ABSTRACT

Title of Dissertation: THE USEFULNESS OF EARNINGS, THE MAGNITUDE OF PRICE CHANGE, AND THE RETURN-EARNINGS COVARIANCE: BEYOND THE ERC AND R^2

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Dissertation Directed By: Professor Oliver Kim
Accounting and Information Assurance Department

This study proposes the return-earnings covariance as a proxy for the usefulness of earnings inferred from the absolute magnitude of price changes associated with earnings information. It is argued that such measurement of the absolute usefulness of earnings information has been neglected in existing long-window studies. For example, the ERC and R^2 measure the marginal impact and the relative impact of earnings information on the stock price, respectively. It is demonstrated that the return-earnings covariance is a close proxy for the absolute magnitude of price change which is free from noise in both return and earnings. Thus, the return-earnings covariance can be used in long-window studies as well as short-window studies. Two covariance measures, the total covariance and the time distribution of weekly covariance are introduced and applied to empirical data to show new insights that can be obtained by the measures. The result indicates that the previously documented decrease on the value relevance of earnings over the past decades is mainly driven by

the increasing influence of factors not directly related to earnings on the regression measures, not by a decrease in the absolute usefulness or timeliness of earnings. It is also found that the previously documented weak return-earnings relation over the short-window announcement period or contemporaneous return-earnings association for larger or more closely followed firms is due not only to more vigorous pre-disclosure information production activities of those firms, but also, and more importantly, to the weaker overall magnitude of price changes associated with earnings information of those firms.

THE USEFULNESS OF EARNINGS, THE MAGNITUDE OF PRICE CHANGE, AND THE RETURN-EARNINGS COVARIANCE: BEYOND THE ERC AND R^2

by

Myojung Cho

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Advisory Committee:

Professor Oliver Kim, Chair
Professor Martin Loeb
Professor Taewoo Park
Professor Partha Sengupta
Professor Bart Landry, Department of Sociology

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Introduction

The usefulness of accounting information, especially the usefulness of earnings, has long been a popular topic of interest to accounting policy makers and academic researchers. The importance of this issue can be found in the Statement of Financial Accounting Concept No. 1, which asserts that the objective of financial reporting is to provide *useful* information to its users in their business decisions.

Seminal papers by Ball and Brown (1968) and Beaver (1968) examine the stock price reaction at the arrival of earnings information and show that earnings carry information content that is *used* by the market participants. As for the definition of the earnings usefulness, Ball and Brown (1968) state that the usefulness of earnings announcement can be inferred from an observed revision of stock price associated with the release of the income report. They reason that price change caused by an earnings announcement would be a consequence of investors' buying or selling actions based on information released through the announcement. Beaver (1968) similarly defines the information content of a firm's earnings as the extent that it changes investors' assessments of the probability distribution of future returns resulting in a stock price change. Analytical studies like Holthausen and Verrecchia (1988) and Kim and Verrecchia (1991) also demonstrate the link between information used by the market and stock price changes.

Accordingly, stock price changes with respect to earnings have been extensively studied in the capital markets research on the usefulness of earnings to investors. For example, studies including Beaver (1968), Francis, Schipper and Vincent (2002a, 2002b) and Landsman and Maydew (2002) use the variance of return of a short-window around earnings announcement to test the usefulness of information released during announcement periods.[1] The variance of stock return of a short window is an indicator of the *absolute* magnitude of price change *caused* by information disseminated by earnings announcement. Thus, short-window studies are called *studies of the information content of earnings* in the literature.

Interestingly, it appears that the absolute magnitude of the impact of earnings information on stock price changes has not received much attention in long-window studies. For a long window, the market has access to information from other sources in addition to earnings information. Thus, one cannot assume that the variation of stock return of a long window is caused by earnings information

[1] They also use trading volume around earnings announcement as an alternative measure of the information content of earnings. Note that Beaver (1968) and Bamber (1986) interpret the trading volume reaction as the changes in the expectations of individual investors due to differential interpretations of earnings reports whereas the price changes to earnings information as an indicator that reflects the changes in the expectations of the market as a whole. The focus of the current study is the price reaction to earnings information from the perspective of the market as a whole.

only. Thus, it is hard to establish a causal relation between earnings information and the stock price response followed by the information arrival in long-window studies. For this reason, studies on the return-earnings relation often shy away from using 'the strong normative connotations of the term *usefulness*,' as stated in Lev (1989). They instead examine *the association* between stock return and earnings. While the marginal or the relative impact of earnings information on stock price movements measured with the regression measures are important, the consideration of the absolute magnitude of price change associated with earnings information can provides new insights about the return-earnings association.

This study proposes *the return-earnings covariance* as a measure of the absolute magnitude of price change associated with information contained in earnings of a certain period, which can be used for long-window studies as well as short-window studies. The usefulness of earnings inferred by the return-earnings covariance is called *the absolute usefulness of earnings information to the market participants*, in that it incorporates the market's perception about both a $1 shock in earnings and the magnitude of earnings information itself used by the market.[2]

Traditional measures of the usefulness of earnings in the long-window studies are obtained from the return-earnings regressions. They are the earnings response coefficient (the ERC), the reverse regression coefficient (the RRC) and the R^2. These measures represent either the relative impact of the marginal impact of earnings information on price changes. This study contributes to the capital markets literature by providing an additional conceptual tool for the

[2]Francis and Schipper (1999) similarly use this term compared to the relative usefulness measure, R^2.

studies on the return-earnings relation: the absolute usefulness of earnings.

The *ERC* is the most popular measure of the return-earnings association. Many studies (Beaver, Lambert and Morse, 1980, Beaver, Lambert and Ryan, 1986, Collins and Kothari, 1989, Loudder and Behn, 1995, Lev and Zarowin, 1999, and Lougee and Marquardt, 2004) present a positive *ERC* to show that earnings information is indeed used by the market.[3] The *ERC* is considered as a proxy for the impact of a $1 shock in earnings on stock price changes while the absolute magnitude of price changes related to earnings information is the product of the marginal impact and the magnitude of earnings information observed by the market during the period. Therefore, the *ERC* cannot be viewed as a measure of the absolute usefulness of earnings. Note that the *ERC* is subject to value-irrelevant noise to be an accurate proxy for the marginal impact of earnings due to the well-known *error-in-variable* problem as discussed in Ball and Brown (1968), Beaver, Clarke and Wright (1979), and Kothari (2001).

The R^2 is another measure of the usefulness of earnings (Lev, 1989, Loudder and Behn, 1995, Lev and Zarowin, 1999, Francis and Schipper, 1999, Ryan and Zarowin, 2003, and Lougee and Marquardt, 2004). Lev (1989) argues that, if stock price changes indicate the usefulness of earnings, greater price changes mean greater usefulness of earnings and the usefulness of earnings can be inferred from the return-earnings correlation or R^2. The R^2 measures the explanatory power of reported earnings with respect to stock price changes expressed as a

[3] There are also studies that examine factors that influence the *ERC*. For example, Kormendi and Lipe (1987), Easton and Zmijewski (1989), and Collins and Kothari (1989) document that the *ERC* varies positively with earnings persistence and growth opportunities and negatively with risk and the risk-free interest rate.

percentage. That is, the absolute magnitude of price changes related to earnings information is divided by the variance of return to get the R^2. Thus, the R^2 can be understood as a measure of the *relative* impact of earnings information on stock price changes rather than that of the absolute usefulness of earnings. It is beneficial to examine the absolute and relative usefulness of earnings separately because the measure of the relative impact of earnings information varies with news that is not directly related to the immediate future earnings (e.g. CEO changes, credit rating changes, etc.) even when the absolute usefulness of earnings is not affected.

The *RRC* is analyzed in this study and treated as a proxy for the relative impact of earnings information rather than the inverse of the marginal impact of earnings information.

Therefore, traditional usefulness measures cannot be used as measure of the absolute usefulness of earnings and it is necessary to develop a measure for the absolute magnitude of price change associated with earnings information used by the market.

In a model, the covariance between stock return and a time-series earnings surprise is proposed as an indicator of the absolute usefulness of earnings.[4] The return-earnings covariance is free from the error-in-variable problem of reported earnings and the influence of non-earnings related news reflected in stock return. Therefore, unlike the variance of return, the covariance can be used as a measure of the absolute usefulness of earnings in long window studies as well as short-window studies.

[4] The reason for the use of a time-series earnings surprise is to examine earnings information used by the market, which is not reflected in the earnings series of prior years.

Two covariance-based measures are constructed: *the total covariance* and *the time distribution of covariance*. The total covariance is the covariance between earnings surprise and the return of the entire dissemination period of earnings information (two years).[5] It measures the overall (long-window) magnitude of price change associated with earnings information of a year. As the second measure, the time distribution of covariance over the information dissemination period is investigated with covariances between earnings surprise and subperiod (weekly) returns. The time distribution of subperiod covariances indicates the timing of earnings information arrival to the market with a given level of the total covariance. Thus, the total covariance and the time distribution of subperiod covariances constitute by design independent measures of the overall absolute usefulness and the timeliness of earnings, respectively.

The time distribution of subperiod covariances is first applied to the pooled sample. The earnings information dissemination period is divided into 104 weeks based on the number of trading days between adjacent quarterly announcement dates so that announcement period and non-announcement period are distinguished. It is shown that earnings information of a year begins to be observed by the market in the second quarter of the prior year and about one third of the total earnings information contained in earnings report is anticipated by the market before the current year. Results also show that there is a clear distinction between announcement period and non-announcement period in the absolute magnitude of price change related to earnings information.

[5] The two-year earnings information dissemination period is adopted in this study because usually the relation between return and earnings surprise is positive up to two years (Collins and Kothari, 1989, and Collins, Kothari, Shanken and Sloan, 1994).

In addition to providing a detailed pattern of the earnings information used by the market, the time distribution of covariance contributes to the earnings timeliness literature because covariance measures the absolute price change related to earnings information without the influence of noise in earnings or return. In the literature, earnings of a year is considered timely to the extent that information reflected in earnings report of the year is incorporated into stock price during the same year. Therefore, the ratio of the contemporaneous covariance to the total covariance can be used as a measure of the timeliness of earnings which is not influenced by noise in earnings or return. Furthermore, the time distribution of covariance provides a tool to extend the timeliness of earnings literature. For example, the extent of information used by the market during announcement period compared to information during non-announcement periods can be evaluated with the ratio of the return-earnings covariance for announcement period to the covariance for non-announcement period. The application to the pooled sample shows that about 33% of earnings information disseminated in the current year is done so during earnings announcement period.

As an alternative to the covariance approach, the magnitude of price change associated with earnings information can be approximated by the hedge portfolio approach. Collins, Kothari and Rayburn (1987), Alford, Jones, Leftwich and Zmijewski (1993), and Francis and Schipper (1999) construct hedge portfolios based on the foreknowledge of earnings before earnings announcements. In this case, the hedge portfolio return of a period can be considered as a proxy for the impact of earnings information on stock price during the period. Thus, the total hedge portfolio return over the entire dissemination period is similar in spirit to the total covariance, and the hedge portfolio return in each sub-period is similar to the covariance for the sub-period. One important advantage of the covariance approach over the portfolio approach is that it is free from both return noise and earnings noise, while the hedge portfolio return is subject to both.

