monthly Labor Review*, November 1983, pp. 50-58.

[4] These other definitions are described in detail in Riche, Hecker, and Burgan or in the following sources: Catherine Armington, Candee Harris, and Marjorie Odle, *Formation and Growth in High Technology Firms: A Regional Assessment*, The Brookings Institution, Washington, D.C., under contract with the U.S. Congress, Office of Technology Assessment; Amy K. Glasmeier, Peter G. Hall, and Ann R. Markusen, *Recent Evidence on High-Technology Industries' Spatial Tendencies: A Preliminary Investigation*, University of California Institute of Urban and Regional Studies; and Browne.

TABLE 1
Growth in high-technology employment, Tenth District and United States, 1978:Q1-1984:Q2
(percentage change in average employment)

Category	Tenth District	United States
Chemicals	7.4	-3.1
Electrical and electronic equipment	12.8	12.9
Instruments	37.0	11.6
Ordnance	40.1	31.2
Office and computing machines	116.6	58.7
Aircraft	-3.3	16.9
Guided missiles and space vehicles	176.0	80.2
Miscellaneous transportation equipment	-31.0	-21.9
Total high-technology employment	18.9	13.6
Total manufacturing employment	2.5	-3.1
Total nonagricultural employment	13.9	12.5

Source: Bureau of Labor Statistics, unpublished ES-202 data
Note: Data for 1984 are preliminary.

ment industries was only modest, while employment in the aircraft and miscellaneous transportation equipment industries declined.

Growth in high-technology employment since 1978 has also been cyclical, with the greatest downturn coinciding with the economic recession in 1982 (Chart 1). High-technology employment in the Tenth District has generally grown faster than U.S. high-technology employment during expansions and has decreased at a faster rate than in the United States during contractions.

The overall distribution of high-technology employment in the Tenth District is much like that in the United States (Table 2). As in the nation, the largest numbers of jobs are found in chemical firms and electrical and electronic equipment firms. However, employment in aircraft manufacturing is relatively more important in the district than in the nation.

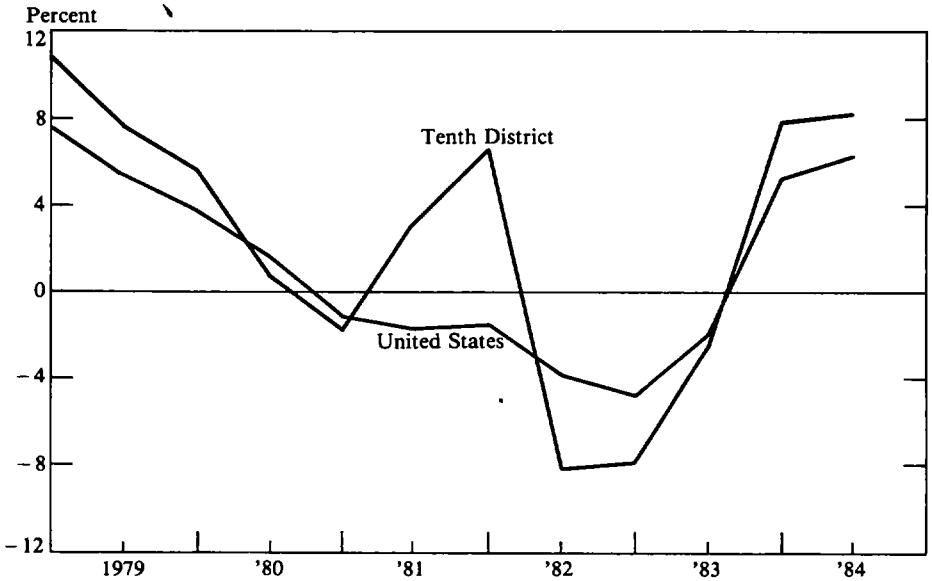
High-technology employment in Tenth District states

The importance of high-technology employment varies widely across the seven district states. For states as a whole, high technology in 1984 accounted for 5.1 percent of total nonagricultural employment, compared with 5.8 percent nationwide. The proportion of high-technology employment to total employment varied from 6.3 percent in Missouri to a scant 0.2 percent in Wyoming. Kansas, Missouri, and Colorado had ratios above the district average, while Nebraska, Oklahoma, New Mexico, and Wyoming had ratios below the average.

Kansas has one of the highest ratios of high-technology employment in the district, due mainly to employment in the aircraft industry. Aircraft is sometimes overlooked as a high-technology industry, even though a large number of jobs related to research and development are in aircraft manufacturing (see survey results below). In addition to aircraft, a substantial number of high-technology jobs in Kansas are in electrical and electronic equipment manufacturing and in instruments manufacturing.

Missouri has by far the largest number of jobs in electrical and electronic equipment establishments—more than twice the number in any other district state. Chemical manufacturing also provides far more jobs in Missouri than in any other state in the district. Aircraft

CHART 1
Growth in high-technology employment



Source: Bureau of Labor Statistics, unpublished ES-202 data

and instruments manufacturing are other important high-technology industries in Missouri.

Employment in office and computing machine production is far higher in Colorado than in any other district state. There is nearly seven times more employment in computer manufacturing in Colorado than the average for the other district states. Colorado is second only to Missouri in employment in the electrical and electronic equipment and instruments industries.

Only moderate numbers of high-technology jobs are found in Nebraska, Oklahoma, and New Mexico. Most of these jobs are in the electrical and electronic equipment and instruments industries, though the chemical and aircraft industries together provide about 11,000 jobs in Oklahoma. While New Mexico is often cited for its high technology, only Wyoming has fewer high-technology jobs in the district. Wyoming has less than 500 high-technology jobs, and more than half of them are in chemical firms.

Most of the district states shared in the strong growth that occurred in high-technology employment in the 1978-84 period. New Mexico led the district with a 66.6 percent increase in high-technology employment, compared with the 18.9 percent increase for the district as a whole (Table 3). So, while New Mexico has relatively few high-technology jobs, its high-technology industries have added jobs at a healthy clip.

Growth in high-technology employment has also been above the district average in Colorado and Nebraska. Growth in employment in ordnance, electrical equipment, and computer firms has been especially strong in Colorado, though that state lost jobs in the miscellaneous

TABLE 2
High-technology employment in Tenth District states, 1984:Q2

Category	Colorado	Kansas	Missouri	Nebraska	New Mexico	Oklahoma	Wyoming	Tenth District	United States
Chemicals	8,204	7,930	28,690	2,706	3,502	1,082	271	52,385	1,050,002
Electrical and electronic equipment	21,660	10,029	50,928	9,635	6,302	11,307	49	109,910	1,947,013
Instruments	23,896	3,995	12,067	4,222	1,153	2,252	60	47,645	636,495
Ordnance	337	897	2,893	*	*	76	*	4,203	57,611
Office and computing machines	18,639	1,333	1,165	2,113	1,133	8,193	*	32,576	526,920
Aircraft	2,214	34,534	26,461	590	1,540	7,586	47	72,972	589,700
Guided missiles and space vehicles	*	-0-	5,423	-0-	674	*	-0-	6,097	83,494
Miscellaneous transportation equipment	236	807	664	898	71	256	59	2,991	52,918
Total high-technology employment	75,186	59,525	128,291	20,164	11,955	33,172	486	328,779	5,354,664
Percent of total nonagricultural employment	5.4	6.2	6.3	3.2	2.4	2.8	0.2	5.1	5.8

Source: Bureau of Labor Statistics, unpublished ES-202 data; Data Resources, Inc.
Note: Data for 1984 are preliminary.
*Not disclosable. Fewer than three firms. Some totals are, therefore, biased downward.

transportation category. Aircraft and instruments manufacturing account for much of the increase in high-technology employment in Nebraska.

Oklahoma has added high-technology jobs at about the same rate as the district as a whole. Most of this growth has been in ordnance, computers, and aircraft manufacturing.

High-technology employment declined in Wyoming and Kansas. Employment in high-technology industries in Wyoming fell by a third. Only in the electrical equipment category was employment growth strong in Wyoming. Jobs were lost in all other high-technology categories. At 1.3 percent, the decline was far less in Kansas, where the largest job losses were in the computer and miscellaneous transportation equipment industries.

Because of the significant differences in the composition and growth of high-technology employment in district states, policymakers in these states must consider varied sources of economic development and face constraints to economic development from high-technology sources that differ across the region. The following survey results provide additional insight into the characteristics of high-technology companies in the district, their location decisions, and the district outlook for high-technology manufacturing.

