Investment Patterns by Type and Industry: What Do They Tell Us About the Boom and the Bust?*

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First draft: October 11, 2002
This draft: June 27, 2003

Abstract. This paper examines patterns of capital expenditures across types of equipment and software as well as across industries during the recent investment boom and bust. The analysis indicates that the end of the boom and the bust reflect developments in the telecom sector, as the role of communications equipment was well beyond its size in the economy. More generally, industries that invested more during the boom reduced their capital expenditures more during the bust. One possible explanation for this pattern is that capital overhangs were one factor behind the bust.

JEL Classification: E22, E32
Keywords: investment, capital expenditures, equipment and software, capital overhang.

* I would like to thank Charles Steindel, Kevin Stiroh, Ken Kuttner, and the New York Fed Domestic Research Brown Bag seminar for their comments on parts of this research. I also want to thank Alisdair McKay for his excellent research assistance. All remaining errors are my responsibility. The opinions expressed in this paper are mine and do not reflect the views of the Federal Reserve Bank of New York nor the Federal Reserve System.

Introduction

One notable feature of the long 1990s economic expansion was the exceptional strength of business investment in equipment and software. Beginning in the middle of 2000, there was a striking reversal, with a marked decline in these expenditures that continued through the first half of 2002 before rebounding some in the second half. This pattern of capital expenditures, particularly for high-tech investment, was a major factor behind the recession of 2001 and the slow growth in 2002.[1]

In this paper, I discuss the patterns of capital expenditures across types of equipment and software as well as across industries during the investment boom and bust. Analyzing these patterns, I quantify the role of IT investment in the recent patterns of capital spending. I also examine which particular industries were major factors behind these patterns. Lastly, I examine whether the industry patterns may have been indicative of a capital "overhang" that was an impetus for the investment bust of 2001.

Two particular points come through in this analysis. The first probably is not surprising from the anecdotes: the end of the investment boom in 2000 and the investment bust in 2001 reflect the developments in the telecom sector. Communications equipment and communications industries (the telephone and telegraph industry and the radio and television industry) influenced these patterns much more than would be expected from their share of the economy. The second may not be as obvious: beyond the developments in the telecom sector, higher-investing industries of the late 1990s

[1] For example, the following was written in the Federal Reserve's *Monetary Policy Report to the Congress* that was submitted on February 27, 2002: "…the boom in capital outlays that had helped drive the expansion through the late 1990s gave way to a softening of spending in late 2000 and to sharp declines [in 2001]. Spending dropped for most types of capital equipment and structures: cutbacks were especially severe for high-tech equipment, some types of which may have been overbought."

tended to reduce their investment rate more in 2001. This pattern could reflect two complementary factors behind the depth of the investment bust: (1) The presence of capital overhangs from the investment boom; and (2) a reassessment of future expected sales growth in the aftermath of the recession.

In the next section, I present some general information about the investment boom and bust such as its size compared to other recent cycles. The third section examines the boom and bust by the type of equipment and software, with particular concern about the role of IT investment. The fourth section documents the boom and bust by industry, documenting where investment expenditures were the strongest in the boom and which ones have contributed the most to the bust. The last section summarizes the results and discusses their implications.

The recent investment boom and bust

One most notable feature of the 1990s investment boom was its persistence. Over most of the 1990s, equipment and software expenditures grew at double-digit rates (year-over-year) after languishing at rather low rates during the late 1980s and early 1990s (Chart 1). Although there were episodes during the 1970s and early 1980s where there were higher investment growth rates, there has not been a time recently when investment growth was as persistently high as it was during the 1990s expansion.

The boom ended abruptly in the second half of 2000. Year-over-year investment growth turned sharply negative in the first half of 2001, reaching lows not seen since the end of the severe recessions of 1973-75 and 1981-82. With this abrupt, large, and relatively persistent decline in investment at the beginning of the latest recession, it is not

surprising that many analysts have cited "over-investment" as a primary contributor to the recession.[2]

When firms invest in equipment, part of the spending is used to increase their capital stock, but part is also used to replace depreciation—the wear and tear as well as obsolescence—on previously purchased equipment. Because faster-depreciating computers and software comprised a larger share of the capital stock in the 1990s, a greater portion of investment spending went into replacing depreciated capital.

Nonetheless, because investment was strong during the late 1990s, the real capital stock of equipment and software grew rapidly during this period (Chart 2). Capital stock growth generally had fallen during the 1980s, so that by the early 1990s it was below 2 percent per year. In the stronger investment climate of the 1990s, the growth rate rose steadily to nearly 7 percent per year during 1998-2000. This strong growth in the capital stock, particularly that of high-tech equipment and software, has been cited in as an important contributor to the rising trend productivity growth rates since 1995.[3] The strength of capital spending in the late 1990s can also be seen in capital growth during the bust. Even though investment spending declined from the exceptionally high levels of the late 1990s, the capital stock still grew nearly 4 percent in 2001, well above the prevailing rates of the 1980s.

The remainder of the paper examines in greater detail the pattern of investment and capital growth during the 1990s boom and the 2001 bust. In the next section, I divide

[2] For example, Krugman (2002): "The key point is that this isn't your father's recession—it's your grandfather's recession. […] It's a classic overinvestment slump, of a kind that was normal before World War II."

