POST-EARNINGS-ANNOUNCEMENT DRIFT: MARKET UNDER-REACTION OR RISK MISSPECIFICATION?

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CHAPTER 1
INTRODUCTION

It is generally accepted by accounting academics that the stock market is efficient in processing publicly available information. In recent years, however, an emerging body of literature has suggested that the stock market does not appear to be efficient in processing new information as it becomes publicly available (see Fama 1991 and Ball 1992 for a review of this literature). The evidence against the efficient market hypotheses (EMH) is called an *anomaly*, defined as "systematic evidence that appears scientifically precise but is inconsistent with the tenets of basic theory"(Ball 1992). The most prominent anomaly in the accounting literature is the post-earnings-announcement drift. The results of most drift studies suggest that predictable abnormal returns can be generated by trading on the earnings numbers contained in firms' quarterly earnings announcements. Since the postannouncement drift has the same sign as the earnings surprises, it suggests that the market under-reacts to information in earnings announcements. The representative work in this literature includes Rendleman, Jones and Latané (1982, 1987), Bernard and Thomas (1989, 1990, thereafter BT 1989, 1990), and Bernard, Thomas and Wahlen (1997), among others. Although the profession has subjected the drift to a battery of tests, a rational, economic explanation for the drift remains elusive (Kothari 1999).

The rationale behind most drift studies is that even though much evidence suggests stock prices react very rapidly (within hours) to earnings announcements, the reaction may only partially reflect the full information content of the earnings releases (Beaver 1998, p. 133). Thus, if abnormal returns are still observed after the earnings announcements, the stock market has mispriced new information as it becomes publicly available. Ball and Brown (1968) first observed the drift and it has been more precisely documented in subsequent studies.

The postannouncement drift is anomalous in at least three aspects. First, there is good reason to believe the stock market to be efficient *a priori*, because such markets are paradigm examples of competition (Ball 1988). Second, earnings are the least likely candidates for inefficiency. Earnings are widely analyzed by the investment community. No other single firm-specific variable receives more attention by the analysts and other capital market participants than earnings (Beaver 1998, p. 136). Third, the drift appears to provide lucrative investment opportunities (e.g., an annualized abnormal return of 18 percent as documented in BT 1989). Yet, although major financial institutions have long ago provided their clients with the information that can be easily used to exploit the postannouncement drift (Foster, Olsen and Shevlin 1984, p. 575, BT 1989, p. 28), it does not seem to diminish over time (Bernard et al. 1997).

Competing explanations for the drift can be classified into two categories: (1) market inefficiency, and (2) risk misspecification. The first class of explanations hypothesizes that the stock market under-reacts to the information contained in the earnings news. If the process of the stock market's assimilating new information contained in reported earnings is lengthy rather than instantaneous, the stock market is not efficient in the semi-strong form. This type of explanation for the drift poses a great challenge to capital market research in accounting. If the stock market fails to fully and correctly impound new information into stock prices rapidly, then using changes in stock prices to infer the information content of accounting reports is questionable. This outcome, then, raises the possibility that the inferences drawn in many prior information content and accounting regulation studies are incorrect (Foster et al. 1984). Moreover, if the stock market is not efficient as suggested by such explanations, researchers in future studies would have to specify *a priori* the relation between security prices and financial information under the null hypothesis (Kothari 1999, p. 18). This is a formidable task since there is a wide range of relations that are feasible under market inefficiency as the maintained hypothesis (Fama 1998).

The purpose of this study is to provide a more careful and rigorous examination of the second class of explanations for the drift: risk misspecification. This alternative explanation suggests that the apparent abnormal returns subsequent to earnings announcements are simply fair compensation for bearing risk that is priced by the market but not captured by researchers. One very real possibility is that researchers have not properly controlled for shifts in beta. The efforts to control for beta shifts have been crude at best. This leaves open the explanation that the observed abnormal returns are the result of using contaminated betas for the calculation of the normal or expected returns.

There are two ways to control for risk shifts in the postannouncement period: cross-sectionally and longitudinally. BT (1989) apply the Ball and Kothari (1991) procedure to control for risk shifts cross-sectionally, on a 60-day return measurement interval, over the postannouncement period, and find that risk shifts can not explain away the drift. However, no prior study has investigated the effect of controlling for risk cross-sectionally over shorter return measurement intervals. Neither has any prior study examined whether the abnormal returns are, *on average*, significantly different from zero on a quarter by quarter basis. Therefore, this study applies the same Ball and Kothari (1991) procedure over various lengths of return measurement intervals, and use the Fama and MacBeth (1973) procedure to examine whether the abnormal returns produced by firms from different earnings groups are significantly different from zero on a quarter by quarter basis.

No prior study has attempted to control for risk shifts longitudinally, i.e., controlling for risk shifts using the time-series returns of individual securities over the postannouncement period. Using the statistical techniques suggested by Brown et al. (1975) to detect and control for beta nonstationarity at the individual firm level, this study investigates the magnitude of the postannouncement drift after the abnormal returns are calculated using the clean betas. When beta nonstationarity is controlled at the individual security level, the postannouncement drift should vanish if it is attributable to risk misspecification.

This study also examines the actual postannouncement market reaction to different earnings groups. It purports to investigate whether the postannouncement drift is due to the information set defined by the earnings release or to a combination of other events. If the market under-reaction hypothesis is true, then it can be expected that the postannouncement market reactions are noticeably different for different earnings groups. On the other hand, if the market reacts similarly to firms in all earnings groups, then it is very likely that the observed postannouncement drift is not due to the original information set defined in the earnings surprises.

The results of this study provide much evidence that is inconsistent with the market under-reaction explanation of the postannouncement drift. When risk is controlled cross-sectionally over the postannouncement period, the BT (1989) 60-day return measurement interval does not generate an abnormal return for the extreme news firms that is, *on average*, significantly different from zero on a quarter by quarter basis, making it difficult for investors to economically exploit the postannouncement drift. Additionally, when the one-day return measurement interval is used in the cross-sectional regression, the market fails to react to the bad news firms when the value-weighted market index is used, to the good news firms when the equal-weighted market index is used, and reacts significantly to the informational neutral firms no matter which market index is used. This result suggests that after risk is controlled cross-sectionally over the postannouncement period, the observed drift is no longer evidence against the semi-strong form of the EMH.

On the other hand, when risk shift is controlled longitudinally at individual security level, the postannouncement drift is no longer economically significant, suggesting that prior drift studies could have failed to adjust security returns fully to risk.

Additionally, when the actual postannouncement market reaction is examined, the study finds that the market reacts similarly to firms in all earnings groups, suggesting that the observed postannouncement drift is not likely due to the market's delayed response to the information set defined by the original earnings surprises, but rather to a combination of other events. Overall, this study has provided much additional evidence bearing upon the ongoing debate about capital market efficiency.

The next chapter reviews the drift study literature. Research design is discussed in chapter 3. Chapter 4 presents the results of the empirical analysis, and chapter 5 concludes the study.

CHAPTER 2
LITERATURE REVIEW

2.1 The Postannouncement Drift Is a Persistent Phenomenon

The post-earnings-announcement drift is the predictability of abnormal returns following earnings announcements (Kothari 1999). It takes the form that abnormal returns of good (bad) news firms continue to drift upward (downward) for up to 180 days subsequent to quarterly earnings announcements. The postannouncement drift has been viewed by many researchers as the market's delayed response to information contained in firms' earnings reports. It is a persistent phenomenon that has been documented in many studies in the accounting and finance literature. First observed by Ball and Brown (1968), the drift has been found in almost any time period examined by various studies, e.g., Joy, Litzenberger and McEnally (1977), Latané and Jones (1977, 1979), Watts (1978), Rendleman et al. (1982, 1987), Foster, Olsen and Shevlen (1984), BT (1989, 1990), and Bernard et al. (1997), among others. It is an anomaly that belongs to the semi-strong form of the efficient market hypotheses. Ball (1992 p. 319) concludes that the drift appears to be a permanent anomaly in the accounting literature.

The magnitude of the postannouncement drift is daunting in some cases. For example, after running the BT (1989) strategy for thirteen quarters, the total feasible pure profit would be approximately 10 percent of the total market value of all NYSE-AMEX firms, without reinvestment (Ball 1992). Major brokerage firms have long time ago provided their clients with information that can be easily used to exploit the drift.

However, "... there is no evidence that the drift has vanished in over thirty years"(Jacob et al. 2000).

The postannouncement drift has survived many attempts to explain it away. Two competing explanations for the drift are: market inefficiency and risk mismeasurement (BT 1989). Most researchers attribute the drift to market inefficiency (Foster et al. 1984). However, due to some methodological issues contained in these studies (discussed later in this paper), such a conclusion may be premature. On the other hand, the risk mismeasurement explanation for the postannouncement drift posits that the observed drift is simply fair compensation for bearing risk that is priced by the market but not captured by researchers. This study will examine the effect of beta non-stationarity on the magnitude of the apparent drift. If beta shifts are the source of the apparent drift, then the drift should disappear when the beta shifts are properly controlled.

The drift studies based on earnings numbers invariably take the following two steps: the estimate of unexpected earnings and the estimate of abnormal returns. The next two sections discuss the methods usually used by researchers to estimate unexpected earnings and the abnormal returns.

2.2 The Estimate of Unexpected Earnings

Information in quarterly earnings announcements is measured by unexpected earnings, which is the difference between the actual quarterly earnings and a measure of the expected earnings, usually standardized by a deflator to form the standardized unexpected earnings (SUEs). Many earnings expectation models have been used in the drift studies. These include the seasonally random walk model, the Watts-Griffin model suggested by Watts (1975) and Griffin (1977), the Brown-Rozeff model suggested by Brown and Rozeff (1978), and the Foster model proposed by Foster (1977), among others. The Foster (1977) model is the most often used earnings expectation model because it "has the best predictive ability and that its forecast errors are the most highly related to contemporaneous abnormal returns" (Watts 1978).

Since information is, by definition, independent across time, the SUEs are more likely to approximate the information in quarterly earnings if they are also independent across time (Watts 1978). However, the above earnings expectation models usually generate the SUEs that are autocorrelated over time. This leads to the "model misspecification" criticism of the drift studies. However, Rendleman et al. (1982) point out that "the earnings forecasting model is designed to capture investors' expectations and not the mathematical time series nature of the reported earnings." In other words, which earnings expectation model the researcher chooses to use does not matter in the drift study. Since the purpose of most drift studies is to find an instance that shows market inefficiency, any earnings expectation model will work as long as it can help document such an instance. Currently the main use of quarterly earnings time-series models is in the drift studies. In other capital market research, researchers typically use analysts' or management forecasts of earnings because these forecasts are not only easily available, but are more accurate and more highly associated with security returns (Kothari 1999).

2.3 The Estimate of Abnormal Returns

Abnormal returns of a security are measured by the difference between the actual returns of the security and the expected returns of the security. Since the actual returns are usually measured without errors, it is crucial that the expected returns are fully adjusted for risk to assure that the abnormal returns are not measured with errors. Three methods of estimating abnormal returns are usually used in the drift studies: the *excess return method*, the *abnormal return method*, and the *companion portfolio approach* (or its variants). It is possible that the expected returns in prior drift studies have been measured without fully adjusting for risk.

The *excess return method* measures the expected returns of a security by the market returns, usually the returns of the portfolio consisting of all stocks in the NYSE-AMEX. The method has been used in Rendlman et al. (1982, 1987), and Bernard et al. (1997), among others. This method essentially does not control for risks, and thus, provides only limited evidence on the test of market efficiency.

The *abnormal return method* measures the expected returns using the CAPM with parameters estimated from an estimation period, usually some time period prior to quarterly earnings announcements. The method has been extensively used in the drift studies (e.g., Joy, et al. 1977, and Watts 1978, among others). This method is subject to the criticism of using the parameters estimated from one period to measure the expected returns of another period. If there is structural change of the model, such as beta shifts, between these two periods, then the expected returns in the test period are measured with error.

It is interesting to note that researchers have somewhat abandoned this method of estimating expected returns. Although the reason for this shift is not clear, it appears that the companion portfolio approach to estimating the expected returns has gained more popularity since it was first introduced by Foster et al. (1984).

Under the *companion portfolio approach*, which purports to control for the Banz-Reinganum size effect, the expected returns of a security are measured by the portfolio returns of the NYSE firm size decile that the firm is a member of at the beginning of the calendar year. However, there is evidence from prior literature that the size of firms is almost randomly distributed among the SUE deciles. Therefore, it can be argued that, at the SUE decile (portfolio) level, the companion portfolio approach could be mathematically equivalent to the market return method, which does not control for risk (the proof is provided in **Appendix I**). Thus, it is still possible that the postannouncement drift observed by using this approach to estimating expected returns is simply due to the lack of control for risk and not to market mispricing.

Foster et al. (1984) compare the abnormal return method and the companion portfolio approach to estimating the expected returns and find similar magnitude of the drift, which could be the turning point where researchers started not to use the abnormal return method. For example, when replicating the drift observed by Foster et al. (1984), BT (1989) only use the companion portfolio approach to estimating the expected returns. The author is not aware of any drift study after Foster et al. (1984) that uses the abnormal return method to estimate the expected returns.

The central issue in estimating abnormal returns is whether the actual security returns have been fully adjusted for risk. The *companion portfolio approach* is one attempt to address this issue. Another method is one used by BT (1989), who run the Ball and Kothari (1991) cross-sectional regression on each SUE decile, using a 60-day return measurement interval. BT (1989) find that risk shifts cannot explain the drift away. However, controlling risk over the whole 60-day interval could fail to capture the temporal variation of betas on a daily basis. Therefore, it is important to examine whether shorter return measurement intervals generate the same result on the drift as the 60-day return measurement interval.

No extant drift study has attempted to control for risk longitudinally, i.e., control for risk using time-series returns at the individual security level over the postannouncement period. This study will also examine this issue.

2.4 Summary

The post-earnings-announcement drift has been documented extensively in the accounting and finance literature and has survived many attempts to explain it away. Although the central issue in any drift study is whether the expected returns have been fully adjusted for risk, there is only limited literature addressing this issue. Therefore, the study conjectures that after risk is controlled cross-sectionally or longitudinally, the postannouncement drift is no longer evidence against the semi-strong form of the market efficiency hypotheses.

CHAPTER 3
RESEARCH METHODOLOGY

In order to examine whether the postannouncement drift is due to market under-reaction to unexpected earnings or to risk misspecification, the starting point of the empirical analysis is to replicate the postannouncement drift. The purpose of the replication is to ensure that the postannouncement drift still exists over the sample period covered in this study.