TABLE 3
High-technology employment growth in Tenth District states, 1978:Q1-1984:Q2
(percentage change in average employment)

Category	Colorado	Kansas	Missouri	Nebraska	New Mexico	Oklahoma	Wyoming	Tenth District	United States
Chemicals	44.0	-9.0	2.9	21.3	92.2	4.5	-22.2	7.4	-3.1
Electrical and electronic equipment	84.4	9.7	2.9	0.5	66.2	-17.0	329.4	12.8	12.9
Instruments	34.5	-0-	61.4	26.9	370.1	20.8	-44.5	37.0	11.6
Ordnance	942.3	*	42.4	*	*	430.2	*	40.1	31.2
Office and computing machines	129.6	-13.7	34.8	*	73.0	162.0	*	116.6	58.7
Aircraft	4.8	-1.7	-14.5	59.5	30.8	33.0	-5.3	-3.3	16.9
Guided missiles and space vehicles	*	†	*	†	-7.9	*	†	176.0	80.2
Miscellaneous transportation equipment	-60.5	-55.3	28.1	-13.0	404.8	-16.2	-9.7	-31.0	-21.9
Total high-technology employment	40.1	-1.3	7.6	20.8	66.6	18.5	-33.9	18.9	13.6
Manufacturing employment	20.3	-1.0	-2.7	-1.3	12.7	4.4	-12.0	2.5	-3.1
Total nonagricultural employment	25.4	9.0	7.6	7.2	17.9	19.7	14.3	13.9	12.5

Source: Bureau of Labor Statistics, unpublished ES-202 data; Data Resources, Inc.
Note: Data for 1984 are preliminary.
*Not disclosable. Fewer than three firms.
†No employment during 1978:Q1 and 1984:Q2.

Survey of Tenth District high-technology companies

During the second quarter of 1985, 240 high-technology manufacturing establishments in the Tenth District were surveyed by the Federal Reserve Bank of Kansas City. The companies were selected systematically from the high-technology establishments in Colorado, Kansas, Nebraska, Oklahoma, Wyoming, western Missouri, and northern New Mexico.[5] These companies had 1,870 associ-

[5] Though survey recipients were randomly selected, the 240 respondent firms do not represent a random sample because of the unevenness of the response. Therefore, results for the entire population of district high-technology firms cannot be inferred from the survey. Survey recipients were selected from: *1985 Directory of Colorado Manufacturers*, Business Research Division, College of Business and Administration, University of Colorado, Boulder; *Directory of Kansas Manufacturers and Products, 1985 Edition*, Kansas Department of Economic Development, Topeka; *Missouri Directory, 1985 Edition*, Informative Data Company, St. Louis; *Directory of Nebraska Manufacturers, 1984-85*, Nebraska Department of Economic Development, Lincoln; *1983 New Mexico Manufacturing Directory*, Economic Development and Tourism Department, Santa Fe; *Oklahoma Directory of Manufacturers and Products, 1983 Edition*, Oklahoma Economic Development Department, Oklahoma City; and *Wyoming Directory of Manufacturing and Mining, 1985-86 Edition*, Wyoming Department of Economic Planning and Development, Cheyenne.

TABLE 4
Comparison of survey respondents with all high-technology firms in Tenth District, 1984:Q2

Category	Percent of Respondents	Percent of High-Technology Firms in District
Chemicals	32.2	30.7
Electrical and electronic equipment	28.0	30.7
Instruments	21.3	21.1
Ordnance	1.3	0.9
Office and computing machines	7.5	5.2
Aircraft	6.3	7.5
Guided missiles and space vehicles	0.4	0.6
Miscellaneous transportation equipment	2.9	3.3

Sources: Federal Reserve Bank of Kansas City High-Technology Survey and Bureau of Labor Statistics, unpublished ES-202 data.
Note: 1984 Tenth District data are preliminary.

ated plants or facilities in the United States and 430 in the district.

Though statistically precise inferences about the whole population of high-technology manufacturers in the district cannot be drawn from the survey results, the types of establishments making up the survey sample are similar to those in the district as a whole. As shown in Table 4, the distribution of survey respondents across broad industrial categories is similar to the corresponding distribution for all district high-technology establishments.

Characteristics of high-technology establishments

Survey results allowed establishments to be categorized by major manufacturing activities. Respondents were asked to describe their products as semiconductors, computers, telecommunications, energy, aerospace/aircraft, biotechnology, drugs, other chemicals, medical instruments, other instruments, and other. (Responses could be made in more than one category.) These product categories allowed respondents to categorize themselves while describing the kind of business conducted at particular establishments. The first column of Table 5 summarizes the major manufacturing activities of high-technology establishments in the district. About a fifth of the companies indicated some activity in the categories of other chemicals and other instruments. Another 15 percent reported aerospace/aircraft activity. Computers, telecommunications, energy, and medical instruments were each cited by about an eighth of the respondents.

Judging by the survey results in Table 5,

TABLE 5
Major manufacturing activity at responding establishments

	Percent Doing Some Business in Category	Average Proportion of Business Conducted in Category
Semiconductors	5	92
Computers	12	45
Telecommunications	12	46
Energy	11	53
Aerospace/aircraft	15	72
Biotechnology	4	10
Drugs	6	34
Other chemicals	21	73
Medical instruments	12	62
Other instruments	20	64
Other	57	80

Source: Federal Reserve Bank of Kansas City High-Technology Survey

much high-technology manufacturing in the district is done in a multiproduct setting. Firms that manufacture more than one product may tend to attract, and be attracted to, less specialized and more diversified work forces. Likewise, capital equipment is probably less specific for multiproduct firms and may imply lower costs of converting facilities from one use to another.

The extent of product specialization varies considerably at responding firms. The second column of Table 5 lists the average percentage of business done in a particular category by establishments that indicated some activity in the category. For example, more than 90 percent of the business that semiconductor manufacturers do is in that same category. This measure of the degree of specialization varies considerably across other product categories.

As indicated by the large number of responses and the high percentage of activity in the "other" category, the list of categories is not exhaustive, nor was it intended to be. The high percentage of establishments listed in the "other" category also indicates that high-technology manufacturing is often associated with more traditional "low-technology" activities. This suggests that areas with manufacturing bases already established may be more successful in developing high technology than areas without such bases. The mix of "high" and "low" technology also affects the composition of the work force, as discussed below.

High-technology companies often develop from already established businesses. A fourth of the respondents indicated that their establishments were spinoffs, meaning they were started by former employees of firms producing related goods or services. This too suggests the importance of a preexisting manufacturing base for areas seeking high-technology

development.

A large part of the high-technology manufacturing activity comes from firms that are fairly new. About 60 percent of the high-technology firms in the sample were started since 1965, and a tenth since 1980. High-technology is not entirely new in the district, however, as 40 percent of respondents indicated they were founded before 1965.

Results of the survey indicate that large, multiestablishment companies employ most of the high-technology workers, as is also true across the United States. Eighty-seven percent of employment was in multiestablishment organizations, virtually the same proportion as in the nation as a whole.[6] Of the establishments surveyed, 18 percent are headquarters for multiplant operations. Branches of multiplant operations and subsidiaries each represent another 10 percent.

Individual establishments tend to be relatively large. Ninety-three percent of the employment is at locations with 100 or more employees, compared with 88 percent nationwide. Plants that employ over 2,500 people account for almost two-thirds of high-technology employment.

Although most high-technology workers are employed at a few large establishments, there are a large number of small high-technology establishments in the district sample. Three-fourths of the sample employ fewer than 100 workers, and 44 percent employ fewer than 25. Most of the establishments are single-plant operations employing fewer people than multiestablishment organizations.

Survey results also indicate that national and international economic conditions affect high-technology manufacturers in the district. More than half the respondents characterize their markets as national and another 10 percent sell their products in an international market. A fifth of the respondents operate in a regional market, while only 13 percent limit their market to their state.

The federal government is an important customer of high-technology manufacturers in the survey. A fifth of the business activity represented in the survey is done under direct contract to the federal government. For aerospace/aircraft companies, the proportion is almost a third. However, drug and semiconductor manufacturers report that government contracts are relatively unimportant to them.

Research and development activities and marketing activities account for substantial portions of the resources of these district manufacturers. An eighth of the resources of these establishments are devoted to research and development. Another fourth is devoted to marketing activities. Two-thirds of the resources are, nevertheless, devoted to manufacturing. This mix of activities has implications for the composition of employment and the distribution of income across different types of establishments. Some high-technology industries may therefore have a less favorable impact on regional employment and income than others.

In addition to the differences in employment levels and growth across industries, the survey results indicate that the composition of the district high-technology work force varies across product categories. The proportions of high-technology employees in occupations related to research and development, manufacturing, and management differ from those in other manufacturing industries. Moreover, these proportions differ across high-technology product categories. The proportion of employment in research and development and other technical occupations is particularly important, as these are among the highest paid and best-trained workers in high-technology manufac-

[6] Armington, Harris, and Odle.

TABLE 6
Percentage of employees in research and development and technical category at responding establishments

Semiconductors	15
Computers	19
Telecommunications	16
Energy	16
Aerospace/aircraft	19
Biotechnology	*
Drugs	11
Other chemicals	10
Medical instruments	19
Other instruments	17
Other	14
All responding companies	14
All U.S. manufacturing	6

Source: Federal Reserve Bank of Kansas City High-Technology Survey and Bureau of Labor Statistics
*Not available because of confidentiality

turing. Employees in this category account for an average 14 percent of the respondents' work forces. For each high-technology product category, they average considerably higher in the work force than the 6 percent average for all U.S. manufacturing. As Table 6 shows, a fifth of aerospace/aircraft, computer, and medical instruments employees are in the research and development/technical category. However, only about a tenth of the employees of companies making drugs and other chemicals perform research and development/technical functions.