[3] For example, see Jorgenson and Stiroh (1999, 2000), Oliner and Sichel (2000), and Stiroh (2001a, 2001b). However, a rising capital stock is not sufficient to explain stronger trend productivity growth: capital stock growth in the 1970s was as high or higher than it was during the 1990s, but trend productivity declined in the 1970s.

equipment and software into the types classified by the BEA—information equipment and software, industrial equipment, etc. In the following section, I examine the division of equipment and software by industries.

Investment by type of equipment

When an aggregate is measured in chain-weighted dollars as in the US national income accounts, its components do not add up to the aggregate level. This situation is particularly severe when some components' relative prices are changing considerably; this is particularly relevant for investment because computer prices have dropped drastically over the years.[4] To assess the importance of investment in types of equipment and software, I will use instead the contributions to investment growth. Growth contributions are the portion of growth in the aggregate attributable to each component, and thus have the advantage of adding up to the aggregate's growth rate.[5]

In the investment boom of the late 1990s, computers and software were the major contributors, as might be expected (Table 1). In 1998 and 1999, these two categories contributed about one-half of the high capital spending growth of the period, even though their share of investment was less than 30 percent.[6] At this time, the preparations for Y2K as well as the Internet boom were major factors behind these expenditures' robustness. Another part of the high tech boom, communications equipment, also was a positive contributor, but to a lesser extent than computers and software.

Even though high tech spending received the most attention, the strength of these components and the strong economy appeared also to spill into some "low tech"

[4] See Steindel (1995) and Whelan (2000).
[5] Growth contributions approximately are the nominal share of a component times its real growth rate. In the calculations in the paper, the exact formula to calculate growth contributions is used. See Moulton and Seskin (1999) and Whelan (2000) for that formula.

components. In particular, transportation equipment was robust, reflecting the rapid expansion of trucking companies and airlines to satisfy the stronger demand for shipping and travel services.

In 2000, as the investment boom began to subside, the patterns changed noticeably. With Y2K past and the Internet bubble beginning to deflate, computer and software spending slowed significantly, with their growth contributions one-half of their 1999 levels. Even more striking is the contraction in transportation equipment that year: its drag on investment growth was over 2½ percentage points.

In contrast, communications equipment contributed almost 3 percentage points to investment growth, well over one-half of the investment growth of that year, whereas their share of investment was slightly over 12 percent. This was the highest growth contribution from this type of equipment since the recovery from the 1973-75 recession, and appeared to be induced by deregulation, the Internet boom and associated investments in broadband Internet connections, and the wireless boom.

Of course, the investment boom turned into the bust of 2001, as real equipment and software expenditures declined almost 9 percent (Table 1). Although the growth contributions of the four main components of equipment were negative that year, much of the decline as well as the focal point of the commentary was in the high tech information equipment and software.[7]

Within information equipment, the principal factor behind the decline was communications equipment, which was a nearly 4 percentage point drag on investment growth one year after being a large positive contributor to growth. This swing in the

[6] Because components of a nominal aggregate do add up, all shares are expressed as a share of nominal investment.

contribution from this type of equipment reflects the drastic change in the financial conditions of the communications industry. What was had been an industry with great prospects and booming stock prices became an industry facing the woes of overburdened balance sheets from licenses' overpayments as well as a large amount of capital with little immediate prospect of positive return.

Real equipment investment recovered some in 2002, rising a little over 3 percent, principally because computers and software were relatively strong. After the horrid 2001, growth in communications equipment was flat. What kept investment from recovering more was weakness in transportation equipment, which reflects the drastic reduction in aircraft investment—almost 50 percent—as many major airlines experienced financial turbulence.

To reiterate, the patterns of the investment boom and bust largely reflect that of information equipment and software. More particularly, the end of the boom and the beginning of the bust was a reflection of developments in communications equipment. In the next section, we examine industry-level data to investigate how widespread these patterns were across industries.

Industry patterns during the investment boom and bust

Because of the role of communications equipment in the boom and bust, we begin our industry analysis by examining capital spending in two communications industries: telephone and telegraph (telephone hereafter), and radio and television (radio-TV hereafter). The patterns of investment rates—investment as a percentage of the capital stock—in these two industries, not surprisingly, are similar to that of communications

[7] The point that the investment decline of 2001 was broadly based was made in McCarthy (2001).

equipment (Chart 3).[8] The telephone industry, whose investment rate through the 1980s and early 1990s fluctuated between 15 and 20 percent, invested at an almost 33 percent rate in 2000, its highest since 1948. This probably reflected the factors behind the communications equipment investment boom discussed in the previous section. As a consequence, this single industry contributed about one-half to total annual investment growth in 2000, even though its investment share was less than 10 percent. As is well known, there was a drastic reversal in 2001 of the industry's investment, although the investment rate remained above the average between 1970 and 1998. Still, the industry accounted for over one-quarter of the aggregate investment decline in that year.

The investment rate in the radio-TV industry turned up earlier and remained high longer than in the telephone industry. With cable TV firms upgrading their equipment, in part induced by the 1996 Telecommunications Act, the investment rate rose above 30 percent in the mid-1990s and stayed there though 2000. In 2001, the investment rate in this industry declined in a manner similar to that of the telephone industry. However, because this industry accounts for a smaller share of investment, its contribution to aggregate investment fluctuations was less than that of the telephone industry.