The central issue in this study is whether the postannouncement drift can be explained by risk misspecification. Since the most influential study against the risk misspecification explanation for the postannouncement drift is perhaps BT (1989), this study reexamines the risk measurement method used by BT (1989). The procedure used by BT (1989) to measure risks is essentially the Ball and Kothari (1991) cross-sectional regression, using a 60-day return measurement interval, on the risk-premium form of the CAPM, pooling observations from all quarters. This study replicates the procedure after correcting certain measurement error, and also runs the cross-sectional regression for shorter return measurement intervals to examine whether return measurement intervals make a difference on the pattern and magnitude of the postannouncement drift.

The Ball and Kothari (1991) procedure is a method that controls for risk cross-sectionally. Another method of examining the risk misspecification argument is to control for risk longitudinally, i.e., to control for risk at each individual security level across time. The algorithm in Appendix II is used on the time-series daily returns of individual securities to calculate the abnormal returns over subperiods during which betas are stationary. These abnormal returns at the individual securities levels are then averaged to obtain the abnormal returns for the SUE deciles. The abnormal returns calculated this way is clean from beta nonstationarity criticism because beta nonstationarity is controlled at individual security levels.

The quiet period test directly examines the market's reaction to the securities in different SUE deciles over the postannouncement period, after controlling for beta nonstationarity. This longitudinal analysis is based on the assumption that if the market reacts to an event, such as unexpected earnings, the reaction should be continuous up to certain point where the market returns back to the equilibrium. During the reaction period, abnormal returns, measured as statistically significant Jensen's alphas, should be observed. During the equilibrium period (or quiet period), no abnormal returns should be observed. If the market reacts to earnings news for some time period, followed by a quiet period, and then by another significant reaction, then the second reaction must be due to events other than the earnings news. Therefore, if the market under-reaction explanation for the postannouncement drift is true, then the market should continue to react positively to good news firms and negatively to bad news firms over the postannouncement period. It can, therefore, be expected that over the postannouncement period the good news firms have many more positive market reactions than the bad news firms, that the bad news firms have many more negative market reactions than the good news firms, and that there are very few market reactions to the information neutral firms. However, if it is found that the market reacts similarly to firms in all SUE deciles, then it can be argued that the postannouncement market reaction to firms across SUE deciles is not due to the earnings surprises that are used to form the SUE deciles. If this is the case, the result is against the market under-reaction explanation for the postannouncement drift.

3.1 Sample Selection

The criteria for inclusion of firms in the sample are very similar to those used by BT (1989). The 1999 version of *Compustat* database is used, which covers companies from the first quarter of 1980 to the fourth quarter of 1998. Since 20 consecutive quarters are needed to estimate the earnings expectation model and an additional quarter is needed to form the SUE distribution (as discussed later), the sample includes all firm-quarters of data for NYSE/AMEX firms from the second quarter of 1985 to the third quarter of 1998. BT (1989) conduct some supplementary tests on NASDAQ firms and find similar postannouncement drifts. Thus, NASDAQ firms are not examined in this study. It is also required that the firm's earnings per share before extraordinary items and discontinued operations be available, and that the date of its quarterly earnings announcements be on the *Compustat.* Further more, the firm must be listed on the CRSP daily files. The final sample consists of 53,308 firm-quarters over the 54-quarter sample period.

3.2 Research Design

3.2.1 Replication of the Postannouncement Drift Using the Market Model

The postannouncement drift is replicated using the market model with parameters estimated from an estimation period to calculate abnormal returns of the test period. The purpose of replicating the drift is to ensure that the phenomenon still exists over the sample period covered in this study. Procedures used in this study to replicate the drift are similar to those used by BT (1989).[1] The sample used in this study covers 1985-98 while BT (1989) cover 1974-86. It is expected that the observed postannouncement drift in this study will be similar to that in BT (1989). In fact, Foster et al. (1984) examine the 1974-81 period and find a similar postannouncement drift. Easton (1997) covers 1963-94 and also observes the same phenomenon.

To maintain comparability with BT (1989), the study uses the same Foster (1977) model to form the market expectation of quarterly earnings. The model assumes that earnings follow a first-order autoregressive process in seasonal differences. The form of the model is:

$$E(Q_{i,t}) = Q_{i,t-4} + \phi_i(Q_{i,t-1} - Q_{i,t-5}) + \delta_i \quad ,$$

---

[1] The portfolio formation procedure is the same as BT (1989) except that in this study it is required that the firm have exactly 21 consecutive quarterly earnings announcements whereas in BT (1989) requires between 10 and 24 consecutive quarterly earnings announcements. Since the magnitude of the postannouncement drift reported in this study is comparable to that in BT (1989), this sample selection criterion should not create significant bias on the drift.

where $Q_{i,t}$ = quarterly earnings of the *i*th firm in period *t*. The ϕ_i and δ_i are parameters estimated using the most recent twenty quarters of data. The difference between actual and forecasted earnings is then scaled by the standard deviation of forecast errors over the estimation period to obtain the standardized unexpected earnings, or SUEs.

The portfolio formation procedure works as follows. For each quarter from the first quarter of 1985 to the second quarter of 1998, all observations are ranked based on the SUEs for that quarter, and the deciles of the ranking are determined. These deciles are used as the cut-offs for assigning firms into one of ten forecast error portfolios in the subsequent quarter. In other words, firms are assigned to portfolios on the basis of their standings relative to the distribution of SUEs in the prior quarter (BT 1989, p. 8). In so doing, the hindsight bias of forming portfolios as discussed in Holthausen (1983) is avoided.

The daily abnormal return of security *i* is calculated as the difference between the security's actual return on that day and its expected return. The expected return is estimated using the following two-parameter market model:

$$r_{it} = \alpha_i + \beta_i r_{mt} + e_{it}, \tag{1}$$

where, r_{it} = raw return for firm *i* on day *t*,
r_{mt}= the equal-weighted CRSP return on day *t* , and
e_{it} = a random error.

The parameters, α_i and β_i, are estimated using the ordinary least squares (OLS) on the 600 trading days prior to the 60th trading day before the day of earnings announcement. The cumulative abnormal returns, or CARs, of firm *i* during a time period are the sum of the firm's daily abnormal returns during that period. The CARs for each SUE decile are the mean of the CARs of all individual stocks in that decile, pooled across all quarters.

The method of calculating abnormal returns and CARs is the same as one of the methods used by Foster et al. (1984, footnote 12).

Patterned after Foster et al. (1984) and BT (1989), CARs of each SUE decile over the 60-day window prior to (and including) the date of quarterly earnings announcements, denoted as [-59, 0], and the 60-day window after the date of the announcements, denoted as [1, 60], are depicted. Since BT (1989) observe that a majority of the total amount of the drift following the quarterly earnings announcements occurs during the [1, 60] time window, this study does not examine the postannouncement drift beyond this time window.

3.2.2 Application of the Ball and Kothari (1991) Procedure to SUE Deciles

The most serious criticism of the procedure used to estimate abnormal returns in the above section is that it uses parameters estimated from one period to calculate the expected returns of a different period. If there are structural changes of the model between these two periods, such as beta shifts, this method will result in biased estimates of abnormal returns. Although researchers have long ago realized this, most drift studies fail to incorporate the appropriate methods to effectively control for risk in the test period. In order to examine whether the postannouncement drift is due to market under-reaction of earnings news or to risk misspecification, it is important to adjust the expected returns of a security fully to risk. The *companion portfolio approach*, which uses the return of a size-controlled portfolio as the expected return of a security, is one attempt to directly control for risk in the test period. Due to the weakness of this approach discussed earlier, however, this study does not use this approach to estimate the expected returns.

Another method to directly control for risk in the test period is the Ball and Kothari (1991) procedure. This procedure purports to control for risk cross-sectionally. A description of the Ball and Kothori (1991) procedure is as follows. Let τ denote event time, with the earnings announcement date labeled as event-time $\tau = 0$. Event-time τ encompasses only one calendar day. The following CAPM, in risk premium form, is estimated separately for each event-time day:

$$R_{it\tau} - R_{ft} = \alpha_\tau + \beta_\tau (R_{mt} - R_{ft}) + \varepsilon_{it\tau}, \tag{2}$$

where $R_{it\tau}$ = daily return on security i for calendar day t and event-time τ,
R_{mt} = market return for calendar day t,
R_{ft} = risk-free rate of return on calendar day t, proxied by the return of the three-month treasury bills,
α_τ = parameter representing Jensen's (1968) alpha (abnormal return),
β_τ = parameter representing the CAPM relative risk on event-time τ, and
$\varepsilon_{it\tau}$ = a random error.

The regression slope β_τ estimates the pooled cross-sectional average relative risk on event-time τ.

Although this procedure is not used by Ball and Kothari (1991) to investigate the postannouncement drift, BT (1989) use the procedure to examine whether risk can be used to explain away the postannouncement drift. Unlike Ball and Kothari (1989), who use a one-day return measurement interval in the cross-sectional regression of equation (2), BT (1989) use a 60-day return measurement interval in the regression. That is, BT (1989) use the compounded total returns on an individual security, treasury bills, and the market index over days [1, 60] as one observation in the regression on equation (2) for each SUE decile, pooling all observations across all quarters.

The advantage of using the Ball and Kothari (1991) cross-sectional regression to estimate abnormal returns, α_τ's, is that it provides effective control for beta shifts cross-sectionally, especially for the short return measurement intervals. For example, for the one-day return measurement interval, risk shift is controlled on a daily basis, and the slope β_τ of equation (2) can be considered to be the weighted-average of the underlying true betas of each security on event time τ. The α_τ's can, therefore, be considered the abnormal returns on event-time τ after removing the market effect. However, when the return measurement interval increases, it is possible that the cross-sectional regression does not control for the beta nonstationarities at the individual security levels over the longer return measurement interval. Thus, it can be argued that the 1-day return measurement interval is superior to the 10-day interval, and so on. In order to examine whether the return measurement interval has an effect on the pattern and magnitude of the postannouncement drift, this study uses one-day, 10-day, 30-day and 60-day return measurement intervals for the cross-sectional regression of equation (2). For the one-day, 10-day and 30-day return measurement intervals, CARs for an SUE decile over days [1, 60] are calculated as the sum of the cross-sectional Jensen's alphas of each return measurement interval over time.

A potential estimation bias could be generated by the BT (1989) procedure. They admit that regressing equation (2) at individual security levels could underestimate the standard errors of the parameters because of the cross-sectional dependence of the data (the bias is discussed in detail in Bernard 1987). In order to correct this measurement error, on each calendar day, firms announcing earnings on that date are grouped within the SUE deciles to form an equal-weighted portfolio, and the return data on the equal-weighted portfolio are used in the cross-sectional regression. This error correction procedure is the same as one used by Ball and Kothari (1991).

Since in BT (1989) there is only one regression for each SUE decile over days [1, 60], they use the t-statistics from the regression, which pools all observations from all quarters, to estimate the significance of the parameters in equation (2). Unlike BT (1989), this study uses the Fama and MacBeth (1973) two-pass procedure to test whether the mean of the time-series quarterly Jensen's alphas of each SUE decile is significantly different from zero. In the first pass, CARs over days [1, 60] are obtained for each SUE decile for each quarter. In the second pass, these time-series CARs for each SUE decile are averaged to determine whether the mean is significantly different from zero, using a standard t-test.

It can be argued that Fama and MacBeth (1973) procedure is superior to the significance test used by BT (1989). The trading strategy suggested by BT (1989) requires an investor to implement it on a quarter by quarter basis. Thus, it is important to assess whether the trading strategy can generate abnormal returns that are, *on average*, significantly different from zero on a quarter by quarter basis. Using the Fama and MacBeth (1973) two-pass procedure, the variation of the time-series quarterly Jensen's alphas for each SUE decile better captures the dispersion of the abnormal returns that could be earned by implementing the trading strategy suggested by BT (1989). This procedure, therefore, can be used to better assess whether the mean of the abnormal returns for each SUE decile across all quarters is significantly different from zero. Pooling all observations in a single regression of equation (2), as in BT (1989), could potentially disguise the variability of Jensen's alphas over time.

In order to examine whether proxies for the market index have an effect on the pattern and magnitude of the postannouncement drift, this study uses both the value-weighted and equal-weighted CRSP index as the market index.

3.2.3 Estimating Jensen's Alpha Using Time-Series Data over the Postannouncement Period

The Ball and Kothari (1991) procedure is a method that controls for risk cross-sectionally. Another method of examining the risk misspecification argument is to control for risk longitudinally, i.e., to control for risk at each individual security level. In order to do this, the same Jensen's (1968) model is used in this study to estimate the abnormal returns of each individual security over days [1, 60], after beta nonstationarity is controlled. The model takes the following form:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_{it} (R_{mt} - R_{ft}) + \varepsilon_{it} , \qquad (3)$$

where
R_{it} = return on security i for calendar day t,
R_{mt} = market return for calendar day t,
R_{ft} = risk-free rate of return for calendar day t,
α_{it} = parameter representing Jensen's (1968) alpha (abnormal return),
β_{it} = parameter representing the CAPM relative risk, and
ε_{it} = a random error.

The subscript t in α_{it} and β_{it} indicates that these parameters could vary over time. Since beta shift is a legitimate concern whenever a linear regression is run over a time-series of data, the algorithm in Appendix II is applied to the estimation of equation (3) on each security over days [1, 60] in order to control for risk shifts during the period. After all stationary subperiods (with a minimum length of three days) on the time-series are identified, the OLS is run to obtain Jensen's alpha for each subperiod. Then the summation of these Jensen's alphas over days [1,60] results in the CARs of the security over the period.

CARs for a given SUE decile are calculated as the mean of the CARs of all individual securities in the decile. The significance test of CARs for each SUE decile is again performed using the two-pass Fama and MacBeth (1973) procedure.

If the market continues to react to earnings news in the direction of unexpected earnings, it can be expected that CARs will be positive for SUE 10 and negative for SUE 1 over days [1, 60]. Additionally, if the market under-reaction theory is true, then CARs for both SUE 1 and SUE 10 firms should be economically exploitable, after beta nonstationarity is controlled at the individual security levels.

One concern of using the sum of Jensen's alphas over time to obtain CARs of the security is that there is a trade-off between the sampling error and nonstationarity error. Since the number of days in each subperiod may not be equal (minimum of 3 days and maximum of 60 days), the summation of Jensen's alphas over time is essentially adding Jensen's alphas that have different sampling errors. On the other hand, when using the parameters estimated from one period to calculate abnormal returns of different period, there could be less sampling error and more nonstationarity error. However, summing Jensen's alphas over time for each individual security and then averaging these Jensen's alphas of all securities in an SUE decile to obtain the abnormal returns for the decile should reduce sampling error through a diversification effect.