As to be expected, manufacturing employees make up the largest proportion of the work force at manufacturing establishments surveyed. An average of 63 percent of the employees at these establishments work in manufacturing. But only about half of the employees in semiconductors, medical instruments, and other chemicals are manufacturing workers. Manufacturing workers also make up only about half the work force at headquarters plants.

For all survey respondents, management and professional employees averaged 20 percent of the work forces. The proportion varied only slightly over nearly all types of enterprises and all categories of products. The only exception was in drug manufacturing, where a fourth of employees were categorized as management or professional.

Generally, the high-technology establishments responding to the survey did not have unionized work forces. Only about a tenth reported that their employees were unionized. For those establishments with unions, however, about half the work force was unionized. Although this is due partly to the low presence of labor unions generally in Tenth District states, it also reflects the absence of unionization in high-technology industries nationally.

To gain some insight into the incomes earned at high-technology companies, respondents were asked about average annual salaries for three categories of employees and about the proportion of wages that could be attributed to each category. Management and professional employees are paid the most at high-technology establishments in the survey, averaging about $39,000 in annual salaries. Energy, other chemicals, and telecommunications companies average more per year, while drug companies average considerably less. For all respondents, 28 percent of the total wages paid go to management/professional employees, with the percentage being slightly higher at drugs, energy, and other chemicals establishments.

Research and development and technical

TABLE 7
Significance of factors determining location in a state
(percent of all respondents)

Location Factor	No Significance*	Some Significance	Significant	Very Significant
State tax climate	52	21	16	11
State regulatory practices	53	18	19	11
Access to markets	39	14	19	28
Labor costs	33	21	28	18
Labor skill/ availability	34	21	25	20
Access to raw materials	57	18	17	8
Cost of living	42	27	23	8
Transportation	42	21	24	13
Energy costs/ availability	47	21	22	10
Climate	50	17	22	11
Cultural amenities	58	22	17	4
Academic institutions	56	22	15	8

Source: Federal Reserve Bank of Kansas City High-Technology Survey
*Includes establishments that did not respond to a particular factor

employees are the next highest paid group. Their annual salaries average about $29,000. Salaries vary only slightly across product categories, though research and development and technical personnel are paid slightly more at semiconductor and energy establishments. Workers of this type receive about a fifth of total wages paid by responding establishments, though for other instruments and semiconductor manufacturers, the proportion is a fourth.

Manufacturing employees average about $18,000 in annual salary, according to survey respondents. Aerospace/aircraft and other chemicals manufacturing salaries average higher, while medical instruments, drugs, and semiconductors plants average less. Fifty-six percent of all wages paid by responding establishments go to manufacturing workers.

Location decisions

The survey included several questions about current location and possible expansion. Other location studies have shown that the factors determining the choice of a particular state are different from the factors determining location within that state.[7] Yet another set of factors

[7] Results from other location decision studies are reported in *Location of High-Technology Firms and Regional Economic Development*, Joint Economic Committee, U.S. Congress, and Glasmeier, Hall, and Markusen.

TABLE 8
Significance of factors determining location in a locality within a state
(percent of all respondents)

Location Factor	No Significance*	Some Significance	Significant	Very Significant
Good transportation facilities for materials and products	32	20	27	20
Good transportation for people	44	27	21	7
Cost of property and construction	31	20	30	19
Proximity to raw materials and component supplies	50	17	21	12
Availability of energy supplies	45	26	19	10
Adequate waste treatment facilities	67	18	9	6
Local government tax structure	49	23	19	9
Water supply	54	20	18	8
Proximity to schools	50	20	23	7
Proximity to recreational and cultural opportunities	48	27	18	7

Source: Federal Reserve Bank of Kansas City High-Technology Survey
*Includes establishments that did not respond to a particular factor

influences decisions to expand existing facilities. Respondents were asked to rank location and expansion factors as not significant, of some significance, significant, or very significant.

Access to markets appears to be an important reason for locating in a particular state. This factor is deemed "very significant" by 28 percent of survey respondents, more than any other factor (Table 7). Access to markets has the highest order of significance among location factors for drugs, other chemicals, energy, and aerospace/aircraft manufacturers.

Labor skill and labor costs also appear to be important reasons for locating in a particular state. Both factors are cited as being very significant by about a fifth of the respondents. Labor skill has the highest order of significance among location factors for manufacturers of computers and other instruments. Labor skills and labor costs both rank highest in order of significance for telecommunications establishments.

Reasons for choosing a particular locality

TABLE 9
Significance of factors in determining expansion
(percent of all respondents)

Location Factor	No Significance*	Some Significance	Significant	Very Significant
Train labor	39	32	22	8
Offer financial incentives	18	20	34	28
Loan guarantees	34	22	28	17
Low interest loans	21	11	27	41
Industrial development bonds	26	21	26	27
Property tax abatement	17	24	31	28
Research subsidies	39	26	22	13
Investment tax credits	17	16	31	37
Procure resources from local businesses	42	29	21	8
Reduce taxes	14	18	29	39
Cut red tape	20	20	26	34
Reduce lost time during inspections	43	28	17	13
Improve community attitude	41	28	17	15
Improve cultural amenities	48	33	14	4
Improve recreational facilities	49	31	15	4

Source: Federal Reserve Bank of Kansas City High-Technology Survey
*Includes establishments that did not respond to a particular factor

within a state differ from those for choosing the state as a general location. Availability of transportation facilities for materials and products and the cost of property appear to be important reasons for choosing a particular locality within a state. These factors were each cited as very significant by about a fifth of the respondents, more than any other factor (Table 8). Transportation for materials and products has the highest order of significance among location factors for manufacturers of other chemicals and aerospace/aircraft. Cost of property has the highest order of significance for computer and telecommunications establishments.

Three actions that state and local governments can undertake to encourage business expansion, as distinct from attracting new businesses, are often considered important by high-technology firms in the survey. Almost

two-fifths of respondents cite reducing taxes as very significant to expansion at their current locations (Table 9). Tax reduction is of the highest order of significance among expansion factors to drug, telecommunications, and medical instrument establishments. Cutting red tape is very significant to a third of the respondents. It is ranked highest in order of significance by producers of energy-related products, other chemicals, and other instruments. Offers of financial incentives are very significant to 28 percent of the establishments and are of highest order of significance among other expansion factors for aerospace/aircraft and computer manufacturers. Financial incentives and cutting red tape both rank highest in order of significance for energy establishments. Drug establishments consider both tax reduction and financial incentives highest in order of significance among other expansion factors.

Of the particular financial incentive programs offered by state and local governments to encourage expansion of businesses, four appeared to be popular—low-interest loans, investment tax credits, property tax abatement, and industrial revenue bonds (Table 9). Of those establishments which ranked financial incentives as having at least "some significance," more than two-fifths deem low-interest loans "very significant" in affecting expansion in their current locations. Almost as many, 37 percent, cite investment tax credits as very significant. Property tax abatement and industrial development bonds are both very significant to a little more than a fourth of these respondents.

In addition to the factors ranked in Tables 7-9, respondents were asked about the significance of some additional factors in their general choice of location. These additional factors include the availability of venture capital, proximity of universities, and the location of federal facilities. The availability of venture capital is very significant to only 6 percent of the establishments in deciding on their current locations. But the number of respondents citing the availability of venture capital as very significant increases threefold when the decision involves expansion. Nineteen percent of the respondents consider it to be very significant to their decision to expand. This suggests that venture capital availability might play an expanded role in states with already established high-technology manufacturing.

Slightly more than a third of the respondents consider proximity to a university system a factor in choosing a location. Semiconductor and other instrument manufacturers are more likely to consider the proximity to a university, but being near a university is a factor in the location decision of almost half of branch enterprises. Three factors appear important to companies that consider university proximity in their location choice. Twenty-three percent consider the availability of college graduates very significant. Degree programs for employees are very significant to 22 percent of the establishments, and 21 percent cite the transfer of scientific knowledge as being very significant.

Only 3 percent of the respondents believe that location near a federal facility, whether military or not, is very significant in their ability to obtain federal contracts. This is true even though they conduct a fifth of their business under direct contract to the government. This result implies that states with few federal facilities can still be hosts to companies doing significant business with the federal government.

Outlook for high-technology manufacturing

The survey provides some insight into the plans of high-technology firms in the Tenth

TABLE 10
New plants and facilities respondents plan for next five years

	Manufacturing Plants	Nonmanufacturing Facilities	Total
Semiconductors	*	*	*
Computers	12	2	14
Telecommunications	5	5	10
Energy	13	9	22
Aerospace/aircraft	6	2	8
Biotechnology	*	*	*
Drugs	1	2	3
Other chemicals	15	17	32
Medical instruments	13	8	21
Other instruments	19	8	27
Other	38	43	81
All responding establishments†	76	76	152
New plants or facilities planned in Tenth District states	37	30	67

Source: Federal Reserve Bank of Kansas City High-Technology Survey
*Not available because of confidentiality.
†Total is not summation of all categories because some establishments have business activities in more than one category.