The use of the return-earnings covariance as a measure of the absolute magnitude of price change associated with earnings information also contributes to the literature on changes in the value relevance of earnings over the past decades. Prior studies including Collins, Maydew and Weiss (1997), Ely and Waymire (1999), Lev and Zarowin (1999), Francis and Schipper (1999), and Ryan and Zarowin (2003) document a decrease in the value relevance of earnings over the past decades based on the decline of the contemporaneous R^2 or RRC, the measures of the relative impact of earnings information on stock price. They explain that the value relevance of earnings declined because accounting could not keep pace with rapidly changing business environment accompanied by increasing intangible assets and losses. Ryan and Zarowin (2003) also suggest that the increasing lack of earnings timeliness is one of the reasons for the declining value-relevance of earnings.

However, it is possible that the measure of the relative impact of earnings information may have declined due to the increasing influence of reasons that cannot be traced to earnings information on stock prices, not by the decrease in the absolute usefulness of earnings, as indicated by Francis and Schipper (1999) and Ely and Waymire (1999). To test which one is the driving force of the declining value relevance of earnings, the covariance measures are obtained along with traditional usefulness measures for each year over the period 1977-2001. The results show that the total covariance did not significantly change while the variance of return increased over the period. In addition, the timeliness of earnings did not decline over the period, either. These results indicate that the decrease in the RRC or R^2 over the past decades is mainly driven by the increase in the price movements caused by non-earnings related news, not by a decrease in the absolute usefulness or the timeliness of earnings.

This study also contributes to studies of the cross-sectional differences in the return-earnings relation. Studies including Grant (1980), Atiase (1985), Collins, Kothari and Rayburn (1987) and Collins and Kothari (1989) document that a weaker return-earnings relation for large firms than that of small firms for a short window around earnings announcement or for the contemporaneous association. They explain that more information about the forthcoming earnings of large firms is predisclosed to the market than that of small firms before earnings announcements. This predisclosure information is an issue of the timing of earnings information arrival, which can be replicated with the time distribution of covariance. However, the timeliness of earnings is one factor of the weak contemporaneous (or announcement period) return-earnings association for large firms. Another factor is the cross-sectional difference in the absolute magnitude of price change associated with earnings information over the entire information period.

To investigate the effects and the interaction between these two factors with respect to cross-sectional difference in the return-earnings association, the total covariance and the two timeliness measures of this study are applied to different firm size portfolios and the number of analysts following portfolios. While results support the previously documented predisclosure information results, it is also found that, for a given level of the timeliness of earnings, the firm size or the number of analysts following is a positive function of the total covariance.

Therefore, the documented weak return-earnings relation over the short-window announcement period or contemporaneous return-earnings association for large firms is due not only to more vigorous pre-disclosure information production activities for large firms, but also, and more importantly, to the weaker overall magnitude of price changes associated with earnings information of large firms over the entire dissemination period.

Rest of this study is organized as follows. In Chapter 2, the link between the usefulness of earnings and the absolute magnitude of price change is discussed. It is also argued why a measure of the absolute magnitude of price change related to earnings information is needed. Chapter 3 presents the analytical model of earnings and stock return and proposes the return-earnings covariance as a measure of the absolute usefulness of earnings inferred by the absolute magnitude of price changes. The total covariance and two measures of the timeliness of earnings are introduced in this chapter. In Chapter 4, the covariance measures are applied to empirical data. The results from the applications demonstrate the advantages of the proposed measures. Chapter 5 concludes.

Chapter 2

The usefulness of earnings, the absolute magnitude of price change, and the return-earnings covariance

Since Ball and Brown (1968) and Beaver (1968), financial accounting researchers have studied stock prices to find evidence of the usefulness of accounting information to investors. Two points are presented in this chapter: (1) the *absolute* magnitude of price change associated with earnings information should be considered to fully understand the usefulness of accounting earnings, and (2) a measure for the absolute usefulness of earnings information needs to be developed .

2.1 The absolute usefulness of earnings

From the short-window and long-window studies of the return-earnings relation, two view points about the usefulness of earnings can be drawn. The first view is to interpret information in earnings report useful to the extent that the release of earnings report provides new information to the market over a short window. This view implies a causal relation between earnings and price response. However, the information content of earnings released through earnings announcement is a small part of overall information contained in earnings report.[1] As a result, studies of short-window announcement period are studies of the information content of earnings announcement rather than that of earnings per se. Therefore, the implications of the short-window studies are rather limited to discuss the usefulness of information contained in earnings report of a certain year.

The second view is to consider information in earnings report of a certain year useful to the extent that the earnings report contains value-relevant information that is not reported in prior years. Thus, earnings information of a year is incorporated into stock price over time. In the second view, a statistical association between earnings and stock price is expected rather than the causal relation due to the well-known important problem in earnings over a long window. That is, because the market can acquire information about a firm's value through many other sources as well as accounting information, the return-earnings relation over a long window does not constitute evidence that earnings caused the price change.

This study takes the second point of view to investigate the overall usefulness of earnings information incorporated to stock over a long-window earnings information dissemination period. Suppose the stock price of a firm changed when the market learned from a news article about the firm's new contract which would

[1] Ball and Brown (1968) report that 85% to 90 % of the information about the sign of earnings surprise is anticipated by the market over the 11 months prior to the month of earnings announcement.

affect the firm's earnings in the future. The price change was not directly caused by the future earnings, but it was due to the arrival of information that would be contained in the future earnings. Study of such price change is valuable because one can learn in which fashion the market uses earnings information in projecting future performances of a firm over the earnings information dissemination period.

The next issue is how to quantify the degree of the usefulness of earnings. Suppose a new accounting rule is introduced requiring firms to disclose information that would alter the market's perception about the firms. How can we measure the change in the earnings usefulness to investors due to the new rule? Stock price changes related to the new information provided by the rule would be an indictor of the use of new information by investors Thus, the usefulness of the new earnings information could be first measured in its absolute magnitude of price change associated with the information. Second, the relative contribution of new information in enhancing the ability of earnings information in explaining stock price movement can be evaluated. The markets information set contains not only earnings information but also other non-earnings-related information. Thus, the relative usefulness measure can be obtained by dividing the absolute magnitude of price change related to the new information by the overall magnitude of price change. Lastly, one can examine the marginal impact of earnings information by measuring changes in stock price caused by a one dollar shock in earnings.

In this study, the usefulness of earnings is found from *the absolute magnitude of price change associated with information contained in earnings of a certain period.* It is termed as *the absolute usefulness of earnings,* following Francis and Schipper (1999). If new accounting rule increases the magnitude of price change associated with earnings in an absolute value, the increase implies that the information contained in earnings is used more extensively by the market. In that sense, the usefulness of earnings increases, unless one insists a causal relationship between earnings and stock price.

On the other hand, if the price movement with the new information relative to overall price movement increases, one cannot conclude that the increase is related to the new earnings information or to non-earnings-related news. That is, the relative price movement would increase when the contribution of non-earnings-related information decreases even without new earnings information available to the market. For example, politics, natural disasters, or man-made disasters (e.g. wars, revolutions, and terrorism) may greatly affect the stock prices even though they are remotely or randomly related to information contained in earnings.

In addition, if the marginal impact of earnings information increases after the new rule is introduced, it is still not clear whether the increase is directly related to new information made available by the new rule or to changes in other factors of the marginal impact like risk, growth potential, risk-free interest rate or persistence, documented by Kormendi and Lipe (1987), Easton and Zmijewski (1989), and Collins and Kothari (1989).

Therefore, the absolute magnitude of price change associated with earning information provides a direct implication about the degree of the usefulness of information contained in earnings reports from the market's perspective.

In the literature, the absolute magnitude of price change related to earnings information is investigated in short window studies like Beaver (1968), Francis, Schipper, and Vincent (2002a, 2002b) and Landsman and Maydew (2002). They use the variance of return around earnings announcement as an indicator of the information content of earnings.[2] However, the absolute usefulness of earnings seems to be neglected in long window association studies in the capital markets literature. The next section presents a discussion that existing measures of the usefulness of earnings including the ERC, RRC, and R^2 do not represent the absolute magnitude of price change associated with earnings information.

This study does not attempt to discredit the contributions of the regression measures to the capital markets research. The measures of the absolute, marginal, and relative impact of earnings information on the stock price serve different purposes in different circumstances. This study intends to contribute to the capital markets literature by providing an additional conceptual tool and a practical measure of the return-earnings relation: the absolute usefulness of earnings.

2.2 Measures of the usefulness of earnings based on regressions

Even though the absolute usefulness of earnings released by earnings announcements can be directly measured with the variance of stock return around the information event, the causal relation cannot be maintained for the long-window return-earnings relation. For this reason, researchers gradually diverted away

[2]See Kothari (2001). There are short-window studies (e.g., Hagerman, Zmijewski and Shah, 1984, and Collins, Maydew and Weiss, 1997) that use the short-window ERC as an indicator of the information content of earnings. It is discussed later that the ERC proxies for the *marginal* impact of earnings information with error.

from the direct measure of the stock price movements and turned to measures of the return-earnings association. In particular, the return-earnings association studies relied heavily on the regression estimates such as the ERC, RRC, and R^2.

The ERC has particularly attracted much attention as a measure of the usefulness of earnings in various areas of the capital markets research. Studies like Beaver, Lambert and Morse (1980), Beaver, Lambert and Ryan (1986), and Lev and Zarowin (1999) report a positive ERC as evidence that earnings information is indeed used by the market. Some studies investigate economic determinants of the ERC. Specifically, Kormendi and Lipe (1987), Easton and Zmijewski (1989), Collins and Kothari (1989) document evidence that the impact of a one dollar shock in earnings on stock price measured by the ERC is a positive function of growth opportunities and the persistence of earnings. They also find the ERC is a negative function of risk-free interest rate, systematic risk (market beta) and firm size. Some studies use the ERC to show that prices lead accounting (See Beaver, Lambert and Morse, 1980, Collins, Kothari and Rayburn, 1987, Freeman, 1987, Collins and Kothari, 1989, Kothari and Sloan, 1992, and Easton, Harris and Ohlson, 1992). Other studies investigate changes in the value-relevance of earnings from changes in the ERC (See Lev and Zarowin, 1999, and Ryan and Zarowin, 2003).

Notwithstanding the importance of the ERC as a measure of the usefulness of earnings, it cannot be viewed as a measure of the absolute usefulness of earnings. The ERC approximates the marginal impact of one dollar earnings shock on the stock price (often called *the price-earnings multiple*) while the absolute magnitude of price change associated with earnings information, i.e., the absolute impact of earnings on the stock price, is the marginal impact times the magnitude of the earnings shock itself. Thus, the ERC measures only a part of the absolute usefulness of earnings information.

