# Has the Response of Investment to Financial Market Signals Changed?*

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**Abstract**

Stock market fluctuations during the late 1990s and early 2000s have been given a prominent role in many accounts for investment behavior during that period. In contrast, earlier studies had found little effect of nonfundamental equity price movements on aggregate investment. This paper examines whether the relationship between equipment investment and equity prices has changed over time. We find evidence some changes in this relationship. Perhaps surprisingly given the late 1990s and early 2000s experience, stock price fluctuations appear to have a weaker relationship with investment in the low macroeconomic volatility period that began in the mid-1980s. It appears the tighter relationship in the late 1990s and early 2000s was a temporary phenomenon, perhaps the result of the unusual behavior associated with the Internet equity price "bubble."

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## 1 Introduction

A prominent factor in many popular accounts of the fluctuations of business fixed investment is the gyrations in financial markets, particularly the stock market. For example, the behavior of the stock market is given a prominent role for the boom and bust of investment in the late 1990s and early 2000s.

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With stock prices rising strongly and IPOs relatively easy during the "Internet bubble" of the late 1990s, many firms found it easy to raise funds for capital expenditures. When stock prices collapsed beginning in 2000, funds were harder to obtain and firms found that they had "too much" capital.[1] Consequently, investment collapsed during this period, and remained sluggish until stock prices began to recover in 2003.

Beyond these casual observations, a slightly more systematic examination indicates that stock prices and fixed investment appear to have a tight link over recent years. Figure 1 shows the year-over-year percentage change of the Wilshire 5000, the broadest index of US stock prices, and private real non-residential fixed investment from the national income accounts over the past 11 years. The behavior of these two series is in accord with the story in the previous paragraph, and there is a high correlation between the two of 0.74.[2]

Of course, equity prices and investment should be related to each other to the extent that equity prices reflect the "fundamentals" of investment for firms, which underlies the $q$ model of investment introduced by Brainard and Tobin (1968) and Tobin (1969).[3] If the fluctuations discussed in the first paragraph are the result of changing evaluations of fundamentals over time, then they may be in some sense"optimal" and of lesser concern for possible policy intervention. However, what underlies the concerns of the public and policymakers is that investment, at least in this instance, may have responded to nonfundamental fluctuations in the stock market, leading to "excessive" volatility of investment.

A number of stories could explain why there now may be a tighter link between stock prices and fixed investment. For example, the development of the US financial system toward a capital markets-based system from a bank-based system could be one factor. In this case, higher stock prices signal to capital markets that the prospects for firms have improved, leading capital markets to provide more funds at better terms for firms, when the allow (capital-constrained) firms to invest more than they had previously.

Furthermore, some recent studies have provided some intellectual basis for a link between investment and non-fundamental equity price movements. Baker, Stein, and Wurgler (2003) develop a model where stock prices have a stronger impact on the investment of "equity-dependent" firms. Their empirical results indicate that such firms' investment is much more sensitive to their stock price movements than is the investment of other firms. Gilchrist, Himmelberg, and

[1] The extent of any capital "overhang" in the late 1990s and early 2000s remains an open question. Using a simple neoclassical model as a basis for measurement, McCarthy (2003) found overhangs to be relatively contained during this period. Still, other aspects of investment behavior at the industry level during this period were consistent with there being significant overhangs; e.g. see McCarthy (2004).

[2] Because the observations are not independent when using year-over-year changes, the correlations may be overstated. In fact, using quarterly changes, the correlation drops to 0.30 in this case. However, the qualitative points that are made in the text remain valid if quarterly changes are used instead.

[3] Hayashi (1982) would formalize the relationship between Tobin's $q$ and investment within a dynamic optimization model of the firm as well as provide the conditions under which average and marginal $q$ are equivalent.

Huberman (2004) develop a model where the combination of short-selling constraints and dispersion of investor beliefs drive a firm's stock price above its fundamental value, leading to greater equity issuance, reduced capital costs, and higher real investment. They find some empirical evidence of such a relationship between investor dispersion, equity issuance, Tobin's Q, and real investment.

These recent studies stand in contrast to previous empirical work, such as Morck, Shleifer, and Vishny (1990), Blanchard, Rhee, and Summers (1993), and Chirinko and Schaller (1996), which have not found much effect of nonfundamental stock price movements on aggregate fixed investment.[4] There could be at least a couple of reasons for these differences. First, there could have been a significant change in investment behavior such that it has become more responsive to nonfundamental stock price movements in the last ten years. Second, the models cited in the previous paragraph are more explicitly micro rather than macro. As such, they suggest that the relationship between real investment and stock price movements at the aggregate level may change over time, depending upon nonfundamental equity price movements are distributed across firms as well as firms' characteristics over time. In either case, this suggests that the relationship between aggregate equity price movements and fixed investment may vary over time, which is not fully explored in these earlier studies.

In this paper, I take a small step to examine whether the links between financial market signals and busines equipment investment has changed over the past 45 years. I do this using three reduced-form "forecasting" models of investment. The first is a simple model that relates equipment investment growth with stock price appreciation. The second has the flavor of the Jorgenson (1963) neoclassical model with stock price appreciation included as an additional regressor as a simple way to examine "nonfundamental" stock price movements. The third is a version of the $q$ model. Each of these are put through a variety of specifications to investigate the relationship between equity price fluctuations and equipment investment may have changed over this period.

To preview the results, I find evidence of parameter instability in each of these models, much of which is consistent with changing coefficients on stock price appreciation over different periods. However, much of the evidence suggests that the relationship between equity price movements and investment has been weaker over much of the past decade, in contrast to the picture in Figure 1. There is a short period in recent years where the relationship may have been stronger, but it was short-lasting. In sum, it is not clear that aggregate investment has become unduly sensitive to nonfundamental equity price movements.

The rest of the paper is organized as follows. The next section present the results of the simple regression model of stock price appreciation on the growth of fixed investment for various categories of equipment. Section 3 presents a similar analysis for a version of the neoclassical model and Section 4 does the same for a version of the $q$ model. Section 5 provides some concluding remarks.

[4] However, Chirinko and Schaller (2001) did find evidence that the Japanese equity price "bubble" did affect Japanese fixed investment.

## 2 Investment and stock price appreciation

The first model provides a simple examination of the changes in the correlation between stock price appreciation and fixed investment apparent in Figure 1. Specifically, we estimate the following reduced form regression.

$$\Delta i_t = \alpha_0 + \sum_{i=1}^{N} \alpha_i \Delta s_{t-i} + \rho \Delta i_{t-1} + \varepsilon_t \qquad (1)$$

In equation (1), $\Delta i_t$ is the growth rate of aggregate nonresidential real equipment and software investment, or some category within it, from the US national income accounts, and $\Delta s$ is the appreciation of real equity prices as measured by the Standard and Poor's 500 price index (S&P 500) relative to the price index for GDP of the nonfarm business sector.[5] The S&P 500 is chosen for this exercise because it is the broadest price index that encompasses the period since 1960.[6] Growth rates and price appreciation are measured by 400 times the log difference. Lagged investment growth is included as a dependent variable in these regressions to account for the properties of the error term in the regression: preliminary results show considerable serial correlation in the error term, although the results for the coefficient(s) on stock price appreciation are not unduly sensitive to it. We let $N = 4$ as a simple device to allow for the possibility of "time-to-build" for fixed investment.