District. Responding establishments answered questions about employment decisions for the next year and about building new manufacturing plants and nonmanufacturing facilities over the next five years. While some establishments expect no change or decreases in employment in the near term, the overall outlook for high-technology employment growth appears generally good in the Tenth District.

Over the next year, two-thirds of responding high-technology establishments expect to increase employment. Increases are planned by more than two-thirds of drugs, medical instruments, and aerospace/aircraft manufacturers. About three-fifths of semiconductor and computer manufacturers plan to increase employment over the next year, but almost 40 percent plan no change and 5 percent are likely to reduce employment.

For all survey respondents, less than 5 percent expect to reduce their work forces. Of these, plants producing medical instruments are the most likely to do so. A third of the establishments expect their employment to remain the same.

Respondents able to discuss their plans for the next few years plan to add 76 new manufacturing plants by 1990. Of these, 37 will be in district states (Table 10). This number may understate the number that are actually built,

because some companies had not completed plans for the next five years. Most of the plant additions will be in other instruments, other chemicals, energy, and medical instruments. Most of the additional plants will be single plant and headquarters operations.

A total of 76 additional nonmanufacturing facilities, such as sales offices and warehouses, are planned over the next five years. Thirty of these facilities are planned for district states (Table 10). Computer companies and makers of other chemicals plan more additions than companies producing any other category of goods. Most of the additional facilities are planned by single plants and headquarters. Again, the number of new facilities may be understated.

Conclusion

High-technology manufacturing is important to the economy of the Tenth Federal Reserve District. In addition to significant recent growth in a number of high-technology manufacturing industries, the future of high-technology in the district appears to be good. As high-technology industries mature in the Tenth District, the region can be expected to specialize in manufacturing activities in which it has a comparative advantage. These activities include the development of high technology for military use and the application of such development to commercial use. Military high technology is developed extensively at government research facilities in New Mexico and facilities near the Consolidated Space Operations Center in Colorado. Given the importance of agriculture and energy in the regional economy, the district is also well suited for development in biotechnology and energy.

The district's future in high-technology development is not limited, however, to growth in high-technology industries alone. A broader view of high technology suggests that the application of high-technology production methods to traditional sectors will be increasingly important in economic development throughout the district. Examples are the use of robotics in mining and automobile manufacturing, and genetic engineering to improve agricultural productivity.

Though high technology has been a source of economic growth in the Tenth District, and will likely continue to be, two qualifications are in order. First, as revealed by the survey of Tenth District high-technology manufacturing firms, some high-technology industries have a less favorable effect on regional employment and income than others. Second, cyclical fluctuations are more pronounced in some high-technology industries, for example, in computer and semiconductor manufacturing. Recognition of these tendencies and the factors affecting location decisions of high-technology manufacturers will be important in shaping economic development policy and the future of high technology in Tenth District states.

Investment in Recession and Recovery: Lessons from the 1980s

By George A. Kahn

Investment spending influences both the trend and cyclical components of economic growth. By adding to the capital stock or allowing the capital stock to depreciate, investment spending affects the economy's future capacity to grow. Because investment spending fluctuates with greater volatility and persistence than most other major components of gross national product (GNP), it can go a long way toward explaining the short-run fluctuations of output and employment. Thus, an understanding of the determinants of investment can lead to a better understanding of the determinants of economic growth and business cycles.

The unusual behavior of investment in the 1981-82 recession and the current economic recovery may help determine key factors in explaining investment spending. Few episodes of modern economic history provide as interesting a set of interacting variables. Declining tax rates, lower inflation, high real interest rates, and a deep recession followed by a strong economic recovery have been associated with an unusually strong rebound in investment spending. Some analysts have attributed this rebound to reductions in corporate taxes.[1] Others have refuted the tax argument and focused on a combination of other factors. These factors include increased business and consumer confidence, lower capital goods prices, and strong expected GNP growth.

This article examines the unusual recent behavior of investment and considers alternative explanations for the investment boom. The article argues that most empirical evidence on the cause of investment's strength points toward a multiplicity of factors. The first section reviews investment's behavior since 1981 by component and in relation to historical patterns. The second section dis-

George A. Kahn is an economist with the Federal Reserve Bank of Kansas City. Thomas W. Dean, a research assistant at the bank, provided research assistance.

[1] See, for example, John Makin, "The Budget Answer Lies in Spending Cuts Not Tax Boosts," *Business Week*, June 17, 1985, p. 22, and Maggie McConas, "Did Supply Side Incentives Work?" *Fortune*, November 26, 1984.

cusses theoretical factors that determine investment spending. The third section surveys empirical evidence on the importance of taxes as compared with other determinants of investment.

The recent behavior of investment in historical perspective

Real business fixed investment boomed during the first six quarters of the current economic expansion. Its growth rate of 16.4 percent, between the last quarter of 1982 and the second quarter of 1984, greatly exceeded the average performance of 6.5 percent growth in the first six quarters of previous postwar recoveries. This strong growth in spending on plant and equipment came during a period in which real GNP grew at 7.1 percent, compared with the postwar average rate of 5.8 percent for the first six quarters of recovery. More recently, investment and overall economic growth have slowed somewhat. From the second quarter of 1984 to the second quarter of 1985, business fixed investment grew at an 8.4 percent annual rate while real GNP grew at a 1.9 percent rate. Even with the slowing of investment spending in the last two quarters, however, business fixed investment has experienced a period of unusually strong growth. This section explores the composition of that growth and compares it with investment behavior in previous business cycles.

Business fixed investment consists of business purchases of capital goods, excluding changes in inventories. It is composed of two major components—structures and equipment. The structures component includes private (nonresidential) new construction, construction and exploration expenditures for petroleum and natural gas drilling and mine shafts, commissions on the sale of structures, and net transfers of used structures from (or to) government. Major categories of structures spending are commercial, industrial, and other nonresidential buildings, public utilities, farm buildings, and mining exploration, shafts, and wells. Equipment spending refers to private purchases of producers' durable equipment. Major categories include office, computing and accounting machinery, electrical and communication equipment, autos, trucks, buses, and truck trailers, and instruments.

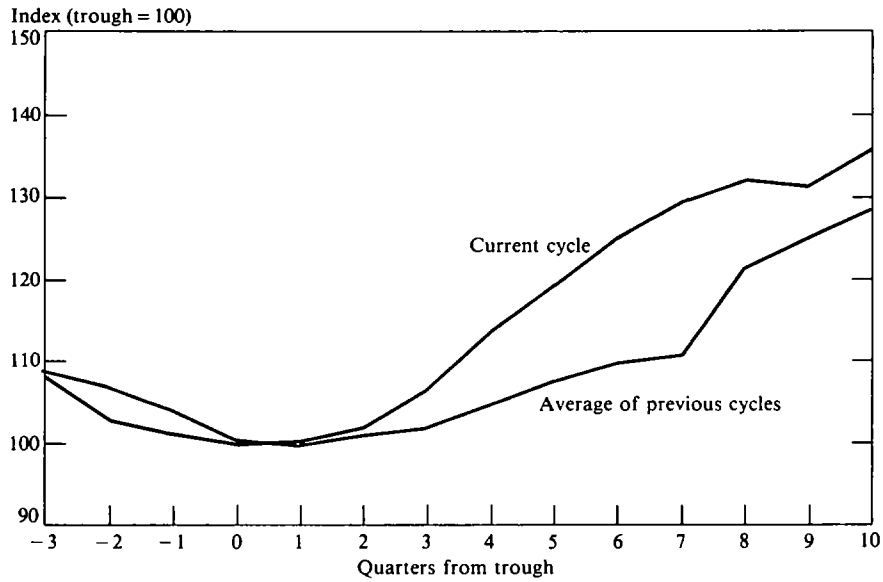
While total investment spending boomed after 1982, not all sectors shared equally in the recovery. The recovery of spending on business structures was slower, and the recovery of spending on business equipment was faster, than the increase in total investment.

Total real business fixed investment

Business fixed investment has been unusually strong in the current recovery. Chart 1 compares total business fixed investment in the current business cycle with an average of fixed investment in five previous postwar business cycles.[2] For the current cycle, the chart runs from 1982:Q2 to the recession trough in 1982:Q4, and from 1982:Q4 to 1985:Q2. The chart shows that while investment behaved in a fairly typical fashion in the 1981-82 recession, it rose more rapidly in the current recovery than was typical of previous recoveries. Because the data in the chart are index numbers based on the recession trough, the chart obscures the fact that the level of real business fixed investment in the current recovery did not catch up with its previous peak (1981:Q3) until 1983:Q4. In fact, real invest-

[2] The trough dates of the five previous cycles are 1954:Q2, 1958:Q2, 1961:Q1, 1970:Q4, and 1975:Q1. The 1981-82 recession trough occurred in 1982:Q4. Average data for the eighth, ninth, and tenth quarters from the trough of previous cycles represent four observations since the second cycle's recovery (trough in 1958:Q2) lasted only seven quarters.