Again, this study uses both the value-weighted and equal-weighted CRSP index as the market index to see whether there is an index effect on the pattern and magnitude of the postannouncement drift after risk is controlled at individual security levels over the test period.

3.2.4 Quiet Period Test

In addition to the cross-sectional test and longitudinal test described in the previous two sections, it is also important to directly examine the market's actual reaction to firms with different earnings surprises over the postannouncement period. The quiet period test serves this purpose.

A quiet period is defined as a stable period where Jensen's alpha is not significantly different from zero. During a quiet period the market is considered in equilibrium and, therefore, not reacting to any event. The purpose of the quiet period test is to determine whether there is evidence to show that the market reaction over the postannouncement period has breaks with the information set defined by earnings releases.

The quiet period test is based on the assumption that if the market reacts to an event, such as unexpected earnings, the reaction should be continuous up to certain point where the market returns back to the equilibrium. During the reaction period, abnormal returns, measured as a statistically significant Jensen's alpha, should be observed, and during the equilibrium period (or quiet period), no abnormal returns should be observed. If the market reacts to earnings news for some time period, followed by a quiet period, and then by another significant reaction, then the second reaction must be due to events other than the earnings news.

To perform the quiet period test, the algorithm in Appendix II is applied to the estimation of equation (3) for each individual security using daily returns over days [1, 60]. The algorithm identifies the stationary subperiods during which Jensen's alphas are significantly positive (positive market reaction), significantly negative (negative market reaction), and not significantly different from zero (no reaction). The algorithm also calculates the Jensen's alphas and the length of these stationary subperiods. A significance level of 0.10 is used to determine whether Jensen's alpha is significantly different from zero. In fact, this significance level is in favor of the market under-reaction argument because at this level more significant Jensen's alphas can be observed.

If the market under-reaction explanation for the postannouncement drift is true, then the market should continue to react positively to good news firms and negatively to bad news firms over the postannouncement period. It can, therefore, be expected that over the postannouncement period: (1) good (bad) news firms should have "many" more positive (negative) Jensen's alphas than other SUE deciles, (2) good (bad) news firms should have longer positive (negative) stable subperiods than other deciles, and (3) good (bad) news firms should produce the Jensen's alphas larger in magnitude than other deciles.

CHAPTER 4
RESULTS OF EMPIRICAL ANALYSIS

4.1 Replication of the Postannouncement Drift Using the Market Model

As the starting point of the empirical analysis, the postannouncement drift is replicated using the market model. For each quarter from the first quarter of 1985 to the second quarter of 1998, firms are ranked based on the SUEs for that quarter, and the deciles of the ranking are determined. These deciles serve as the cut-offs for assigning firms into one of ten forecast error portfolios in the subsequent quarter. The abnormal returns of a security are calculated using the market model with parameters estimated from 600 trading days prior to the 60th trading day before the earnings announcement. CARs of the firm during a time period are the sum of the firm's daily abnormal returns over that period. CARs for a given SUE decile are calculated as the mean of CARs of all individual stocks in the decile, pooled across all quarters. Lastly, CARs of each SUE decile are depicted over the 60-day window surrounding the earnings announcement date.

Results of replicating the postannouncement drift are presented in Figures 1 and Table 1. Figure 1 depicts CARs for each SUE decile over the 60-day period around the earnings announcement date, using the equal-weighted CRSP index as the market index. The postannouncement drift is apparent and reveals the same pattern as documented in prior studies, e.g., Foster et al. (1984), and BT (1989). CARs continue to drift up for good news firms after earnings announcement, down for bad news firms, and essentially flat for the information neutral firms. In Table 1, the postannouncement abnormal return

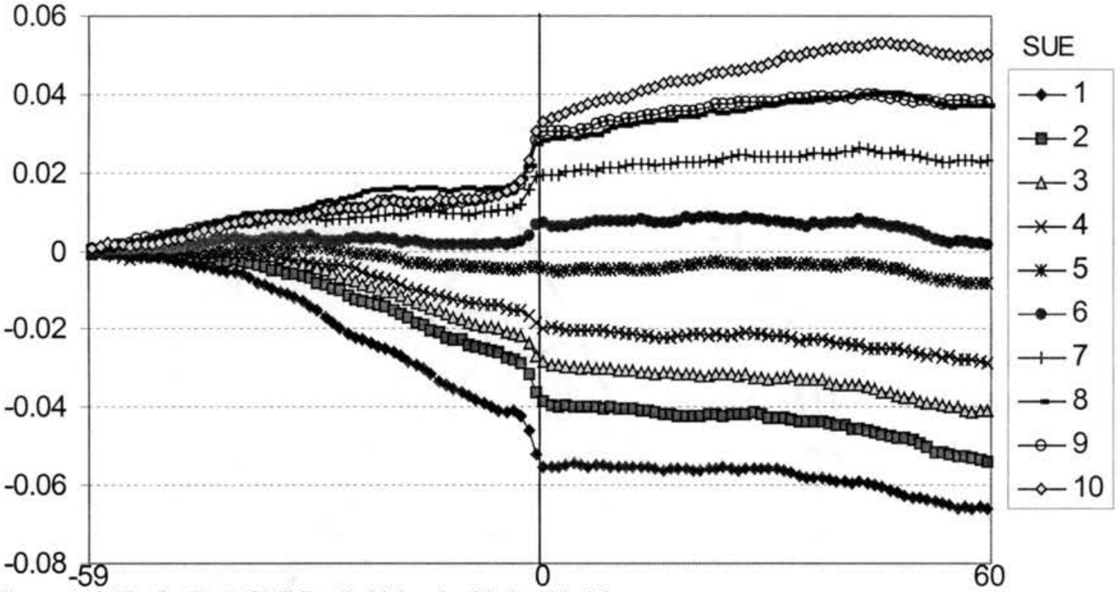


Figure 1. CARs for Each SUE Decile Using the Market Model

TABLE 1
CARs for Each SUE Decile Using the Market Model Over the 60-Day Period Around the Earnings Announcement Date[1]

SUE Decile (1 = low; 10 = high)	Preannouncement Days [-59, 0]	Postannouncement Days [1, 60]
1	-5.199 %	-1.385 %
2	-3.623	-1.779
3	-2.698	-1.374
4	-1.839	-1.006
5	-0.415	-0.396
6	0.688	-0.527
7	1.912	0.382
8	2.730	0.975
9	2.817	1.003
10	3.072	1.926
SUE10 – SUE1	*8.271*	*3.311*

[1] For each earnings announcement, the market model is estimated over 600 days prior to the 60th trading day of the earnings announcement date. The parameters from the estimation period are used to estimate the abnormal returns of the 60 days around the announcement date. CARs of individual securities are the sum of daily abnormal returns over time. CARs for the SUE decile are the mean of CARs of individual securities in the decile, pooled all observations over time. The equal-weighted CRSP indices is used as the market index. The sample consists of 53,308 quarterly earnings announcements.

for the extremely good news firms (SUE 10) is about 1.93 percent over the 60 days subsequent to earnings announcement (-1.39 percent for the extremely bad news firms, or SUE 1 firms). Thus, a long position in firms of SUE 10, combined with a short position in firms of SUE 1, could yield an abnormal return of about 3.31 percent over days [1, 60], or 13.24 percent on an annualized basis, before transaction costs. This result confirms that the postannouncement drift also exists in the sample period covered in this study and is consistent with the market mispricing explanation of the drift, i.e., the market under-reacts to the information contained in the earnings news. However, the criticism of the procedure to generate this result is that it uses parameters from the estimation period to calculate the expected returns for the test period.

4.2 Results of Applying the Ball and Kothari (1991) Procedure to SUE Deciles

4.2.1 Measuring Risk Using the BT (1989) Method

The same Ball and Kothari (1991) procedure is used by BT (1989) to directly control for risk cross-sectionally in the test period in order to examine whether risk misspecification argument can be used to explain the postannouncement drift. Unlike Ball and Kothari (1991), who use a one-day return measurement interval in the cross-sectional regression of equation (2), BT (1989) use a 60-day return measurement interval. BT (1989, p. 17) conclude that beta is only 10 percent as large as necessary to explain the postannouncement drift.

This study replicates the risk measurement method used by BT (1989), who estimate equation (2) cross-sectionally using the 60-day return measurement interval and

Figure 2. Cross-Sectional Regression Using Value-Weighted CRSP Index

Panel A. 60-Day Interval

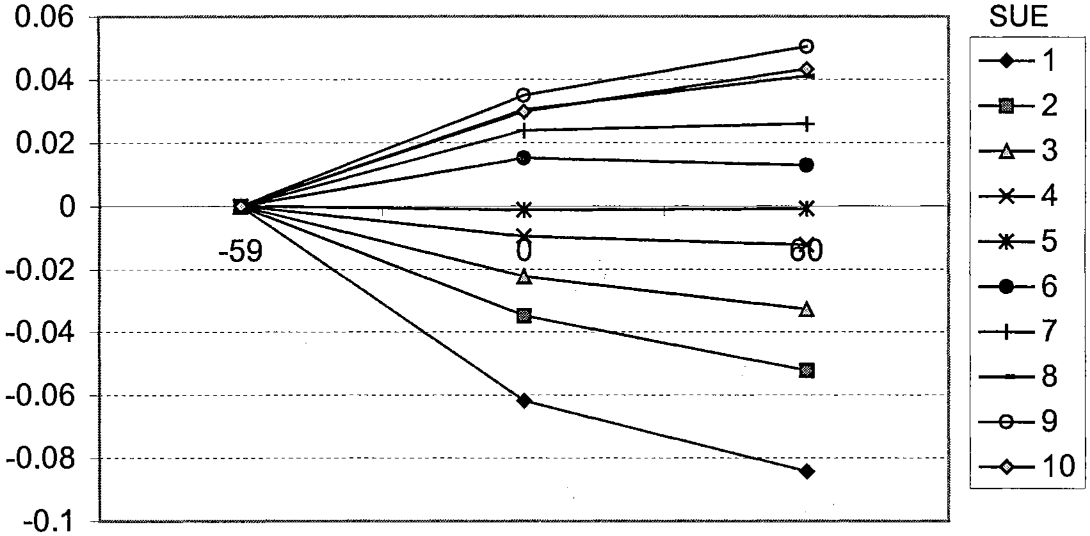


Figure 2. (*Continued*)

Panel B. 30-Day Interval

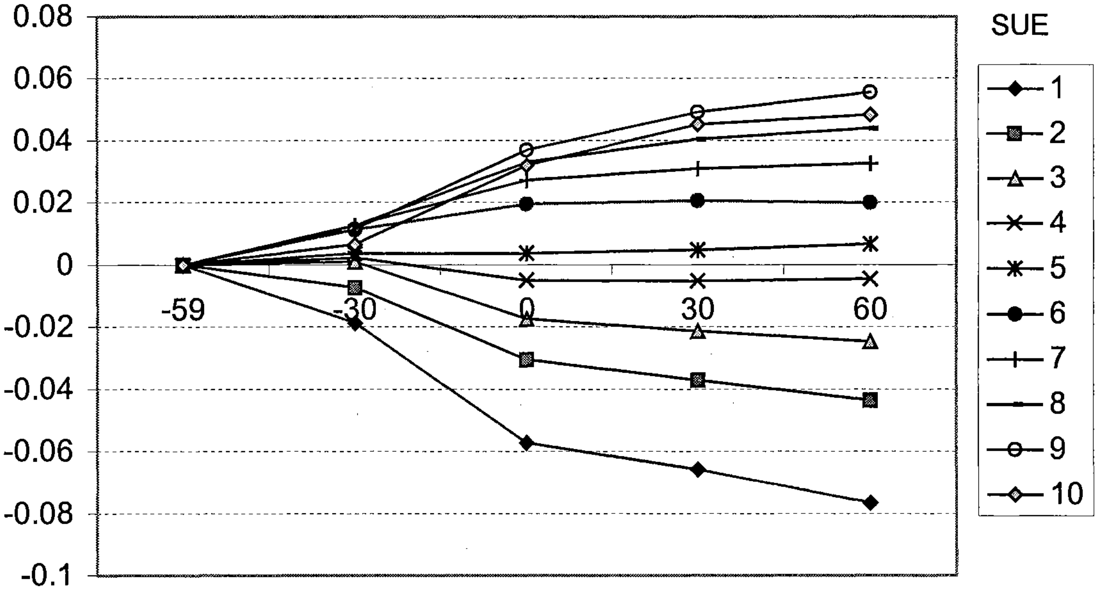


Figure 2. (*Continued*)

Panel C. 10-Day Interval

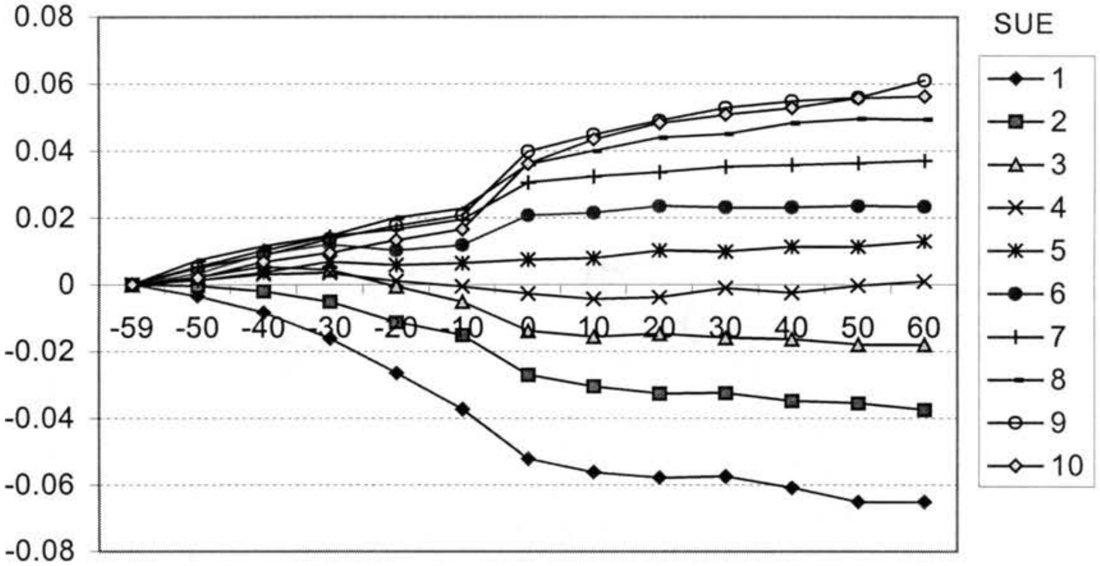


Figure 2. (*continued*)