Although communications was important in the investment boom and bust, other industries also contributed to the aggregate pattern. To examine industry patterns during the boom and bust more generally, we analyze the relationships between previous

[8] The industry data come from Fixed Assets database compiled by the Bureau of Economic Analysis (available at http://www.bea.gov/bea/dn/faweb/Details/Index.html). Because the aggregate investment rate is a ratio of two chain-aggregated real variables, a sensible estimate of it cannot be calculated simply by dividing aggregate investment by the aggregate capital stock. Instead, as in Whelan (2000), we compute investment rates using the detailed data (by industry and by type), aggregating the individual investment rates by type using each type's share of current cost capital stock in the industry. Also note that industry investment and capital stock data are available only through 2001.

industry investment patterns and changes in investment rates as well as between changes in industry GDP growth rates and changes in investment rates.[9]

General industry investment patterns

First, we examine whether the investment boom or bust was concentrated in industries that previously had high investment rates. In regard to the boom, such a pattern would suggest a "momentum" story where high-investment industries continue to invest more. On the other hand, the opposite pattern would suggest that low-investment industries are attempting to "catch-up" during the boom.

Comparing the change in the investment rate in 1998 to the average rate over the previous five years does not display either of these patterns (Chart 4).[10] Most of the industries (38 out of 54) had higher investment rates in that year and included those with high investment rates during 1993-97 as well as those with low investment rates during that period. Among the industries that reduced their investment rates, there is also a similar diversity of prior investment rates. Thus the rise in investment rates during the boom was a general phenomenon rather than being a matter of traditionally high-investment industries continuing to invest more or low-investment industries attempting to catch up. This also suggests that general macroeconomic factors were primary contributors to the boom: most prominent among these would be the strong economic growth of this period.[11]

In contrast, a more definite pattern emerges during the bust of 2001. Comparing the change in the investment rate in 2001 to the average investment rate over the previous

[9] Because of their minor role in the boom and the bust, industries in agriculture, mining, and construction were excluded from the analysis, leaving 54 industries.
[10] A similar conclusion would arise examining any of the boom years around 1998.
[11] This is one conclusion from McCarthy (2001).

five years, there is a clear negative relationship (Chart 5).[12] Most industries lie near the trend line, indicating that the relationship is not dominated by a few outliers. Of course, as would be expected from the previous discussion, the telephone and radio-TV industries were outliers—both reduced their investment rate more in 2001 than other industries with similar investment rates in the late 1990s.

This pattern during the bust may reflect two, possibly complementary, factors.[13] The first is that many of the high-investment industries during the boom developed capital overhangs and began to "correct" them in 2001.[14] The second is that more-cyclical industries reassessed their growth prospects in light of the recession and cut their investment more after having been more optimistic earlier.

As an initial pass at scrutinizing the latter factor, we examined the relationship between GDP growth fluctuations and investment rate fluctuations. In many investment models, the investment rate is positively related to GDP growth; therefore, changes in the investment rate should be positively related to changes in GDP growth. By this reasoning, we expect to see that industries experiencing accelerating growth also should be increasing their investment rate more.

Unfortunately, we do not observe this pattern across industries. In 1998 there is a positive relationship, but it is quite weak. Furthermore, any relationship appears to be dependent upon the exceptionally volatile industry SIC 67—holding companies and

[12] In a simple regression, the slope of the trend line is estimated to be –0.252 with a standard error of 0.044; the R-squared of the regression is 0.402.

[13] The analysis was repeated for years previous to the most recent boom and bust. The pattern in most years during expansions is similar to that of 1998; i.e., there is little pattern. In contrast, many recession years display a negative pattern similar to that of 2001, although not as stark as that year.

[14] This pattern and the correction hypothesis would also call into question whether convex adjustment costs, which underlie many investment models, are consistent with aggregate investment behavior. Without resorting to an unobserved shock, it is hard to rationalize with convex costs such an abrupt one-year decline after many years of increases.

investment offices (Chart 6).[15] In 2001, the relationship between changes in output growth and investment rates across industries is slightly negative, but again weak (Chart 7).[16] From these two years as well as the other years, we conclude that there is no reliable relationship across industries between output growth changes and investment rate changes, despite the relationship across time.

Although this absence of a pattern is contrary to a simple version of the cyclicality story, it does not preclude it. Recessions may be periods where firms reassess their prospects; if so, then changing assessments of future growth could explain the patterns between changes in investment in 2001 and previous investment rates. Of course, these patterns are also consistent with correcting previous overinvestment. To differentiate further between these two explanations is beyond the scope of this analysis. Still, the ultimate effects of overinvestment or reassessment will appear similar—high-investing industries would tend to cut investment more in a recession. Therefore, under either story, this analysis suggests that the optimism of the late 1990s may have sowed the seeds of the investment bust of 2001.

Conclusion

This paper has examined patterns by type of equipment and by industry during the recent investment boom and bust. Not surprisingly, IT capital spending, particularly in communications equipment, was a major factor in both the boom and the bust. The patterns of investment for these types of equipment suggest that Y2K and the telecom bubble were important. Consistent with this picture, when examining investment by

[15] The slope of the trend line is 0.017 with a standard error of 0.032, making it statistically insignificant from zero at the usual confidence levels. The R-squared is 0.006. When SIC 67 is excluded, the slope is 0.026, but the standard error rises to 0.091 and the R-squared falls to 0.002.

industry, the capital spending patterns of the telephone and radio-TV industries were major influences on aggregate investment patterns.