CHART 1
Real business fixed investment



Source: *Survey of Current Business,* Bureau of Economic Analysis. Obtained from Data Resources, Inc.

ment spending started out the current recovery at a point equal to only its 1978:Q3 level. Thus, while investment boomed in the recovery, it boomed from a depressed starting point and only recently caught up to its previous peak.

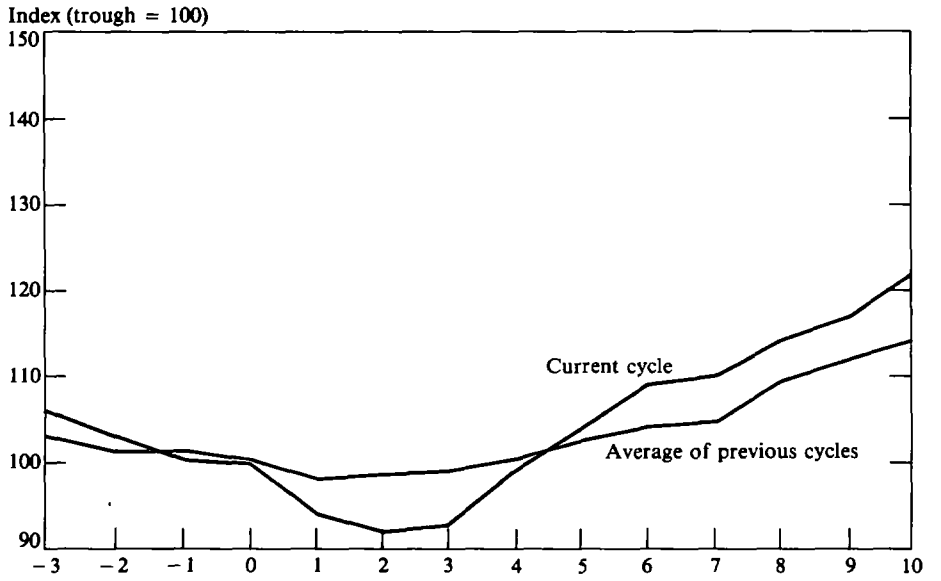
Real business structures investment

Business structures investment makes up the smaller share of business fixed investment. For example, investment in business structures accounted for 27.8 percent of total real business fixed investment in 1984. As is typical of previous cycles, investment growth in structures has been slower than growth for business fixed investment in general. Chart 2 compares real business structures investment in the current business cycle to that of an average of five previous postwar business cycles. It reveals a fairly typical behavior of structures investment during the 1981-82 recession. However, in the first four quarters of the current expansion, investment in structures fell below the average of previous expansions, and, in the last six quarters, rose above the average of previous expansions.

Much of the recent strength in structures investment has come from commercial construction. Relative to real GNP, real commercial construction has climbed to all-time highs, while other nonresidential construction, including industrial, religious, educational, and public utility construction, has fallen off steadily from its peak in 1966.[3] As Chart 3 shows, from 1984:Q1 to 1985:Q2, commercial

[3] Along with the increase in commercial construction, however, office building vacancy rates have risen, from a low of about 3.5 percent in 1980 to about 15 percent in the first quarter of 1985.

CHART 2
Real business structures investment



Source: *Survey of Current Business,* Bureau of Economic Analysis. Obtained from Data Resources, Inc.

construction was significantly higher than it was on average in the fourth through tenth quarters of previous recoveries. On the other hand, noncommercial structures construction (not shown), has behaved much the same as in previous recoveries.

Real business equipment investment

Real business equipment investment accounts for the greater part of total real business fixed investment. For example, it accounted for 72.2 percent in 1984. As Chart 4 shows, it also accounts for much of the strength in business fixed investment since 1982. While investment in equipment fell somewhat faster in the early stages of the 1981-82 recession than is typical of postwar recessions, it also subsequently rose higher and faster. Between 1982:Q4 and 1984:Q3 it rose at a particularly fast 18.6 percent a year, as compared with an average annual rate of 13.8 percent in the comparable period of previous postwar recoveries.

Despite the overall strength in equipment investment since 1982, not all sectors have shared equally in equipment's recovery. While some types of equipment spending have boomed, others have not yet reached their peaks from the 1970s, and still others have remained quite depressed. Table 1 shows purchases of producers' durable equipment, disaggregated by type and measured in real dollars for 1984 (the second year of the current recovery) and an average of five second years of previous recoveries. The table shows that office, computing, and accounting machinery have become increasingly important as sources of equipment purchases. Also becoming more important, but growing at a slower rate, are

CHART 3

Business structures investment: commercial buildings

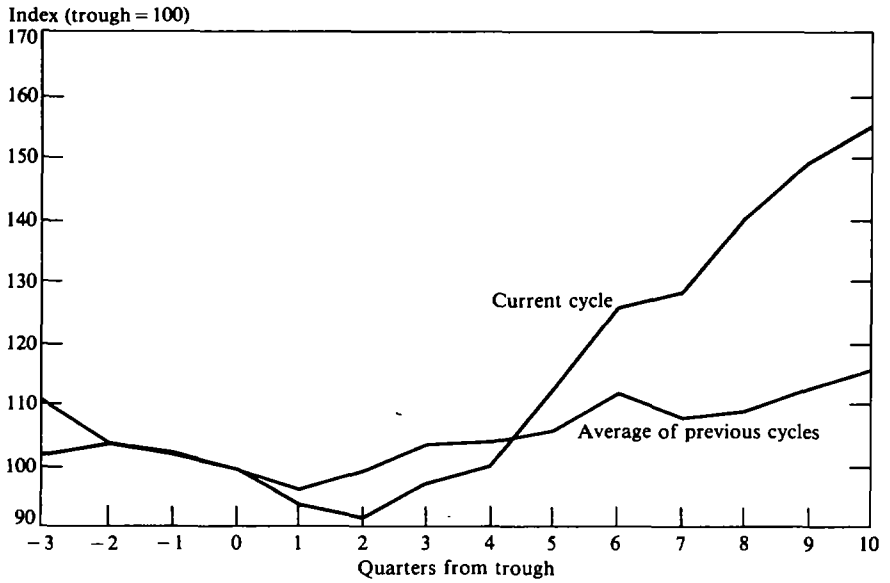
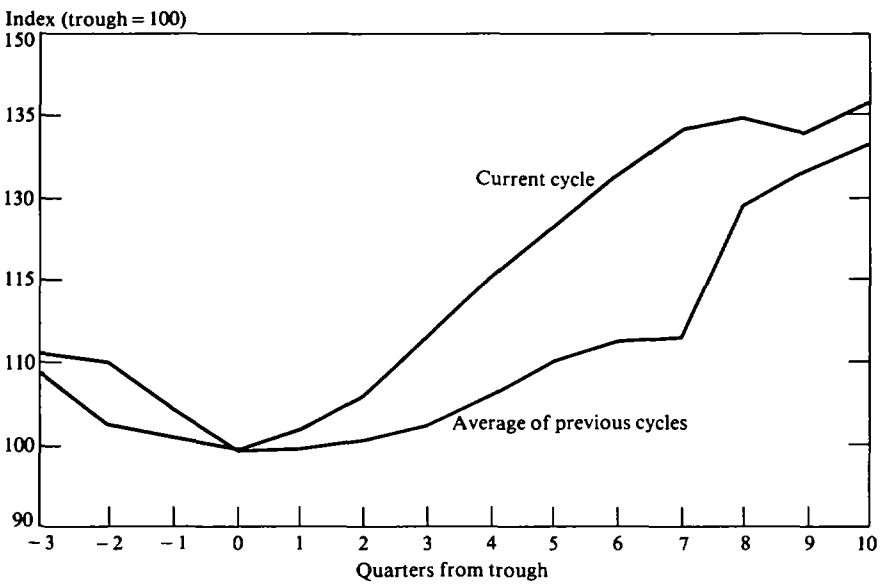


CHART 4

Real business equipment investment



Source: *Survey of Current Business,* Bureau of Economic Analysis. Obtained from Data Resources, Inc.

TABLE 1
Purchases of producers' durable equipment by type
(Billions of 1972 dollars)

Equipment Type	Average of 5 Previous 2nd Years of Recovery	1984
Furniture and fixtures	2.4	5.3
Fabricated metal products	1.9	3.7
Engines and turbines	1.0	1.1
Tractors	1.7	2.7
Agricultural machinery	2.1	1.6
Construction machinery	2.0	2.1
Mining and oilfield machinery	0.9	2.3
Metalworking machinery	3.3	4.9
Special industry machinery	3.5	4.8
General industrial machinery	3.4	4.9
Office, computing, and accounting machinery	3.4	39.5
Service industry machinery	2.1	3.0
Electrical and communications equipment	8.4	24.2
Trucks, buses, and truck trailers	6.0	12.7
Autos	5.5	16.9
Aircraft	1.2	2.4
Ships and boats	0.9	0.6
Railroad equipment	1.3	1.0
Instruments	3.1	12.7
Other miscellaneous	1.7	3.0
Total	55.6	148.0

Source: Department of Commerce, *Survey of Current Business*, various issues

electrical and communications equipment, autos, and instruments.