Panel D: One-Day Interval

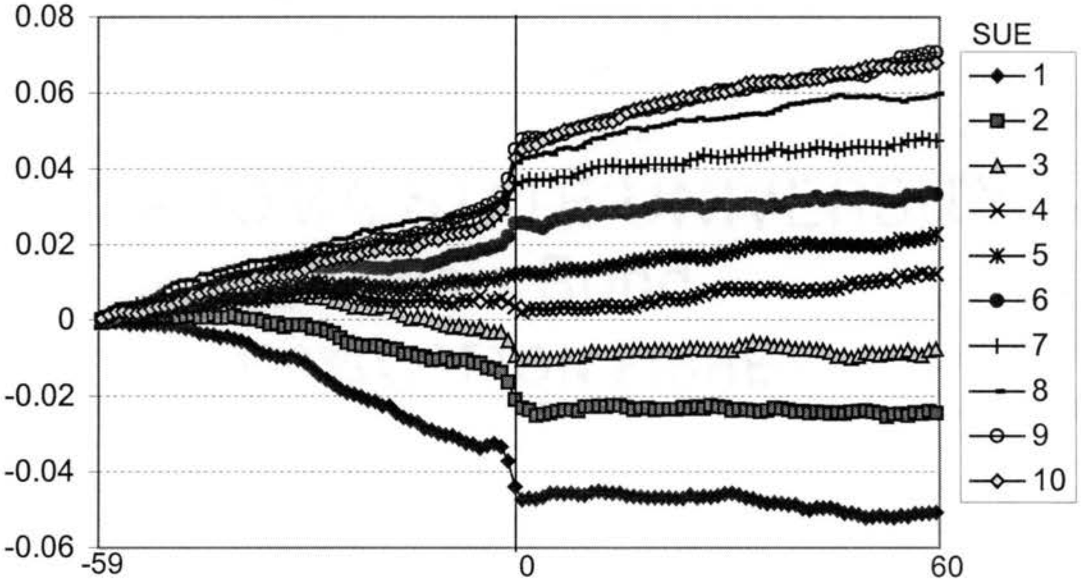


TABLE 2

CARs for Each SUE Decile over Days [1, 60] Using the Ball and Kothari (1991) Cross-Sectional Regression with Value-Weighted CRSP Index[1]

	60-Day Interval					30-Day Interval			10-Day Interval			1-Day Interval		
	Two-Pass Procedure			*BT (1989) Procedure*			*Two-Pass Procedure*			*Two-Pass Procedure*			*Two-Pass Procedure*	
SUE	CAR	t-stat	Pr>|t|	t-stat	Pr>|t|	CAR	t-stat	Pr>|t|	CAR	t-stat	Pr>|t|	CAR	t-stat	Pr>|t|
1	-2.25%	-1.91	0.062	-5.95	<0.0001	-2.13%	-2.26	0.028	-1.48%	-1.69	0.097	-0.69%	-0.84	0.404
2	-1.738	-1.26	0.212	-5.19	<0.0001	-1.450	-0.88	0.381	-1.171	-1.21	0.231	-0.367	-0.43	0.671
3	-1.047	-0.98	0.334	-3.08	0.002	-0.847	0.54	0.593	-0.587	-0.16	0.871	0.160	0.69	0.492
4	-0.255	1.34	0.185	-0.83	0.407	-0.152	1.05	0.299	0.206	1.17	0.248	0.865*	2.39	0.020
5	0.026	0.80	0.429	0.08	0.935	0.101	1.85	0.07	0.393*	2.24	0.030	1.094*	3.10	0.003
6	-0.221	1.28	0.206	-0.72	0.471	-0.130	0.18	0.857	0.104	1.21	0.233	0.752*	2.18	0.034
7	0.209	1.04	0.303	0.66	0.508	0.343	1.51	0.138	0.508*	1.93	0.059	1.164*	2.73	0.009
8	1.056	0.61	0.546	3.29	0.001	0.987	1.13	0.264	1.237*	3.85	0.0001	1.817*	4.46	<.0001
9	1.560	1.81	0.077	4.78	<0.0001	1.745*	3.35	0.002	2.016*	4.65	<.0001	2.552*	5.02	<.0001
10	1.338	1.52	0.134	3.79	0.0002	1.496	1.45	0.154	1.899*	4.97	<.0001	2.509*	4.82	<.0001
SUE10-1	**3.586***	3.15	0.003			**3.625***	3.69	0.001	**3.379***	7.27	<.0001	**3.200***	6.72	<.0001

[1] Equation (2) is estimated cross-sectionally for each SUE decile over the 60-day postannouncement period. The intercept, or Jensen's alpha, is used to measure the abnormal returns over the regression period. One-day, 10-day, 30-day, and 60-day return measurement intervals are used in the cross-sectional regressions. For the one-day return measurement interval, CARs are the sum of Jensen's alphas from the one-day cross-sectional regressions. In the 10-day return measurement interval regression, the compounded return of individual security returns over the 10-day period, the compounded rate of market returns, and the compounded rate of risk-free rates constitute one observation in the cross-sectional regression. CARs are the sum of Jensen's alphas from the 10-day interval cross-sectional regressions. The 30-day and 60-day return measurement intervals are constructed similarly. In order to reduce the bias introduced by the cross-sectional dependence of the error terms in equation (2), firms that announce earnings on the same calendar date are grouped in an equal-weighted portfolio if these firms belong to the same SUE decile, and the returns of these equal-weighted portfolios are used in the cross-sectional regressions. There are 53,308 earnings announcements in the sample. After grouping, there are 17,600 equal-weighted portfolios.

* Significantly different from zero at less than .05 level (two-tailed test). The significant test is performed using the Fama and MacBeth (1973) two-pass procedure. In the first pass, the CARs over days [1, 60] are obtained for each SUE decile for each quarter. In the second pass, these time-series CARs for each SUE decile are averaged to determine whether the mean is significantly different from zero, using a standard t-test. The means of the time-series Jensen's alphas for each SUE decile are not reported in the table. In the 60-day return measurement interval, the table also reports the significance test of the BT (1989) cross-sectional regression.

the value-weighted CRSP index as the market index. The results are reported in Panel A of Figure 2 and Table 2.

The pattern and magnitude of the postannouncement drift are similar to those obtained by BT (1989). For example, the abnormal return for SUE 1 firms is –2.248 percent and 1.338 percent for SUE 10 firms over days [1, 60]. BT (1989, Table 2) obtain -1.6 percent for SUE 1 firms and 3.0 percent for SUE 10 firms. The difference could be due to a different sample period covered in this study and also to the fact that the cross-sectional dependence of error terms in equation (2) is corrected in this study.

Additionally, when using the t-statistics of a single cross-sectional regression on equation (2) for each SUE decile, the study finds that Jensen's alphas are statistically significant for both SUE 1 and SUE 10 firms. This result is also consistent with the findings of BT (1989).

However, when the Fama and MacBeth (1973) two-pass procedure is used to test whether the mean of the time-series quarterly Jensen's alphas of each SUE decile is significantly different from zero, the study finds that Jensen's alphas are not statistically significant for SUE 1 and SUE 10 firms. The Fama and MacBeth (1973) procedure for testing the significance of Jensen's alpha is superior to the one that pools all quarterly observations in a single regression of equation (2). The pooling approach fails to consider that investment strategies must follow a strict temporal sequential pattern. The Fama and MacBeth procedure explicitly addresses this chronological issue. Figure 3 presents the histogram of the quarterly Jensen's alphas for good news firms (SUE 10), bad news firms (SUE 1) and information neutral firms (SUE 5). It appears that after risk is controlled cross-sectionally, the quarterly Jensen's alphas for SUE 10 are not

Figure 3. Quarterly Cross-Sectional Jensen's Alphas, 60-Day Return Measurement Interval, Value-Weighted CRSP Index

Panel A. Good News Firms (SUE 10)

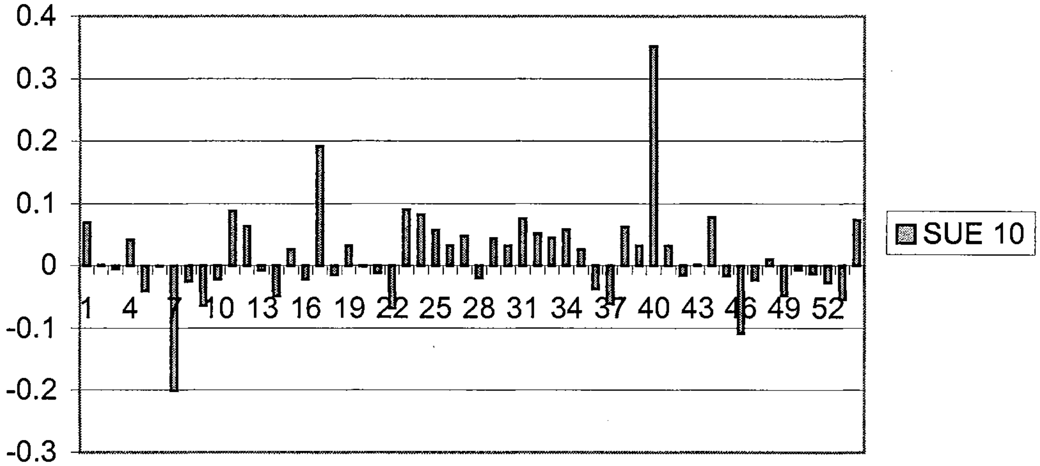


Figure 3. (*Continued*)

Panel B. Bad News Firms (SUE 1)

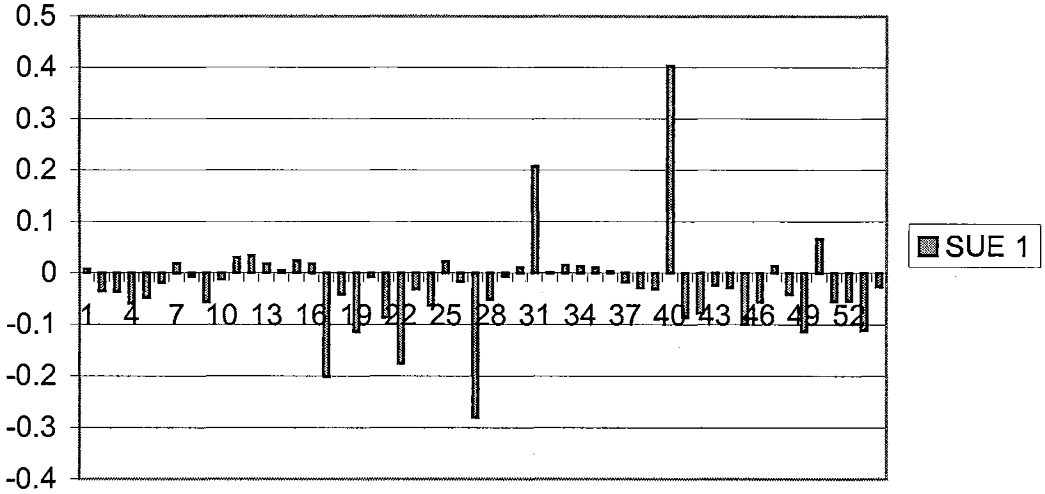
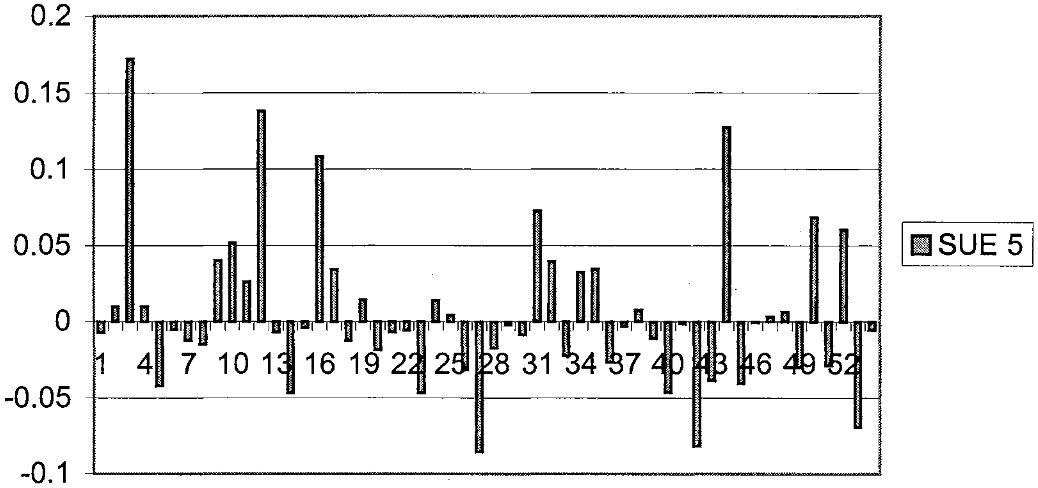


Figure 3. (*Continued*)

Panel C. Information Neutral Firms (SUE 5)



predominately positive, for SUE 1 are not predominately negative, and distributed fairly evenly around zero for the information neutral firms.

The finding that none of the SUE's postannouncement abnormal returns is, *on average*, significantly different from zero at the 5 percent level across all quarters suggests that the market under-reaction explanation for the postannouncement drift is not valid. The pattern of the postannouncement drift does exist, that is, the market appears to continue to react positively to good news firms and negatively to bad news firms. The magnitude of the postannouncement abnormal returns for both the good news and bad news firms also appears economically attractive. However, neither good news firms nor bad news firms generate an abnormal return that is, *on average*, significantly different from zero on a quarter by quarter basis, indicating that although the pattern of the postannouncement drift exists, the market really is not under-reacting to earnings surprises.

It appears that the hedge portfolio, which is a combination of a long position in SUE 10 firms and a short position in SUE 1 firms, can generate an abnormal return (3.586 percent over days [1,60]) that is statistically different from zero across all quarters. Why anyone would be motivated to form a hedge portfolio when the SUE 1 and SUE 10 portfolios do not by themselves produce abnormal returns significantly different from zero remains unclear. Perhaps the pattern itself would suggest it. But if this is the case, the hedge portfolio is more consistent with evidence of weak form inefficiency than semi-strong form inefficiency. This possibility, however, becomes less likely when the patterns for shorter return measurement intervals and the equal-weighted CRSP index are examined.

4.2.2 Using the Value-Weighted CRSP Index and Shorter Return Measurement Intervals in the Cross-Sectional Regressions

Table 2 also reports the results of using shorter return measurement intervals (1-day, 10-day and 30-day) and the value-weighted CRSP index as the market index in the cross-sectional regression of equation (2). CARs for these shorter returns measurement intervals over 60 days around the earnings announcements date are depicted in Panels B, C and D of Figure 2.