More generally, the widespread increases in investment rates across industries during the investment boom suggest that macroeconomic factors, such as strong aggregate GDP growth, were major contributors to the boom. In contrast, investment rates declined more during the investment bust of 2001 for industries that previously had high investment rates. This suggests either that there may have been some payback in these industries for the overly exuberant capital spending during the late 1990s or such industries had greater reassessments of prospects. It also suggests fixed costs and/or irreversibilities may have influenced the patterns of investment spending during this period; for example, in the laying of fiber optic cable in the late 1990s.

As mentioned previously, this analysis provides only a partial answer to the patterns behind the boom and the bust. One prominent outstanding issue is the role of the large fluctuations in stock prices during this period. McCarthy (2001) suggested that Tobin's q, through which stock prices should affect capital spending, had only a small effect on aggregate investment spending once the effect of variables like GDP growth were taken into account. Nevertheless, industries with better performing stocks may have been able to secure financing for capital spending more easily during the late 1990s. Conversely, larger declines in stock prices probably made financing capital purchases more difficult in some industries. With these and other open issues, explaining the patterns of investment spending around the year 2000 probably will continue to provoke lively debate in the coming years.

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[16] The slope of the trend line is -0.026 with a standard error of 0.048, making it statistically insignificant from zero; the R-squared is 0.006.

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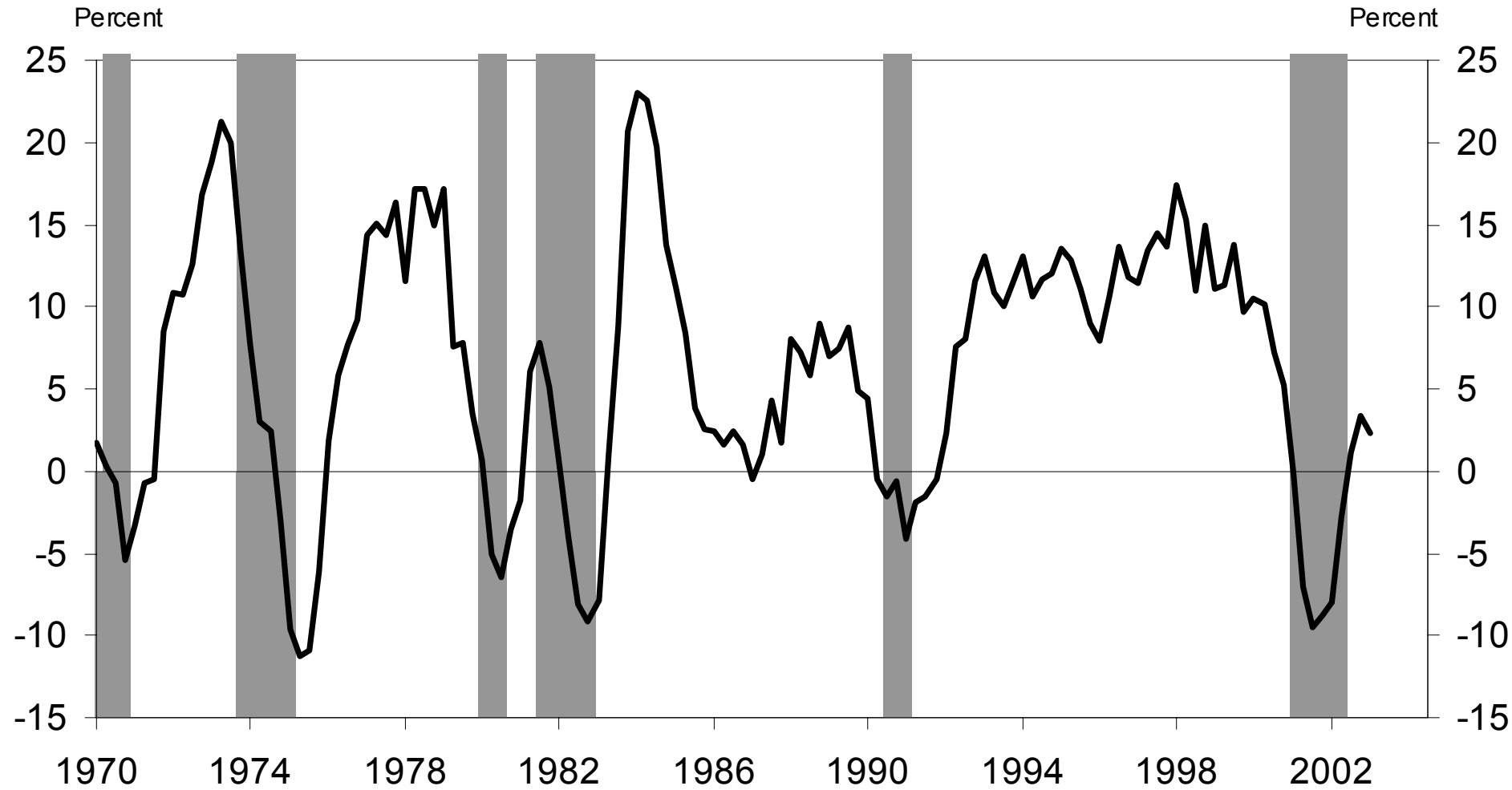
Table 1. Accounting for the investment boom and bust across types of equipment.