The plan in this section is to begin by estimating equation (1) across various "exogenous" splits of the sample based on previous studies that have identified possible structural shifts of the aggregate economy. We then test for general parameter instability in the model, and then test for a single structural break at an unknown date. Finally, we estimate some rolling regressions as a simple way to allow for the relationship to vary over time and examine how the relationship has changed based on that.

### 2.1 Changes across "exogenous" eras

In this section, we examine how the relationship between stock price appreciation and fixed investment may have changed across different eras based on changes in the behavior of real aggregate output growth over 1960-2004 that has been identified by previous studies. The first split of the data is based on changes in productivity growth during the post-World War II period. The reasoning behind this split is that changes in trend productivity reflect possible changes in the return on fixed investment. As such, the incentives for investment

[5] Preliminary work indicated that for nonresidential structures investment, it was rare to find any cases of signficant coefficients. This is another reflection of the difficulty of estimating standard investment models for nonresidential structures relative to that for equipment, see Oliner, Rudebusch, and Sichel (1995). As such, we concentrate on equipment investment in this paper.

[6] Data on the Wilshire 5000 is available only from 1972. For such a period, the results are similar when using the Wilshire or the S&P 500.

| | Productivity split | | | | Volatility split | |
|---|---|---|---|---|---|---|
| | All coefficients | | Appreciation only | | All | Appreciation |
| Investment category | 1974-93 | 1994-2004 | 1974-93 | 1994-2004 | coefficients | only |
| Equip. and software | 0.142 | 0.003 | 0.298 | 0.007 | 0.000 | 0.001 |
| Info. equip. | 0.113 | 0.481 | 0.336 | 0.689 | 0.097 | 0.589 |
| Computers | 0.057 | 0.020 | 0.289 | 0.075 | 0.040 | 0.281 |
| Software | 0.491 | 0.022 | 0.776 | 0.083 | 0.300 | 0.370 |
| Other info. equip. | 0.047 | 0.549 | 0.252 | 0.622 | 0.195 | 0.715 |
| Industrial equip. | 0.186 | 0.015 | 0.532 | 0.123 | 0.003 | 0.009 |
| Trans. equip. | 0.099 | 0.000 | 0.082 | 0.000 | 0.000 | 0.000 |
| Other equip. | 0.327 | 0.654 | 0.383 | 0.433 | 0.012 | 0.039 |

Table 1: Structural stability tests: simple model

in different eras for productivity growth could be markedly different, which may lead to different responsiveness to financial market signals.

As many authors have observed and shown, trend productivity growth slowed notably after 1973; for example, see Kahn and Rich (2004). Also, some studies as well as observations from some economic policymakers (e.g., Federal Reserve Board Chairman Greenspan) have found that trend productivity apparently has increased since the mid-1990s. Because it has occurred relatively recently, the date for this shift is less certain, Kahn and Rich (2004) date it more toward the latter part of the decade, while others would place it a little earlier. For our purposes, to ensure sufficient observations in the latter period, we will date the new high productivity period beginning in 1994; somewhat later dates have little qualitative effect on the results. Thus, in this split, we define three eras: 1960-1973, 1974-93, and 1994-2004.

The second split of the data is based on changes in the volatility of GDP growth during the post-World War II period. McConnell and Perez Quiros (2000) found a structural break in GDP growth with signficantly lower volatility beginning in 1984. A number of subsequent studies have confirmed their basic result as well as finding similar declines in the volatility of many macroeconomic variables; for example, see Stock and Watson (2002) and Ahmed, Levin, and Wilson (2004). As such, in this split, we define two eras: 1960-1983 and 1984-2004. The reasoning behind this split is that changes in volatility of macroeconomic variables may reflect changes in the uncertainty of the returns to investment projects. This in turn may influence investment incentives and thus the responsiveness to financial market signals.

Table 1 presents the p-values from structural stability tests assuming that the dates for the productivity and volatility splits were chosen "exogenously." For the productivity split, the p-values are for the hypothesis that the coefficients estimated for the 1974-93 and 1994-2004 periods are not different from those estimated for the 1960-73 period. For the volatility split, the null hypothesis is that the coefficients estimated for the 1984-2004 period are not different from those estimated in the 1960-83 period. For each split, we test for struc-

| | Sample period | Productivity split | | | Volatility split | |
|---|---|---|---|---|---|---|
| Investment category | 1960-2004 | 1960-73 | 1974-93 | 1994-2004 | 1960-83 | 1984-2004 |
| Equip. and software | 0.214*** | 0.408*** | 0.182** | 0.138* | 0.345*** | 0.079 |
| Info. equip. | 0.171*** | 0.297** | 0.076 | 0.212** | 0.234*** | 0.125* |
| Computers | 0.210 | 0.608 | 0.107 | 0.199 | 0.474* | 0.025 |
| Software | 0.037 | -0.008 | -0.032 | 0.219*** | 0.021 | 0.085 |
| Other info. equip. | 0.183*** | 0.359*** | 0.073 | 0.221* | 0.239*** | 0.180* |
| Industrial equip. | 0.148*** | 0.320*** | 0.130* | 0.116 | 0.260*** | 0.030 |
| Trans. equip. | 0.468*** | 1.107*** | 0.455** | 0.118 | 0.915*** | 0.049 |
| Other equip. | 0.200*** | 0.134 | 0.219** | 0.162*** | 0.261*** | 0.124** |

Table 2: Sum of coefficients on stock price appreciation: simple model

tural stability for all coefficients as well as for the equity price appreciation coefficidents only.

For both splits there appear to be some evidence of differences across the eras. For the productivity split, there is evidence that the coefficients in the 1994-2004 period are different from those in 1960-73, although the evidence is weaker when we consider only the stock price appreciation coefficients. In the volatility split, there is stronger evidence of differences across the two eras, at least outside of information equipment and software and its various subcomponents. We would not in general that results will tend to be weaker for these categories, reflecting the difficulty of estimating these components of investment (which have generally grown rapidly throughout this 1960-2004 period) with these models.

However, when we examine the sum of the coefficients on the lags of equity price appreciation as a measure of the responsiveness of equipment investment to stock prices, we find a result that may be surprising in light of the picture seen in Figure 1. As shown in Table 2, the coefficient estimates in the latter period of productivity and volatility splits are generally smaller than they are in earlier periods; this is especially evident in the volatility split. These estimates thus imply that real equipment investment has become less responsive to equity price fluctuations.