Notice that as the return measurement interval decreases, the CARs for all SUE deciles over days [1, 60] systematically increase, and many of them have become statistically significant. This result is also inconsistent with the market under-reaction hypothesis. For example, when the one-day return measurement interval is used, a significant and economically attractive abnormal return is observed for SUE 10 (2.509 percent over days [1, 60]). However, the market fails to react to bad news firms. The CAR for the SUE 1 firms is only –0.691 percent over days [1, 60] and is not significantly different from zero on a quarter by quarter basis.

But even more bothersome for the under-reaction hypothesis is evidence that the market can now produce significant economically attractive abnormal returns for information neutral SUE deciles. For example, the CAR for SUE 5 is 1.09 percent over days [1, 60], or an annualized abnormal return of 4.36 percent. Why the results vary by the return measurement interval is not clear. But it does raise questions about the validity of the inefficiency explanation of the drift – especially given the market's "reaction" to information neutral firms as the return measurement interval decreases.

Furthermore, the use of a different market index seems to produce results that further challenge an inefficiency explanation of the postannouncement drift.

4.2.3 Using the Equal-Weighted CRSP Index and Various Return Measurement Intervals in the Cross-Sectional Regressions

The results of using the equal-weighted CRSP index as the market index and various return measurement intervals in the cross-sectional regression of equation (2) are reported in Figure 4 and Table 3. If the choice of market index is not an issue, then the results should be very similar for both the value-weighted and equal-weighted indices. BT (1989) indicate that the results for the two market indices are similar. Comparing the 60-day return measurement interval results in Tables 2 and 3, and Figures 2 and 4, the results do appear similar.[2] However, the CARs for the equal-weighted index are systematically lower (BT (1989) do not report the Jensen's alphas for their SUE deciles using the equal-weighted index). Additionally, using the t-statistic of the single cross-sectional regression to perform the significance test, the bad news firms still have a significant Jensen's alpha. But the good news firms no longer have a statistically significant Jensen's alpha, and the information neutral firms start to have a significant Jensen's alpha. Moreover, when the Fama and MacBeth (1973) two-pass procedure is used for the significance test, the hedge portfolio no longer produces a statistically significant abnormal return. In fact, if the equal- weighted index is used in the

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[2] When the 60-day return measurement interval is used, the hedge portfolio can generate an abnormal return of 3.747 percent over days [1, 60], or an annualized abnormal return of 15 percent. This is consistent with the results obtained by BT (1989, p. 17, footnote 10) who find an annualized abnormal return of 16 percent for their hedge portfolio.

Figure 4. Cross-Sectional Regression Using Equal-Weighted CRSP Index
Panel A. 60-Day Interval

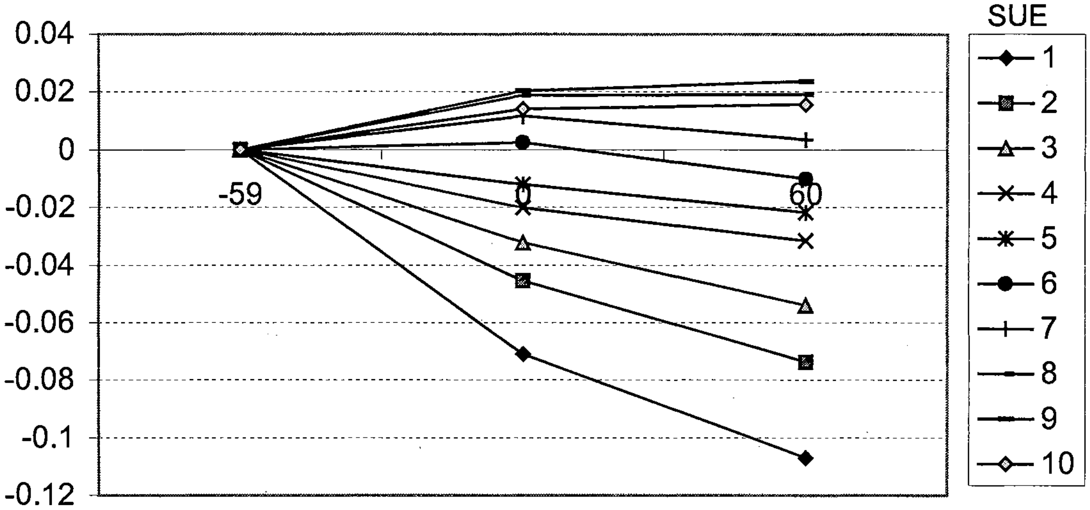

Figure 4. (*Continued*)
Panel B. 30-Day Interval

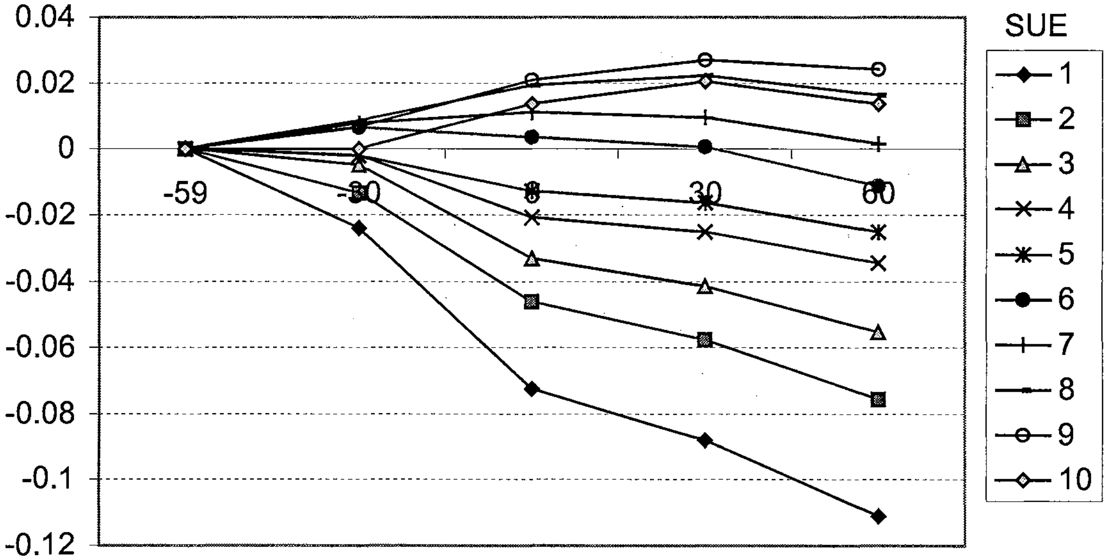

Figure 4. (*Continued*)
Panel C. 10-Day Interval

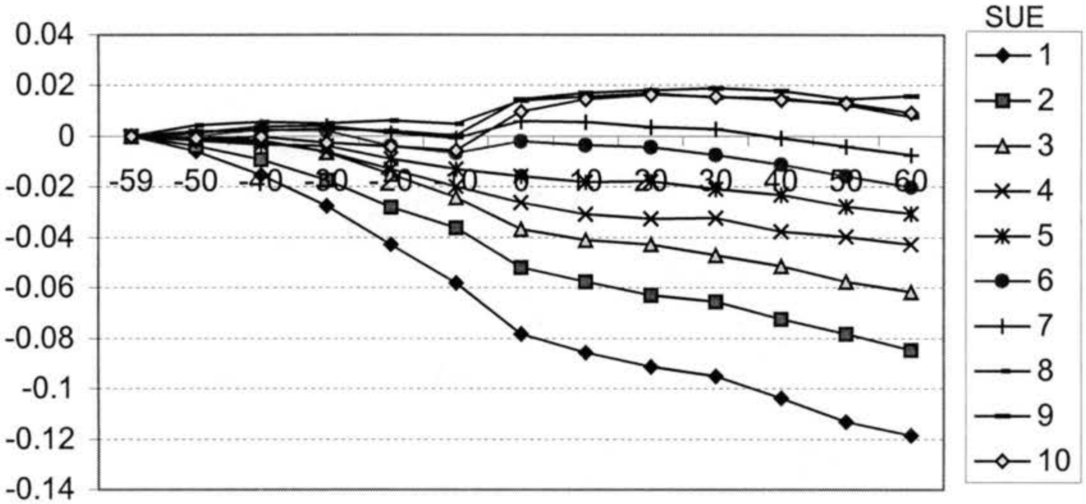

Figure 4. (*Continued*)
Panel D. One-Day Interval

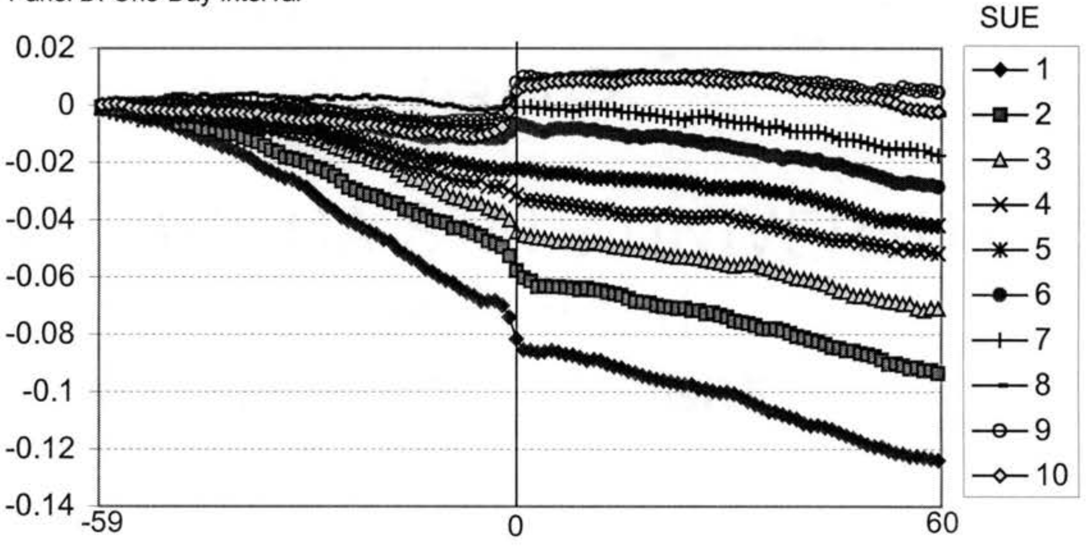

TABLE 3
CARs for Each SUE Decile over Days [1, 60] Using the Ball and Kothari (1991) Cross-Sectional Regression with Equal-Weighted CRSP Index[1]

	60-Day Interval					30-Day Interval			10-Day Interval			1-Day Interval		
	Two-Pass Procedure			*BT (1989) Procedure*		*Two-Pass Procedure*			*Two-Pass Procedure*			*Two-Pass Procedure*		
SUE	CAR	t-stat	Pr>|t|	t-stat	Pr>|t|	CAR	t-stat	Pr>|t|	CAR	t-stat	Pr>|t|	CAR	t-stat	Pr>|t|
1	-3.60%	-1.43	0.158	-8.97	<0.0001	-3.86%*	-4.70	<.0001	-4.02%*	-6.75	<.0001	-4.24%*	-8.15	<.0001
2	-2.825	-0.21	0.838	-7.92	<0.0001	-2.937*	-1.90	0.063	-3.268*	-5.05	<.0001	-3.576*	-6.11	<.0001
3	-2.180*	-2.18	0.033	-6.15	<0.0001	-2.226*	-2.29	0.026	-2.512*	-5.60	<.0001	-2.675*	-6.90	<.0001
4	-1.150	-0.03	0.978	-3.48	0.0005	-1.367	-1.23	0.223	-1.661*	-4.04	0	-2.052*	-3.91	0.0005
5	-0.973	-1.29	0.203	-2.87	0.004	-1.229	-1.11	0.273	-1.480	-1.85	0.069	-1.940*	-2.80	0.007
6	-1.244	0.45	0.656	-3.81	0.0001	-1.482*	-2.63	0.011	-1.808*	-3.24	0.002	-2.204*	-3.85	0.0001
7	-0.807	0.29	0.776	-2.41	0.016	-0.953	-1.21	0.231	-1.328*	-2.86	0.006	-1.691*	-3.72	0.001
8	0.041	-1.77	0.082	0.12	0.904	-0.288	-1.93	0.059	-0.627*	-2.24	0.029	-1.227*	-2.44	0.018
9	0.335	0.14	0.891	0.97	0.331	0.343	0.45	0.656	0.122	0.39	0.697	-0.332	-1.77	0.083
10	0.144	0.04	0.971	0.39	0.699	0.016	-0.16	0.875	-0.064	0.03	0.979	-0.731	-1.86	0.069
SUE10–1	**3.747**	1.89	0.065			**3.878***	3.04	0.004	**3.961***	5.28	<.0001	**3.505***	6.85	<.0001

[1] Equation (2) is estimated cross-sectionally for each SUE decile over the 60-day postannouncement period. The intercept, or Jensen's alpha, is used to measure the abnormal returns over the regression period. One-day, 10-day, 30-day, and 60-day return measurement intervals are used in the cross-sectional regressions. For the one-day return measurement interval, CARs are the sum of Jensen's alphas from the one-day cross-sectional regressions. In the 10-day return measurement interval regression, the compounded return of individual security returns over the 10-day period, the compounded rate of market returns, and the compounded rate of risk-free rates constitute one observation in the cross-sectional regression. CARs are the sum of Jensen's alphas from the 10-day interval cross-sectional regressions. The 30-day and 60-day return measurement intervals are constructed similarly. In order to reduce the bias introduced by the cross-sectional dependence of the error terms in equation (2), firms that announce earnings on the same calendar date are grouped in an equal-weighted portfolio if these firms belong to the same SUE decile, and the returns of these equal-weighted portfolios are used in the cross-sectional regressions. There are 53,308 earnings announcements in the sample. After grouping, there are 17,600 equal-weighted portfolios.

* Significantly different from zero at less than .05 level (two-tailed test). The significant test is performed using the Fama and MacBeth (1973) two-pass procedure. In the first pass, the CARs over days [1, 60] are obtained for each SUE decile for each quarter. In the second pass, these time-series CARs for each SUE decile are averaged to determine whether the mean is significantly different from zero, using a standard t-test. The means of the time-series Jensen's alphas for each SUE decile are not reported in the table. In the 60-day return measurement interval, the table also reports the significance test of the BT (1989) cross-sectional regression.

cross-sectional regression, there is no evidence of any market inefficiency.