In addition, the ERC is subject to the error-in-variable problem. The market incorporates more information about a firm's value than information reflected in the earnings forecast model typically assumed in empirical studies. As a result, expected earnings conditional on the information in the time series of past earnings can be different from the market's expected earnings conditional on its richer information set. This value-irrelevant noise in earnings increases the denominator of the ERC (or R^2), the variance of earnings, leading to a downward bias in the ERC (or R^2). Without this noise in earnings, the ERC would be an accurate proxy for the price-earnings multiple. Therefore, the ERC is a measure of the marginal impact of earnings with error and cannot be viewed as a measure of the absolute usefulness of earnings.

The ERC provides useful insights when the focus of a study is the price-earnings multiple and not related to the magnitude of earnings information. For example, Hayn (1995) shows that the ERC is lower for losses than profits. She interprets that the information content of earnings of loss firms is lower than that of profit firms because earnings information of loss firms is perceived as temporary by the market. To state her intuition more precisely, there is a lower *marginal* impact of losses than that of profits on stock price. The ERC serves the purpose of her study well because the price-earnings multiple is theoretically a positive function of the persistence of earnings for a given dollar of earnings.

The R^2 is another measure of the usefulness of earnings, which proxies for the impact of earnings information in explaining stock movement relative to that of overall information of the market.[3] Therefore, the R^2 is a proxy for the relative impact of earnings with error, not the absolute usefulness of earnings.

The relative impact of earnings information on stock price would be an important aspect of the usefulness of earnings when a researcher is interested in the relative contribution of earnings as an information source to the market. For example, Lev and Zarowin (1999), Francis and Schipper (1999), and Ryan and Zarowin (2003) report a decline of the contemporaneous R^2 over recent decades. Their results show that the contribution of earnings in explaining stock price changes has declined when it is compared with contributions of other information observed by the market. The concept of the absolute usefulness of earnings can add to the existing result of the declining R^2. The decline can be explained with one or any combinations of three possible reasons: a decrease in the absolute usefulness of earnings, an increase in earnings noise (the error-in-variable problem), and an increase in return noise. The analysis of the absolute magnitude of price change associated with earnings information enables one to distinguish among the three possible reasons for changes in the R^2.

Lastly, the RRC is the return-earnings covariance divided by the variance of return. It can be considered as a proxy for the inverse of the marginal effect of earnings. However, the variance of return over a long window is subject to noise from non-earnings-related news and so does the RRC to be considered as an accurate proxy for the inverse of the price-earnings multiple. It is later shown that the RRC can be considered as a measure of the relative impact of earnings information on the stock price.

In sum, existing regression measures represent either the marginal impact

[3] Lev (1989) supports the R^2 as a measure of the usefulness of earnings.

or the relative impact of earnings information on stock price changes. Therefore, they cannot be viewed as measures of the absolute usefulness of earnings. An existing measure of the absolute magnitude of price change associated with earnings information is discussed in the next section.

2.3 The hedge portfolio return

Ball and Brown (1968), Collins, Kothari and Rayburn (1987), Alford, Jones, Leftwich and Zmijewski (1993), Francis and Schipper (1999), and Butler, Kraft and Weiss (2005) use hedge portfolio returns to gauge the absolute impact of the information content of earnings with respect to stock price movement. Hedge portfolios are typically constructed based on the foreknowledge about forthcoming earnings. They interpret the hedge portfolio return obtained with the knowledge of earnings information over a certain period as an indicator of the usefulness of earnings observed by the market during the period.

The hedge portfolio return can be considered as a measure of the absolute usefulness of earnings because it is the rate of return from the hedge portfolio based on earnings information. Ball and Brown (1968, p.175) report that hedge portfolio return is approximately 8% for 11 months and interpret it as 'the value of information contained in the annual earnings number' of the year and that it is associated with about 50% of the market's information about a firm's value. Alford, Jones, Letfwish and Zmijewski (1993) similarly interpret the level of the hedge portfolio return over 15 months ending 3 months after the fiscal year end as a proxy for the level of the information content of earnings of a country. The pattern of hedge portfolio return over a long window is used to infer the timeliness of earnings. Alford, Jones, Leftwich and Zmijewski (1993) and Butler, Kraft and Weiss (2005) use the area below the cumulative hedged return graph over the return cumulation period as their measure of the timeliness of earnings. The earlier the information arrives to the market, the faster the cumulative hedge portfolio return increases in earlier period, resulting in a increase in the area below the cumulative return graph.

However, there are some concerns in the hedge portfolio returns as a measure of the absolute usefulness of earnings. First, the hedge portfolio is usually constructed based on the sign of earnings surprise whereas the market participants place different weights on earnings surprise depending on the magnitude of information content of earnings as well as the sign of earnings surprise. Thus, some of the information content of earnings can be left out if only the sign of earnings surprise is used in constructing the hedge portfolio, as Beaver, Clarke and Wright (1979) and Kothari (1992) note.[4] Second, earnings surprise used to construct the hedge portfolio is based on the reported earnings, which include the value-irrelevant noise. This value-irrelevant noise in earnings surprise dampens the ability of the hedge portfolio return to accurately represent the absolute usefulness of earnings. Lastly, returns of firms included in the hedge portfolio are also affected by information that is not directly related to earnings information. The price movement that is not related to earnings information acts like noise in

[4] Beaver, Clarke and Wright (1979) examine the effect of the magnitude of earnings surprise instead of the sign of earnings surprise on the return-earnings relation for a long window of 52 weeks (approximately one year). They find a positive cross-sectional rank correlation between abnormal return and the magnitude of earnings surprise. Kothari (1992) states that if usefulness of earnings is assessed by a portfolio-based measure, the assessment of the usefulness of earnings is critically depends on a researcher's ability to correctly classify firms into portfolios.

interpreting the hedge portfolio return as a measure of the information content of earnings.

In sum, even though the hedge portfolio return over a long window is an accepted measure of the information content of earnings for a long window in the literature, noise in earnings and return dampens its ability to represent the absolute magnitude of price response to earnings information. Therefore, a new measure of the absolute usefulness of earnings needs to be developed, which is free from the value-irrelevant noise in earnings and the influence of non-earnings-related price movements.

2.4 The return-earnings covariance

This study proposes the return-earnings covariance as a proxy for the absolute magnitude of price change associated with earnings information. The important advantage of the covariance over the hedge portfolio return as a measure of the absolute usefulness of earnings is the fact that it is free from noise in both return and earnings. The next chapter presents the discussion of how closely the covariance proxies for the absolute usefulness of earnings in a formal model.

Chapter 3

The model

3.1 Earnings information and stock return

To formally analyze how stock returns are related to earnings information, consider year t earnings surprise based on a time-series model, denoted by y_t. Earnings surprise y_t is calculated as the reported earnings at the end of year t minus expected earnings conditional on past earnings of years $t-1, t-2, \ldots$. To investigate the relation between return and earnings information that is not reflected in past earnings series, a time-series model is used for expected earnings.[1]

[1] Analysts forecasts are not used in this study for three reasons. First, analysts forecasts reflect some of information that the market uses. Therefore, if analyst forecasts errors are used as earnings surprise, information that is already observed by analysts would be left out in the analysis. Second, O'Brien (1988) documents that a time-series earnings surprise is more strongly associated with stock returns than analysts forecast errors based on the results of the *RRC* even though analysts forecasts are more accurate than expected earnings from autoregressive time-series models. Barron, Kim and Stevens (2004) present a similar argument. Untabulated results of this study are consistent with results of these studies. Lastly, it is also documented that analysts forecasts tend to be optimistic in studies including Francis and Philbrick (1993), Dugar and Nathan (1995) and Das, Levine and Sivaramakrishnan (1998).

The market incorporates more information about a firm's value than the information reflected in the earnings forecast model that is typically assumed in empirical studies (the error-in-variable problem). For this reason, Ball and Brown (1968) and Beaver, Clarke and Wright (1979) model earnings surprise as new information to the market with error. Following them, earnings surprise y_t of year t, which is *ex post* observed by a researcher, is modeled as the sum of two components. The first component, termed as *earnings information* x_t, is the portion priced by the market, which is independently normally distributed with mean zero and variance v for all t. The second component is value-irrelevant *noise* δ_t. δ_t is independently normally distributed with mean zero and variance d for all t. The two components are independent with each other with $cov(x_t, \delta_t) = 0$ for all t. Thus, earnings surprise of year t, y_t, can be expressed as follows:

$$y_t = x_t + \delta_t, \tag{3.1}$$

with mean zero and variance $v + d$ for all t.

It is assumed that the market anticipates from year $t - 1$ a portion of information x_t in time-series earnings surprise, incorporating prices leading earnings documented in prior studies.[2] Earnings information is anticipated by the market prior to earnings announcement because earnings recognition is subject to accounting conventions such as conservatism, objectivity, verifiability, and revenue-expense matching principle, which limit the ability of accounting earnings to reflect information about a firm value perceived by the market participants. In other words, accounting recognizes the outcomes as a part of earnings only pe-

[2] See Ball and Brown (1968), Beaver, Lambert and Morse (1980), Collins, Kothari and Rayburn (1987), Freeman (1987), Collins and Kothari (1989), Kothari and Sloan (1992), Kothari (1992), and Easton, Harris and Ohlson (1992).

riodically and only if they satisfy certain accounting criteria for the recognition of revenues and expenses while the market learns about the news through other sources continuously over time.

Note that x_t is modeled as value-relevant information as a part of the *ex post* measured time-series earnings surprise. The market observes information about year t earnings from various sources during year $t-1$. At the earnings announcement of year $t-1$, the market updates its expectation about year t earning conditional on the information obtained from the earnings announcement and during year $t-1$. During year t, the market continues to update its expectation about year t earnings with the arrival of new information. Earnings information x_t is the value-relevant information contained in year t earnings that the market observes from sources other than past years' earnings numbers. By modeling earnings information x_t as the information that is not included in the past earnings series, one can investigate the association between return and earnings information newly contained in year t earnings report.