Why accounts for this pattern? Much like many other real economic variables, real equipment investment has become less volatile over the past twenty years. In contrast, equity prices have not experienced such a decline in volatility. As such, this would imply that investment should have a smaller coefficient in in the regression for the later periods. Of course, this still leaves the question of the observed high correlation during the late 1990s and early 2000s seen in Figure 1. We defer further discussion of this until later.

## 2.2 General parameter instability

We now move away from the "exogenously determined" splits of the data and consider the evidence of general instability of the parameters in the estimates of equation (1). Although we argued that split dates used in the previous section were exogenous and thus we could use standard Chow-type statistics to determine whether there were structural breaks at those dates, it is still true that there is some prior data analysis that has gone into picking those dates. Therefore, the standard statistics may be biased toward finding structural breaks at those dates. We address this issue in two ways. In this section, we test for general parameter instability using a test statistic developed in Hansen (1992). In the next section, we test for and date endogenously determined structural breaks, using statistics originally developed by Andrews (1993).

The Hansen (1992) test statistic is approximately a Lagrange multiplier test of the null of constant parameters in a model against the alternative that the parameters follow some sort of martingale process. Such an alternative incorporates the possibilities of structural breaks as well as the parameters following random walks. It thus has greater power than the CUSUM statistic (see Brown, Durbin, and Evans (1975)), which primarily tests for constancy in the intercept of a regression (see Kramer, Ploberger, and Alt (1988)). However, this statistic does not provide a date for a structural break or some other type of nonconstancy of the parameters. We address this in the subsequent sections.

The Hansen (1992) test statistics for the model described in equation (1) are presented in Table 3. Three statistics are presented. The first is that for testing the stability of all parameters of the model: the coefficients on the dependent variables as well as the variance of the error term of the regression. The second statistic is a test for the stability of only the coefficients on the lags of equity price appreciation. The third is the test statistic for the stability of the variance of the error term.

The statistics in the first column of Table 3 provide evidence of instability of at least some of the parameters of the model for equipment investment and its components. The statistic is above the 5% critical value for most categories of equipment investment and is above the 10% critical value for the aggregate.[7] In the two categories where the statistic is not above the 10% critical value, they are close to exceeding it.

With regard to the instability of the coefficients on lags of stock price appreciation, the evidence is mixed.[8] The test statistic for this case in the second column of Table 3 is above its 5% critical value for aggregate equipment and software investment expenditures as well as for the industrial and transportation equipment components. For the other components, the test statistic is well below its critical values, which on the face of it suggests that we cannot reject the hypothesis that these coefficients are constant.

However, as seen in the third column of Table 3, the test statistic for the variance of the error term indicates strong evidence that this variance is not constant in most of these categories. As discussed in Hansen (1992), instability in the error term variance reduces the power of the test for the constancy of

[7] This test statistic has a nonstandard distribution. The critical values come from Table 1 in Hansen (1992).

[8] Statistics for each of the parameters of the model, including the coefficient on each separate lag of stock price appreciation, are in a separate appendix available from the author.

| Investment category | All parameters | $\Delta s_{t-i}$ coefficients | $\sigma^2$ |
|---|---|---|---|
| Equipment and software | 1.707* | 1.507** | 0.136 |
| Infomation equipment | 3.190*** | 0.757 | 1.863*** |
| Computers | 2.002** | 0.642 | 1.108*** |
| Software | 3.769*** | 0.577 | 2.388*** |
| Other infomation equipment | 1.973** | 0.941 | 0.356* |
| Industrial equipment | 2.583*** | 1.723*** | 0.848*** |
| Transportation equipment | 1.614 | 1.406** | 0.064 |
| Other equipment | 1.604 | 0.742 | 0.362* |

Table 3: Hansen test statistics for parameter stability: simple model

coefficients in the model. We would thus conclude that at this point the test does not provide conclusive evidence concerning the constancy of the equity price coefficients in the information equipment and software categories. Still, we have found at least some evidence that the responses of equipment investment expenditures to equity price fluctuations has changed over the 1960-2004 period.

### 2.3 Endogenous structural break

With additional evidence of instability in the model represented in equation (1), we now turn to a further examination of its nature. In this section, we test for a possible structural break in the regression using the $\sup F$ statistic discussed in Andrews (1993) as well as estimating a date for any such break.[9]

Table 4 presents the results of this exercise. The first three columns of the table relate to the null hypothesis that there is no structural break in any of the coefficients of the model. The first column displays the $\sup F$ statistic and the second column presents the asymptotic p-value, calculated according to the method of Hansen (1997). The third column presents the estimated structural break, calculated as that break date that minimizes residual variance (see Hansen (2001) concerning this). The last two columns relate to the coefficients on the lags of equity price appreciation given the estimated structural break date. The fourth column displays the test statistic of the null hypothesis that these coefficients are the same across the estimated structural break, and the fifth column provides the standard p-values of the statistic.

The test statistics generally point to a structural break in the regression, although the estimated dates differ across the various components of equipment and software investment expenditures. In six of the eight categories, including the aggregate, the test statistic and its associated p-values indicate a rejection of no structural break at the 5% level or better. For aggregate equipment and software expenditures and transportation equipment, the estimated break date

[9]Note that for now, we test for only a single break; see Hansen (2001) for a discussion of one strategy in estimating multiple structural breaks in a regression model. Also, we have not had a chance to estimate a confidence interval for the estimated break date; methods of doing so are discussed in Bai (1997).

| | All coefficients | | | $\Delta s_{t-i}$ coefficients | |
|---|---|---|---|---|---|
| Investment category | statistic | p-value | date | statistic | p-value |
| Equipment and software | 29.44 | 0.001 | 1984:3 | 19.90 | 0.001 |
| Infomation equipment | 15.31 | 0.186 | 1969:1 | 6.01 | 0.198 |
| Computers | 27.03 | 0.003 | 1975:3 | 9.39 | 0.052 |
| Software | 23.72 | 0.011 | 1970:1 | 9.37 | 0.052 |
| Other infomation equipment | 16.05 | 0.150 | 1969:1 | 11.08 | 0.026 |
| Industrial equipment | 28.34 | 0.002 | 1975:4 | 14.61 | 0.006 |
| Transportation equipment | 34.32 | 0.000 | 1984:1 | 29.44 | 0.000 |
| Other equipment | 19.63 | 0.048 | 1991:2 | 17.53 | 0.025 |

Table 4: Structural stability tests with unknown breakpoint: simple model

is close to that associated with the GDP volatility break discussed in Section 2.1. The estimated break dates for most of the other categories are in the early- to mid-1970s, which is reasonably close to the date associated with a decline in trend productivity growth: the one exception is "other" equipment where the estimated date is in the early 1990s.

