The Journal of Psychology and Financial Markets
2002, Vol. 3, No. 3, 141–151



# Market Underreaction and Overreaction of Technology Stocks

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*Several studies have assessed stock market under- or overreaction of stocks and there is some agreement among them. However, there is much disagreement about what constitutes market underreaction or overreaction, and the conditions that cause it. The substantial variation in results among studies may be partially attributed to the types of firms that are contained in any sample. We investigate this premise by focusing on a sample of technology stocks that experienced an extreme change in stock price, along with a corresponding control sample of non-technology stocks that experienced a similar extreme change in stock price on the same day.*

*Based on the subsequent stock price behavior of each sample, we find a greater degree of overreaction within extreme positive changes in technology stock prices (winners) than in non-technology stock prices. In addition, we find a greater degree of underreaction within extreme negative changes in technology stock prices (losers) than in non-technology stock prices. When considering winners and losers collectively for technology and non-technology firms, it appears the market is overoptimistic when it initially revalues technology stock prices relative to non-technology stock prices.*

*The degree of under- or overreaction of technology stocks varies within the sample of technology stocks, and is conditioned on firm-specific characteristics. Overall, our results suggest that technology stocks exhibit unique stock price behavior subsequent to an extreme change in price, and that this unique behavior can even vary among technology firms according to firm-specific characteristics.*

Analyzing technology stocks is different than analyzing other types of stocks because their pricing behavior is not necessarily comparable to other stocks. Technology stocks have many of their own media, such as financial columns, newsletters, analysts, and mutual funds. And, within the technology sector, pricing behavior can vary depending on many characteristics.

The market often treats technology firms differently because their production process is still evolving and subject to possible improvement. Consequently, their future market share is subject to even more uncertainty than other firms. While barriers to entry exist, new entrants can replicate most forms of technology production. In fact, many start-up technology firms are created by former employees of larger technology businesses. Technology firms applying their technology to old economy products and services are subject to competition from start-ups and from old economy firms who have recognized the need to restructure their means of customer service and distribution.

One distinction between technology stocks and other stocks is the general trend of the technology sector versus the trends of other stocks. During the 1998–2000 period, technology stocks outperformed other stocks, but during the bear market of the first quarter of 2001, technology stocks performed worse than other stocks. General trends may be partially explained by the higher betas of technology stocks, the fundamental differences in consumption patterns of technology products, and competition within the technology sector. While there is a limited understanding of how technology stock prices respond to fundamental shifts in consumption or competition, less is known about how investors respond to information conveyed about technology firms.

Our objective is to assess the degree of under- or overreaction of technology stocks that is subject to external shocks. In a world with complete and instantaneous information, such shocks should cause an immediate revaluation. Conversely, in a world of limited information, the appropriate response to external shocks is uncertain, which can cause an under- or overreaction. Since there is much uncertainty surrounding the valuation of technology firms, any external shock that signals possible changes to production, distribution, or

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market share can lead to additional uncertainty. Market dynamics force a movement from one equilibrium price to another but the path to the new equilibrium is not necessarily straight or quick. Therefore, technology stocks subjected to external shocks may be subject to under- or overreaction.

## Valuation of a Technology Firm

The valuation of a firm can be modeled as a function of the coming year's expected cash flow and an annual growth rate. Previous research has documented that the valuations of firms with more stable growth rates, such as utility companies, are subject to less uncertainty. Using the same argument, technology companies would have more volatile expected growth rates for two reasons, as noted earlier: 1) Their respective industries have a higher potential for growth because their products and services are relatively new and evolving, but 2) they are also subject to new competitors with technology advantages that could cause extreme adjustments in market share.

Overall, the growth of a technology firm has large upside potential because of protective patents and continued growth in consumption of technology products, but also large downside potential because of the firm's susceptibility to loss in market share to new competitors. Since the valuations of technology firms are highly dependent on growth rates, and potential errors in valuations are extra sensitive to errors in growth rates, the valuation of technology firms is subject to much uncertainty.

As the following comments by Nortel Networks Corporation in its 2000 annual report illustrate, the uncertainty surrounding its business is symbolic of most technology firms:

> We participate in a highly volatile and rapidly growing industry that is characterized by vigorous competition for market share and rapid technological development. Our industry is also subject to uncertainty over adoption of industry standards and protection of intellectual property rights. There can be no assurance that claims of intellectual property infringement will not be asserted against us…. These factors could result in aggressive pricing practices and growing competition both from start-up companies and from well-capitalized computer systems and communications companies, which, in turn, could have a material adverse effect on our business, results of our operations, and financial condition (p. 38).

Besides the difficulty in estimating cash flows and growth rates of a technology firm, there is also uncertainty in the market valuation practices of investors, which can affect future cash flows and valuations. Nortel's annual report summarizes this form of uncertainty as follows:

> The Company's common shares have experienced, and may continue to experience, substantial price volatility, particularly as a result of variations between our actual or anticipated financial results and the published expectations of analysts and as a result of announcements by our competitors and us. In addition, the stock market has experienced extreme price fluctuations that have affected the market price of many technology companies in particular and that have often been unrelated to the operating performance of these companies. A major decline in the capital markets generally, or in the market price of our securities may negatively impact our ability to make future strategic acquisitions, raise capital, issue debt, or retain employees. These factors, as well as the general economic and political conditions, may in turn have a material adverse effect on the market price of our common shares (p. 39).

Given the high degree of uncertainty surrounding the valuation of technology stocks, there may be a delay before investors agree on a new equilibrium price. Consequently, more informed investors could capitalize on a sluggish transition to a new equilibrium.