It is also interesting to notice that as the return measurement interval decreases, the abnormal returns are systematically lower across all SUE deciles and many of them become significant. For example, when the one-day return measurement interval is used, the abnormal returns of *all* SUE deciles are negative. Although the market reaction is significantly negative to the bad news firms (SUE 1), it does not react positively to the good news firms (SUE 10). In fact, the market does not appear to react to good news firms at all (SUE 10 firms can generate an abnormal return of –0.731 percent over days [1, 60], which is not significantly different from zero on a quarter by quarter basis). Note also that the information neutral firms report a significant, economically exploitable abnormal return. For example, SUE 5 firms can produce an abnormal return of –1.94 percent over days [1, 60], or 7.76 percent on an annualized basis. It is not clear why the market reacts significantly positively to the information neutral firms when the value-weighted index is used on the one-day return interval, and significantly negative to the information neutral firms when the equal-weighted index is used. In either case, the result is inconsistent with the market under-reaction hypothesis.

Furthermore, when the one-day return measurement interval is used, the two market indexes appear to send out conflicting signals to the investors. For example, when the value-weighted CRSP index is used as the market index, an investor could go long on the SUE 10 firms and take no position in the SUE 1 firms. By so doing, the investor can avoid the cost of short selling. On the other hand, when the equal-weighted index is used, an investor may could go short on the SUE 1 firms and take no position in the SUE 10 firms. Since the investor does not know which market index is sending out the correct signal, he/she cannot exploit the postannouncement drift if only one position can be taken. Indeed, the investor can make a significant abnormal return by *only* forming the hedge portfolio. However, although the ability of making abnormal returns by trading on the pattern is not supportive of the weak form of the EMH, neither is it supportive of the market under-reaction hypothesis.

4.2.4 Summary

When risk is directly controlled in the test period cross-sectionally, the study finds evidence that is inconsistent with the market under-reaction explanation for the postannouncement drift. When the 60-day return measurement interval is used, no matter which market index is used in the cross-sectional regression, neither the good news firms (SUE 10) nor the bad news firms (SUE 10) generate a postannouncement abnormal return that is significantly different from zero on a quarter by quarter basis. When shorter return measurement intervals are used, e.g., 1-day interval, the market has no reaction to the bad news firms when the value-weighted index is used, no reaction to the good news firms when the equal-weighted CRSP index is used, and significant reaction to the information neutral firms no matter which index is used. This result is inconsistent with the market under-reaction hypothesis. Additionally, when the 1-day return measurement interval is used, the two market indices send out conflicting signals to the investors, making it difficult to economically exploit the postannouncement drift.

The overall evidence suggests that when risk is controlled cross-sectionally in the test period, the market does not react to earnings surprises in the way the market under-reaction hypothesis predicts. The cross-sectional analysis raises some doubts about the validity of the postannouncement drift anomaly. A longitudinal analysis may offer more evidence by allowing the examination of risk-controlled returns over time, where abnormal returns are calculated using stable betas – betas free of nonstationarity error.

4.3 Results of Time-Series Jensen's Alpha over the Postannouncement Period

The purpose of running the CAPM over the time-series returns of a security is to identify all subperiods where betas are stationary so that Jensen's alphas of the stationary subperiods become a clean measure of abnormal returns. If the market under-reaction hypothesis is true, it can be expected that the market continues to react to earnings news in the direction of unexpected earnings. Therefore, the CARs should be positive for SUE 10, negative for SUE 1, and zero for SUE 5 and 6 over days [1, 60]. Additionally, CARs for both SUE 1 and SUE 10 firms should be economically exploitable.

Table 4 reports the CARs for each SUE decile over days [1, 60] after beta nonstationarity is controlled longitudinally at the individual security levels. When the value-weighted CRSP index is used as the market index, the market appears to react positively to all SUE deciles (0.1661 percent for SUE 1, 0.2651 percent for SUE 5, and 0.3258 percent for SUE 10) over days [1, 60]. Except for SUE 3, these reactions are significantly different from zero. Since the market does not continue to react negatively to bad news firms, and has significant reaction to the information neutral firms, the result is not consistent with the market under-reaction hypothesis. Furthermore, if economic significance is defined as the magnitude of an abnormal return that can make it profitable for investors to trade on, then no SUE decile produces an abnormal return that

TABLE 4
Time-Series Jensen's Alphas for Each SUE Decile Over Days [1, 60] When Beta Nonstationarity Is Controlled[1]

SUE Decile (1 = low; 10 = high)	Value-Weighted Index	Equal-Weighted Index
1	0.1661%*	-0.1617 %
2	0.1822*	-0.1421
3	0.0749	-0.1745*
4	0.1896*	-0.1406
5	0.2651*	0.0505
6	0.2390*	-0.0421
7	0.1335*	-0.0642
8	0.3415*	-0.0159
9	0.2896*	-0.0326
10	0.3258*	-0.0258
SUE10 – SUE1	*0.1597**	*0.1359*

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[1] The algorithm in Appendix II is applied to equation (3) estimated over the [1, 60] period for each earnings announcement. The sum of Jensen's alphas of all stationary periods of a security represents the abnormal returns of that security. Abnormal returns of all securities in the same SUE decile are averaged to obtain the abnormal returns for that decile.

* Significantly different from zero at less than .05 level (two-tailed test). The significant test is performed using Fama and MacBeth (1973) two-pass procedure. In the first pass, abnormal return over days [1, 60] is obtained for each SUE decile for each quarter. In the second pass, these time-series abnormal returns for each SUE decile are averaged to determine whether the mean is significantly different from zero, using a standard t-test. The means of the time-series abnormal returns for each SUE decile are not reported in the table.

is *economically significant*, suggesting that after risk is controlled longitudinally at the individual security levels, exploiting the postannouncement drift is no longer economically attractive to investors.

The similar magnitude of the CARs for all SUE deciles suggests that there is no systematic difference in the pattern of the drift across the SUE deciles, suggesting that the pattern is not attributable to the earnings surprises. Furthermore, the presence of a small but statistically significant Jensen's alpha may be evidence of a slight misspecification of the asset pricing model, but it is not evidence of any postannouncement drift.

Table 4 also reports the CARs for each SUE decile when the equal-weighted CRSP index is used as the market index. Except for SUE 3, none of the SUE deciles can produce an abnormal return that is significantly different from zero. Additionally, the CARs of all SUE deciles over days [1, 60] are not economically significant. The implication of this result should be clear when compared with CARs in Table 1, where the expected returns are estimated using the market model with parameters estimated from an estimation period (and the equal-weighted index as the market index). In Table 1, the postannouncement abnormal return for the extremely good news firms (SUE 10) is about 1.93 percent over days [1, 60] and -1.39 percent for the extremely bad news firms (SUE 1). However, these apparent drifts have mostly disappeared after risks at the individual security levels are directly controlled over the test period.

Interestingly, the hedge portfolio no longer generates economically attractive abnormal returns. This suggests that along with the disappearance of the postannouncement drift for each SUE decile, the hedge portfolio can no longer be used as evidence against even the weak form of the EMH.

In summary, the postannouncement drift documented in prior studies has mostly vanished after beta nonstationarity is controlled longitudinally at the individual security levels over the test period. The results suggest that although the pattern of the postannouncement drift appears to indicate that the market under-reacts to earnings surprises, the drift is not economically significant after returns are fully adjusted for risks. Therefore, the observed postannouncement drift is not evidence against the semi-strong form of the EMH.

4.4....Results of Quiet Period Test

A quiet period is defined as a stable period of which Jensen's alpha is not significantly different from zero. During a quiet period the market is considered in the equilibrium and not reacting to any event. The purpose of the quiet period test is to determine whether there is evidence to show that the market reaction over the postannouncement period has breaks with the information set defined by the earnings releases.

If the market reacts to an event, such as an earnings surprise, the reaction should be continuous up to the point where the market returns back to equilibrium. During this reaction period, a statistically significant Jensen's alpha should be observed. During the equilibrium period, or quiet period, no abnormal returns should be observed. If there is a quiet period either immediately after the earnings announcement or after a market reaction to earnings announcement, then the quiet period can be considered a break of the original information set contained in the earnings news. It therefore can be argued that any subsequent market reaction is due to some event other than the earnings news.

If the market under-reaction explanation for the postannouncement drift is true, then the market should continue to react positively to good news firms and negatively to bad news firms over the postannouncement period. It can, therefore, be expected that over the postannouncement period: (1) good (bad) news firms should have “many” more positive (negative) Jensen’s alphas than other SUE deciles, (2) good (bad) news firms should have longer positive (negative) stable subperiods than other deciles, and (3) good (bad) news firms should produce the Jensen’s alphas larger in magnitude than other deciles.

In order to examine whether the observed postannouncement drift is due to market’s reaction to earnings news or a combination of other events, the algorithm in Appendix II is used on equation (3) estimated for each security over days [1, 60]. The algorithm identifies the stationary subperiods during which Jensen’s alphas are significantly positive (positive market reaction), significant negative (negative market reaction), and not significantly different from zero (no reaction). The algorithm also calculates the Jensen’s alphas and the length of these stationary subperiods.

The results of the quiet period test are reported in Tables 5 and 6, where the value-weighted and equal-weighted market index, respectively, is used. Panel A of Table 5 reports the results of total stable subperiods, grouped by SUE deciles. It appears that the total number of stationary period are fairly comparable across all SUE deciles. SUE 10 has slightly more stationary subperiods than any other decile. This is because by

TABLE 5
Results of Quiet Period Test Using Value-Weighted CRSP Index[1]

Panel A. Results of Total Stable Periods

	Total Stable Periods			Stable Periods with Positive Alphas			Stable Periods with Negative Alphas		
SUE	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha
1	15235	21.14	0.0005	7531	20.84	0.0104	7704	21.43	-0.0091
2	14557	21.59	0.0006	7226	21.42	0.0094	7331	21.75	-0.0081
3	14736	21.55	0.0003	7247	21.12	0.0091	7489	21.97	-0.0082
4	14323	21.79	0.0008	7311	21.71	0.0091	7012	21.87	-0.0080
5	14745	21.36	0.0008	7549	21.22	0.0095	7196	21.51	-0.0084
6	14943	21.63	0.0008	7545	21.39	0.0092	7398	21.88	-0.0078
7	14585	22.00	0.0005	7446	22.38	0.0088	7139	21.61	-0.0081
8	14834	21.22	0.0011	7792	21.68	0.0093	7042	20.71	-0.0081
9	14801	21.26	0.0010	7808	22.05	0.0091	6993	20.37	-0.0082
10	16283	21.07	0.0012	8539	21.56	0.0101	7744	20.53	-0.0086

Panel B. Results of Total Stable Periods with Significant Jensen's Alphas

	Total Stable Periods With Significant Alphas			Stable Periods with Significant Positive Alphas			Stable Periods with Significant Negative Alphas		
SUE	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha
1	4460	11.39	0.0009	2005	10.46	0.0189	2455	12.15	-0.0138
2	4184	11.31	0.0005	1921	10.61	0.0171	2263	11.91	-0.0136
3	4247	11.83	0.0002	1915	11.26	0.0166	2332	12.30	-0.0133
4	3990	11.07	0.0011	1903	10.67	0.0175	2087	11.44	-0.0139
5	4174	10.91	0.0007	1975	10.25	0.0172	2199	11.51	-0.0141
6	4234	11.45	0.0012	2028	10.88	0.0169	2206	11.98	-0.0132
7	4133	11.79	0.0008	2028	11.79	0.0162	2105	11.80	-0.0141
8	4354	11.25	0.0015	2143	11.76	0.0171	2211	10.75	-0.0136
9	4323	11.17	0.0020	2214	11.66	0.0169	2109	10.66	-0.0137
10	4753	11.48	0.0018	2453	11.96	0.0177	2300	10.96	-0.0152

(TABLE 5. *Continued*)

Panel C. Results of Total Stable Periods with Insignificant Jensen's Alphas

SUE	Total Stable Periods With Insignificant Alphas			Stable Periods with Insignificant Positive Alphas			Stable Periods with Insignificant Negative Alphas		
	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha
1	10775	25.18	0.0004	5526	24.60	0.0073	5249	25.78	-0.0068
2	10373	25.73	0.0006	5305	25.33	0.0066	5068	26.15	-0.0056
3	10489	25.49	0.0004	5332	24.66	0.0064	5157	26.34	-0.0059
4	10333	25.93	0.0006	5408	25.60	0.0062	4925	26.29	-0.0055
5	10571	25.49	0.0008	5574	25.10	0.0068	4997	25.91	-0.0058
6	10709	25.66	0.0006	5517	25.25	0.0064	5192	26.09	-0.0055
7	10452	26.04	0.0004	5418	26.34	0.0061	5034	25.72	-0.0057
8	10480	25.36	0.0009	5649	25.44	0.0064	4831	25.27	-0.0055
9	10478	25.42	0.0005	5594	26.16	0.0061	4884	24.56	-0.0058
10	11530	25.02	0.0009	6086	25.43	0.0070	5444	24.57	-0.0059

[1] The algorithm in Appendix II is applied to equation (3) estimated over days [1, 60] using value-weighted CRSP index as the market index. After the stationary subperiods are identified, the OLS is run over each subperiod to obtain Jensen's alpha for the period. Jensen's alpha is the measure of abnormal returns. The minimum length of stationary period is 3 days. The number of stationary subperiods is totaled for all securities in the same SUE decile, pooled across all quarters. The average Jensen's alpha is calculated as the mean of Jensen's alphas of all stationary subperiods. There are 5369 firm-quarters in SUE 1, 5239 in SUE 2, 5295 in SUE 3, 5203 in SUE 4, 5251 in SUE 5, 5389 in SUE 6, 5350 in SUE 7, 5248 in SUE 8, 5245 in SUE 9, and 5719 in SUE 10.