	1998	1999	2000	2001	2002
Equipment & software growth (Q4/Q4)	**14.9**	**9.7**	**5.2**	**-8.8**	**3.3**
Growth contributions of:					
Information equipment & software	9.4	6.6	5.8	-4.9	4.1
Computers and peripherals	4.2	2.6	1.6	-0.4	1.9
Software	3.2	2.5	1.0	-0.5	1.1
Communications equipment	1.9	1.6	2.9	-3.9	0.2
Other information equipment	0.1	-0.1	0.3	-0.1	0.9
Industrial equipment	0.2	0.7	1.5	-2.1	0.1
Transportation equipment	4.1	1.9	-2.7	-0.8	-1.7
Other equipment	1.3	0.3	0.6	-0.9	0.8

Note: Contributions do not add up exactly because of rounding error.

Chart 1:

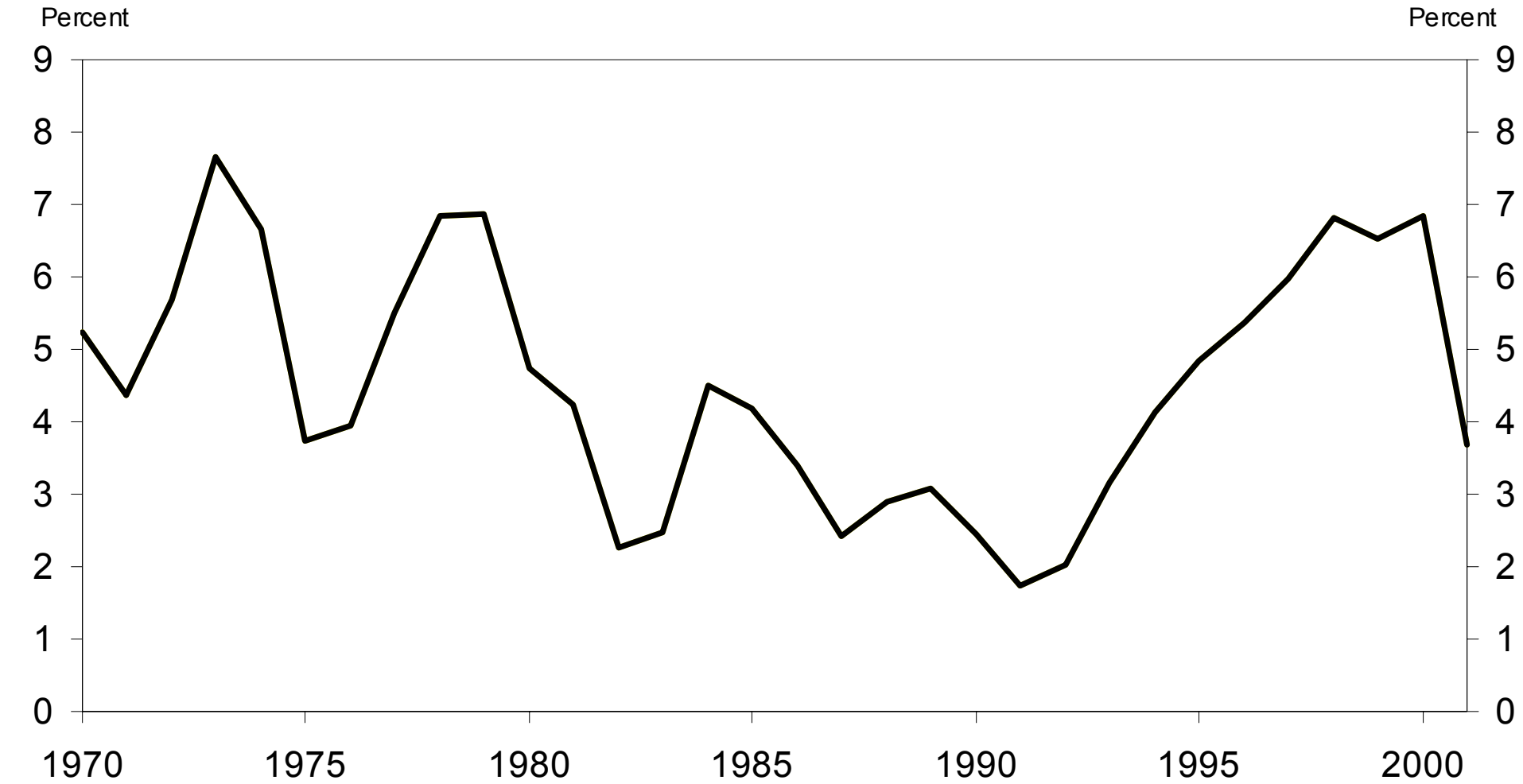
Nonresidential investment in equipment and software: year-over-year growth



Source: Bureau of Economic Analysis/Haver Analytics

Chart 2:

Growth rate of net stock of nonresidential equipment and software



Source: Bureau of Economic Analysis/Haver Analytics

Chart 3: Investment Rates of Equipment and Software: Communications Industries

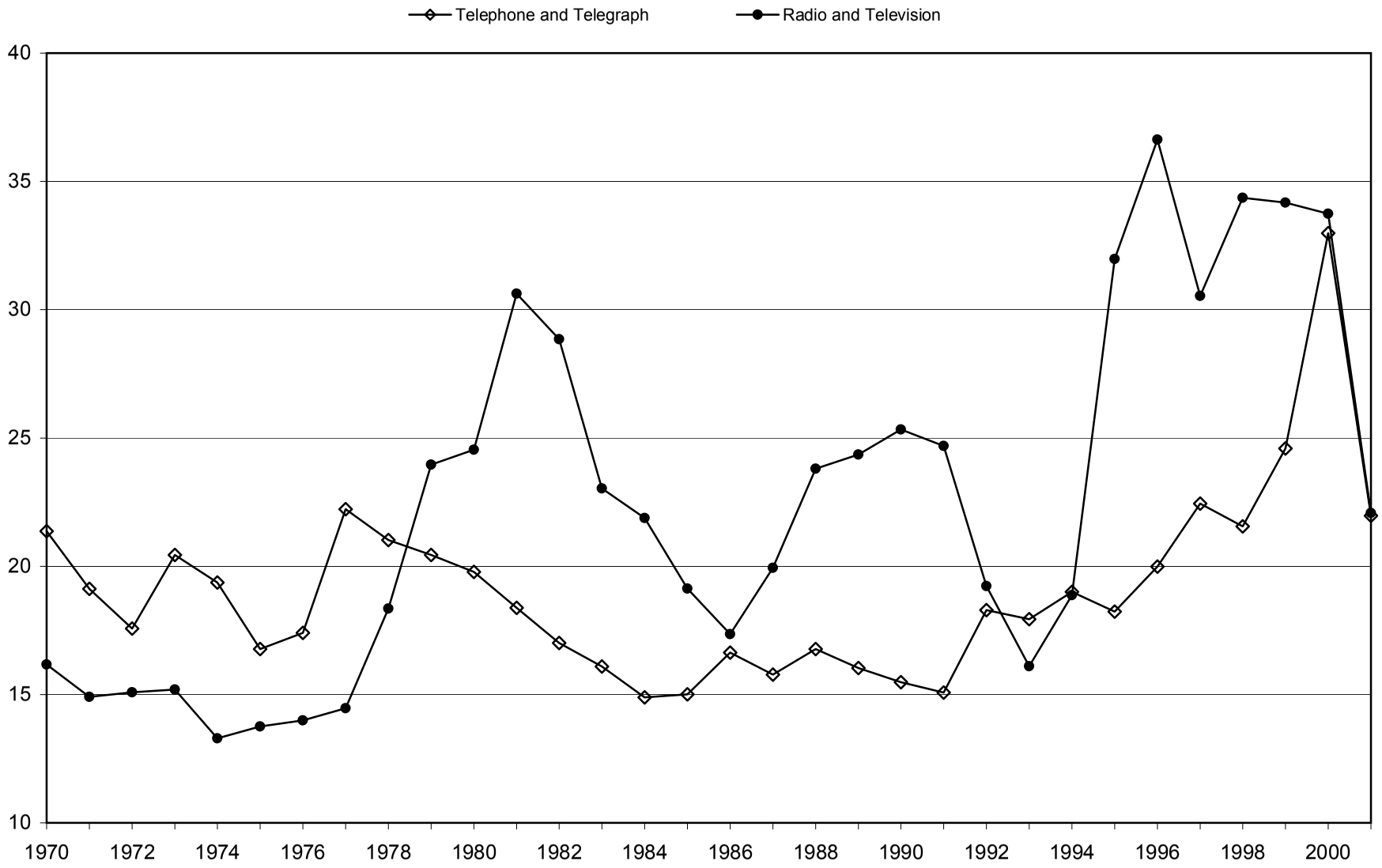


Chart 4: Investment Rates by Industry