Despite substantial real growth in the economy since 1948, some sectors of business equipment spending have actually declined from their postwar average in terms of constant dollar purchases. Among these are agricultural machinery, railroad equipment, and ships and boats. Other sectors of equipment spending rose higher in 1984 than in an average of previous recoveries, but grew at a much slower rate than growth in total business equipment. They include industrial, metal working and construction machinery, engines and turbines, and tractors.[4] While some of these structural shifts are the inevitable result of changes in tastes and technology, others may be the result of such nonfundamental influences as differential tax incentives. Assessment of what underlies the uneven investment boom, therefore, requires an understanding of factors affecting business investment.

Factors in business investment

Gross investment spending consists of two parts. One part is replacement investment, that is, spending merely to replace worn out plant

[4] For further discussion, see "The Capital Goods Recovery: Why Some Lag Behind—Part II," *Capital Goods Review*, Machinery and Allied Products Institute, May 1985.

and equipment. Any investment beyond replacement of worn out capital is net investment. Net investment increases the capacity of the economy to produce goods and services. Because net investment changes the size of the capital stock, most theories of investment spending try to explain net investment, treating replacement investment as a constant proportion of the capital stock.[5]

The demand for net investment is a derived demand. It results from consumers' and firms' demand for final and intermediate products and technological requirements for capital as an input to the production process. In deciding how much capital to acquire over a given period, firms evaluate the size of their capital stock relative to expected sales. If sales are expected to rise, more capital may be needed to produce the increased output demanded. If so, net investment results. If sales are expected to fall so that less capital is required, firms may not invest in new capital and may even allow their existing capital stock to depreciate without replacement.

In deciding how much capital to acquire, firms also consider cost. Investment projects will be undertaken only if they yield a stream of returns that, in discounted present value, exceeds the cost of financing. In measuring the cost of investment, firms must consider the influence of taxes, interest rates, inflation, and other variables. Thus, two main factors affect investment decisions—changes in expected sales, also known as the accelerator effect, and the cost of capital. This section describes these factors in greater detail.[6]

The accelerator effect

According to the accelerator principle, net investment depends directly on changes in expected sales. Thus when expected sales accelerate, investment increases. The accelerator relationship results from the assumption that firms try to maintain their capital stock at a constant multiple of expected sales. Assuming for the moment that firms keep their capital stock at desired levels every period, investment is simply the change in the desired capital stock. And since the desired capital stock depends on expected sales, investment depends on changes in expected sales. Because expected sales react with varied responses to such volatile variables as business and consumer confidence, net investment spending can be highly volatile. "Any random event—an export boom, an irregularity in the timing of government spending, or ... a revision of consumer estimates of permanent income"—can cause expected sales growth and investment to shift in the same direction.[7]

While the accelerator theory, in conjunction with a theory or assumption about the determination of expected sales, can explain some of the variation in investment spending, it is far too simple and incomplete a theory to explain most of investment behavior. While the theory is consistent with the near coincidence of peak investment years and peak years of real GNP growth (1950, 1956, 1960, 1966, 1973, and 1978) and the coincidence of investment slumps and real GNP growth troughs (1949, 1952, 1954, 1958, 1961, 1971, 1976, and

[5] For an alternative treatment of replacement investment in which firms do not replace worn out plant and equipment on a fixed schedule, see Martin Feldstein and David Foot, "The Other Half of Gross Investment: Replacement and Modernization Expenditures," *The Review of Economics and Statistics*, Vol. 53, no. 1, February 1971, pp. 49-58.

[6] The following discussion draws heavily on Chapter 14 of Robert Gordon, *Macroeconomics*, 3rd edition, Little, Brown and Company, Boston, 1984.

[7] J. M. Clark, "Business Acceleration and the Law of Demand," *Journal of Political Economy*, Vol. 25, March 1917, pp. 217-235, as quoted in Gordon, p. 448.

1982), the theory only partly explains year-to-year fluctuations in investment.[8] Two problems with empirical efforts to explain investment with a simple accelerator equation are variations in the timing and the size of the response of investment to changes in real sales (often proxied by real GNP). In other words, investment reacts to sales growth with a variable lag and an unstable coefficient.

The delay with which investment sometimes responds to changes in sales results from production lags and adjustment costs. These effects can be incorporated in the accelerator theory by relaxing the assumption that firms maintain their capital stock in every period at its desired level. If it takes time for investment projects to be completed or if costs rise as a result of carrying out investment projects too fast, firms will allow their actual capital stock to deviate from desired levels. Any change in desired capital will be made up only partially through current investment.

In addition to a lag structure, another way of generalizing the simple accelerator model is to allow a variable ratio of desired capital to expected sales. If the desired capital-expected sales ratio reacts systematically to changes in the cost of capital, an explanation emerges for variations in the size of the response of desired capital to expected sales growth.

Cost of capital and the capital-sales ratio

In a more general accelerator model, the desired capital-sales ratio varies with the real user cost of capital. When considering investment projects, firms evaluate the potential increase in revenue from adding to their existing stock of capital. Expressed as a percentage, this additional revenue, called the marginal product of capital (MPK), equals the change in revenue divided by the cost of the investment project. As firms add more and more capital to their production process, the marginal product of capital declines because of diminishing marginal returns. Firms evaluate the merit of investment projects by comparing the marginal product of capital with the real user cost of capital. The user cost of capital is the added cost of operating new plant or equipment over some period. This cost is also expressed as a percentage of the cost of the investment project.

New investment projects will be undertaken up to the point where the marginal product of capital just equals the real user cost. If the marginal product of capital were greater than the real user cost, firms could increase profits by investing in new plant and equipment. But if the marginal product of capital were less than the real user cost, firms would make losses on marginal additions to their capital stock. If something happened to lower the real user cost of capital and firms had previously invested to the point where the marginal product of capital equaled user cost, firms would have a new incentive to invest in more capital. Thus, changes in the user cost of capital affect firms' desired capital-sales ratio and lead to fluctuations in investment demand. Where before only changes in expected sales influenced investment behavior, changes in user cost now also influence investment.

What determines the user cost of capital? Ignoring taxes for the time being, three factors affect user cost. First, there is an interest cost. Firms either pay interest on loans used to buy capital or forego interest by tying up funds in the purchase of capital goods. The higher the interest rate, the higher the user cost of capital and the lower the rate of investment. Second, there is a depreciation cost. Plant and equipment gradually wear out through normal use and need to be replaced. The cost of this

[8] Gordon, pp. 448-449.

wearing out of capital is the depreciation rate, which measures the amount per year a firm must invest simply to maintain its capital stock at a constant level of productivity. The faster capital depreciates, the higher its user cost. Third, there is an offset to user cost through inflation. As inflation raises the cost of new plant and equipment, it simultaneously raises the value of existing plant and equipment. Inflation, therefore, provides a capital gain that lowers the user cost of capital.

Taxes, acting independently or in conjunction with interest rates, depreciation, and inflation, add another dimension to user cost. There are four basic ways in which taxes influence user cost. One effect is through the corporate income tax. In a world with taxes, an investment project must earn a higher before-tax rate of return to provide investors the same after-tax rate of return. Thus, when the corporate income tax rises, firms pay a higher interest rate and incur a higher user cost of capital. Fewer investment projects provide a marginal product greater than user cost, causing investment to fall.[9] Another avenue of influence of taxes on user cost is the rate of depreciation. Because U.S. tax laws allow firms to deduct the value of their depreciating plant and equipment from their corporate income tax, the tax code influences user cost. If the government liberalizes depreciation allowances, as it did in 1954, 1962, 1964, and 1981, user cost falls and investment may rise.

A third way in which taxes affect user cost is through the investment tax credit. Since 1962, firms have been able to receive a credit on their corporate tax bill equal to a small proportion of investment on plant and equipment. This amount was 10 percent in 1983. Any investment tax credit directly reduces tax liabilities and increases profits. Thus, an increase in the investment tax credit decreases user cost and tends to increase investment. Finally, with inflation, corporate taxes indirectly raise user cost. This effect results from the lack of indexing provisions in the tax code for the valuation of depreciation.[10]

While the direct effects of user cost and expected sales changes on investment are theoretically known, there is more uncertainty about their relative importance and how they interact. Other things constant, increases in interest rates, economic depreciation rates, or effective tax rates raise user cost and depress net investment. Inflation raises user cost and lowers investment by interacting with an unindexed tax code, but lowers user cost and raises investment by providing capital gains. Finally, increases in expected sales growth, which are often associated with increases in real GNP growth, raise the desired capital stock and increase investment spending. Thus, when other things are constant, the effects on investment of expected sales (or GNP) growth and various components of user cost are known. But other things are seldom constant. When all factors of investment are changing at the same time, theory alone cannot determine their relative importance. The next section, therefore, reviews empirical evidence on the interaction of various factors of investment and their impact on investment behavior since 1981.