### Implications of Uncertainty for Under- or Overreaction

Some research has shown that the first day's share price response of stocks to an external shock is not complete. That is, the stock price continues to gravitate toward a new equilibrium over the next few days. However, no study to our knowledge has attempted to measure under- or overreaction in technology stocks. Since technology stock valuations are more uncertain, any revisions to these valuations should also be more uncertain. In a market filled with heterogeneous valuation models and expectations among investors, such a higher degree of uncertainty should cause more caution and a general lack of confidence in the new equilibrium price. Therefore, the lagged response following an extreme change in stock price may be more cautious for technology stocks.

## Hypothesized Impact on Technology Stocks

Several hypotheses attempt to explain the under- or overreaction following an extreme change in a stock's price. These hypotheses typically do not take into consideration a firm's individual traits, however, which we believe may be one reason for conflicting results among studies.

Since technology stocks are subject to more uncertainty, they may fit the behavior described by the overreaction hypothesis, which posits that investors may overreact to both favorable news (e.g., the FDA approval of a drug), and unfavorable news (e.g., a product liability lawsuit). That is, after the initial reaction, a second set of investors responds to the new price caused by the first set of investors (on the event date). In the case of a positive initial price change, the second set of investors may sense temporary irrational exuberance, and either short the tech stocks or reduce their long positions in those stocks. To the extent that the initial price change is partially caused by noise traders, a second set of more sophisticated traders may be able to capitalize on any over- or underreaction to the external shock.

For an extreme decline in price, two hypotheses are applicable. First, there could be overreaction by a first set of investors, which could lead to a reversal in the stock price. However, there are unique aspects of the market microstructure that may cause a different response to extreme declines, relative to extreme increases in the stock price. Some investors restrict their trading to taking or reducing long positions. When a stock experiences an extreme decline in price, investors who are not presently holding the stock and are unwilling to short stocks will not initially respond. Thus, there are fewer unsophisticated investors to irrationally depress a stock's price, so any decline that does occur may be deserved. In fact, an initial shock to the stock price could cause additional aftershocks due to paranoia (whether deserved or not). Tech stocks are naturally more likely to experience aftershocks because of their uncertain valuations.

## Related Research

### Studies on the Valuation of Technology Stocks

Recent studies have documented how unique technology stocks are. Trueman, Wong, and Zhang [2000] suggest the value of Internet stocks is driven by gross profits, not earnings. The specific relationship varies among technology segments. Demers and Lev [2000] attempt to determine exactly how Internet stocks have been valued. They identify firm–specific factors that reflect technology and the firm's surplus cash position. One indirect implication of these studies is that the inherent uniqueness of some technology stocks means that results of other studies do not necessarily apply to them.

### Studies on Overreaction

Several types of studies have assessed whether stocks under- or overreact. While some studies focus on momentum or reversal tendencies over relatively long-term periods, we examine under- or overreaction at the time of an external shock. Therefore, the more closely related studies on under- or overreaction are those that investigate daily adjustments to new information.

Atkins and Dyl [1990] examined extreme price changes and subsequent abnormal returns for winners and losers on 300 randomly selected trading days from January 1975 through December 1984. Their objective was to determine whether investors overreact to releases of new information. For winners, the average abnormal return the day after the extreme price changes was –0.46% (statistically significant); for losers the cumulative average abnormal return for the two-day period following the event was 2.26% (statistically significant). Hence, their results suggest the market overreacts to favorable and unfavorable information.

Bremer and Sweeney [1991] examined abnormal returns following extreme price declines to determine if the market overreacts to unfavorable information. Their sample includes Fortune 500 firms trading during the period 1962 to 1986. A –10% trigger value was used to identify events. Stocks experiencing a one-day return of –10% or smaller were selected for their sample. The cumulative average abnormal return for the two-day period following the events was 2.64% (statistically significant). Thus, their results suggest the market overreacts to unfavorable information.

Cox and Peterson [1994] examined extreme stock price declines and subsequent abnormal returns to determine if stocks overreacted to unfavorable information. Their sample includes NYSE, AMEX, and NMS firms trading from January 1963 through June 1991. A return of –10% or lower identified the events. They partitioned their sample into six periods. For the latest time period examined (November 1987 through June 1991), NYSE firms experienced underreaction from Day 4 through Day 20 after the extreme price changes. Specifically, the cumulative average abnormal return for this period is –2.64% (statistically significant). Similar results are reported for AMEX firms. Thus, for NYSE and AMEX firms, the data support the underreaction hypothesis.

The availability of both closing transaction prices and closing bid–ask prices enabled Cox and Peterson [1994] to control for the bid–ask bounce for NMS firms. When returns following extreme price changes were based on transaction prices, weak evidence supported the overreaction hypothesis; when returns were based on bid–ask average prices, however, weak evidence supported the underreaction hypothesis. Therefore, their results indicate that the bid–ask bounce can influence results.

Peterson [1995] studied the effect of option trading on abnormal returns during the period following stock

price declines of –10% or lower. His sample period was June 1985 through December 1992. Peterson only examined NMS firms for which he constructed daily returns using bid–ask average prices. For each firm associated with exchange–traded options he identified a matching non-option firm experiencing a –10% return or lower on the same day. This matching procedure ensures that any difference between the option and non-option samples cannot be attributed to the time the events occurred. For example, it is not possible for events associated with option firms to have occurred at the beginning of the sample period while events associated with non-option firms occurred at the end of the sample period.