For the most part, the test statistics also indicate that the coefficients on lagged stock price appreciation differ across the estimated structural break for the associated category. As in the exogenous structural breaks, the weaker results occur for information equipment and software and its subcomponents, which again probably reflects the difficulty of estimating these components with this model. Also, because the estimated break dates are not all that different from the exogenous break dates of Section 2.1, the sum of the coefficients on equity price appreciation (not presented here) display a similar pattern to that in that section: the sum is less in the later period of the split, suggesting that investment expenditures are less responsive to equity price fluctuations in the later period. This may be contrary to the popular presupposition that stock price fluctuations have been important in the recent fluctuations of equipment investment, although consistent with the decline in real macroeconomic volatility since the mid-1980s. The next section provides a higher frequency analysis of possible changes in the relationship between stock prices and investment to examine the late1990s more closely.

## 2.4 Rolling regressions

Structural breaks in regression models are only one type of parameter instability that can occur for regression models. As a simple method to examine more general forms of instability as well as to provide another analysis of possible changes in the relationship between stock prices and investment, we estimate the regression model (1) over a fixed window that we roll through the sample. To balance having sufficient degrees of freedom in the regression with having a compact period for analysis, we decided to fix the window at 24 quarters (six

| Investment category | maximum | date | minimum | date | full sample est. |
|---|---|---|---|---|---|
| Equipment and software | 0.587 | 1970:2 | -0.303 | 1990:1 | 0.158 |
| Infomation equipment | 0.590 | 2002:1 | -0.251 | 1990:1 | 0.214 |
| Computers | 1.269 | 1965:4 | -3.132 | 1966:3 | 0.171 |
| Software | 0.676 | 1970:4 | -0.648 | 1966:2 | 0.210 |
| Other infomation equipment | 0.562 | 1966:1 | -0.202 | 1990:1 | 0.037 |
| Industrial equipment | 0.567 | 1966:2 | -0.377 | 1990:2 | 0.183 |
| Transportation equipment | 1.732 | 1970:2 | -1.084 | 1966:4 | 0.468 |
| Other equipment | 0.784 | 1984:4 | -0.189 | 1977:1 | 0.200 |

Table 5: Rolling regressions summary, sum of $\Delta s_{t-i}$ coefficients: simple model

years).[10]

To summarize the results of this exercise, Figure 2 displays for aggregate equipment and software investment the sum of the coefficients on the lags of stock price appreciation in each of the rolling samples estimated. The horizontal axis of the graph corresponds to the last period of the rolling sample. Two standard error confidence bands are placed around the rolling estimates, and a horizontal line conforming to the full sample estimate is included as reference for the rolling estimates.

From this figure, we see some results that are consistent with our previous analysis. For example, the sum of the coefficients is generally larger and is usually significantly positive through the mid-1980s. Afterwards, the estimates are generally smaller with a number of cases of negative point estimates and statistically insignificant. These patterns are consistent with our prior results finding a break in the estimates around the GDP volatility break of the mid-1980s and that the response of investment to stock market fluctuations declined after that break.

However, there is one major exception to this pattern. For samples that end in 2001 and 2002, there is a sharp rise in the estimated coefficient sum to levels seen in the early part of the sample. These particular samples correspond to the period of the late 1990s-early 2000s investment boom and bust as well as the Internet stock price "bubble." After these two years, the coefficient estimate drops sharply and again becomes statistically insignificant.

Figure 3 presents the results for this exercise for the high-tech category of information equipment and software. These results have patterns that are very similar to those for the aggregate equipment and software. Table 5 present a summary of the results of this rolling regression exercise for the other components of equipment investment. The rough patterns in the table are similar across components: with the exception of information equipment and software (whose peak estimate occurs during the bump up during 2001-02 as seen in Figure 3), the maximum estimate of the coefficient sum occurs before 1985, and the minimum estimate generally occurs after that date. As far as the "bump"

[10]Preliminary analysis indicates that the results are not particularly sensitive to small changes in the size of the window.

| | Productivity split | | | | Volatility split | |
|---|---|---|---|---|---|---|
| | All coefficients | | Appreciation only | | All | Appreciation |
| Investment category | 1974-93 | 1994-2004 | 1974-93 | 1994-2004 | coefficients | only |
| Equip. and software | 0.000 | 0.000 | 0.041 | 0.000 | 0.000 | 0.000 |
| Info. equip. | 0.008 | 0.000 | 0.132 | 0.298 | 0.000 | 0.744 |
| Computers | 0.000 | 0.000 | 0.608 | 0.212 | 0.061 | 0.484 |
| Software | 0.004 | 0.000 | 0.770 | 0.048 | 0.001 | 0.172 |
| Other info. equip. | 0.174 | 0.000 | 0.110 | 0.043 | 0.019 | 0.783 |
| Industrial equip. | 0.002 | 0.000 | 0.288 | 0.000 | 0.005 | 0.000 |
| Trans. equip. | 0.135 | 0.000 | 0.065 | 0.012 | 0.000 | 0.000 |
| Other equip. | 0.001 | 0.001 | 0.704 | 0.399 | 0.000 | 0.015 |

Table 6: Structural stability tests: “neoclassical” model

in the estimates seen in the aggregate and information equipment, it is apparent in industrial equipment (although it is more subdued than seen in Figures 2 and 3) but not in transportation and “other” equipment.

Returning to the simple picture in Figure 1, the results of these rolling regressions point to the period of the late 1990s and early 2000s as a special period in regard to the relationship between stock prices and equipment investment. This is especially true for high-tech information equipment and software. Given the behavior of high-tech stocks and investment during this period, these results would be consistent with stories that emphasize the unique role of the Internet stock price “bubble” in determining investment during this period, which would include the story behind the model of Gilchrist, Himmelberg, and Huberman (2004). However, to this point we have not differentiated between “fundamental” and “nonfundamental” equity price fluctuations. To make the case for the unique behavior during this period more solid, we need to begin to control for some fundamental movements in equity prices and investment.

# 3 Investment, “fundamentals,” and stock price appreciation

To be written.

# 4 Investment responsiveness to q

To be written.

# 5 Concluding remarks

Summarize and conclude.

| | Sample period | Productivity split | | | Volatility split | |
|---|---|---|---|---|---|---|
| Investment category | 1960-2004 | 1960-73 | 1974-93 | 1994-2004 | 1960-83 | 1984-2004 |
| Equip. and software | 0.190*** | 0.429*** | 0.122* | 0.042 | 0.324*** | 0.067 |
| Info. equip. | 0.109** | 0.277** | -0.012 | 0.045 | 0.152* | 0.096 |
| Computers | 0.067 | 0.256 | -0.029 | -0.098 | 0.345 | -0.089 |
| Software | -0.040 | -0.173 | -0.117* | 0.162** | -0.108 | 0.051 |
| Other info. equip. | 0.131** | 0.351*** | 0.004 | -0.030 | 0.150* | 0.137* |
| Industrial equip. | 0.059 | 0.219** | 0.044 | 0.002 | 0.175*** | -0.037 |
| Trans. equip. | 0.393*** | 0.998*** | 0.323 | -0.044 | 0.856*** | 0.035 |
| Other equip. | 0.140*** | 0.119 | 0.140* | 0.195*** | 0.190* | 0.048 |