1993-1997 Average Investment Rate vs. 1997-1998 Change in Investment Rate

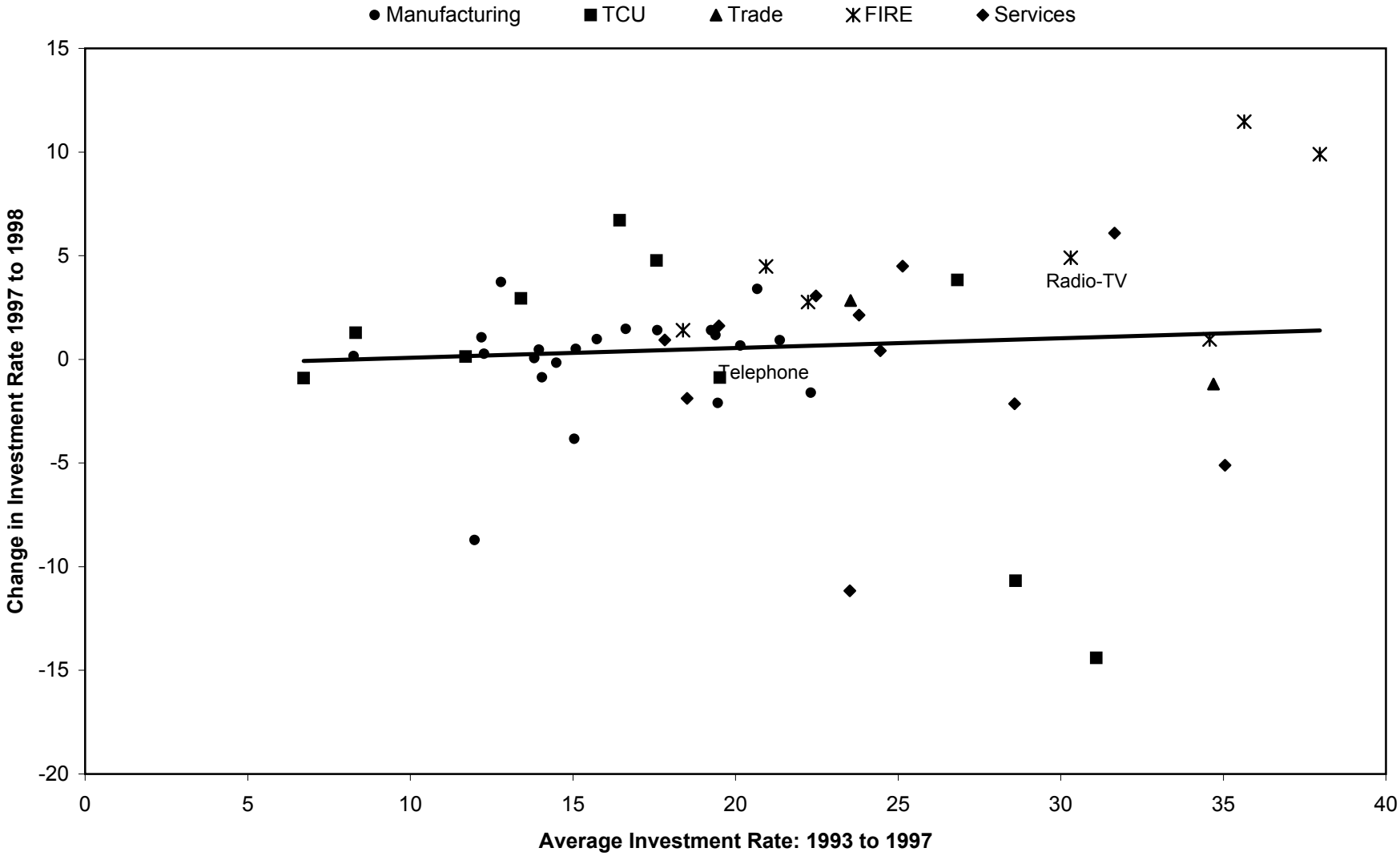


Chart 5: Investment Rates by Industry

1996-2000 Average Investment Rate vs. 2000-2001 Change in Investment Rate

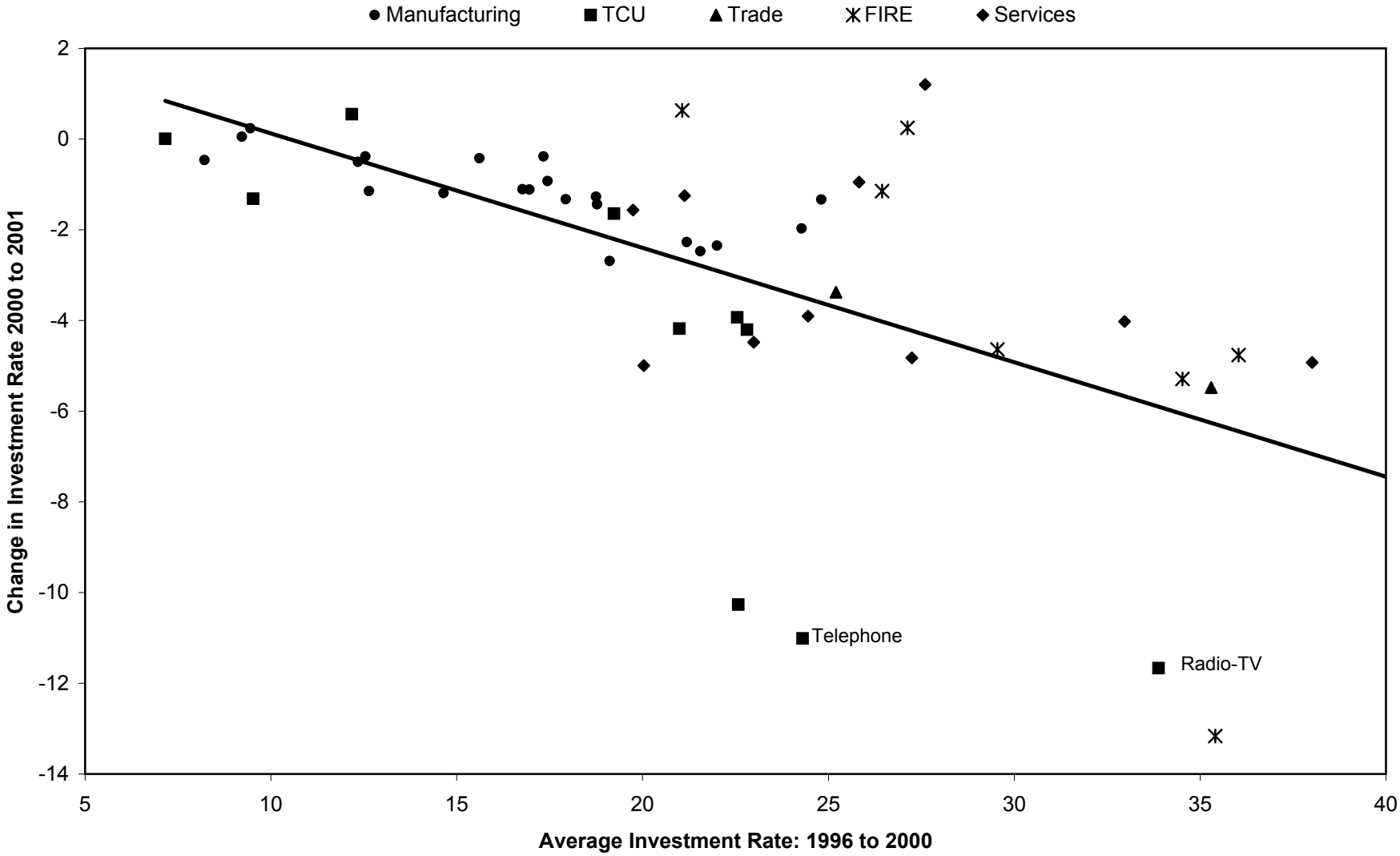