Following the extreme price changes, the three-day cumulative average abnormal return for his sample of option firms was 1.57% lower than that for the sample of non-option firms. This difference was statistically significant. Peterson attributed his findings to the enhanced liquidity and efficiency of option trading.

Akhigbe, Gosnell, and Harikumar [1998] examined the largest-percentage NYSE winner and the largest-percentage NSYE loser reported in the *Wall Street Journal* in 1992. Their objective was to determine whether returns following extreme price changes were larger than the bid–ask spreads, which would enable investors to profit by trading against overreaction. Their largest losers, with initial price changes between –50% to –20%, experienced reversals that substantially exceeded the average bid-ask spread. This occurred during the two-day period following the extreme price changes. They also reported evidence of information leakage: Winners experienced an average abnormal return of 3.34% for the day just prior to the extreme price changes.

Brown, Harlow, and Tinic [1988] developed the uncertain information hypothesis, which competes with the over- and underreaction hypotheses. This theory suggests that investors initially underprice stocks in the wake of new information (favorable or unfavorable) in order to incorporate a risk premium into the shares. The risk premium reflects the extra uncertainty caused by the event. As the uncertainty caused by the event is resolved, share prices rise to their new intrinsic values.

The uncertain information hypothesis predicts stock price drift for winners and reversals for losers. The authors used a one-day price trigger of 2.5% to identify winners and losers for 200 of the largest firms in the S&P 500 during the sample period 1962 through 1985. The cumulative average abnormal returns following the extreme price changes are positive and statistically significant for winners and losers, thereby providing support for the hypothesis.

It is important to note, however, that none of the forgoing studies controlled for the type of firm, as we do here.

## Sample Selection and Descriptive Statistics

### Sample Selection

To assess whether technology stocks experienced under- or overreaction in response to external shocks, we first identified a sample of large technology firms subjected to external shocks. We focused on technology stocks that are closely monitored by the market and are highly liquid so that our analysis would not be distorted by the lack of trading or information on a particular stock.

Events are defined as stock price changes in excess of 10% (sign ignored) during the period January 1998 through December 2000. A winner (loser) is a stock that experienced a one-day return of at least 10% (–10%). Bremer and Sweeney [1991], Cox and Peterson [1994], and Peterson [1995] also use this 10% trigger value to identify events.

To determine whether the speed and type of response to technology stocks is different from other types of stocks, a matching set of non-technology stocks is also assessed. For a technology stock that qualifies for our sample, a non-technology stock that experienced an external shock on the same date and traded on the same exchange is selected. The matching procedure was designed so that each pair of technology and non-technology stocks would have a similar initial return in response to the external shocks.

### Descriptive Statistics

Based on the sample selection criteria, 271 technology firms qualify for the sample: 170 winners and 101 losers. Table 1 reports the timing, frequency, and summary statistics of the sample. The average market values of equity for tech (non-tech) winners and losers are $9,200.06 ($530.36) million and $12,568.89 ($498.17) million, respectively. The average betas for tech (non-tech) winners and losers are 1.74 (0.54) and 1.72 (0.41), respectively. As a comparison, the technology firms were larger in market capitalization and had higher betas.

## Results from Testing Under- or Overreaction

To determine the degree of underreaction and overreaction for tech stocks and non-tech stocks, abnormal returns following the initial large price changes are shown in Tables 2 and 3. The results for large positive initial price changes (winners) are shown in Table 2. The results are segmented into various post-event time periods in order to pinpoint the timing of any under- or overreaction. The purpose of the pre-event windows is to disclose leakage.

**Table 1.** *Descriptive Statistics for the Sample*

| Year | # | AKBD | CAP | IPC | PRLK | BETA | VARIANCE |
|---|---|---|---|---|---|---|---|
| Panel A – Technology Stock Winner | | | | | | | |
| 1998 | 24 | 0.1849 | 4269.90 | 16.37 | 1.05 | 1.48 | 0.28 |
| 1999 | 79 | 0.2421 | 7895.08 | 15.40 | 0.14 | 2.04 | 0.46 |
| 2000 | 67 | 0.0924 | 12504.79 | 14.58 | –1.54 | 1.47 | 0.32 |
| Total | 170 | 0.1750 | 9200.06 | 15.22 | –0.39 | 1.74 | 0.38 |
| Panel B – Non-Technology Stock Winners | | | | | | | |
| 1998 | 24 | 0.4960 | 357.90 | 16.34 | –0.62 | 0.80 | 0.28 |
| 1999 | 79 | 0.3053 | 512.06 | 15.09 | 1.61 | 0.60 | 0.36 |
| 2000 | 67 | 0.2733 | 613.72 | 15.58 | –0.16 | 0.37 | 0.22 |
| Total | 170 | 0.3197 | 530.36 | 15.49 | 0.60 | 0.54 | 0.29 |
| Panel C – Technology Stock Losers | | | | | | | |
| 1998 | 14 | 0.1786 | 3267.92 | –15.40 | –0.91 | 1.46 | 0.27 |
| 1999 | 33 | 0.1686 | 9401.49 | –12.62 | –1.72 | 2.16 | 0.44 |
| 2000 | 54 | 0.0671 | 16915.89 | –13.38 | –1.30 | 1.52 | 0.30 |
| Total | 101 | 0.1157 | 12568.89 | –13.41 | –1.39 | 1.72 | 0.34 |
| Panel D – Non-Technology Stock Losers | | | | | | | |
| 1998 | 14 | 0.8392 | 364.80 | –14.86 | –1.35 | 0.57 | 0.10 |
| 1999 | 33 | 0.0033 | 754.94 | –13.16 | –0.64 | 0.57 | 0.20 |
| 2000 | 54 | 0.0038 | 375.83 | –12.72 | 1.91 | 0.28 | 0.19 |
| Total | 101 | 0.4257 | 498.17 | –13.16 | 0.63 | 0.41 | 0.18 |

*Note.* The sample consists of 170 tech and 170 non-tech firms that experienced a positive external price shock, and 101 tech and 101 non-tech firms that experienced a negative external price shock during the 1998–2000 period. AKBD = bid–ask spread on Day –6; CAP = natural log of the market capitalization on Day –6; IPC = initial price change on event day 0; PRLK = abnormal return on Day –1, pre-event leakage; BETA = pre-event beta; and VARIANCE = pre-event volatility.