Table 7: Sum of coefficients on stock price appreciation: “neoclassical” model

| Investment category | All parameters | $\Delta s_{t-i}$ coefficients | $\sigma^2$ |
|---|---|---|---|
| Equipment and software | 2.741 | 1.058 | 0.185 |
| Infomation equipment | 3.750** | 0.654 | 1.347*** |
| Computers | 3.815** | 0.590 | 1.182*** |
| Software | 4.532*** | 0.693 | 2.537*** |
| Other infomation equipment | 3.116 | 0.777 | 0.282 |
| Industrial equipment | 3.297* | 1.199* | 1.059*** |
| Transportation equipment | 2.690 | 1.408** | 0.055 |
| Other equipment | 3.716** | 0.893 | 0.671** |

Table 8: Hansen test statistics for parameter stability: ”neoclassical” model

| | All coefficients | | | $\Delta s_{t-i}$ coefficients | |
|---|---|---|---|---|---|
| Investment category | statistic | p-value | date | statistic | p-value |
| Equipment and software | 155.35 | 0.000 | 1984:2 | 28.20 | 0.000 |
| Infomation equipment | 381.40 | 0.000 | 1969:1 | 12.92 | 0.012 |
| Computers | 94.78 | 0.000 | 1970:4 | 8.45 | 0.076 |
| Software | 104.86 | 0.000 | 1969:4 | 22.05 | 0.000 |
| Other infomation equipment | 279.96 | 0.000 | 1969:1 | 6.79 | 0.147 |
| Industrial equipment | 66.72 | 0.000 | 1971:4 | 13.12 | 0.011 |
| Transportation equipment | 106.22 | 0.000 | 1984:1 | 36.25 | 0.000 |
| Other equipment | 99.98 | 0.000 | 1979:2 | 5.83 | 0.212 |

Table 9: Structural stability tests with unknown breakpoint: “neoclassical” model

| | Productivity split | | | | Volatility split | |
|---|---|---|---|---|---|---|
| | All coefficients | | $\Delta q_{t-i}$ only | | All | $\Delta q_{t-i}$ |
| Investment category | 1974-93 | 1994-2004 | 1974-93 | 1994-2004 | coefficients | only |
| Equip. and software | 0.053 | 0.032 | 0.462 | 0.114 | 0.756 | 0.610 |
| Info. equip. | 0.011 | 0.039 | 0.007 | 0.012 | 0.303 | 0.600 |
| Computers | 0.206 | 0.045 | 0.886 | 0.896 | 0.050 | 0.314 |
| Software | 0.000 | 0.001 | 0.000 | 0.012 | 0.024 | 0.051 |
| Other info. equip. | 0.000 | 0.011 | 0.000 | 0.007 | 0.224 | 0.737 |
| Industrial equip. | 0.000 | 0.004 | 0.000 | 0.014 | 0.013 | 0.053 |
| Trans. equip. | 0.012 | 0.001 | 0.004 | 0.002 | 0.091 | 0.031 |
| Other equip. | 0.388 | 0.620 | 0.938 | 0.408 | 0.152 | 0.147 |

Table 10: Structural stability tests: "Q" model

| | Sample period | Productivity split | | | Volatility split | |
|---|---|---|---|---|---|---|
| Investment category | 1960-2004 | 1960-73 | 1974-93 | 1994-2004 | 1960-83 | 1984-2004 |
| Equip. and software | 0.142*** | 0.195*** | 0.126*** | 0.139** | 0.152*** | 0.102* |
| Info. equip. | 0.105*** | 0.131** | 0.074** | 0.219** | 0.104*** | 0.154** |
| Computers | 0.169* | 0.237 | 0.145 | 0.163 | 0.198 | 0.098 |
| Software | 0.033 | 0.118** | -0.020 | 0.203*** | 0.032 | 0.083 |
| Other info. equip. | 0.102*** | 0.090* | 0.068** | 0.291** | 0.088*** | 0.224** |
| Industrial equip. | 0.112*** | 0.090*** | 0.114*** | 0.149 | 0.122*** | 0.076 |
| Trans. equip. | 0.318*** | 0.527*** | 0.301*** | 0.092 | 0.396*** | 0.048 |
| Other equip. | 0.144*** | 0.111 | 0.142*** | 0.161*** | 0.146*** | 0.140*** |

Table 11: Sum of coefficients on Tobin's Q: "Q" model

| Investment category | All parameters | $\Delta q_{t-i}$ coefficients | $\sigma^2$ |
|---|---|---|---|
| Equipment and software | 0.683 | 0.248 | 0.186 |
| Infomation equipment | 1.613 | 0.325 | 0.847*** |
| Computers | 1.686 | 0.260 | 1.093*** |
| Software | 1.893* | 0.594 | 1.155*** |
| Other infomation equipment | 1.242 | 0.553 | 0.061 |
| Industrial equipment | 1.625 | 0.922 | 0.064 |
| Transportation equipment | 0.757 | 0.479 | 0.074 |
| Other equipment | 1.162 | 0.212 | 0.462* |

Table 12: Hansen test statistics for parameter stability: "Q" model

| | All coefficients | | | $\Delta q_{t-i}$ coefficients | |
|---|---|---|---|---|---|
| Investment category | statistic | p-value | date | statistic | p-value |
| Equipment and software | 22.33 | 0.019 | 1971:3 | 5.12 | 0.275 |
| Infomation equipment | 30.12 | 0.001 | 1972:1 | 19.06 | 0.001 |
| Computers | 29.77 | 0.001 | 1975:3 | 9.50 | 0.050 |
| Software | 56.20 | 0.000 | 1972:1 | 44.30 | 0.000 |
| Other infomation equipment | 22.17 | 0.020 | 1980:2 | 6.69 | 0.153 |
| Industrial equipment | 45.25 | 0.000 | 1985:1 | 8.80 | 0.066 |
| Transportation equipment | 25.58 | 0.006 | 1975:1 | 20.93 | 0.000 |
| Other equipment | 17.33 | 0.089 | 1979:1 | 5.02 | 0.285 |

Table 13: Structural stability tests with unknown breakpoint: "Q" model

| Investment category | maximum | date | minimum | date | full sample est. |
|---|---|---|---|---|---|
| Equipment and software | 0.433 | 2002:1 | -0.200 | 2000:3 | 0.142 |
| Infomation equipment | 0.479 | 2001:3 | -0.147 | 1981:1 | 0.105 |
| Computers | 0.633 | 1971:1 | -0.820 | 1969:1 | 0.169 |
| Software | 0.318 | 1970:3 | -0.166 | 1982:2 | 0.033 |
| Other infomation equipment | 0.730 | 2002:1 | -0.093 | 1981:1 | 0.102 |
| Industrial equipment | 0.518 | 2001:4 | -0.345 | 1998:3 | 0.112 |
| Transportation equipment | 1.075 | 1970:1 | -0.767 | 1997:4 | 0.318 |
| Other equipment | 0.569 | 1982:2 | -0.154 | 1997:2 | 0.144 |