Information of x_t is incorporated into stock price over two years $t-1$ and t with prices leading earnings by one year.[3] Without loss of generality, it is assumed that information of x_t contained in year t earnings report is observed

[3] The two-year earnings information dissemination period is adopted because usually the relation between return and earnings surprise is positive up to two years. For exmple, Collins and Kothari (1989) and Collins, Kothari, Shanken and Sloan (1994) report a negative return-earnings relation beyond two year period. Untabulated results of this paper also show a negative return-earnings relations when earnings surprise of year t is regressed on returns of year $t-2$ or $t-3$. In addition, when those periods are divided into weeks, the pattern of weekly return-earnings relations does not appear to follow a systematic path that is expected for earnings information dissemination.

by the market every week i over the two-year period of year $t-1$ and year t, where $i = -103, ..., -52$ of year $t-1$ and $i = -51, ..., 0$ of year t. Week $i = 0$ is the earnings announcement week at the end of year t and week $i = -103$ is the first week of year $t-1$ (the first week of the two-year period) as in figure 1. The market has no information about x_t at the beginning of year $t-1$. Information contained in year t earnings report is completely revealed to the market when earnings report is released at the end of year t.[4]

Suppose $E_i[x_t]$ is the market's expectation of x_t conditional on information available at the end of week $i = -103, ..., 0$. The market's expectation of x_t at the beginning of year $t-1$, denoted by $E_{-104}[x_t]$, is equal to the unconditional mean of x_t, zero. $E_0[x_t]$, the market's expectation of x_t at the earnings announcement week $i = 0$, is equal to x_t because the earnings announcement is assumed to resolve all uncertainty about x_t. The weekly information disseminated during week i is denoted as $x_{t,i}$ and defined as a change in the market's expectation of x_t during the week as follows:

$$x_{t,i} \equiv E_i[x_t] - E_{i-1}[x_t], \tag{3.2}$$

normally distributed with mean zero and variance v_i for $i = -103, ..., 0$ and for all t. Therefore, year t earnings information $x_{t,i}$ of week $i = -103, ..., 0$ is mutually independent and additive as follows:

$$\sum_{i=-103}^{0} x_{t,i} = \sum_{i=-103}^{0} (E_i[x_t] - E_{i-1}[x_t]) = E_0[x_t] - E_{-104}[x_t] = x_t - 0 = x_t. \tag{3.3}$$

In the above information structure, the variance of earnings information v_i represents the degree of earnings uncertainty resolved in week i. The total uncer-

[4]The post-earnings-announcement drift documented by Foster, Olsen and Shevlin (1984) and Bernard and Thomas (1989) is ignored for the purpose of this study.

tainty in year t earnings v can be obtained as the sum of the degree of earnings uncertainty resolved each week over two years:

$$v = \sum_{i=-103}^{0} v_i. \tag{3.4}$$

Now consider stock return $r_{t,i}$ for week i in year t that is log-transformed as follows:

$$R_{t,i} \equiv \ln(1 + r_{t,i}). \tag{3.5}$$

The weekly log returns $R_{t,i}$ are additive and mutually independent.[5] Stock returns are linked to earnings information by assuming that the impact of $1 earnings innovation on price is $\$\beta$ for all t and for all i. Thus, β is the marginal impact of earnings information on stock price changes. It is often called the price-earnings multiple.

Because prices lead earnings, only a fraction of information contained in earnings surprise is new to the market in the current year and the rest is anticipated by the market in the earlier period. Stock price changes during year t reflect revisions in the market's expectation of the current earnings of year t as well as that of the future earnings of year $t + 1$ as follows:

$$R_{t,i} = \beta(x_{t,i} + x_{t+1,i-52}) + \varepsilon_{t,i}, \tag{3.6}$$

for $i = -51, ..., 0$ for all t. $\varepsilon_{t,i}$ is white noise normally distributed with mean zero and variance e_i such that $e \equiv \sum_{i=-51}^{0} e_i$ for all t. Equation (3.6) shows that stock return for week i consists of the reaction to the current earnings information x_t, the reaction to the future earnings information x_{t+1}, and independent noise $\varepsilon_{t,i}$

[5] Untabulated result shows that the correlation among weekly log returns is ignorable at about -0.002 on average.

that is unrelated to earnings information. Among the three terms, only $\beta x_{t,i}$ is related to the information contained in earnings report of year t, from which the usefulness of earnings of year t is inferred.

In the next section, the theoretical value of the absolute magnitude of price changes associated with earnings information is presented as an indicator of the absolute usefulness of earnings information. The theoretical value of the relative magnitude of price change related to earnings information compared to the overall magnitude of price change for a certain period is also presented to analyze measures of the usefulness of earnings in the literature.

3.2 The absolute and the relative magnitude of price change associated with earnings information

The extent of price movement related to earnings information has a direct implication about the usefulness of earnings information to the market participants. Consider the stock return for the entire 104 weeks of the two-year dissemination period of year t earnings.[6] Using equations (3.3) and (3.6), the two-year return is written as follows:

$$(R_{t-1} + R_t) = \beta \sum_{i=-103}^{0} x_{t,i} + \beta \sum_{i=-51}^{0} (x_{t-1,i} + x_{t+1,i-52}) + \sum_{i=-51}^{0} (\varepsilon_{t-1,i} + \varepsilon_{t,i}), \quad (3.7)$$

with mean zero and variance $2(\beta^2 v + e)$ for all t. As shown in figure 1, R_{t-1} is affected by earnings of years $t-1$ and t, and R_t is affected by earnings of

[6] The discussion is based on the two-year earnings information dissemination period for simplicity. It can be generalized to periods with different lengths.

years t and $t+1$. In the above equation, the first term $\beta \sum_{i=-103}^{0} x_{t,i} = \beta x_t$ represents how much stock price changes due to news that is related to year t earnings information. Thus, the variance of the first term $var(\beta x_t) = \beta^2 v$ is interpreted as *the absolute usefulness of earnings of year t* inferred from the absolute magnitude of price change associated with year t earnings information. The second term reflects the stock return related to earnings information of year $t-1$ and $t+1$. The last term is the price movement related to news that is not related to earnings information, i.e., noise in return.

Note that the absolute magnitude of price change associated with earnings information is the product of the price-earnings multiple β and earnings information x_t. Therefore, the marginal impact of earnings information on stock price, i.e., the price-earnings multiple, is a part of the absolute magnitude of price change related to earnings information.

Besides the absolute magnitude of price response measure, it is sometimes useful to consider the magnitude of price response to earnings information *relative to* the magnitude of the overall price change. The overall magnitude of price change over the two years can be inferred from the variance of the two-year return $var\,(R_{t-1} + R_t) = 2(\beta^2 v + e)$. The ability of earnings information in explaining the stock price movement $\frac{\beta^2 v}{2(\beta^2 v + e)}$ is the absolute impact of earnings information $\beta^2 v$ divided by the overall magnitude of price movement $2(\beta^2 v + e)$. *The relative impact of earnings information on stock price* $\frac{\beta^2 v}{2(\beta^2 v + e)}$ is an indicator of the importance of earnings information to the market compared to other information available to the market.

In sum, the absolute magnitude and the relative magnitude of price change related to earnings information along with the marginal impact of earnings information represent the usefulness of earnings from three different perspectives. In the next section, by analyzing existing measures of the return-earnings relation with respect to theoretical values of the marginal, absolute, and relative measures of the price change associated with earnings information, it is argued that an empirical measure of the absolute usefulness of earnings needs to be developed.

3.3 Traditional measures of the usefulness of earnings

Four measures have been widely used in the literature to gauge the strength of the earnings-return relation. The first measure is the variance of return,

$$var(R_{t-1} + R_t) = 2\left(\beta^2 v + e\right). \tag{3.8}$$

The variance of return can be viewed as a proxy for the absolute magnitude of price change related to earnings information $\beta^2 v$. Especially for a short window around an information event, noise e in return can be ignored. Thus, it is often used to measure the information content of earnings around earnings announcement in short window studies. However, for a long window, the influence of non-earnings-related news on price change can be substantial and cannot be ignored, as Ball and Brown (1968) point out. As a result, the variance of return renders a poor proxy for the absolute magnitude of price change associated with earnings information for long-window studies.

In long-window studies, regression estimates are usually used such as the earnings response coefficient (*ERC*) from the regression of return on earnings, the reverse regression coefficient (RRC) from the reverse regression of earnings on return, and the R^2 of these regressions. Consider the regression of earnings surprise y_t on the two-year return $(R_{t-1} + R_t)$ and vice versa. Under the assumption of normality of all the variables in regressions, the theoretical values of the traditional measures, denoted by RRC, ERC, and R^2, respectively, can be obtained as follows:[7]

$$ERC \equiv \frac{cov(y_t, R_{t-1} + R_t)}{var(y_t)} = \beta \cdot \frac{v}{v+d}, \tag{3.9}$$

$$RRC \equiv \frac{cov(y_t, R_{t-1} + R_t)}{var(R_{t-1} + R_t)} = \frac{\beta v}{2(\beta^2 v + e)}, \text{ and} \tag{3.10}$$

$$R^2 \equiv RRC \cdot ERC = \frac{\beta^2 v^2}{2\left(\beta^2 v + e\right)(v+d)}. \tag{3.11}$$

Equation (3.9) shows that the ERC proxies for the price-earnings multiple β with error, not the absolute usefulness of earnings $\beta^2 v$. Thus, the ERC may be an insightful measure for the marginal impact of earnings information on stock price only. However, if price changes related to earnings information mainly arises from the earnings information itself, the ERC does not provide a full understanding about the return-earnings association. Therefore, the ERC cannot be considered as a proxy for the absolute magnitude of price changes associated with earnings information represented by $\beta^2 v$.

Even as a proxy for the price-earnings multiple, the ERC has the error-in-variable problem reflected in the value-irrelevant noise d in reported earnings y_t. The error-in-variable problem can be serious if earnings observed by the researcher y_t is significantly different from the value-relevant information x_t that

[7] Using other return windows results in somewhat different expressions for the measures but qualitatively the same conclusions. The measures from the contemporaneous regressions are presented in appendix A.

the market extracts from its richer information set.[8]

The reverse regression coefficient RRC in equation (3.10) can be rewritten as:

$$RRC = \frac{1}{\beta} \cdot \frac{\beta^2 v}{2(\beta^2 v + e)}. \quad (3.12)$$

Equation (3.12) suggests that the RRC can be viewed as a proxy for the inverse of β. Similar to the case of the ERC, the use of the RRC as a proxy for $\frac{1}{\beta}$ requires caution because a valid implication can be drawn only when noise in return e is insignificant or adequately controlled. Another way to understand the RRC is to treat it as a proxy for the relative magnitude of price changes associated with earnings information, $\frac{\beta^2 v}{2(\beta^2 v+e)}$.

Finally, the R^2 in equation (3.11) can be written as:

$$R^2 = \frac{v}{v+d} \cdot \frac{\beta^2 v}{2(\beta^2 v + e)}. \quad (3.13)$$

Equation (3.13) shows that the R^2 proxies for the relative magnitude of price change related to earnings information, $\frac{\beta^2 v}{2(\beta^2 v+e)}$, not the absolute usefulness of earnings. In addition, the R^2 measures the explanatory power of the *reported earnings* with respect to stock return where the reported earnings contains value-irrelevant noise d. Therefore, the error-in-variable problem in earnings also dampens the ability of the R^2 to represent the relative magnitude of price change associated with earnings information.

In sum, traditional measures represent either the marginal impact or the relative impact of earnings information on stock price movement, not the absolute

[8] The market can learn much more than the stripped-down earnings number alone from, for example, its knowledge about different weights for different components of earnings. Studies like Kothari and Sloan (1992), Easton, Harris and Ohlson (1992), and Kothari (1992) adopt various approaches to reduce the error-in-variable problem of the ERC.

magnitude of price change related to earnings information. It is especially true for studies of the long-window return-earnings association. Therefore, it is necessary to find a measure of the absolute magnitude of price change related to earnings information to infer the absolute usefulness of earnings.