In Panel A of Table 2, tech winners experienced negative returns over the three-day period following the event. Non-tech winners experienced insignificant valuation effects over the same period. A paired t-test is applied to compare the abnormal returns over the first day and over the three-day period. The t-statistic for the one-day comparison is 2.01, which is significant at the 0.05 level. The t-statistic for the three-day window comparison is 1.63. Overall, the results suggest that tech firms experienced overreaction while the non-tech matched sample did not. This supports the hypothesis that investors may have a greater degree of temporary irrational exuberance in response to favorable information about a tech firm than they do about a non-tech firm.

Panel B of Table 2 repeats the results of Panel A, except that returns are based on closing bid–ask average prices instead of on closing prices. This is done to ameliorate the bid–ask bounce (see Cox and Peterson, 1994). The results in Panel B show weak evidence of negative abnormal returns for non-tech firms on Day 2. A paired t-test is applied to compare the abnormal returns over the first day and over the three-day period. The t-statistic for the one-day comparison is 2.02, which is significant at the 0.05 level. The t-statistic for the three-day window comparison is 1.63.

Table 3 provides results for large negative initial price changes (losers). In Panel A, tech firms experienced a positive and significant abnormal return on Day 1, but a negative and significant abnormal return on Day 3. The cumulative average abnormal return for the three-day event window is statistically insignificant.

The non-tech firms experienced strong positive returns on average on Day 1. The cumulative average abnormal return for Days 1 through 3 is positive and significant and is mostly attributable to the market's response on Day 1. A paired t-test is applied to compare the valuation effects over the first day and over the three-day period. The t-statistic for the one-day comparison is 1.02, and insignificant. For the three-day window comparison it is 1.80, which is significant at the 0.10 level. Overall, the results suggest that matched loser firms experienced overreaction, while tech firms did not experience under- or overreaction.

The bid–ask bounce is controlled for in Panel B of Table 3. The cumulative average abnormal return for tech firms during Days 1 through 3 is negative and significant; non-tech firms experienced moderate positive abnormal returns over the same period. A paired t-test is applied to compare the valuation effects over the first day and over the three-day period. The t-statistic for the one-day comparison is 1.04, and insignificant. For the three-day window comparison it is 1.79, which is significant at the 0.10 level. These results support the hypothesis that loser tech firms may suffer from aftershocks, perhaps due to the uncertainty surrounding their valuations.

**Table 2.** *Average Abnormal Returns Associated With 170 Tech and 170 Non-Tech Winners During 1998–2000*

| | % Day –3 | % Day –2 | % Day –1 | % Day 0 | % Day 1 | % Day 2 | % Day 3 | % Days 2, 3 | % Days 1, 3 |
|---|---|---|---|---|---|---|---|---|---|
| Panel A Examination Returns Based on Closing Prices | | | | | | | | | |
| 1 Tech Firms, N = 170 | | | | | | | | | |
| Mean Abnormal Return | –0.05 | –1.41[a] | –0.06 | 12.57[a] | –1.51[b] | –1.21[b] | 0.93[c] | –0.28% | –1.79[b] |
| Z-Statistic | 0.22 | –2.90 | –0.15 | 29.26 | –2.73 | –2.91 | 1.96 | –0.65 | –2.08 |
| Significance | | *** | | *** | *** | *** | ** | | ** |
| Percent Greater than Zero | 45.29 | 36.47[a] | 42.94[a] | 100.00[a] | 34.71[b] | 37.06[b] | 50.59 | 44.12 | 39.41[b] |
| Z-Statistic | –1.23 | –3.53 | –1.84 | 13.04 | –3.99 | –3.37 | 0.15 | –1.53 | –2.76 |
| Significance | | *** | * | *** | *** | *** | | | *** |
| 2 Non–Tech Matched Sample, N = 170 | | | | | | | | | |
| Mean Abnormal Return | 0.30 | –0.72[a] | 0.40 | 14.57[a] | –0.25 | –0.44 | –0.21 | –0.65 | –0.90 |
| Z–Statistic | 0.86 | –2.44 | 0.61 | 48.17 | –1.05 | –1.02 | 0.20 | –0.58 | –1.08 |
| Significance | | ** | | *** | | | | | |
| Percent GreaterA than Zero | 45.29 | 41.76[a] | 50.59 | 100.00[a] | 42.35 [a] | 42.94[b] | 48.82 | 44.71 | 46.47 |
| Z–Statistic | –1.23 | –2.15 | 0.15 | 13.04 | –1.99 | –1.84 | –0.31 | –1.38 | –0.92 |
| Significance | | ** | | *** | ** | * | | | |
| Panel B Examination Returns Based on Closing Bid–Ask Average Prices | | | | | | | | | |
| 1 Tech Firms, N = 170 | | | | | | | | | |
| Mean Abnormal Return | –0.66 | –1.83[a] | –0.39 | 12.54[a] | –1.71[b] | –1.54[b] | 0.47 | –1.08[b] | –2.79[b] |
| Z–Statistic | –1.33 | –3.93 | –0.81 | 29.22 | –2.90 | –3.83 | 1.25 | –1.79 | –3.10 |
| Significance | | *** | | *** | *** | *** | | * | *** |
| Percent Greater than Zero | 45.29 | 35.29 [a] | 42.35[a] | 100.00[a] | 34.71[b] | 37.06[b] | 49.41 | 43.53[b] | 37.65[b] |
| Z–Statistic | –1.23 | –3.83 | –1.99 | 13.04 | –3.99 | –3.37 | –0.15 | –1.69 | –3.22 |
| Significance | | *** | ** | *** | *** | *** | | * | *** |
| 2 Non–Tech Matched Sample, N = 170 | | | | | | | | | |
| Mean Abnormal Return | 0.33 | –0.73 | 0.60 | 13.68 | –0.03 | –0.53[b] | –0.14 | –0.68 | –0.71 |
| Z–Statistic | 1.09 | –2.40 | 1.22 | 44.33 | 0.15 | –1.66 | 0.54 | –0.78 | –0.55 |
| Significance | | ** | | *** | | * | | | |
| Percent Greater than Zero | 47.65 | 42.94[a] | 51.18 | 100.00[a] | 50.00 | 42.35[b] | 51.18 | 40.59[b] | 45.88 |
| Z–Statistic | –0.61 | –1.84 | 0.31 | 13.04 | 0.00 | –1.99 | 0.31 | –2.45 | –1.07 |
| Significance | | * | | *** | | ** | | ** | |