TABLE 6
Results of Quiet Period Test Using Equal-Weighted CRSP Index

Panel A. Results of Total Stable Periods

	Total Stable Periods			Stable Periods with Positive Alphas			Stable Periods with Negative Alphas		
SUE	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha
1	15316	21.02	-0.0006	6971	18.89	0.0127	8345	22.79	-0.0117
2	14708	21.36	-0.0003	6694	19.70	0.0119	8014	22.74	-0.0104
3	14740	21.54	-0.0009	6590	19.86	0.0110	8150	22.89	-0.0106
4	14054	22.20	-0.0003	6514	20.76	0.0113	7540	23.44	-0.0103
5	14486	21.74	0.0002	6777	20.32	0.0117	7709	22.98	-0.0099
6	14808	21.82	-0.0001	6790	20.00	0.0119	8018	23.37	-0.0103
7	14718	21.80	-0.0003	6967	21.22	0.0112	7751	22.32	-0.0105
8	15030	20.94	0.0001	7168	20.10	0.0116	7862	21.70	-0.0104
9	14535	21.64	0.0000	6985	21.18	0.0112	7550	22.06	-0.0103
10	16304	21.03	0.0001	7852	19.97	0.0121	8452	22.02	-0.0110

Panel B. Results of Total Stable Periods with Significant Jensen's Alphas

	Total Stable Periods With Significant Alphas			Stable Periods with Significant Positive Alphas			Stable Periods with Significant Negative Alphas		
SUE	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha
1	4632	12.08	-0.0022	1874	9.03	0.0227	2758	14.16	-0.0192
2	4534	12.16	-0.0009	1837	9.95	0.0228	2697	13.67	-0.0171
3	4521	12.27	-0.0017	1822	10.24	0.0213	2699	13.64	-0.0171
4	4107	12.56	-0.0011	1690	10.37	0.0219	2417	14.10	-0.0173
5	4347	12.29	-0.0003	1845	10.42	0.0219	2502	13.66	-0.0166
6	4416	12.54	-0.0006	1855	10.39	0.0214	2561	14.11	-0.0166
7	4446	12.58	-0.0007	1885	11.28	0.0206	2561	13.54	-0.0164
8	4597	12.00	-0.0002	2000	10.96	0.0208	2597	12.80	-0.0164
9	4309	12.43	-0.0003	1908	11.48	0.0209	2401	13.19	-0.0172
10	4966	12.49	-0.0002	2207	11.23	0.0217	2759	13.49	-0.0177

(TABLE 6. *Continued*)

Panel C. Results of Total Stable Periods with Insignificant Jensen's Alphas

	Total Stable Periods With Insignificant Alphas			Stable Periods with Insignificant Positive Alphas			Stable Periods with Insignificant Negative Alphas		
SUE	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha	Number	Average Length	Average Alpha
1	10684	24.89	0.0001	5097	22.51	0.0090	5587	27.06	-0.0080
2	10174	25.46	0.0000	4857	23.39	0.0078	5317	27.34	-0.0071
3	10219	25.64	-0.0006	4768	23.53	0.0071	5451	27.47	-0.0073
4	9947	26.18	0.0001	4824	24.41	0.0076	5123	27.85	-0.0070
5	10139	25.79	0.0004	4932	24.02	0.0079	5207	27.46	-0.0066
6	10392	25.77	0.0001	4935	23.61	0.0083	5457	27.72	-0.0073
7	10272	25.79	-0.0001	5082	24.90	0.0077	5190	26.66	-0.0076
8	10433	24.88	0.0003	5168	23.64	0.0081	5265	26.09	-0.0074
9	10226	25.52	0.0002	5077	24.82	0.0076	5149	26.20	-0.0071
10	11338	24.78	0.0003	5645	23.39	0.0084	5693	26.15	-0.0077

[1] The algorithm in Appendix II is applied to equation (3) estimated over days [1, 60] using equal-weighted CRSP index as the market index. After the stationary subperiods are identified, the OLS is run over each subperiod to obtain Jensen's alpha for the period. Jensen's alpha is the measure of abnormal returns. The minimum length of stationary period is 3 days. The number of stationary subperiods is totaled for all securities in the same SUE decile, pooled across all quarters. The average Jensen's alpha is calculated as the mean of Jensen's alphas of all stationary subperiods. There are 5369 firm-quarters in SUE 1, 5239 in SUE 2, 5295 in SUE 3, 5203 in SUE 4, 5251 in SUE 5, 5389 in SUE 6, 5350 in SUE 7, 5248 in SUE 8, 5245 in SUE 9, and 5719 in SUE 10.

construction, SUE 10 has more firm-quarters than any other decile.[3] However, the result does not show that good news firms (SUE 10) have "many" more positive Jensen's alphas than any other decile firms. Also, bad news firms (SUE 1) do not have "many" more negative Jensen's alphas than any other decile firms. If the market under-reaction hypothesis is true, the difference should be materially noticeable. "Many" more means that there must be a material difference between the information surprise categories and the other categories. While material is subjective, a common rule used is a 10 percent difference. Thus, we can use this as a rough guideline to assess the effect of good (bad) news. Suppose the positive (negative) proportion of a decile is defined as the total number of positive (negative) stable subperiods divided by the total number of stable subperiods in the decile. At the 5 percent significance level, we can safely reject the null hypothesis that the difference of the positive proportion of SUE 10 firms and that of SUE 1 (or SUE 5) firms is equal to 10 percent. We can also reject the null hypothesis that the difference of the negative proportion of SUE 1 firms and that of SUE 10 (or SUE 5) firms is equal to 10 percent.

The market under-reaction hypothesis also predicts that good (bad) news firms should have longer positive (negative) stable subperiods than other deciles. The results in Panel A of Table 5 do not suggest that this is the case. For example, the average length of positive Jensen's alphas is 21.56 days for SUE 10, 21.22 days for SUE 5 and 20.84 days for SUE 1. The results of the means test indicate that although the average length of positive stable subperiods for SUE 10 firms is significantly (at 5 percent level)

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[3] When calculating the cutoffs of SUE deciles, firms are first sorted in the ascending order. Whenever the total number of firms in a given quarter is not divisible by 10, the first 9 deciles have the same number of firms, and SUE 10 has more firms.

larger than that for SUE 1 firms, it is not significantly different from that of SUE 5 firms (or information neutral firms). Also, although the average length of negative stable subperiods for SUE 1 firms is significant larger than that for SUE 10 firms, it is not significantly different from that for SUE 5 firms. This result is not consistent with the market under-reaction hypothesis.

In terms of the average Jensen's alphas, the market under-reaction hypothesis predicts that good (bad) news firms should produce the Jensen's alphas larger in magnitude than other deciles. Results in Panel A of Table 5 do not seem to support this prediction. The average positive Jensen's alpha is 0.0101 for SUE 10, 0.0104 for SUE 1 and 0.0095 for SUE 5. Although the average positive Jensen's alpha of the stable subperiods for SUE 10 firms is significantly larger than that for the information neutral firms (SUE 5), it is not significantly different from that for the bad news firms (SUE 1). Interestingly, the average positive Jensen's alpha of the stable subperiods for the SUE 1 firms is significantly larger than that for the information neutral firms (SUE 5). Also, the average negative Jensen's alpha for SUE 1 is not significantly different from that for SUE 10. This result is also inconsistent with the market under-reaction hypothesis.

It is very important to notice that for the *average* firm in each decile, the postannouncement market reaction involves one relatively short stable subperiod with significant Jensen's alpha, and two very long quiet subperiods. The *average* firm in all SUE deciles behaves very similarly. Panel B of Table 5 shows the total number of subperiods that have significant Jensen's alphas. In every decile, it is slightly less than 30 percent of total number of stable subperiods in the decile. The average length of these subperiods is about 11 days for all deciles. In panel C of Table 5, for every decile, the total number of quiet subperiods is slightly more than 70 percent of the total number of stable subperiods of the decile. The average length of these quiet subperiods is about 25 days. Thus, if the average firm of each decile is constructed over the 60-day postannouncement period, it should have a roughly 10-day subperiod with a significant Jensen's alpha, and two 25-day quiet subperiods. No matter how these three subperiods are distributed in the 60-day period, and considering that the average firm of all deciles behave almost the same, it is hard to argue that the average firm is really reacting to the earnings announcement during the postannouncement period.

There does appear to have some evidence that good news firms have more significant positive than negative Jensen's alphas, and that bad news firms have more significant negative than positive Jensen's alphas. For example, SUE 10 firms have 2,453 significant positive alphas and 2,300 significant negative alphas. The difference is 153. However, as a proportion of the total number of stable periods for the SUE 10 decile (16,283), this difference is less than 1 percent and could be by chance. Especially when compared with the results of using the time-series security returns, this difference really is not strong enough to show that there is a drift.

The analysis of Table 6 reaches the same conclusion.

The overall results from the quiet period test show that the market reacts very similarly to the firms in all SUE deciles, which suggests that the postannouncement drift is not due to market's reaction to the information set defined by the earnings surprises. It could be due to a combination of other events.

CHAPTER 5
CONCLUSIONS

The purpose of this study is to investigate whether the post-earnings-announcement drift is due to market's delayed reaction to earnings news or to risk misspecification by the methodology used by researchers. The study uses more refined and rigorous methodology than prior studies to control for risks in the postannouncement period and examines its effect on the pattern and magnitude of the postannouncement drift. The results of this study provide much evidence that is inconsistent with the market under-reaction explanation of the postannouncement drift. Instead, the results suggest that after risk is properly controlled, the postannouncement drift is no longer evidence against the semi-strong form of the efficient market hypotheses.

When risk is controlled cross-sectionally over the postannouncement period, the study finds that the BT (1989) 60-day return measurement interval does not generate an abnormal return for the extreme news firms that is, *on average*, significantly different from zero on a quarter by quarter basis, making it difficult for investors to economically exploit the postannouncement drift. Additionally, when the one-day return measurement interval is used in the cross-sectional regression, the market fails to react to the bad news firms when the value-weighted market index is used, to the good news firms when the equal-weighted market index is used, and reacts significantly to the informational neutral firms no matter which market index is used. This result is inconsistent with the market under-reaction hypothesis which predicts that the market continues to react positively to the good news firms, negatively to the bad news firms, and no reaction to the informational neutral firms.

On the other hand, when risk shift is controlled longitudinally at individual security level, the postannouncement drift is no longer economically significant, suggesting that prior drift studies could have failed to adjust security returns fully to risk.

Additionally, when the actual postannouncement market reaction is examined, the study finds that the market reacts similarly to firms in all earnings groups, suggesting that the observed postannouncement drift is not likely due to the market's delayed response to the information set defined by the original earnings surprises, but rather to a combination of other events. Overall, this study has provided much additional evidence bearing upon the ongoing debate about capital market efficiency.

There are at least two unresolved issues in this study. One issue is why the hedge portfolio in the cross-sectional regression continues to make significant abnormal returns over the test period no matter which return measurement interval is used or which market index is used. It is possible that even though the CAPM is valid, the cross-sectional regression can produce an apparent abnormal return if security returns cluster around different risk groups. However, the necessary conditions to generate this result are not clear, and it is also not clear whether the securities returns used in this study meet these conditions.

Another unresolved issue is why when the value-weighted market index is used in the cross-sectional regression, the abnormal returns of all SUE deciles are systematically higher as the return measurement interval decreases, and why when the equal-weighted market index is used in the cross-sectional regression, the abnormal returns of all SUE deciles are systematically lower as the return measurement interval decreases. These issues are left for the future research.

Appendix I. The Companion Portfolio Approach as a Non-Effective Tool of Adjustment to Risks in Estimating the Expected Returns

The purpose of this appendix is to demonstrate that the companion portfolio approach used by BT (1989) and Foster et al. (1984) does not provide an appropriate control for the risk in measuring the expected returns. The analysis is based on the observation that the size of firms is almost randomly distributed among the SUE deciles. If this is the case, then the companion portfolio may be mathematically equivalent to simply using the market return as the security's expected return, which does not have any control for risk at all. Although BT (1989, fn. 13) observe that large firms are more heavily represented in the extreme SUE deciles, Bernard et al. (1997, Table 1) show that the correlation between SUE quintiles and size quintiles is 0.00, and Rendleman et al. (1987, p. 136) find that "... the size of firms contained in these (SUE) portfolios is essentially random." Thus, it is reasonable to believe that the distribution of the size of firms in the SUE deciles is *relatively* random, if not *completely* random.

Under the companion portfolio approach, the abnormal returns are computed as:

$$u_{i,s,t} = R_{i,s,t} - R_{s,t} ,$$

where s = the NYSE/AMEX firm size decile that firm i is a member of at the beginning of the calendar year, and $s \in \{1, 2, \ldots, 10\}$,
$u_{i,s,t}$ = abnormal return for firm i, within firm size decile s, on day t,
$R_{i,s,t}$ = raw return for firm i, within firm size decile s, on day t, and
$R_{s,t}$ = equally weighted mean return on the firm size decile s, on day t.

For simplicity, it is assumed that in a given quarter all firms make their earnings announcements on the same calendar day, denoted as day 0. It is further assumed that the size of firms is randomly distributed among the SUE deciles. If there are $10m$ firms in a given SUE decile p, $p \in \{1, 2, \ldots, 10\}$, it can be expected that exactly m firms come from each firm size decile. By definition, the equal-weighted market return on day t is

$R_{mt} = 1/10\ (R_{1,t} + R_{2,t} + \ldots + R_{10,t})$. Then the abnormal return of SUE decile p on day t can be calculated as follows:

$$
\begin{aligned}
AR_{p,t} &= \frac{1}{10m}\sum_{s=1}^{10}\sum_{i=1}^{m} u_{i,s,t} \\
&= \frac{1}{10m}\Big(\sum_{i=1}^{m} u_{i,1,t} + \ldots + \sum_{i=1}^{m} u_{i,10,t}\Big) \\
&= \frac{1}{10m}\Big(\sum_{i=1}^{m} (R_{i,1,t} - R_{1,t}) + \ldots + \sum_{i=1}^{m} (R_{i,10,t} - R_{10,t})\Big) \\
&= \frac{1}{10m}\Big(\Big(\sum_{i=1}^{m} R_{i,1,t} + \ldots + \sum_{i=1}^{m} R_{i,10,t}\Big) - m(R_{1,t} + \ldots + R_{10,t})\Big) \\
&= \frac{1}{10m}\Big(\Big(\sum_{i=1}^{m} R_{i,1,t} + \ldots + \sum_{i=1}^{m} R_{i,10,t}\Big) - 10mR_{mt}\Big) \\
&= \frac{1}{10m}\Big(\Big(\sum_{i=1}^{m} R_{i,1,t} - mR_{mt}\Big) + \ldots + \Big(\sum_{i=1}^{m} R_{i,10,t} - mR_{mt}\Big)\Big) \\
&= \frac{1}{10m}\sum_{s=1}^{10}\sum_{i=1}^{m} (R_{i,s,t} - R_{mt}).
\end{aligned}
$$

Thus, if firms release their quarterly earnings on the same day and the size of firms is randomly distributed among the SUE deciles, the abnormal returns of each SUE decile under the companion portfolio approach is mathematically equivalent to using the market return as the benchmark return.

In reality, firms do not announce earnings on the same day. However, since there is no evidence that suggests the size of firms announcing quarterly earnings is conditional upon the calendar day, these two approaches will generate similar empirical results of CARs for each SUE decile. In fact, Foster et al. (1984) use the market returns as the benchmark returns and find this "... does not change any of the inferences drawn previously in this paper..."

Appendix II. Tests of Parameter Nonstationarity in Linear Regression Relationships Using the Time-Series of Data

This appendix is organized in such a way that a programmer can replicate the tests and procedures that are used in this study to examine parameter nonstationarities in the linear regression relationship of a time-series of data. The tests and procedures described in this appendix have been implemented by the author in the C/C++ programming language. The source code of the program is available upon request.