Explanations for the recent investment boom

The unusually rapid growth of business investment after 1982 occurred simultaneously

[9] The deductibility of interest payments partly offsets this effect by providing an incentive for savers to borrow to invest.

[10] There is also a lack of indexing in the tax code for the valuation of inventories. Because inventory valuation affects cash flow, the lack of indexing of inventories to inflation may raise user cost and reduce investment.

CHART 5

Real gross national product

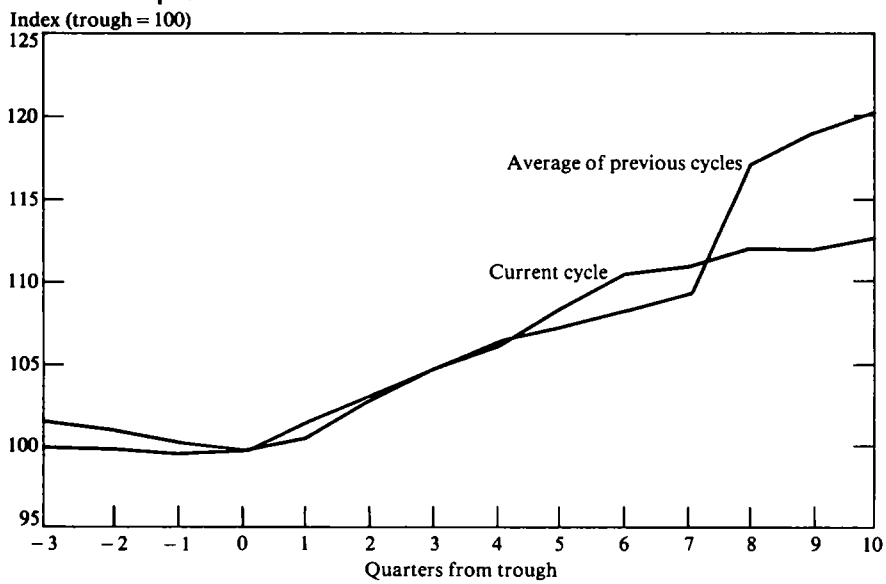
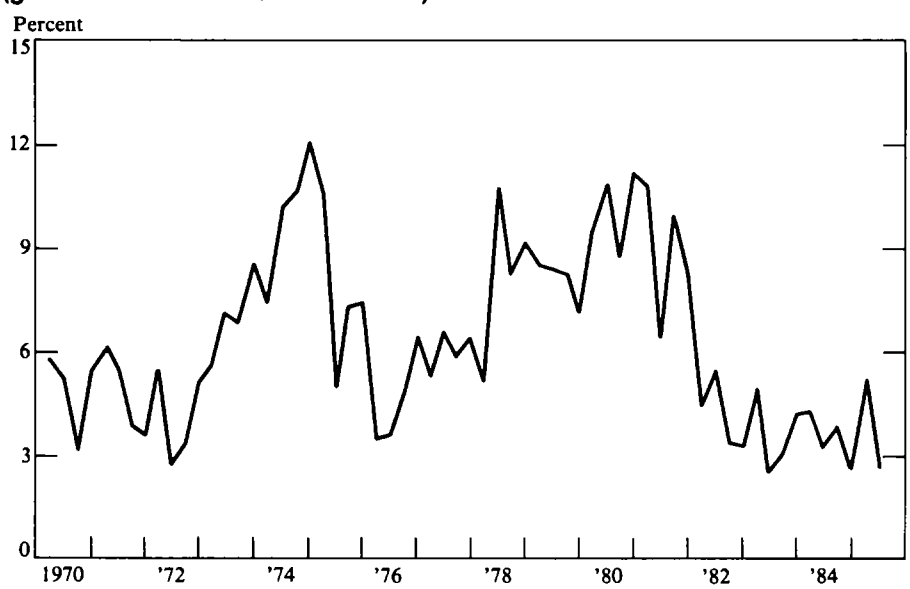


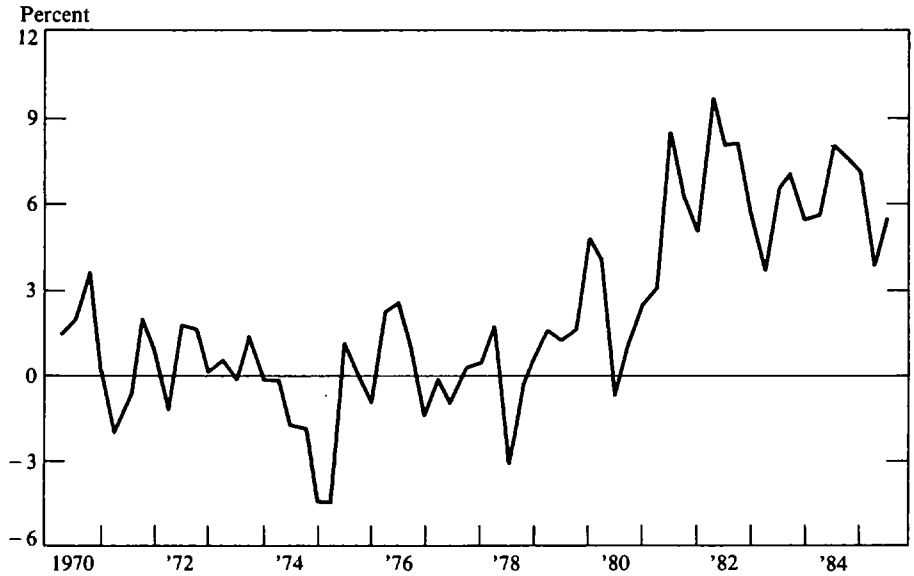
CHART 6

Inflation (growth rate of the GNP deflator)



Source: *Survey of Current Business,* Bureau of Economic Analysis. Obtained from Data Resources, Inc.

CHART 7
Real interest rate



Source: Yield on Treasury securities at constant one-year maturity minus annual percentage change of the GNP implicit price deflator. Yield from Board of Governors.

with rapid real GNP growth, falling inflation, and a high level of real interest rates. Furthermore, investment boomed shortly after the introduction of tax legislation designed specifically to stimulate investment spending. This section looks at the behavior of key variables since 1981 relative to their historic norms, describes the tax legislation introduced in 1981 and 1982, and reviews the methods and findings of recent investment studies.

Charts 5 through 7 track the recent behavior of real GNP growth, inflation, and interest rates relative to past behavior. Chart 5 compares quarterly real GNP growth in the current business cycle with its growth in an average of five previous postwar business cycles. As a proxy variable for changes in expected sales growth, increases in real GNP growth should be associated with rising investment. But while investment has been unusually strong since 1982, real GNP growth—as shown in Chart 5—has been fairly typical of previous postwar business cycles. Thus, growth in real GNP alone probably cannot explain recent investment behavior.[11]

Chart 6 shows quarterly changes in the implicit GNP deflator. By this measure, inflation has fallen dramatically since 1980. But because inflation affects investment in two offsetting ways, it is not clear what effect lower inflation has had on investment. Inflation raises the value of existing capital while, for tax purposes, lowering the value of depreciation.[12] Thus, lower inflation has a theoretically ambiguous impact on investment.

[11] In the accelerator model, the level of investment depends on growth in GNP. The rate of changes in investment, therefore, depends on the change in the growth rate of GNP. Because, in the early stages of the current recovery, the change in GNP growth was higher than average, GNP growth probably explains part of the investment boom.

[12] Inflation also lowers, for tax purposes, the value of inventories. See footnote 9.

Finally, Chart 7 shows real interest rates on one-year U.S. Treasury bills, a variable that should move closely with long-term real interest rates. Theoretically, the real interest rate should measure the difference between market rates of interest and expected inflation. But because expected inflation cannot be observed, actual inflation is used instead. Chart 7, therefore, only approximates the recent behavior of real interest rates. In light of apparently high real interest rates since 1980, it is surprising that investment spending was so strong. According to the theory developed in the previous section, high real interest rates imply a high user cost of capital. A high user cost of capital, in turn, reduces the number of investment projects that can be profitably undertaken. Thus, looking at interest rates alone, investment spending should have been weak.

In addition to high real interest rates, low inflation, and typical real GNP growth, two tax cuts potentially influenced the course of investment since 1980. The Economic Recovery Tax Act (ERTA) of 1981 introduced an accelerated cost recovery system that reduced the period over which assets could be depreciated for tax purposes, increased the investment tax credit on eligible assets, and liberalized rules governing the transfer of tax benefits from one party to another. In 1982, the Tax Equity and Fiscal Responsibility Act (TEFRA) reversed some aspects of ERTA and liberalized others. Among the new rules affecting business, "the scheduled acceleration in depreciation write-offs due in 1985 and 1986 was repealed, a 'basis adjustment' was adopted to offset part of the investment tax credit, and the safe-harbor leasing laws were repealed and replaced by a somewhat liberalized version of the pre-1981 leasing laws."[13]

TEFRA's main effect was to restrict the equipment tax benefits contained in ERTA. These benefits, however, had not been very great in the first place. According to the theory developed in the previous section, tax law changes such as the combination of ERTA and TEFRA should reduce user cost and stimulate investment.[14]

What were the relative importance of various factors influencing investment, such as high real interest rates, low inflation, rapid GNP growth, and tax incentives after 1982? Two principal views have emerged. One view attributes the investment boom mainly to the tax cuts of 1981 and 1982. The other view downplays the importance of tax cuts and attributes the boom to a combination of factors.