[a]denotes statistical significance at the 0.01 (***), 0.05 (**), and 0.1 (*) levels.
[b]denotes overreaction.
[c]denotes underreaction.

When considering winners and losers collectively during this sample period (1998 through 2000), it appears the market is overoptimistic when it initially (Day 0) reevaluates tech stock prices in response to new information relative to non-tech stock prices. During the post-event period, tech firms experienced substantial price declines relative to non-tech firms.

## Explaining the Variation in Under- or Overreaction

Our next objective is to explain the variation in valuation effects following the initial large change in prices among tech and non-tech firms.

### Hypothesized Effects of Firm-Specific Characteristics

We hypothesize that the magnitude of the under- or overreaction of tech firms depends on the following firm-specific characteristics.

**Firm size.** Small firms are not monitored as closely by market participants as larger firms. Therefore, it is possible that smaller firms are subject to larger degrees of error when the market reevaluates their share prices in response to new information. For a sample of stocks that experience overreaction (underreaction), it is expected that the degree of reversal (drift) will be larger for small firms. For their sample of firms experiencing overreaction, Cox and Peterson

**Table 3.** *Average Abnormal Returns Associated with 101 Tech and 101 Non-Tech Losers During the Period 1998–2000*

| | % Day –3 | % Day –2 | % Day –1 | % Day 0 | % Day 1 | % Day 2 | % Day 3 | % Days 2, 3 | % Days 1, 3 |
|---|---|---|---|---|---|---|---|---|---|
| Panel A Examination Period Returns Based on Closing Prices | | | | | | | | | |
| 1 Tech Firms, N = 101 | | | | | | | | | |
| Mean Abnormal Return | 0.87 | 0.62 | –0.86[a] | –10.41[a] | 0.91[b] | –0.69 | –1.43 [c] | –2.12[c] | –1.21 |
| Z–Statistic | 1.56 | 1.13 | –1.84 | –19.40 | 1.97 | –1.35 | –2.35 | –2.61 | –1.00 |
| Significance | | | * | *** | ** | | ** | *** | |
| Percent Greater than Zero | 50.50 | 48.51 | 33.66[a] | 0.00[a] | 56.44 | 40.59[c] | 38.61[c] | 35.64[c] | 44.55 |
| Z–Statistic | 0.10 | –0.30 | –3.28 | –10.05 | 1.29 | –1.89 | –2.29 | –2.89 | –1.09 |
| Significance | | | *** | *** | | * | ** | *** | |
| 2 Non-Tech Matched Sample, N = 101 | | | | | | | | | |
| Mean Abnormal Return | 0.02 | 0.32 | 1.39[a] | –12.20[a] | 2.27[b] | –0.33 | 0.14 | –0.19 | 2.08[b] |
| Z–Statistic | 1.21 | 0.89 | 4.48 | –37.24 | 7.69 | –0.27 | 0.48 | 0.13 | 4.57 |
| Significance | | | *** | *** | *** | | | | *** |
| Percent Greater than Zero | 47.52 | 43.56 | 55.45 | 0.00[a] | 64.36[b] | 47.52 | 44.55 | 49.50 | 59.41[b] |
| Z–Statistic | –0.50 | –1.29 | 1.09 | –10.05 | 2.89 | –0.50 | –1.09 | –0.10 | 1.89 |
| Significance | | | | *** | *** | | | | * |
| Panel B Examination Returns Based on Closing Bid–Ask Average Prices | | | | | | | | | |
| 1 Tech Firms, N = 101 | | | | | | | | | |
| Mean Abnormal Return | 0.84 | 0.14 | –1.39[a] | –10.34[a] | 0.20 | –0.57 | –1.55[c] | –2.12[c] | –1.92[c] |
| Z–Statistic | 1.52 | 0.57 | –2.71 | –19.27 | 0.62 | –1.16 | –2.59 | –2.65 | –1.81 |
| Significance | | | *** | *** | | | *** | *** | * |
| Percent Greater than Zero | 51.49 | 49.50 | 32.67[a] | 0.00[a] | 56.44 | 39.60[c] | 38.61[c] | 34.65[c] | 42.57c |
| Z–Statistic | 0.30 | –0.10 | –3.48 | –10.05 | 1.29 | –2.09 | –2.29 | –3.08 | –1.49 |
| Significance | | | *** | *** | | ** | ** | *** | |
| 2 Non-Tech Matched Sample, N = 101 | | | | | | | | | |
| Mean Abnormal Return | 0.11 | 0.28 | 0.63[a] | –10.79[a] | 1.31[b] | –0.39 | –0.15 | –0.54 | 0.77[b] |
| Z–Statistic | 0.94 | 1.11 | 1.91 | –32.36 | 4.47 | –0.56 | –0.61 | –0.83 | 1.91 |
| Significance | | | * | *** | *** | | | | * |
| Percent Greater than Zero | 47.52 | 46.53 | 50.50 | 0.00[a] | 58.42[b] | 46.53 | 44.55 | 46.53 | 55.45 |
| Z–Statistic | –0.50 | –0.70 | 0.10 | –10.05 | 1.69 | –0.70 | –1.09 | –0.70 | 1.09 |
| Significance | | | | *** | * | | | | |