The tests of nonstationarity of the set of parameters in the linear regression relationship are based on the statistical techniques, called the TIMVAR program, described in Brown et al. (1975). The basic regression model considered is

$$y_t = \boldsymbol{x}_t'\beta_t + u_t, \qquad t = 1, \ldots, T,$$

where y_t is the observation on the dependent variable at time t, $\boldsymbol{x}_t$ is the column vector of observations on k regressors, and β_t is the column vector of parameters. The first regressor, x_{1t}, takes the value of one if the model contains a constant. The use of subscript t in β_t is to indicate that the parameters may change over time. The error terms, u_t, are assumed to be independent and normally distributed with means zero and variances σ_t^2, $t = 1, \ldots, T$. The null hypothesis of constancy over time can be expressed as:

$$\text{H}_0: \quad \beta_1 = \beta_2 = \ldots = \beta_T = \beta\,.$$

The TIMVAR program uses cusum test, cusum of squares test and homogeneity test to investigate the validity of H_0. If H_0 is rejected by any of these tests, then the Quandt's log-likelihood ratio statistic is used to identify the single time-point at which the structural change occurs. The cusum test is instrumental in detecting gradual structural changes, whereas the homogeneity test is useful in detecting abrupt changes. These two tests are used in this study. A third test, the cusum of squares test, is excluded in the study because Brown et al. (1975) observe that this test is sensitive to changes in the variances of the residuals.

Cusum Test

The cusum test provides formal significance test of parameter constancy by examining the cusum quantity, i.e., the cumulative sums of recursive residuals. This test has been used by many authors such as Belsley, Kuh and Welsh (1980, pp. 217), Foster, Hansen and Vickrey (1988), Greene (2000), and Hendry (2000), among others.

The recursive residuals are defined as

$$w_r = \frac{y_r - \mathbf{x}_r' \mathbf{b}_{r-1}}{\sqrt{(1 + \mathbf{x}_r' (\mathbf{X}_{r-1}' \mathbf{X}_{r-1})^{-1} \mathbf{x}_r)}}, \qquad r = k+1, \ldots, T,$$

where $\mathbf{X}'_{r-1} = [\, \mathbf{x}_1, \ldots, \mathbf{x}_{r-1}]$, $\mathbf{b}_{r-1} = (\mathbf{X}'_{r-1}\mathbf{X}_{r-1})^{-1}\mathbf{X}'_{r-1}\mathbf{Y}_{r-1}$, and $\mathbf{Y}'_{r-1} = [y_1, \ldots, y_{r-1}]$. Under H_0, it can be shown that $w_{k+1}, \ldots, w_T$ are independent, $N(0, \sigma^2)$.

If β_t stays constant up to certain time-point and differs from this constant value thereafter, then the w_r's will have zero means for r up to that point and non-zero means afterwards. Thus, the cusum test examines the cusum quantity

$$W_r = \frac{1}{\hat{\sigma}} \sum_{k+1}^{r} w_j \, ,$$

against r for $r = k+1, \ldots, T$, where $\hat{\sigma}$ denotes the estimated standard deviation determined by $\hat{\sigma}^2 = S_T/(T-k)$, and S_T denotes the residual sums of squares of the regression using all T observations.

Since the w_r's are $N(0, \sigma^2)$, under H_0 the W_r's are approximately normal variables such that

$$E(W_r) = 0, \quad Var(W_r) = r - k, \quad \text{and} \quad Cov(W_r, W_s) = \min(r, s) - k\,.$$

Using these mean and covariance functions, a test can be derived by approximating W_r through the Brownian motion process starting from zero at time $t = k$. This results in a pair of symmetrical straight lines, above and below, the mean value line $E(W_r) = 0$. These two lines go through the points $\{k, \pm a\sqrt{(T\text{-}k)}\}$, $\{T, \pm 3a\sqrt{(T\text{-}k)}\}$, where the parameter a is determined based on known results of Brownian motion theory such that the probability of the sample path crossing one or both lines is α, the desired significant level. Critical values of a for $\alpha = .01$, .05, and .10 are, respectively, 1.143, .948, and .850. If for any r, W_r falls outside the region between the two lines, the null hypothesis is rejected.

Homogeneity Test

Another method for detecting the changes in β_t over time is to fit the regression on a short segment of n successive observations and to move this segment along the time-series. Based on this approach, the homogeneity test can be derived from the results of regressions based on non-overlapping time segments, using the analysis of variance. The time segments used in the moving regression are $(1, n)$, $((n+1), 2n)$, ..., $((p\text{-}2)n+1, (p\text{-}1)n)$, $((p\text{-}1)n+1, T)$, where p is the integral part of T/n. The homogeneity statistic is calculated as

$$\frac{(\mathrm{T-kp})}{(\mathrm{kp-k})} \cdot \frac{\mathrm{S(1,T)-\{S(1,n)+S(n+1,2n)+\ldots+S(pn-2n+1,pn-n)+S(pn-n+1,T)\}}}{\mathrm{\{S(1,n)+S(n+1,2n)+\ldots+S(pn-n+1,T)\}}},$$

where *S(r, s)* is the residual sums of squares from the regression using observations from $t = r$ to s inclusive. Under H_0 this statistic is distributed as *F(kp-k, T-kp)*. If $p = 2$, the above *F* test is equivalent to the Chow test.

Quandt's Log-likelihood Ratio Technique

The Quandt's log-likelihood ratio technique is used to detect the single unknown time-point $t = r$ in which the parameters of linear regression change from one constant values to another constant values. The development of this technique is described in Quandt (1958). For each r from $r = k+1$ to $r = T - k - 1$ the ratio

$$Q_r = \log_{10}\left(\frac{\text{max likelihood of the observations given } \mathrm{H_0}}{\text{max likelihood of the observations given } \mathrm{H_A}}\right),$$

is computed, where H_A is the hypothesis that the observations in the time segments $(1,\ldots,r)$ and $(r+1, \ldots, T)$ come from two different regressions. It can be shown that

$$Q_r = \frac{1}{2} r \log \hat{\sigma}_1^2 + \frac{1}{2}(T-r) \log \hat{\sigma}_2^2 - \frac{1}{2} T \log \hat{\sigma}^2 \quad ,$$

where $\hat{\sigma}_1^2$, $\hat{\sigma}_2^2$ and $\hat{\sigma}^2$ are the ratios of the residual sums of squares to number of observations when the regression is fitted to the first r observations, the remaining T-r observations, and the whole set of T observations, respectively. The estimate of the point at which the switch from one relationship to another has occurred is the value of r at which Q_r attains its minimium.

Algorithm Used to Examine Parameter Nonstationarities of a Time-Series of Data

Given a time-series of stock returns from day r_1 to r_2, where $r_2 \geq r_1+k$, both the cusum test and the homogeneity test are used to examine beta non-stationarity of equation (2). A significance level of 0.10 is used in both tests. In the homogeneity test, the moving regression is performed on length n, which is from k to the integral part of $(r_2 - r_1+1)/2$, incremented by one. If the homogeneity statistic of using any of these lengths is significant, then the time-series fail the homogeneity test. A stable beta is defined for an interval when both tests fail to reject the null hypothesis.

The recursive procedure used to identify all periods where beta is stationary works as follows:

Step 1. Initialize by letting $r_1 = 1$ and $r_2 = T$; i.e., the program starts by examining the full period of the original time-series.

Step 2. If the time-series from r_1 to r_2 passes both the cusum test and the homogeneity test, then the OLS parameter estimates on the time series from r_1 and r_2 are considered to be stationary.

Step 3. If the time-series from r_1 to r_2 fail either the cusum test or the homogeneity test, then the Quandt's log-likelihood ratio technique is used on the time-series from r_1 to r_2 to identify the single point of time, r, at which the non-stationarity has most likely occurred. This defines two new subperiods, (r_1, r) and $(r+1, r_2)$.

Step 4. Repeat the tests for each subperiod, i.e., return to Step 2, where r_1 and r_2 are defined as the lower and upper limits of the two subperiods, respectively.

The algorithm ends when all subperiods with stable betas have been identified.

REFERENCES

Ball, R. 1992. The Earnings-Price Anomaly. *Journal of Accounting and Economics* 15: 319-345.

______. 1988. What Do We Know About Stock Market Efficiency? Working paper, University of Rochester.

______, and P. Brown. 1968. An Empirical Evaluation of Accounting Income Numbers. *Journal of Accounting Research* 6: 159-178.

______, and S. P. Kothari. 1991. Security Returns Around Earnings Announcements. *The Accounting Review* 66: 718-738.

Banz, R. W. 1981. The Relationship between Return and Market Value of Common Stocks. *Journal of Financial Economics* 9: 3-18.

Belsley, D. A., E. Kuh, and R. E. Welsch. 1980. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. John Wiley & Sons.

Bernard, V. 1987. Cross-Sectional Dependence and Problems in Inference in Market-Based Accounting Research. *Journal of Accounting Research* (Spring): 1-48.

______ and J. Thomas. 1989. Post-Earnings-Announcement Drift: Delayed Price Response or Risk Premium. *Journal of Accounting Research* 27 (Supplement): 1-36.

______ and ______. 1990. Evidence That Stock Prices Do Not Fully Reflect the Implications of Current Earnings for Future Earnings. *Journal of Accounting and Economics* 13: 305-340.

______, ______ and J. Wahlen. 1997. Accounting-Based Stock Price Anomalies: Separating Market Inefficiencies from Risk. *Contemporary Accounting Research* 14 (Summer): 89-136.

Brown, R. L., J. Durbin, and J. M. Evans. 1975. Techniques for Testing the Constancy of Regression Relationships. *Journal of the Royal Statistical Society*, Series B, 37: 149-163.

Brown, P. and M. Rozeff. 1979. Univariate Time Series Models of Quarterly Accounting Earnings Per Share: A Proposed Model. *Journal of Accounting Research*: 179-189.

Chow, G. 1960. Tests of Equality between Sets of Coefficients in Two Linear Regressions. *Econometrica* 28: 591-605.

Easton, P. 1997. Use of Comparisons of Patterns of Stock Return and Accounting Data in Understanding Apparently Anomalous Returns to Accounting-based Trading Strategies. *Contemporary Accounting Research* 14 (Spring): 137-151.

Fama, E. F. 1965. The Behavior of Stock Market Prices. *Journal of Business* 38: 34-105.

______. 1970. Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance* (May): 383-417.

______. 1976. *Foundations of Finance.* New York: Basic Books.

______. 1991. Efficient Capital Markets: II. *Journal of Finance* (December): 1575-1617.

______. 1998. Market Efficiency, Long-Term Returns, and Behavioral Finance. *Journal of Financial Economics* 49: 283-306.

______ and J. MacBeth, 1973. Risk, Return and Equilibrium: Empirical Tests. *Journal of Political Economy* 81: 607-636.

Foster, G. 1977. Quarterly Accounting Data: Time-Series Properties and Predictive-Ability Results. *The Accounting Review* (January): 1-21.

Foster, G., C. Olsen and T. Shevlin. 1984. Earnings Releases, Anomalies, and the Behavior of Securities Returns. *The Accounting Review* 59: 574-603.

Foster, T. W., D. R. Hansen and D. W. Vickrey. 1988. Additional Evidence on the Abatement of Errors in Predicting Beta through Increases in Portfolio Size and on the Regression Tendency. *Journal of Business Finance and Accounting* 15(2): 185-197.

Greene, W. 2000. *Econometric Analysis.* 4th Edition, New Jersey: Prentice-Hall, Inc.

Griffin, P. 1977. The Time-Series Behavior of Quarterly Earnings: Preliminary Evidence. *Journal of Accounting Research* 15: 71-83.

Guan, L., D. Hansen, S. Leikam and J. Shaw. 2001. Stable Betas, Size, Earnings-to-Price, Book-to-Market, and the Validity of the Capital Asset Pricing Model. Working Paper, Oklahoma State University.

Hendry D. F. 2000. On Detectable and Non-Detectable Structural Change. *Structural Change and Economic Dynamics* 11: 45-65.

Holthausen, R. 1983. Abnormal Returns Following Quarterly Earnings Announcements. *Proceedings of the Seminar on the Analysis of Security Prices*, May 1983: 37-59. Chicago: University of Chicago.

Ibbotson, R. G. 1975. Price Performance of Common Stock New Issues. *Journal of Financial Economics* 2: 235-272.

Jacob, J., T. Lys and J. Sabino. 1999. Autocorrelation Structure of Forecast Errors from Time-Series Models: Alternative Assessments of the Causes of Post-Earnings Announcement Drift. *Journal of Accounting & Economics* (December): 329-358.

Jensen, M. C. 1968. The Performance of Mutual Funds in the Period 1945-1964. *Journal of Finance* 23: 389-415.

Joy, O., R. Litzenberger and R. McEnally. 1977. The Adjustment of Stock Prices to Announcements of Unanticipated Changes in Quarterly Earnings. *Journal of Accounting Research* (Autumn): 207-225.

Kothari, S. P. 1999. Capital Markets Research in Accounting. Working Paper, Massachusetts Institute of Technology.

Latané, H. and C. Jones. 1977. Standardized Unexpected Earnings: A Progress Report. *Journal of Finance* (December): 1457-1465.

______ and ______. 1979. Standardized Unexpected Earnings: 1971-77. *Journal of Finance* (June): 717-724.

Quandt, R. E. 1958. The Estimation of the Parameters of a Linear Regression System Obeying Two Separate Regimes. *Journal of American Statistical Association* B, 27: 873-880.

Reinganum, M. 1981. Misspecification of Capital Asset Pricing. *Journal of Financial Economics* (March): 19-46.

Rendleman, R., C. Jones, and H. Latané. 1982. Empirical Anomalies Based on Unexpected Earnings and the Importance of Risk Adjustments. *Journal of Financial Economics* 10 (November): 269-287.

______, ______, and ______. 1987. Further Insight into the Standardized Unexpected Earnings Anomaly: Size and Serial Correlation Effects. *The Financial Review* 22 (February): 131-144.

Scholes, M. and J. Williams. 1977. Estimating Betas from Non-synchronous Data. *Journal of Financial Economics* (December): 309-327.

Watts, R. 1975. The Time Series Behavior of Quarterly Earnings. Unpublished Working Paper , University of Newcastle, Newcastle, N.S.W.

______. 1978. Systematic 'Abnormal' Returns After Quarterly Earnings Announcements. *Journal of Financial Economics* (June-September): 127-150.

______ and J. Zimmerman. 1986. *Positive Accounting Theory*, Englewood Cliffs, N. J.: Prentice-Hall.

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