3.4 The return-earnings covariance

In this section, the covariance between return and earnings is proposed as a close proxy for the magnitude of price change associated with earnings information, which is free from either return noise or earnings noise. Two covariance-based measures are introduced. The first measure is the *total covariance*, the covariance between earnings surprise and the return for the entire earnings dissemination period. The second measure, which is by design conceptually independent from the first, is the *time distribution* of covariances of sub-periods over the information dissemination period.

3.4.1 The total covariance

Recall that the variance of earnings surprise is $var(y_t) = v + d$, where $v = \sum_{i=-103}^{0} v_i$ is the variance of value-relevant earnings information x_t. From the variance of return, $var(R_{t-1}+R_t) = 2\beta^2(v+e)$, $\beta^2 v$ is the variance of stock return associated with year t earnings information. The covariance between earnings surprise and the two-year return captures the comovement of earnings and stock price over the two-year information dissemination period as follows:

$$TC \equiv cov(y_t, R_{t-1} + R_t) = cov(x_t, R_{t-1} + R_t) = \beta var(x_t) = \beta v. \qquad (3.14)$$

Considering that it represents the return-earnings covariance over the entire dissemination period, it is called the total covariance and denoted as TC. The total covariance can be written as $TC = \beta v = \frac{1}{\beta} \cdot \beta^2 v$, indicating that it proxies for the absolute magnitude of price change associated with earnings information over the entire information dissemination period. Even though β is not squared in the total covariance, the total covariance is a positive function of both β, the marginal impact of earnings information, and v, the degree of overall earnings uncertainty resolved over the two years. These are two factors of the variance of the two-year return associated with earnings information, $\beta^2 v$. Therefore, the total covariance can be interpreted as an indicator of the absolute usefulness of earnings over the entire information dissemination period.

Importantly, the value-irrelevant noise d in earnings and the effect of non-earnings-related news e in stock return are excluded from the covariance because it captures information commonly reflected in earnings and stock price only. Thus, whenever a significant fraction of the return volatility is influenced by news unrelated to earnings information, the covariance would be an insightful indicator of the absolute usefulness of earnings compared to the variance of return.

3.4.2 Time distribution of covariance

While the total covariance measures the absolute usefulness of earnings that is cumulated over the two-year information dissemination period, new information about year t earnings is observed by the market every week. The weekly earnings information $x_{t,i}$, $i = -103, ..., 0$, is independent among each other. Thus, the absolute magnitude of price change associated with earnings for each week can be examined to investigate how early and how fast earnings information is disseminated to the market.

From the variance of return of week i, $var(R_{t,i}) = \beta^2(v_i + v_{i-52}) + e_i$, $\beta^2 v_i$ is the variance of stock return associated with year t earnings information. Weekly covariance is obtained as the covariance between earnings surprise and stock return of the week i as follows:

$$cov(y_t, R_{t,i}) = cov(x_t, R_{t,i}) = \beta var(x_{t,i}) = \beta v_i, \tag{3.15}$$

for $i = -51, ..., 0$ in year t, and

$$cov(y_t, R_{t-1,i}) = cov(x_t, R_{t-1,i}) = \beta var(x_{t,i}) = \beta v_i, \tag{3.16}$$

for $i = -103, ..., -52$ in year $t-1$. Thus, weekly covariance captures the absolute magnitude of price movement related to year t earnings information for each week such that:

$$TC \equiv \sum_{i=-51}^{0} [cov(y_t, R_{t-1,i-52}) + cov(y_t, R_{t,i})] = \sum_{i=-103}^{0} \beta v_i = \beta v. \tag{3.17}$$

To examine the timing of earnings information arrival to the market for a given level of return-earnings association over the entire information dissemination period, weekly covariances are divided by the total covariance. Specifically, the flow of earnings information to the market is measured with *the earnings information arrival rate*, denoted by λ_i, for each week i as follows:

$$\lambda_i \equiv \frac{cov(y_t, R_{t,i})}{TC} = \frac{\beta v_i}{\beta v} = \frac{v_i}{v}, \tag{3.18}$$

for $i = -51, ..., 0$ in year t, and

$$\lambda_i \equiv \frac{cov(y_t, R_{t-1,i})}{TC} = \frac{\beta v_i}{\beta v} = \frac{v_i}{v}, \tag{3.19}$$

for $i = -103, ..., -52$ in year $t-1$, where $\sum_{i=-103}^{0} \lambda_i = 1$. The information arrival rate λ_i can be interpreted as the fraction of year t earnings information that is absorbed into stock price in each week relative to the total information content of year t earnings. The weekly information arrival rates λ_i are expected to be non-negative and sum up to 1. Thus, they are similar to densities and their distribution is similar to a density function.

Since earnings information arrival rates are defined for any given total covariance, they describe the dimension of the general timeliness of earnings that is by design separate from the absolute magnitude of earnings, measured by the total covariance.

3.4.3 Measures for the timeliness of earnings

Price leading earnings indicates that earnings report is not a timely source of information to the market, i.e., a significant portion of information is absorbed into price before it is reflected in earnings report. As a result, earnings of a certain year is considered *timely* to the extent that information contained in earnings is new to the market during that year, not anticipated by the market in earlier years.

The distribution of the λ_i's for all 104 weeks provides a complete picture of the timing of the dissemination of earnings information to the market. Thus, the covariance-based measure can be used to discuss the timeliness of earnings information. A measure called *the current year arrival rate* is first introduced as an alternative measure of the earnings timeliness aligned with the definition. In the literature, the timeliness of earnings is commonly measured with the degree of the contemporaneous return-earnings association compared with the association between current year earnings and lagged year return based on the RRC or R^2.[9] The covariance-based timeliness measure, called the current year arrival rate λ, is defined as follows:

$$\lambda \equiv \frac{\sum_{i=-51}^{0} cov(y_t, R_{t,i})}{TC} = \frac{cov(y_t, R_t)}{TC} = \frac{\sum_{i=-51}^{0} v_i}{v}. \tag{3.20}$$

Consistent with the definition of timeliness of earnings, the current year arrival rate λ measures the fraction of overall year t earnings information that is disseminated to the market during the current year, not anticipated in prior years. Under the assumption that the dissemination period is two years, a $1-\lambda$ fraction of the overall earnings information of year t is disseminated in year $t-1$. The current year arrival rate can be used to replicate existing timeliness results of the traditional timeliness measures. Appendix B analyzes traditional timeliness measures with respect to the current year arrival rate.

Even though the commonly adopted definition of the timeliness of earnings is also used in this study, the term *timeliness* can be misleading. For example, very timely earnings (say, $\lambda = 1$) implies that the market does not obtain much earnings information before the current year. Thus, from the market's viewpoint,

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[9] For example, Collins, Kothari and Rayburn (1987) and Lev and Zarowin (1999) measure the timeliness of earnings with the ratio of the RRC of current return to that of lagged return. They interpret the higher ratio as earnings report reflecting more information used by the market or prices anticipating less earnings information prior to the current year. Ryan and Zarowin (2003) interpret the RRC from the regression of current earnings level on current and lagged returns as the portion of the return of each year that is reflected in current earnings. To show the lack of timeliness of earnings, Warfield and Wild (1992) and Collins, Kothari, Shanken and Sloan (1994) use the incremental R^2 as future earnings is added to the contemporaneous regression of return on earnings. Appendix B presents existing measures of the timeliness of earnings in the literature.

earnings information arrives late and is untimely.

The time distribution of covariance conveniently provides detailed information about the arrival pattern of earnings information to the market in terms of the absolute magnitude of price changes without the influence of noise in return and earnings. Thus, it provides opportunities for examining other aspects of the time distribution such as differences in the amount of earnings information disseminated across different quarters or differences between earnings announcement and non-announcement periods. As an example, the information arrival rates are applied to measure the extent of earnings information delivered during earnings announcement period versus non-announcement period. *The announcement period arrival rate*, denoted by θ, is defined as:

$$\theta \equiv \frac{\lambda_{-39} + \lambda_{-26} + \lambda_{-13} + \lambda_0}{\lambda}, \tag{3.21}$$

where λ_i, $i = -39, -26, -13$, and 0, are the earnings information arrival rates during the four quarterly announcement weeks in year t. The variable θ measures the contribution of earnings announcements as a vehicle of disseminating earnings information to the market by measuring the extent of earnings information delivered during earnings announcement weeks relative to the earnings information released during the current year t.

These two timeliness measures λ and θ constructed from the time distribution of covariance are applied to empirical data along with the TC.

Chapter 4

Empirical applications of the covariance measures

In this chapter the measures of the absolute magnitude and the timing of the arrival of earnings information to the market, i.e., the total covariance TC, the current year arrival rate λ, and the announcement period arrival rate θ, are empirically applied to three different sets of samples. The results are compared with existing results in the related literature and new insights from the proposed measures are discussed.

The first application is an investigation of the weekly time pattern of the dissemination of earnings information over the two-year earnings dissemination period for a pooled sample. A detailed picture of when and how much earnings information is disseminated to the market is presented from the application. Second, the proposed measures are applied to different years to address the long-run changes in the usefulness of earnings over recent decades. The intertemporal results with the covariance measures are compared with the results of prior studies that report a decline of the value relevance of earnings with regression-based measures. Finally, the covariance measures are cross-sectionally applied to different firm size portfolios and number of analysts following portfolios. The results provide interesting insights into different aspects of the information environment that vary with firm size or the number of analysts following.

4.1 Data

Data for this study are collected from two sources. First, the CRSP merged database is used to obtain variables of annual income before extraordinary items (in millions of US dollars), daily returns, stock prices, the number of shares outstanding and quarterly earnings announcement dates for all CRSP firms. Second, if quarterly earnings announcement dates are missing in the CRSP merged database, the missing observations are filled with quarterly earnings announcement dates collected from the I/B/E/S database.

4.1.1 Time-series earnings surprise

Earnings surprise y_t for each fiscal year t is computed as incomes before extraordinary items of year t, denoted by Y_t, minus time-series expected earnings for the year. That is,

$$y_t = Y_t - E_{t-1}[Y_t], \tag{4.1}$$

where $E_{t-1}[Y_t] = E[Y_t|Y_{t-1}, Y_{t-2}, ...]$. Expected earnings of year t, $E_{t-1}[Y_t]$, are estimated based on the AR(1) time series model with the first order difference as follows:

$$E_{t-1}[Y_t] = Y_{t-1} + \mu + \phi(Y_{t-1} - Y_{t-2}). \tag{4.2}$$

The AR(1) with the first-order difference is adopted in this study to eliminate the negative first-order autocorrelation in earnings, documented in Ball and Watts

(1972).[1] If earnings surprise is autocorrelated, the result of the absolute magnitude of price change associated with earnings information of year t is confounded with effects of earnings information of other years.

For the iterative estimation process of the AR(1) model, ten observations of the first-order difference of earnings from year $t-10$ to year $t-1$ are used for each firm-year to increase the chance to acquire converged results of parameters. Thus, it is required that at least twelve years of annual incomes before extraordinary items be available in the CRSP merged database for each firm-year. The estimation process has produced $49,861$ firm-year observations of earnings surprise. The mean (median) estimate of μ is 4.34 (0.36) in this initial sample. The mean (median) estimate of ϕ is -0.15 (-0.17), which shows the negative first-order autocorrelation of annual earnings.