[a]denotes statistical significance at the 0.01 (***), 0.05 (**), and 0.1 (*) levels.
[b]denotes overreaction.
[c]denotes underraction.

[1994] found that small firms experienced larger reversals. They attributed this finding to liquidity. In this study, the hypothesized sign on the size coefficient for a sample of losers experiencing overreaction (underreaction) is negative (positive); for a sample of winners experiencing overreaction (underreaction) it is positive (negative). The size of the firm is measured by the log of its market capitalization six days prior to the shock.

**Bid–ask spread.** Illiquid stocks (those with large bid–ask spreads) are traded infrequently, and may be subject to more error when market participants reevaluate share prices in response to new information. For a sample of stocks that experienced overreaction, Cox and Peterson's [1994] results suggest illiquid stocks are associated with more overreaction. In this study, the hypothesized sign on the bid-ask coefficient for a sample of losers experiencing overreaction (underreaction) is positive (negative); for a sample of winners experiencing overreaction (underreaction) it is negative (positive).

**Pre-event leakage.** Pre-event leakage is defined as stock price changes in the same direction as the initial price change occurring in the days just before the extreme initial price change. Pre-event leakage suggests information has leaked out to at least some market participants. It seems reasonable that announcements preceded by pre-event leakage would be associated with less uncertainty and therefore less under- or overreaction. For winners (losers) experiencing overreaction, the hypothesized sign on the leakage co-

efficient is positive (negative). For winners (losers) experiencing underreaction, it is negative (positive).

**Initial price change.** The degree of correction is expected to be more pronounced for firms that experience larger initial price changes. News announcements that cause larger stock price movements may be associated with larger degrees of uncertainty and therefore larger degrees of error when investors reevaluate share prices. For their sample of losers experiencing overreaction, Akhigbe, Gosnell, and Harikumar [1998] found evidence suggesting that larger initial price changes are associated with larger degrees of overreaction. In this study, for winners and losers, the hypothesized sign on the initial price change coefficient is negative for a sample of stocks experiencing overreaction and positive for those experiencing underreaction.

**Variance of stock returns (volatility).** The volatility of the stock return during the pre-event period may be related to the degree of correction during the time period just following the event. This control variable captures any relationship that exists between stock price volatility and the degree of correction. Peterson [1995] included this variable in his cross-sectional analysis and found weak evidence suggesting that higher degrees of return volatility are associated with higher degrees of overreaction. It is possible that firms with larger degrees of return volatility will experience more pronounced corrections, since a higher degree of uncertainty is associated with these stocks.

**Monday effect.** A dummy variable is set equal to 1 if the event date occurred on Monday, and zero otherwise. This control variable prevents the results from being confounded by events occurring on Monday, which are typically associated with more pessimism. The coefficient on the Monday variable is expected to be positive, indicating higher returns in the correction phase for events occurring on Monday.

**Month of the year effect.** These variables are also included to prevent the results from being confounded by the time of year in which the event occurred**.** A dummy variable called DEC is set equal to 1 if the event date is in December, and zero otherwise. A second dummy variable called JAN is set equal to 1 if the event date is in January, and zero otherwise.

### Method for Assessing Variation in the Under- or Overreaction

The under- or overreaction of a stock to an external shock may be dependent on firm-specific characteristics, the market, or macroeconomic conditions at the time of the shock. Our matching procedure is designed to compare technology firms to non-technology firms with approximately equal initial price changes on the same date. The purpose of this matching procedure is to eliminate any differences caused by the timing or magnitude of the events. The focus is not on measured responses to a particular external shock, since the type of shock is not controlled for. Instead, we focus on the stock price behavior after the initial price response, so we can assess whether there is an under- or overreaction to an initial shock. We also attempt to explain the variation within the tech sample and the non-tech sample. To distinguish the sensitivity of tech firm from non-tech firm under- or overreaction, the following model is separately applied to the sample of tech firms and non-tech firms:

$$CAR_j = \lambda_0 + \lambda_1 AKBD_j + \lambda_2 CAP_j + \lambda_3 IPC_j + \lambda_4 PRLK_j + \lambda_5 MON_j + \lambda_6 DEC_j + \lambda_7 JAN_j + \lambda_8 VAR_j \mu_j$$

where CAR = the abnormal return; AKBD = the bid–ask spread on Day –6; CAP = the natural log of the market capitalization on Day –6; IPC = the initial price change on event day 0; PRLK = the abnormal return on Day –1, pre-event leakage; MON = the dummy variable equal to 1 if event occurred on a Monday and zero otherwise; DEC = the dummy variable equal to 1 if event occurred in December and zero otherwise; JAN = the dummy variable equal to 1 if the event occurred in January and zero otherwise; and VAR = pre-event volatility.