Chart 6: Investment Rates by Industry

1997-1998 Change in GDP Growth vs. 1997-1998 Change in Investment Rate

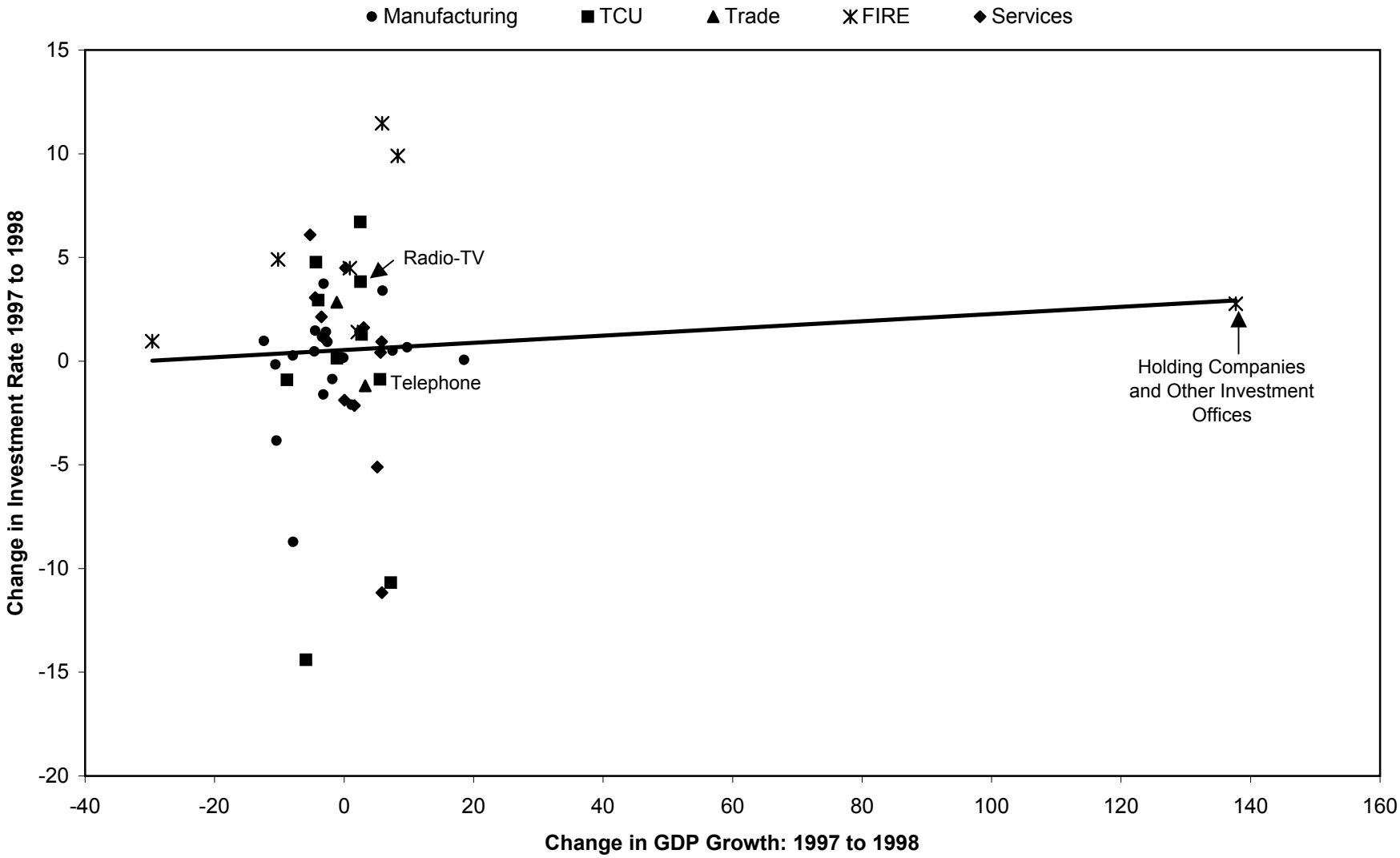


Chart 7: Investment Rates by Industry

2000-2001 Change in GDP Growth vs. 2000-2001 Change in Investment Rate