While the use of AR(1) earnings process by design eliminates the first-order autocorrelation in earnings, the estimation of the time series model requires a relatively long data history of earning (12 years in this study). For this reason, studies including Collins and Kothari (1989) use earnings changes as their proxy for earnings surprise assuming a random walk earnings process. Ball and Watts (1972) and Watts and Leftwich (1977) suggest that, despite the negative autocorrelation of earnings change, a random walk model may be a reasonable time-series process for annual earnings. Therefore, empirical applications of this study are repeated with earnings change, $\Delta Y_t \equiv Y_t - Y_{t-1}$.

The AR(1) earnings surprise y_t and earnings change ΔY_t in the initial sample

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[1] The AR(1) earnings process is also used in prior studies including Foster (1977) and Easton and Zmijewski (1989). They use the seasonal first order autoregressive model to estimate the quarterly earnings expectation.

are scaled by the market value at the beginning of year $t-1$. The market value of a firm is computed as of the beginning of year $t-1$ as stock price multiplied by the number of shares on the third day after the announcement date of year $t-2$ annual earnings. This market value at the beginning of year $t-1$ is also used as a measure of firm size in this study. After deleting observations with missing firm size variable, the sample contains annual earnings surprise deflated by the beginning stock price for $40,896$ firm-years.

4.1.2 Weekly returns

For each AR(1) earnings surprise of year t in the sample, weekly stock returns over two fiscal years (years $t-1$ and t) are obtained as follows. First, a fiscal quarter is defined as the period between two adjacent quarterly earnings announcement dates. As an example, the first quarter of year $t-1$ is the period that begins at the third day after the fourth quarter earnings announcement date of year $t-2$ and ends at the second day after the first quarter earnings announcement date of year $t-1$. Therefore, nine consecutive quarterly earnings announcement dates are needed to get eight quarters over two fiscal years for each firm-year earnings. If any of the nine quarterly earnings announcement dates are missing, the firm-year is excluded from the sample.

Second, each quarter is divided into 13 weeks based on the number of trading days. The number of trading days is counted for each quarter and evenly divided into 13 weeks so that the 13th week is the earnings announcement week for the quarter. Since the number of trading days in a quarter is typically not cleanly divided by 13, some weeks have up to one more trading day than other weeks. If the number of trading days in a quarter is less than 15 days, the quarter is deleted from the sample.

Lastly, daily returns collected from the CRSP database are cumulated for each week. The cumulative weekly returns are natural log transformed so that the log transformed weekly returns $R_{t,i}$, $i = 1, ..., 104$, are additive over different intervals. Therefore, a quarterly return is the sum of 13 weekly returns in the quarter and annual return R_t is the sum of four quarterly returns of the year.

4.1.3 The final pooled sample

To be included in the final sample, firms are required to have AR(1) earnings surprise for two years y_t and y_{t+1}, earnings change ΔY_t and ΔY_{t+1}, both earnings variables scaled by the beginning stock price of year $t-1$. Earnings variables for year $t+1$ are used to check autocorrelation. Firms in the final sample are also required to have uninterrupted data of weekly returns for the full two fiscal years.[2] After deleting one percent extreme observations of earnings surprise y_t and y_{t+1}, earnings change ΔY_t and ΔY_{t+1}, annual returns R_{t-1} and R_t, and the two-year return $(R_{t-1}+R_t)$, the final pooled sample consists of $28,050$ firm-years from $3,545$ firms for years from 1973 to 2001.

Panel A of table 1 reports the industry composition of the sample firms based on the 48 industries classification by Fama and French (1997) and size of the firms. The mean firm size in each industry tends to be greater than the median firm size, indicating that firms in the final sample tend to be large

[2] Durnev, Morck, Yeung and Zarowin (2003) state that disruptions in trading can be due to initial public offerings, delistings, or unusual events such as takeover bids, bankruptcy filings, or legal irregularities. Therefore, I believe that firms with those irregular information events are mostly excluded from the sample.

firms. It is because the selection criteria of this study require that firms with less than 12 years of history or firms not covered by the CRSP merged database be excluded from the final sample. The requirements may reduce the generality of the results of this paper. However, note that the firms in the final sample are well diversified in terms of industry as presented in panel A of table 1.

Panel B of table 1 reports that 18,465 firms are December fiscal year end firms, which is 65.83% of the final sample. This paper's main results do not qualitatively change with December fiscal-year-ending firms only.

According to panel C, the number of firm-years in the final sample significantly increases from 1973 to 2001. The percentages of losses, negative AR(1) earnings surprise, and negative earnings changes for each year are also reported. The results of this study do not qualitatively change when loss firms are excluded from the sample.

Table 2 presents the descriptive statistics of earnings and return variables. Table 3 reports correlation among earnings and return variables. In panel A, the correlation between earnings change ΔY_t and ΔY_{t+1} is -0.11 while the correlation between y_t and y_{t+1} is only 0.02.

Untabulated result shows that the correlation between annual returns R_{t-1} and R_t is -0.12. However, the correlation among returns decreases as the return period decreases. Panel B presents correlation among quarterly returns as an illustration. The correlation among quarterly returns is about -0.03 on average. Untabulated result shows that the correlation among weekly returns is minimal at about -0.002 on average. Therefore, weekly returns can be considered to be independent of each other.

To test the autocorrelation in annual returns drive the result of this study, empirical applications are repeated with abnormal return variables considering that abnormal returns are not autocorrelated by construction. Two abnormal return variables are used: (1) stock return excess the equally-weighted market return from the CRSP merged database and (2) abnormal return from the market model.[3] The main results do not qualitatively change by the use of abnormal returns.

This final sample is used in the first application and it is divided into sub-samples of each year for the second application. The final sample is also divided into different size portfolios and the number of analysts following portfolios for the third application.

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[3] The market model abnormal returns are obtained as follows. For a given year t, weekly returns $r_{t,i}$ of a firm over two years $t-3$ and $t-2$ (104 observations) are regressed on market returns $r_{m,t,i}$ for corresponding weeks to get the market model parameters $\hat{\psi}_{t,0}$ and $\hat{\psi}_{t,1}$. Market return for week i is obtained by taking the average of stock returns of the week for all firms in the sample. The abnormal returns based on the market model, denoted by $ar_{t,i}$ for week $i = -51, .., 0$ in year t is calculated as follows:

$$ar_{t,i} = r_{t,i} - (\hat{\psi}_{t,0} + \hat{\psi}_{t,1} r_{m,t,i}).$$

The abnormal return $ar_{t-1,i}$ for week $i = -103, ..., -52$ in year $t-1$ is similarly obtained as:

$$ar_{t-1,i} = r_{t-1,i} - (\hat{\psi}_{t,0} + \hat{\psi}_{t,1} r_{m,t-1,i}).$$

The log-transformed market model abnormal returns $AR_{t,i} = \ln(1 + ar_{t,i})$ for all t are used for the analysis.

4.2 Time distribution of covariance

Figure 2 presents the time pattern of weekly covariances between AR(1) earnings surprise and stock returns divided by the total covariance, i.e., the information arrival rates λ_i, over the entire information dissemination period of 104 weeks for the pooled sample. Figure 3 presents the time pattern of weekly covariances between earnings changes and stock returns scaled by the total covariance. The results of the time pattern of weekly covariances with AR(1) earnings surprise are discussed in this section because the results of the two earnings variables are similar.

This detailed picture provides interesting observations about when and how much earnings information is disseminated to the market. For example, it is shown that earnings information of year t begins to arrive in the second quarter of year $t-1$. By the end of year $t-1$, 33.9% of the total earnings information has been disseminated to the market, which makes the current year arrival rate $\lambda = 66.1\%$ for the pooled sample as reported in panel A of table 4.

In addition, the pronounced spikes of the quarterly earnings announcement weeks show that significantly more earnings information is disseminated in the announcement weeks than in non-announcement weeks.[4] The announcement

[4] There are mixed results on the market reaction during earnings announcement period versus non-announcement period. Ball and Brown (1968) conclude that most of the information contained in earnings report is anticipated by the market before earnings announcements and this anticipation is so accurate that there is no unusual jumps in the abnormal return during the month of earnings announcements. However, Foster, Olsen and Shevlin (1984) and Bernard and Thomas (1989) report pronounced jumps in abnormal return during a short window around earnings announcement. Therefore, the results in figure 2 and table 4 are consistent with those of Foster, Olsen and Shevlin (1984) and Bernard and Thomas (1989).

period arrival rate θ is 33.7% for the pooled sample in panel A of table 4, indicating that 22.2% (i.e., 33.7% of the 66.1%) of the total earnings information is disseminated during the four weeks of quarterly announcements in year t. Note that the spikes are less pronounced in the third and the fourth quarters of year $t-1$ than in the four quarters of year t. The reason for this result is that, unlike year $t-1$ quarterly earnings, the four quarterly earnings of year t constitute year t annual earnings and hence their announcements resolve large fractions of uncertainty of year t earnings.

Another interesting observation from table 4 is that 42.5% of earnings information arrives during the first two quarters of year t, while only 23.6% arrives during the last two quarters of the year. Though a decrease is expected in the second half of the year due to the advance dissemination of each quarter's earnings information, the severity of the drop warrants further investigation. The results in panel B with earnings changes are similar to those in panel A.

Independent of the specific patterns of the dissemination of earnings information depicted in figure 2 and figure 3, the detailed time pattern of covariance is easy to understand and the covariance measure can be easily applied to any number of sub-periods of any length without the influence of noise in return or earnings. Therefore, it can be a valuable tool in examining issues related to the dissemination of earnings information such as the impact of new accounting rules or other events that potentially affect the timing of the dissemination and the quality of earnings information used by the market.

4.2.1 Time distribution of the ERC

Interestingly, the ERC has been rarely used in the literature to depict the detailed pattern of earnings information dissemination because it is difficult to get a separate earnings response coefficient for each week from the regression of stock return on earnings unless earnings data for each week are available. For this reason, Collins and Kothari (1989, p.153) comment that they use regression of earnings on return to obtain the coefficients of returns (the RRC) for multiple periods in their analysis of the lead-lag relation between current return and lagged returns. However, the information arrival rate λ_i for each week i in figure 2 and figure 3 can be obtained with the ERC by taking the covariance between annual earnings y_t and weekly return $R_{t,i}$ over the variance of annual earnings y_t. Then, the ERC of week i divided by the ERC with the two-year return is the information arrival rate, λ_i. Note that the ERC produces the pattern of the absolute impact of earnings information on price change over the information dissemination period, not the pattern of the price-earnings multiple over the period even though the measure is a proxy for the marginal impact of earnings information. Thus, the covariance measure reveals a neglected angle of the usefulness of earnings in the ERC studies.