### Cross-sectional Results

The results from applying the cross-sectional analysis of the degree of under- or overreaction (as measured by valuation effects following the initial extreme change in the stock price) are shown in Tables 4 and 5.

Table 4 shows the results of the tech and non-tech winners. Panel A provides results based on the one-day abnormal return; Panel B provides results based on the three-day CAR. Each model represented in Table 4 exhibits a significant F-statistic. For tech winners where Day 1 is used as the dependent variable (Panel A), the valuation effects are inversely related to the initial price change and to the pre-event stock price volatility. In addition, the valuation effects are more negative if the event occurred on a Monday. For non-tech winners, the valuation effects are positively related to the degree of pre-event leakage. Like the tech firms, their valuation effects are also inversely related to the pre-event stock price volatility.

Panel B of Table 4 shows that the valuation effects (based on a three-day CAR) of tech winners are inversely related to firm size and pre-event stock price volatility. They are also more unfavorable for December events, and less unfavorable for January events. The valuation effects of non-tech winners are posi-

**Table 4.** *Cross-Sectional Analysis of Tech and Non-Tech Winners*

| | Tech Winners | | Non-Tech Winners | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **t-Statistic** | **Coefficient** | **t-Statistic** |
| **Panel A — Analysis Using One-Day Abnormal Return as the Dependent Variable** | | | | |
| Intercept | 0.0588 | 2.80[c] | 0.0039 | 0.21 |
| AKBD | 0.0053 | 0.30 | –0.0145 | –0.81 |
| CAP | –0.0029 | –0.54 | –0.0074 | –1.30 |
| IPC | –0.2089 | –2.20[b] | –0.0359 | –0.35 |
| PRLK | 0.0204 | 0.25 | 0.3410 | 4.18[c] |
| MON | –0.0261 | –1.89[a] | –0.0071 | –0.43 |
| DEC | –0.0136 | –0.76 | 0.0113 | 0.53 |
| JAN | 0.0313 | 1.57 | –0.0002 | –0.01 |
| VAR | –9.5525 | –4.28[c] | –2.2214 | –1.65[a] |
| Sample Size | 170 | | 170 | |
| F-Value | 4.21[c] | | 3.52[c] | |
| R-Squared | 0.17315 | | 0.14896 | |
| Adjusted R-Squared | 0.13206 | | 0.10668 | |
| **Panel B — Analysis Using Three-Day CAR as the Dependent Variable** | | | | |
| Intercept | 0.0894 | 2.20[b] | 0.0178 | 0.79 |
| AKBD | –0.0132 | –0.38 | –0.0107 | –0.50 |
| CAP | –0.0208 | –1.98[b] | –0.0039 | –0.57 |
| IPC | –0.1266 | –0.69 | –0.0940 | –0.75 |
| PRLK | 0.1336 | 0.85 | 0.3308 | 3.35[c] |
| MON | –0.0282 | –1.06 | 0.0177 | 0.88 |
| DEC | –0.0691 | –1.99[b] | –0.0135 | –0.52 |
| JAN | 0.0847 | 2.20[b] | –0.0090 | –0.31 |
| VAR | –14.0420 | –3.26[c] | –5.3615 | –3.30[c] |
| Sample Size | 170 | | 170 | |
| F-Value | 3.27[c] | | 3.25[c] | |
| R-Squared | 0.13960 | | 0.1391 | |
| Adjusted R-Squared | 0.09685 | | 0.09634 | |

[a]Indicates statistical significance at the 0.10 level.
[b]Indicates statistical significance at the 0.05 level.
[c]Indicates statistical significance at the 0.01 level.

*Note:* $CAR_j = \lambda_0 + \lambda_1 AKBD_j + \lambda_2 CAP_j + \lambda_3 IPC_j + \lambda_4 PRLK_j + \lambda_5 MON_j + \lambda_6 DEC_j + \lambda_7 JAN_j + \lambda_8 VAR_j \mu_j$

*Note:* The sample consists of 170 tech and 170 non-tech firms that experienced a positive external price shock during the 1998-2000 period. CAR = abnormal return; AKBD = bid-ask spread on Day –6; CAP = natural log of the market capitalization on Day –6; IPC = initial price change on event day 0; PRLK = abnormal return on Day –1, pre-event leakage; MON = dummy variable equal to 1 if event occurred on a Monday, and zero otherwise; DEC = dummy variable equal to 1 if event occurred in December, and zero otherwise; JAN = dummy variable equal to 1 if event occurred in January, and zero otherwise; and VAR = pre-event volatility

tively related to pre-event leakage and inversely related to the firm's pre-event stock price volatility.

Table 5 shows the results of tech and non-tech losers. When using a one-day abnormal return to measure valuation effects (Panel A), the F-statistic for each cross-sectional model is not significant. When using a three-day CAR to measure valuation effects (Panel B), the F-statistic for each cross-sectional model is not significant.