Table 14: Rolling regressions summary, sum of $\Delta q_{t-i}$ coefficients: "Q" model

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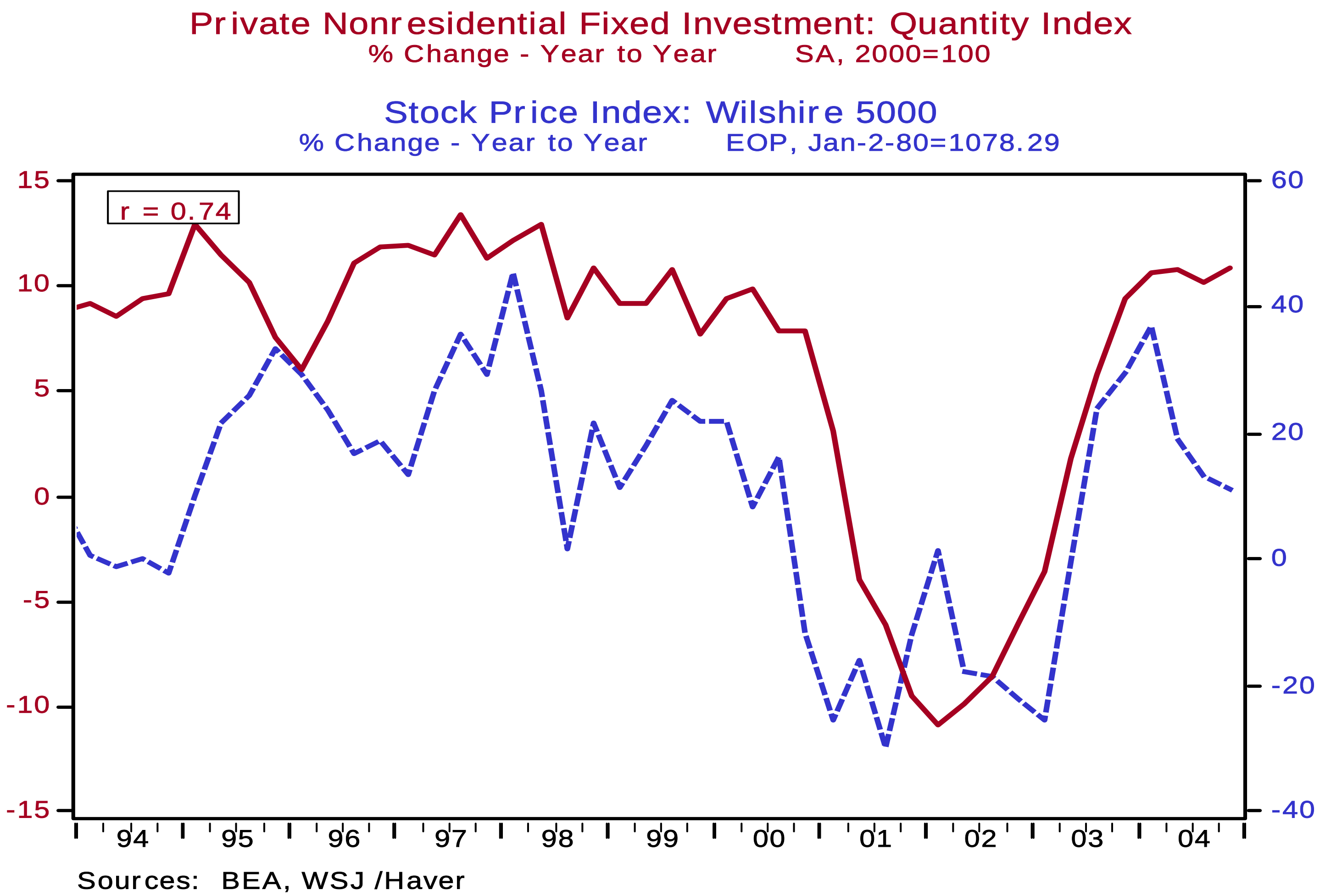
Figure 1




| | Q1 | Q2 | Q3 | Q4 | Year |
|---|---|---|---|---|---|
| 1997 | 11.93 | 11.50 | 13.43 | 11.37 | 12.06 |
| 1998 | 12.27 | 12.93 | 8.46 | 10.90 | 11.10 |
| 1999 | 9.22 | 9.18 | 10.75 | 7.69 | 9.20 |
| 2000 | 9.39 | 9.87 | 7.86 | 7.83 | 8.72 |
| 2001 | 3.16 | -3.91 | -6.09 | -9.59 | -4.18 |
| 2002 | -10.91 | -9.90 | -8.54 | -5.97 | -8.89 |
| 2003 | -3.57 | 1.70 | 5.76 | 9.44 | 3.27 |
| 2004 | 10.61 | 10.76 | 10.10 | 10.82 | 10.57 |