4.2.2 Comparison with the time distribution of the hedge portfolio returns

The hedge portfolio approach inspired by Ball and Brown (1968) shares the same spirit with the proposed covariance measure. Among prior studies using the hedge portfolio approach to investigate the return-earnings relation are Collins, Kothari and Rayburn (1987), Alford, Jones, Leftwich, and Zmijewski (1993), Francis and Schipper (1999) and Butler, Kraft and Weiss (2005). The hedge portfolio return is usually calculated as the cumulative abnormal returns of firms with positive time-series earnings surprise minus those of firms with negative earnings surprise. The hedge portfolio return for each sub-period (say, each week) can be considered as a proxy for the information content of earnings disseminated during the week similar to the return-earnings covariance for the period. For example, Alford, Jones, Leftwich, and Zmijewski (1993) use the hedge portfolio return over 15 months as a measure of the information content of earnings and also proxy for the timeliness of earnings with the area under the cumulative hedge portfolio return over the 15 months for each country in a cross-country setting. Therefore, the covariance approach and the hedge portfolio approach are expected to produce similar implications about the information dissemination of earnings.

While the hedge portfolio approach and the covariance approach share the same purpose of measuring the absolute magnitude of price change associated with earnings information used by the market, the hedge portfolio approach potentially suffers from the presence of earnings noise and return noise unlike the covariance approach. It is because the hedge portfolios are formed based on reported earnings which contain noise. In addition, the hedge portfolio return contains noise to the extent that the influence of non-earnings related information on stock return is not diversified away by constructing the portfolio. As a result, the two approaches are expected to generate similar results if the sample size is sufficiently large and independent errors are diversified away. However, when there is significant noise in earnings or return or when the sample size is small, the hedge portfolio method would generate results not as sharp as those generated from the covariance approach.

To investigate the time distribution of covariance and the hedge portfolio return in detail, the hedge portfolio returns are estimated for the two fiscal years of the earnings information dissemination period. For this analysis, the market model abnormal returns are used to be consistent with prior studies of the hedge portfolio return. The comparison between these two approaches are conducted with AR(1) earnings surprise only.

Hedge portfolio returns

A hedge portfolio is constructed for each year from 1977 to 2001 (25 years) based on the foreknowledge of earnings. Specifically, firms in the sample of each year are ranked by the AR(1) earnings surprise deflated by the beginning stock price of year $t-1$. Then an equally weighted hedge portfolio is constructed for the year by taking a long position in firms with highest 40% of earnings surprise and a short position in firms with lowest 40% of earnings surprise. Hedge portfolio return for week i associated with earnings information of year t is differences between the average market model abnormal return of top 40% firms and that of bottom 40% firms.[5]

[5] Weekly abnormal returns are obtained using the market model, following Ball and Brown (1968) and Collins, Kothari and Rayburn (1987). Alford, Jones, Leftwich, and Zmijewski (1993) use the equally weighted market return as their proxy for the expected return. The results of this paper do not qualitatively change with different measures of expected returns.

The time distribution of the hedge portfolio returns

The hedge portfolio returns for each week is averaged over the 25 years. Similar to the weekly information arrival rate λ_i based on covariance, weekly arrival rate η_i is constructed as the ratio of weekly hedge portfolio return to the two-year cumulative hedge portfolio return. The information arrival rate η_i for $i = -103, ..., 0$ is summed up to one and can be treated like density similar to the information arrival rate λ_i constructed with weekly covariances. Figure 4 presents the time patterns of the two information arrival rates, η_i and λ_i for comparison. The information arrival rate λ_i based on covariance is estimated with the market model abnormal returns and AR(1) earnings surprise to be consistent with the hedge portfolio returns approach. As expected, figure 4 shows that two approaches generate similar patterns of earnings information dissemination and the correlation between the two information arrivals rates is 0.93.

Despite the similarity of the patterns of the two measures, the distribution of hedge portfolio return is relatively smooth compared to that of covariance in that the standard deviation of η_i is 1.03% compared to 1.16% for λ_i. Specifically, the η_i tends to be higher than the λ_i when the information rates are relative low and the λ_i tends to be higher than the η_i when the arrival rates are relatively high. This result is consistent with a scenario that random noise in return or earnings of the hedge portfolio returns smoothes out the information arrival rates η_i.

To see the difference in more detail, differences in the two weekly arrival rates of the 104 weeks are ranked based on either η_i or λ_i and divided into two groups into weeks of high arrival rates and weeks of low arrival rates. The result shows that the η_i is higher than the λ_i in 34 weeks out of 52 low arrival rate weeks and the λ_i is higher than the η_i in 27 weeks out of 52 high arrival rate weeks.

The student's T test is performed with the null hypothesis of zero mean of the difference $(\eta_i - \lambda_i)$ for both high and low arrival rate groups for a significance test of the difference. The null hypothesis of no difference is not rejected in both groups. The insignificant results in the pooled sample can be observed because noise in return and earnings is largely diversified away in the pooled sample. Further research is required to investigate in which circumstances the effects of noise on the hedge portfolio returns are significant.

In summary, the two information arrival measures produce a similar pattern of earnings information dissemination over the two years. An advantage of covariance approach over the hedge portfolio approach is the fact that covariance is free of noise. It is indicated that noise in return and earnings tends to bias down (up) the information arrival rate η_i based on the hedge portfolio return when the level of earnings information dissemination is relatively high (low). Another advantage of the covariance measure over the hedge portfolio approach is in its simplicity. The weekly covariances can be easily obtained with weekly returns and earnings surprise while the hedge portfolio approach requires multiple steps to produce the hedge portfolio returns.

4.3 Changes in the usefulness of earnings over recent decades

4.3.1 The decline of the value relevance of earnings

Prior studies conclude that the value relevance of earnings has declined over the past decades. Documented reasons for the declining value relevance of earnings in the literature are the rapidly changing business environment from an industrialized manufacturing-based economy to a high-tech, service-oriented economy, accompanied by an increase in intangible assets, an increase in reporting losses and one-time items, and a decrease in the timeliness of earnings.

Prior studies measure the value relevance of earnings with the contemporaneous return-earnings regression measures. For example, Lev and Zarowin (1999), Francis and Schipper (1999), and Ryan and Zarowin (2003) report a decline of the contemporaneous R^2 over time. Ryan and Zarowin (2003) report a significant decrease in the contemporaneous RRC over time. The results on the ERC are mixed. Collins, Maydew and Weiss (1997), Ely and Waymire (1999), and Ryan and Zarowin (2003) report no clear time trend of the contemporaneous ERC, while Francis and Schipper (1999) and Lev and Zarowin (1999) report a significant decline in the ERC.

4.3.2 Changes in the absolute usefulness of earnings in the literature

While the regression measures provide evidence on changes of the marginal or relative impact of earnings information on stock price, changes in the absolute magnitude of price changes associated with earnings information have been rarely studied in the capital markets literature. An exception is Landsman and Maydew (2002). They investigate changes in the absolute impact of earnings information on price over a short window around earnings announcements with the short-window variance of return. They find no evidence of a decline in the absolute impact of earnings information on stock price around earnings announcements over the period 1972-1998. However, changes in the absolute usefulness of earnings of a long window still remain largely unexplored in the literature.

4.3.3 Implications of the covariance-based measures

The total covariance is used to investigate whether the absolute magnitude of price change associated with earnings information for a long window changed over the period 1977-2001. The result of the total covariance contributes to the value relevance literature because the total covariance represents the absolute usefulness of earnings without the influence of non-earnings-related news on stock price. Ely and Waymire (1999) suggest that the contemporaneous R^2 is influenced by business environments that the accounting rule makers cannot control, referring to the conclusion of the AICPA's Special Committee Report (1994). Similarly, Francis and Schipper (1999) suspect that the documented result of the decrease in the R^2 may be the product of the increasing return volatility due to reasons that cannot be linked to earnings information, reporting an increase in the variance of return. However, an increase in the variance of return cannot be interpreted as the increase in stock return volatility due to the non-earnings-related news because stock return varies with earnings information as well.

Unlike the variance of return, the covariance measures the absolute magnitude of price change associated with earnings information, not influenced by non-earnings-related price movement. Therefore, temporal trend of the contemporaneous return-earnings covariance accompanied with that of the variance of return can be used to understand whether the decline in the value relevance documented in prior studies stems from a decrease in the price movement related to the information content of earnings or an increase in non-earnings related price movements.

In addition, Ryan and Zarowin (2003) suggest that one of the reasons of the declining value-relevance is a decrease in the timeliness of earnings. Therefore, the temporal changes of current year arrival rate λ and the announcement period arrival rate θ are presented to examine whether the timeliness of earnings has indeed declined over the past decades.

4.3.4 Changes in the total covariance and the timeliness measures

In the empirical application, the contemporaneous regression measures are estimated for each year from 1977 to 2001 to check whether the sample of this study confirms the prior results. Then changes in the contemporaneous return-earnings covariance, variance of earnings and variance of return are examined for the period. Finally, changes in the total covariance and the two covariance-based timeliness measures are investigated. The results with AR(1) earnings surprise are presented for the analysis because earnings changes produce similar results.

First four columns of table 5 contain the summary of changes in the usefulness measures in four subperiods. Last three columns of the table present results of the regression of each variable on a trend variable $\tau = 1, ..., 25$ assigned to years from 1977 to 2001. Figure 5 presents time trends of the variables from 1977 to 2001 where each data point for each year is the average of five observations for the past five years including the current year.

Panel A of table 5 and that of figure 5 report a significant decrease in the contemporaneous RRC, a weak decrease in the contemporaneous R^2, and no significant change in the contemporaneous ERC, consistent with previously documented results.

Panel B of table 5 and that of figure 5 show that the contemporaneous return-earnings covariance $cov(y_t, R_t)$ and the variance of earnings $var(y_t)$ did not change significantly while the variance of return $var(R_t)$ significantly increased over the period. The combined results that the covariance did not change and that the variance of stock return increased can be interpreted as evidence that the main reason of the declining contemporaneous RRC or R^2 is the increasing influence of the stock return volatility related to news that is not related to earnings information, not the decrease in the absolute usefulness of earnings to the market.

Panel C of table 5 and that of figure 5 present the time trends of the three covariance measures, TC, λ, and θ. The total covariance TC does not show a significant trend over the past decades, similar to the result of the contemporaneous covariance. This result indicates that the usefulness of earnings inferred from the absolute magnitude of price change associated with earnings information for a long window did not significantly change over the past decades, as well as for a short-window as reported in Landsman and Maydew (2002).

It is also shown that the current year arrival rate λ weakly increased, indicating that the decrease in the timeliness of earnings is not the main reason for the decline of the contemporaneous RRC or R^2, contrary to the results of Ryan and Zarowin (2003). In addition, the announcement period arrival rate θ did not significantly change over the period.[6] Thus, the earnings information disseminated during earnings announcement periods compared to that of non-announcement

[6] The unusually high θ in years from 1984 to 1989 in panel C of figure 5 is due to an abnormal observation of the variable in 1984.

period did not decline over time, either.