For winners (Table 4), the firm's pre-event stock price volatility is inversely related to the magnitude of the valuation effects for both tech and non-tech stocks, whether using the one-day abnormal return or the three-day CAR to measure valuation effects. The degree of overreaction is stronger for firms that experience higher degrees of pre-event stock price volatility. This suggests market participants overreact more to favorable information when firms are associated with higher degrees of uncertainty.

This evidence supports Peterson's [1995] findings. For non-tech winners, whether using the one-day abnormal return or the three-day CAR to measure valuation effects, higher degrees of pre-event leakage are associated with less overreaction. When examining tech winners (one-day abnormal return and three-day CAR), larger initial price increases are associated with more overreaction, events occurring on Mondays or in December are associated with more overreaction, and events occurring in January are associated with less overreaction.

## Summary

Several studies have assessed the market under- or overreaction of stocks, and there is some agreement among them. However, there is also much disagree-

**Table 5.** *Cross-Sectional Analysis of Tech and Non-Tech Losers*

| Variable | Tech Losers | | Non-Tech Losers | |
|---|---|---|---|---|
| | Coefficient | t-Statistic | Coefficient | t-Statistic |
| **Panel A — Analysis Using One-Day Abnormal Return as the Dependent Variable** | | | | |
| Intercept | 0.0347 | 0.89 | 0.0646 | 2.47[b] |
| AKBD | –0.0543 | –0.86 | –0.0237 | –1.51 |
| CAP | –0.0052 | –0.59 | –0.0007 | –0.12 |
| IPC | –0.0154 | –0.08 | 0.1610 | 1.01 |
| PRLK | 0.0068 | 0.06 | 0.0028 | 0.03 |
| MON | –0.0413 | –1.75[a] | –0.0159 | –0.75 |
| DEC | –0.0676 | –1.33 | –0.0185 | –0.42 |
| JAN | –0.0138 | –0.46 | 0.0095 | 0.37 |
| VAR | –2.5168 | –0.56 | –10.8189 | –2.16 [b] |
| Sample Size | 101 | | 101 | |
| F-Value | 0.73 | | 1.19 | |
| R-Squared | 0.05997 | | 0.09407 | |
| Adjusted R-Squared | -0.02177 | | 0.01529 | |
| **Panel B — Analysis Using Three-Day CAR as the Dependent Variable** | | | | |
| Intercept | 0.0488 | 0.84 | 0.0163 | 0.44 |
| AKBD | –0.1049 | –1.12 | –0.0187 | –0.83 |
| CAP | –0.0117 | –0.90 | –0.0060 | –0.64 |
| IPC | –0.0780 | –0.27 | –0.0249 | –0.11 |
| PRLK | –0.1694 | –1.01 | –0.1204 | –0.95 |
| MON | –0.0118 | –0.34 | 0.0170 | 0.56 |
| DEC | –0.0066 | –0.09 | 0.0036 | 0.06 |
| JAN | –0.0825 | –1.85[a] | –0.0025 | –0.07 |
| VAR | –10.2961 | –1.53 | –8.0573 | –1.13 |
| Sample Size | 101 | | 101 | |
| F-Value | 1.13 | | 0.44 | |
| R-Squared | 0.08925 | | 0.03665 | |
| Adjusted R-Squared | 0.01005 | | -0.04711 | |

[a]Indicates statistical significance at the 0.10 level.
[b]Indicates statistical significance at the 0.05 level.
*Note:* $CAR_j = \lambda_0 + \lambda_1 AKBD_j + \lambda_2 CAP_j + \lambda_3 IPC_j + \lambda_4 PRLK_j + \lambda_5 MON_j + \lambda_6 DEC_j + \lambda_7 JAN_j + \lambda_8 VAR_j \mu_j$
*Note:* The sample consists of 101 tech firms and 101 non-tech firms that experienced a negative external price shock during the 1998-2000 period. CAR = abnormal return; AKBD = bid-ask spread on Day –6; CAP = natural log of the market capitalization on Day –6; IPC = initial price change on event day 0; PRLK = abnormal return on Day –1, pre-event leakage; MON = dummy variable equal to 1 if event occurred on a Monday, and zero otherwise; DEC = dummy variable equal to 1 if event occurred in December, and zero otherwise; JAN = dummy variable equal to 1 if event occurred in January, and zero otherwise; and VAR = pre-event volatility.

ment about whether there is market under- or overreaction, and about the conditions that cause it. Conflicting generalizations about under- or overreaction may be partially attributable to differences in firm type. Our focus is on technology stocks, since their unique characteristics may cause unique investor perceptions of their valuations, and unique stock price behavior.

We investigate this premise by focusing on a sample of technology stocks that experienced an extreme change in stock price, along with a corresponding control sample of matched non-tech stocks with a similar extreme price change on the same event date. We find a greater degree of overreaction within extreme positive changes in technology stocks than within non-tech stocks, based on their subsequent stock price behavior. In addition, we find a greater degree of underreaction within extreme negative changes in technology stocks than in non-tech stocks. It seems the market is overoptimistic when reevaluating technology stock prices in response to favorable and unfavorable information relative to a matched sample of non-technology firms.

Furthermore, the sensitivity of the subsequent stock price behavior to firm–specific characteristics is different for tech stocks than for non-tech stocks. Generalizations about stock price under- or overreaction must be interpreted with caution. Such caution must be used even when interpreting results from samples focused on technology (as in our study) or any other sector, as the degree of under- or overreaction is partially due to firm–specific characteristics.

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