Figure 2

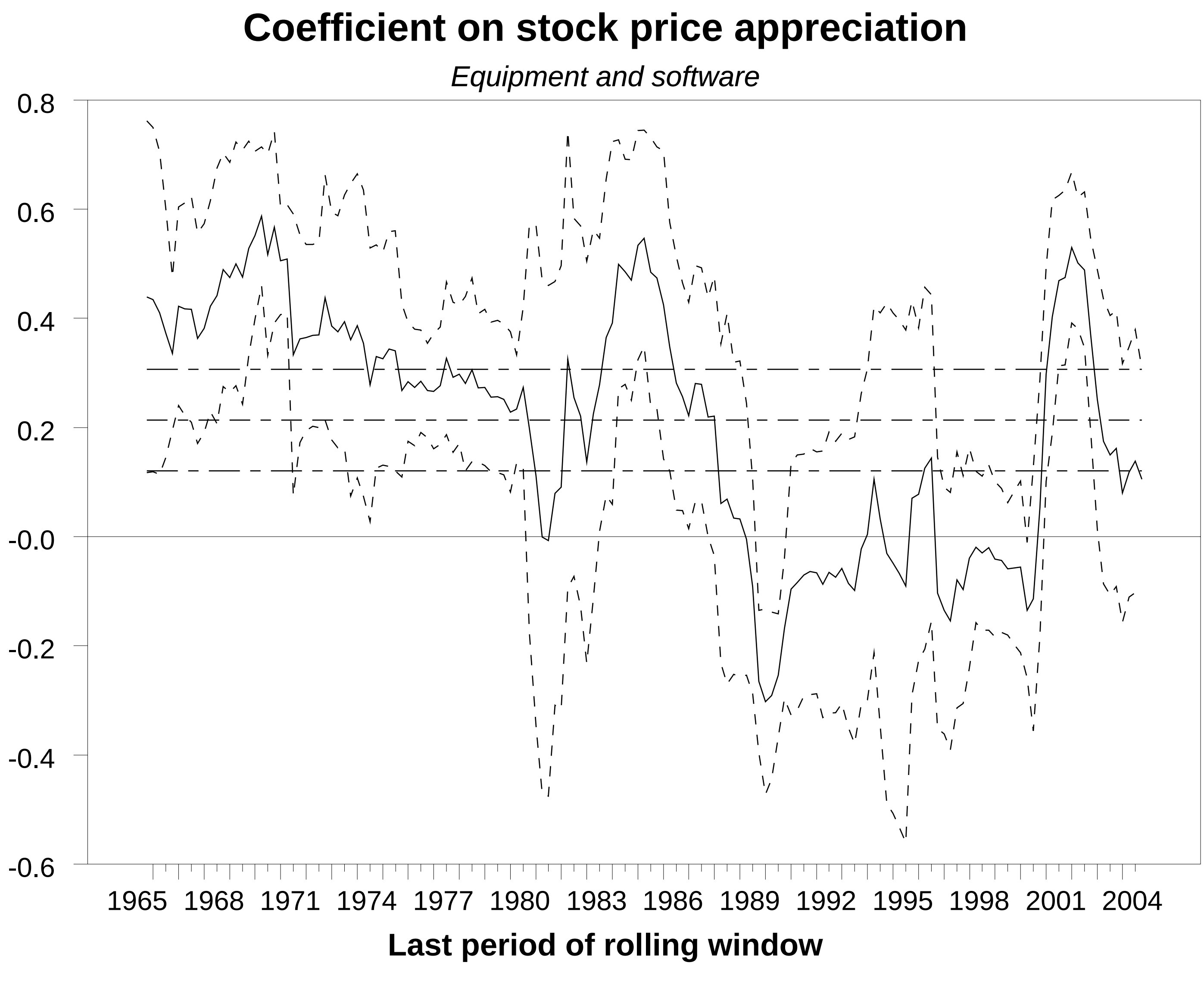
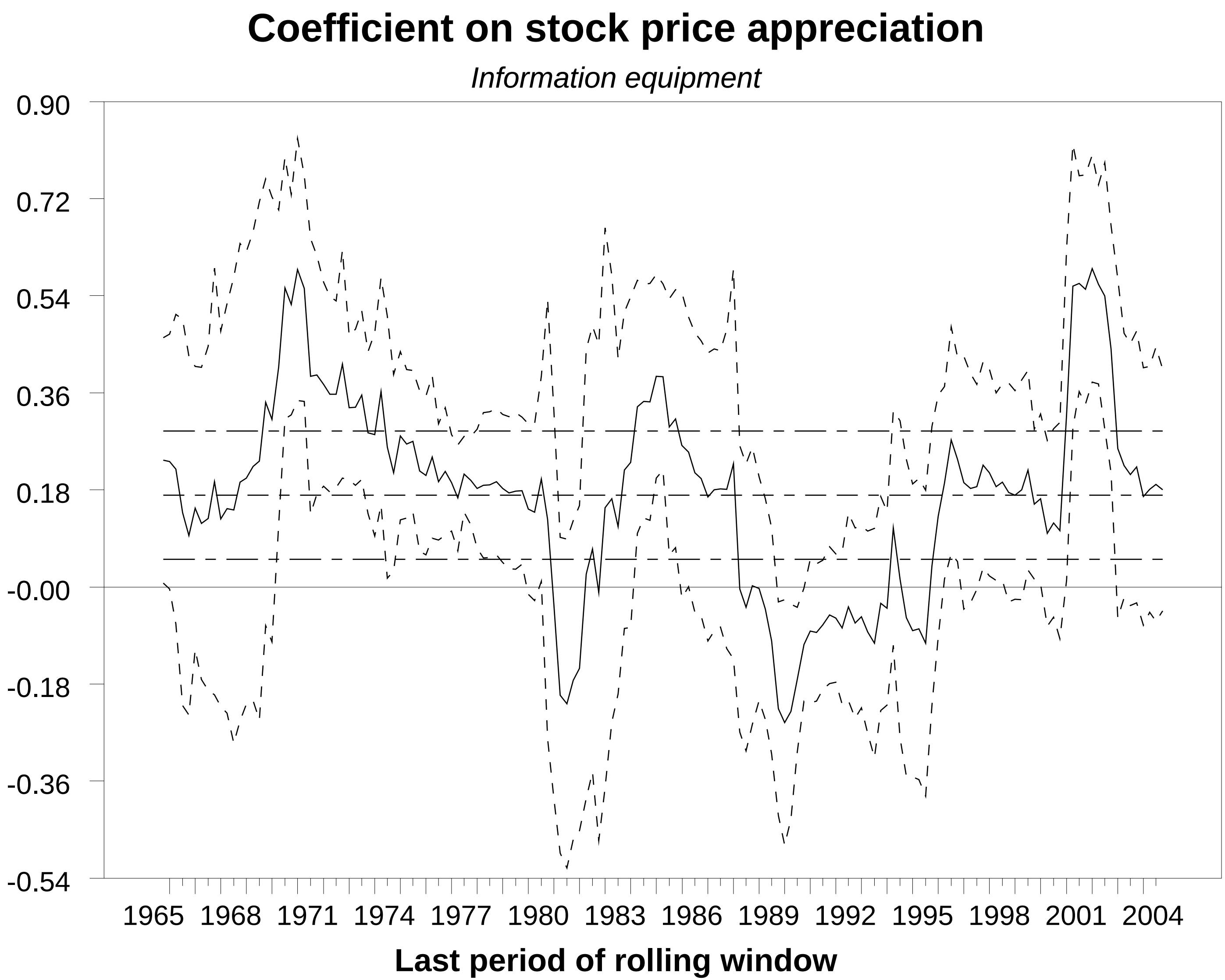

Coefficient on stock price appreciation
Equipment and software
0.8
0.6
0.4
0.2
-0.0
-0.2
-0.4
-0.6
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
Last period of rolling window

Figure 3



Coefficient on stock price appreciation
Information equipment
0.90
0.72
0.54
0.36
0.18
-0.00
-0.18
-0.36
-0.54
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
Last period of rolling window