The view that tax cuts stimulated investment after 1981 has been put forward by John Makin and Raymond Sauer.[15] They argue that tax cuts more than offset high real interest rates and, together with strong real GNP growth, produced a vigorous investment recovery. Their analysis is based on a model in which investment depends directly on actual and prospective changes in output and inversely on actual and prospective changes in user cost. Rather than estimate user cost, however, they prefer the proxy measure of changes in the ratio of federal debt to GNP. This is because, they claim, actual user cost "typically displays too little quarter-to-quarter movement to identify reliable parameter estimates of its impact on

[13] Leonard Sahling and M. A. Akhtar, "What Is Behind the Capital Spending Boom?" *Quarterly Review*, Federal Reserve Bank of New York, Winter 1984-85, p. 25.

[14] For a discussion of the sensitivity of investment to alternative tax incentives, see David Berson and V. Vance Roley, "Business Fixed Investment in the 1980s: Prospective Needs and Policy Alternatives," *Economic Review*, Federal Reserve Bank of Kansas City, February 1981, pp. 3-16.

[15] John Makin and Raymond Sauer, "The Effect of Debt Accumulation on Capital Formation," Studies in Fiscal Policy, American Enterprise Institute Working Paper No. 1, November 1984.

capital formation."[16] The debt-to-GNP ratio, they claim on the other hand, is a valuable indicator of the level of real interest rates and the effective marginal tax rate on income from capital.[17]

Makin and Sauer's model tracks investment very well for the 1960:Q1 to 1982:Q3 sample period.[18] As a test of the role of the 1981-82 tax cuts, the authors forecast their model out-of-sample from 1982:Q4 to 1984:Q2 and beyond. Because ERTA was enacted only shortly before the end of the sample and TEFRA was enacted after the end of the sample, the implied reduction in expected marginal user cost would probably not have been captured by the debt-to-GNP ratio. Thus the model would be expected to underpredict investment after 1982. Because, in fact, the model does underpredict investment, it adds support to the idea that tax changes had a strong influence on investment. "While systematic effects of user cost changes on capital formation are difficult to detect in lengthy time series studies such as ours, sharp exogenous changes in user cost resulting from tax code changes do appear to produce significant deviations of investment from its projected path."[19]

Most other recent investment studies contradict the view that tax cuts were the primary cause of the investment boom. Barry Bosworth directly attacks the view by looking at the differential impact of tax reductions on various types of investment spending.[20] For each of 19 categories of producers' durable equipment and two types of structures, he estimates an accelerator equation for the period from 1958 to 1980. He then uses these equations to forecast investment by sector from 1980 to 1984. Finally, he relates the cumulative error from each equation during 1983 and 1984 to changes in the user cost of capital and various components of the user cost. He finds that office equipment (mainly computers) and automobiles bought by business accounted for 93 percent of the rise in business spending between 1979 and 1984. But he also finds that "the tax changes were of little benefit for purchases of autos, and that they actually increased the tax rate on computers."[21]

If not taxes, what then induced the increased investment in autos and equipment? According to Bosworth, a sharp decline in their relative—or inflation-adjusted—prices. During the first half of the 1980s, for example, the price deflator for producers' durable equipment rose at less than half the general rate of inflation. Furthermore, relative to price rises in the nonfarm business sector, equipment prices dropped 11 percent between 1980 and 1984.

Another piece of the puzzle, according to Bosworth, is the behavior of business structures. As noted in the first section, commercial construction rose sharply in 1983 and 1984 while other construction, such as that for industrial buildings, actually declined. Both types of structures, however, had the same tax treatment throughout the period. Bosworth reconciles this anomaly by suggesting that investment in commercial construction is less risky than industrial construction. Commercial structures, he claims, are less specialized and,

[16] Makin and Sauer, p. 12.

[17] Makin and Sauer justify this claim on the basis of Olivier Blanchard, "Current and Anticipated Deficits, Interest Rates, and Economic Activity," *European Economic Review*, June 1984, pp. 7-27.

[18] Makin and Sauer, p. 12.

[19] Makin and Sauer, pp. 11-12. Another implication of the Makin-Sauer model is that as tax cuts eventually raise the debt-to-GNP ratio, they potentially lead to higher real interest rates, inflation, and future taxes. Thus tax cuts large enough to raise the debt-to-GNP ratio raise the user cost of capital and eventually lower investment.

[20] Barry Bosworth, "Taxes and the Investment Recovery," *Brookings Papers on Economic Activity*, 1985:1, pp. 1-38.

[21] "Was the Investment Recovery Really a Supply-Side Miracle?" *Business Week*, July 29, 1985, p. 14.

therefore, easier to sell. As a result, financing is easier to obtain for commercial projects through borrowing. The higher leveraging of commercial projects, combined with the tax deductibility of interest payments, gave structures a greater effective reduction in tax rates. In some cases, these factors may have resulted in a net subsidy to commercial real estate investment.

Another approach to determining the cause of the strong investment recovery is to examine the investment sectors of large econometric models. While most large models, including those of Data Resources, Inc., the Board of Governors of the Federal Reserve System, the University of Michigan, and Wharton, all underestimate investment spending, even after allowing for tax code changes and using actual values for the determinants of spending,[22] there is one exception. In a study conducted at the Federal Reserve Bank of New York, two standard models fairly accurately forecast investment after 1981.[23] Specifically, the study forecast investment spending out-of-sample and found that the two models—a version of the Bureau of Economic Analysis model and an old version of the Federal Reserve Board-MIT-Pennsylvania (FMP) model—performed about as well after 1981 as before 1981. More to the point, their performance was about the same after the tax policy changes as they were before.

The difference between the New York Federal Reserve Bank study and other large econometric models is the treatment of an unobserved variable—the real cost of funds. Most large models imply a rise in the real cost of funds as a result of the rise in nominal interest rates and the fall in inflation. This rise in the cost of funds more than offsets the fall in real capital goods prices and cuts in taxes. The New York Federal Reserve study, however, differs in its adjustment of nominal interest rates for inflation. Unlike other studies, it also combines debt and equity finance costs into a single measure of the cost of funds. As a result, the real cost of funds in the New York Federal Reserve study rises only slightly during the 1980-84 period and, after adjusting for declining taxes and capital goods prices, actually declines.[24]

While the New York Federal Reserve Bank study suggests no structural change in the behavior of investment after the 1981-82 tax cuts, it does suggest that ERTA and TEFRA significantly reduced the user cost of capital below what it would otherwise have been. "But judged in terms of the FMP model, these tax changes appear to have contributed only about one-fifth of the 1983-84 growth in capital spending."[25] The greater part of the boom in capital spending, the authors go on to say, came from the personal tax cuts under ERTA, which stimulated actual and expected sales, and the sharp drop in interest rates in 1982.

One final piece of evidence casting doubt on the view that tax cuts held primary responsibility for the investment boom comes from comparative international studies. A National Bureau of Economic Research (NBER) study recently found that countries with higher effective taxes on income from capital also have higher growth in nonfinancial corporate capital.[26] Of the countries examined, West Germany had the highest overall effective tax on

[22] Bosworth, p. 7.

[23] Sahling and Akhtar, pp. 19-20. While the New York Federal Reserve Bank study predicts the change in investment fairly well, it makes the same (rather large) level error that other models make in the 1981-84 period.

[24] Bosworth, pp. 9-10.

[25] Sahling and Akhtar, pp. 19-20.

[26] Mervyn King and Don Fullerton, "The Taxation of Income From Capital: A Comparative Study of the U.S., U.K., Sweden and West Germany—Comparisons of Effective Tax Rates." National Bureau of Economic Research Working Paper No. 1073, February 1983, Chapter 7.6, p. 6.

income from capital and the highest capital growth rate. Sweden was second in both categories, and the United States was third. The United Kingdom had the lowest overall effective tax on income from capital and the lowest capital growth rate. On the other hand, because this evidence does not establish causality in either direction, it could simply be the result of slower growing countries reacting to their slow growth by providing investment incentives which reduce overall effective tax rates.

Summary and conclusions

Investment spending has boomed since the beginning of the current economic expansion, but not all types of investment have shared equally in the recovery. Spending on commercial construction and certain types of business equipment—computers and automobiles, for example—take most credit for the unusually strong growth in business fixed investment. While some analysts have claimed that the tax cuts of 1981-82 were responsible for the unusual strength of investment, most empirical evidence points toward a multiplicity of factors. These include lower user cost resulting from declining capital goods prices and from the sharp drop in nominal interest rates in 1982. These factors also include expected sales growth resulting from increased consumer confidence and from personal tax cuts. Thus, while the business tax cuts contributed to the growth in investment spending after 1982, they probably were not responsible for business investment's unusual strength.

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