Figure 4

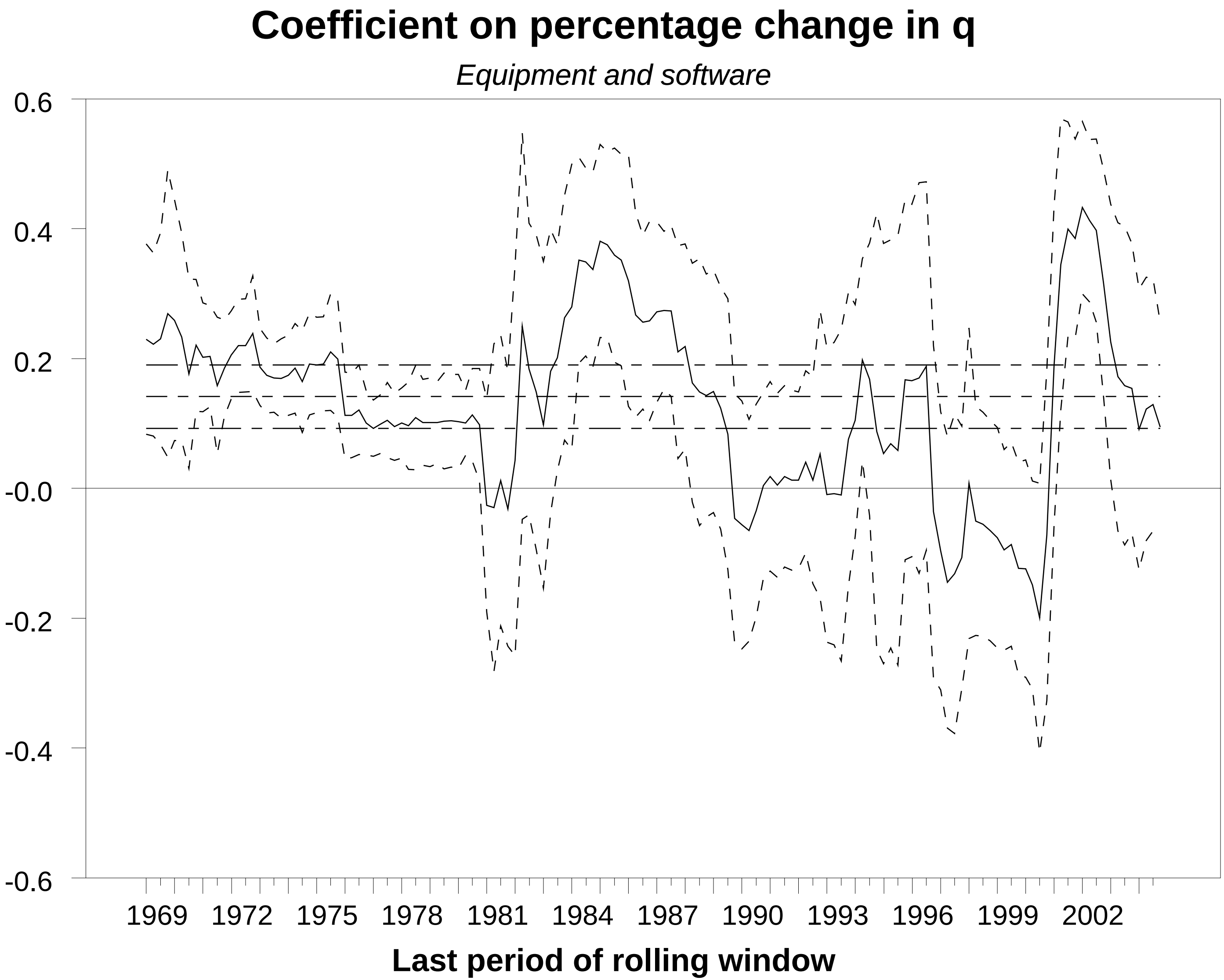
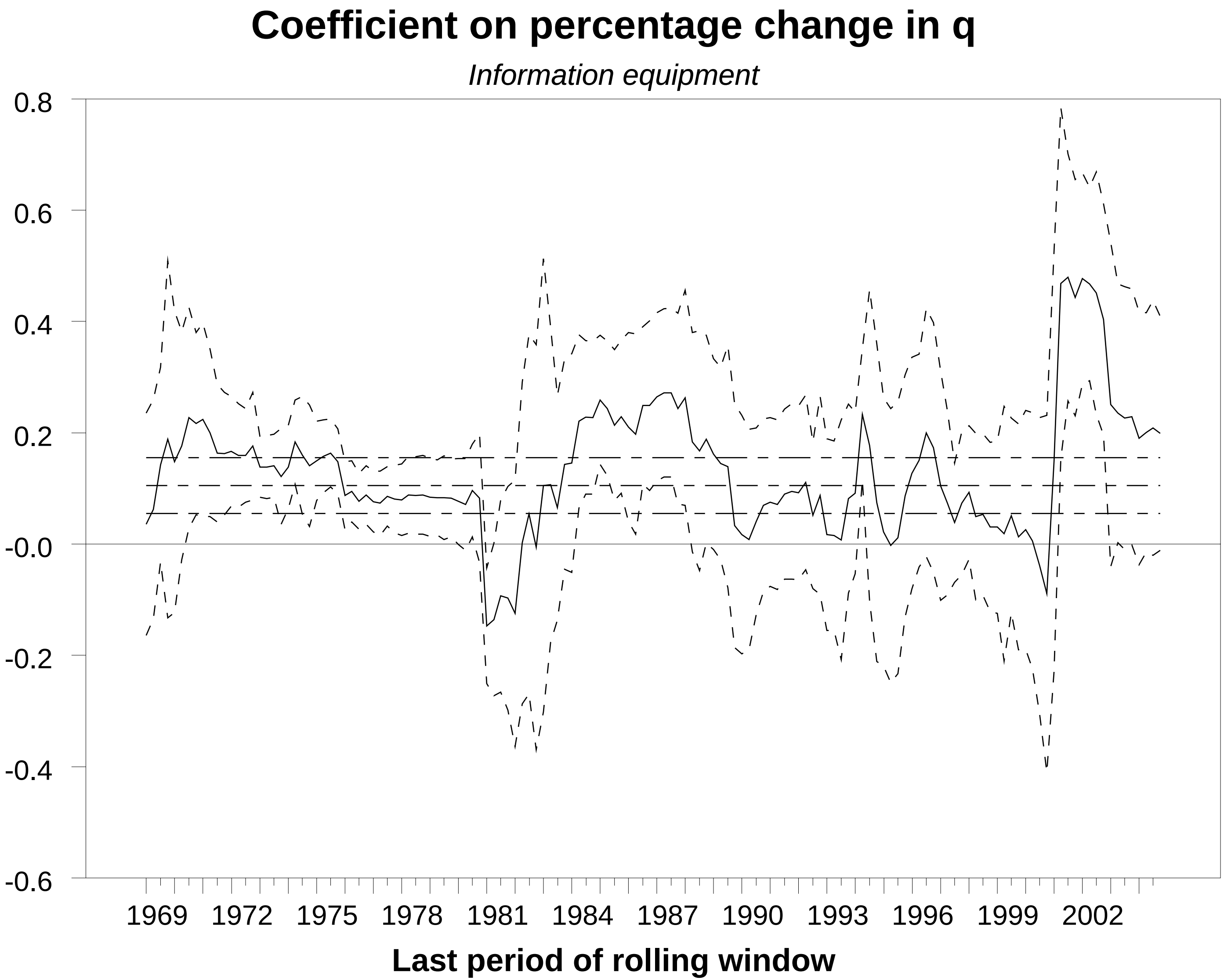

Coefficient on percentage change in q
Equipment and software
0.6
0.4
0.2
-0.0
-0.2
-0.4
-0.6
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
Last period of rolling window

Figure 5


Coefficient on percentage change in q
Information equipment
0.8
0.6
0.4
0.2
-0.0
-0.2
-0.4
-0.6
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
Last period of rolling window