It is interesting to observe no significant change in the absolute magnitude of price changes of long window (the total covariance) as well as short window (short-window variance of return), considering that prior studies discuss counter forces that would reduce the value relevance of earnings. An explanation for the results can be found in accounting rule makers' efforts to improve financial reporting. The accounting principles and procedures have evolved over hundreds of years to incorporate changes in business practices. Since the formal standard-setting process was initiated by the stock market crash in 1929 in the United States, the accounting rules have evolved to the current Generally Accepted Accounting Principles through different accounting standard-setting organizations.[7] The result of no significant change in the absolute magnitude of price change associated with earnings information is consistent with a scenario where the continuous efforts to provide useful financial information to information users have canceled off the counter forces that would reduce the value relevance of earnings.

In sum, the total covariance and the timeliness of earnings did not change over the period 1977-2001 while the variance of stock returns significantly increased over the period. The results are consistent with an intuition that the previously documented decline in measures of the relative impact of earnings information on price change is not the result of decreasing absolute usefulness of earnings information or timeliness of earnings. It is mainly due to the increasing influence

[7] Accounting standard-setting bodies have changed from the Committee on Accounting Procedure (1939-1959), the Accounting Principles Board (1959-1973), to the Financial Accounting Standards Board (since 1973). The Securities and Exchange Commission created in 1934 and other accounting organizations interact one other to achieve the general goal of providing more useful information to investors and creditors.

of non-earnings-related stock price movement on the measures.

4.3.5 Changes in the two-year hedge portfolio return

The time trend of the two-year hedge portfolio returns based on foreknowledge of earnings surprise of each year is presented in figure 6. Consistent with the result of the total covariance, the two-year hedge portfolio return does not show a significant time trend.

This result is different from the result in Francis and Schipper (1999) who report a decline in the hedge portfolio return. Note that Francis and Schipper (1999) use the earnings-based hedge portfolio return scaled by a return-based hedge portfolio return. They compute the return-based hedge portfolio returns by taking long (short) positions in the firms with positive (negative) 15-month stock returns. They interpret this scaled measure as the percentage of all information in security returns that is reflected in earnings.

However, it is likely that their return-based hedge portfolio returns are also subject to noise in return. Increasing non-earnings related price movement reflected in the return-based hedge portfolio returns may have resulted in the decrease of their scaled hedge portfolio returns when the earnings-based hedge portfolio return did not significantly change over time. More research is needed for more discussion on this issue.

4.4 Cross-sectional difference in the return-earnings relation

4.4.1 Cross-sectional difference in the predisclosure information

Prior studies document a cross-sectional difference in the return-earnings relation based on the relation between firm size and the market reaction to earnings information, following Atiase (1980). For example, Grant (1980), Atiase (1985), Lobo and Mahmoud (1989) and Shores (1990) report that the variance of return around earnings announcements relative to the variance of return over non-annoumcement period is smaller for large firms than for small firms. Kross and Schroeder (1988) and Christensen, Smith and Stuerke (2004) similarly find a negative relation between the ERC around earnings announcements and firm size. They explain that, for large firms, earnings information is disclosed and produced earlier and more extensively before earnings announcements because investors of large firms have various alternative information sources than those of small firms. Thus, there is more predisclosure information for large firms' earnings than small firms' earnings.

A similar argument is adopted for the contemporaneous return-earnings association in long window studies like Collins and Kothari (1989) and Collins, Kothari and Rayburn (1987). They find that the ratio of the RRC of current return to the RRC of return of lagged years is smaller for large firms than for small firms and conclude that lagged return is increasingly more important as firm size increases.

The argument of the predisclosure information is consistent with the intuition that a greater fraction of earnings information is disseminated earlier to the market for large firms than for small firms. This is an issue of the timeliness of earnings information. Therefore, a negative relation between firm size and the announcement period arrival rate θ and the current year arrival rate λ would provide a consistent result with the prior results. It should be noted, however, that the timeliness of earnings information is one of two factors of the market response to earnings information for a subperiod. The second factor is the overall magnitude of price change related to earnings information over the entire earnings information dissemination period, which can be measured by the total covariance TC.

4.4.2 Cross-sectional difference in the absolute usefulness of earnings

For a given level of the current year arrival rate λ, the magnitude of price change during the current year positively varies with the total covariance, which represents the absolute magnitude of price change related to earnings information over the entire information dissemination period. Similarly, the magnitude of price change over a short-window around earnings announcement is also a positive function of the total covariance for given λ and θ.

Understandably, there is no direct evidence about the relation between firm size and the overall absolute magnitude of price change in the literature because the absolute usefulness itself has not been closely investigated. Chaney and Jeter (1992) is one of few studies that investigate the relation between firm size and the ERC for a window longer than one year. They report a positive relation between firm size and the two-year ERC from the regression of the two-year return on unexpected annual earnings. They explain that the broader set of information available about large firms leads to an increase in the ERC because the richer information set for large firms makes it easier for the market to identify earnings information isolating value-irrelevant noise in reported earnings. In other words, the negative relation between firm size and the two-year ERC is due to the fact that large firms' earnings are less noisy.

This study differs from Chaney and Jeter (1992) in that the focus is the influence of earnings information used by the market, not the ratio of noise to information.

4.4.3 Results of firm size portfolios

The covariance-based timeliness measures (λ and θ) are first applied to different firm size portfolios to replicate the documented negative relation between firm size and predisclosure information. As the second factor, the total covariance is applied to different firm size groups. Lastly, it is tested which of the two factors is the main driving force of the cross-sectional differences in the absolute usefulness of earnings during a subperiod with respect to firm size. The results with AR(1) earnings surprise are presented for the analysis.

The final pooled sample is divided into three firm-size groups based on the market value at the beginning of year $t-1$: small, medium and large firms with 9,350 firm-years in each group. Table 6 reports descriptive statistics of earnings surprise and returns for the size portfolios. It shows that the variance of returns and annual earnings surprise are decreasing in firm size.

In order to test the significance in the relation between firm size and different measures, the pooled sample is also divided into 20 firm-size portfolios. The median firm size of each of the 20 portfolios is obtained and the twenty median firm size variables are transformed to normal score variables using Blom's (1958) formula. For each measure of interest, a rank regression of firm size on the measure is performed.

Figure 7 presents the cumulative weekly covariances for the three size groups. It shows that the cumulative covariance of large firms is higher than those of smaller firms in the early period of year $t-1$. However, it stays below the cumulative covariances of smaller firms in later periods till the earnings announcement at the end of year t. The different paths of the cumulative covariances of three firm size groups indicate that a greater fraction of earnings information is disseminated to the market in earlier period for large firms than for small firms, consistent with the previously documented predisclosure information result.

Panel A of table 7 summarizes this result. The current year information arrival rate λ of large firms is 54.8% whereas it is 72.8% for small firms. The result is similar for the announcement period arrival rate θ. These results are significant according to the result of rank regressions of firm size and the two timeliness measures, reported in the panel B of table 7.

Figure 7 also shows that the total covariance of large firms cumulated over the 104 weeks is only about one third of small firms' total covariance. This result indicates that the absolute magnitude of price change associated with earnings information is smaller for large firms than for small firms. The model 3 in panel B of table 7 confirms that the negative relation between firm size and the total covariance is significant.

Interestingly, the model 5 in panel B of table 7 shows that when firm size is regressed on all three covariance measures, only the TC remains highly significant. This result indicates that the existing results of weaker return-earnings association for large firms in short-window studies or contemporaneous studies are mainly driven by the strong relation between firm size and the overall absolute usefulness of earnings measured by the total covariance even though the effect of the predisclosure information plays an important role in the cross-sectional difference in the return-earnings relation.

In sum, the results from firm size application show that the use of the proposed covariance measures clarifies and complements existing results on firm size and provide new insights.

4.4.4 Results of the number of analysts following portfolios

In the literature, the number of analysts following is also used as a proxy for the amount of predisclosure information along with firm size.[8] Dempsey (1989) argues that analysts purposefully search information about firms that they are interested and stimulate more information production about those firms. As a result, the number of analysts following a firm is positively linked to the predisclosure information. To check whether the use of the number of analysts produces consistent results with firm size portfolios results, the relation between the number of analysts followings and the covariance-based measures is examined with subsample of firms with non-missing observations of the number of analysts following (NOA).

[8] See Dempsey (1989) and Christensen, Smith and Stuerke (2004).

The number of analysts for each firm-year is obtained with the analysts identification number specified with their forecasts in the I/B/E/S database. The NOA is the average number of analysts following of each firm of the four quarters of year $t-1$. The number of firm-year observations in the sample is reduced to $11,091$ because of missing NOA variables. This sample is divided into three groups based on the number of analysts following and table 8 presents the descriptive statistics of the three NOA portfolios: low, medium and high.

Figure 8 presents the cumulative weekly covariances the three NOA groups. Table 9 presents a summary of the covariance measures for the three NOA groups and rank regression results with the twenty NOA portfolios. These results are similar to those of firm size even though the significance of the rank regression estimates is weaker due to the reduced number of observations.

Chapter 5

Conclusion

The earnings information is useful to the market only if it is used by the market. This paper argues that existing usefulness measures including regression estimates and the variance of return represent either the relative or the marginal impact of earnings information on stock price. Therefore, a new measure of the absolute usefulness of earnings needs to be developed, especially for long window studies. The return-earnings covariance is proposed as the measure of the absolute magnitude of price changes associated with earnings information. It is shown in a theoretical model that the proposed measure closely proxies for the absolute usefulness of earnings and is free from both return and earnings noise. The total covariance for the two fiscal years is proposed as a measure of the total magnitude of price change related to earnings information over the entire information dissemination period. The time distribution of the covariance is presented as a dimension separate from the absolute magnitude of price change, which describes the timeliness of earnings.

The total covariance and the time distribution of covariance are empirically applied to the pooled sample of firms, longitudinally over the past decade, and cross-sectionally across different firm-size groups and the number of analysts following portfolios.

In the application to the pooled sample, a detailed time pattern of earnings information dissemination to the market over the entire earnings information dissemination period is presented using the weekly covariances over the two fiscal years. In the second application, it is found that the absolute usefulness of earnings or the timeliness of earnings did not decline over the past decades while the relative magnitude of price changes measured with the RRC and R^2 decreased. The significant decrease in the variance of return combined with the result of no time trend of the total covariance suggests that the previously documented decline in the RRC or R^2 is the result of the increasing influence of non-earnings-related news on stock return, rather than the decreasing absolute usefulness of earnings. In the last application to different firm size and NOA groups, it is found that large firms or firms with high NOA have smaller absolute usefulness of earnings than small firms or firms with low NOA. In addition, the cross-sectional difference in the return-earnings association is the combined result of difference in the predisclosure information and, more importantly, the absolute magnitude of price change associated with earnings over the entire information dissemination period.

Appendix A: The alternative measures of the contemporaneous return-earnings association

In many studies accounting earnings y_t is regressed on the contemporaneous annual return R_t. The covariance between the two variables can be calculated as:

$$cov(y_t, R_t) = \beta \cdot var(\sum_{i=-51}^{0} x_i) = \beta \sum_{i=-51}^{0} v_i = \beta v_{ctp} = \lambda TC,$$

where $v_{ctp} \equiv \sum_{i=-51}^{0} v_i$ and $\lambda = \frac{v_{ctp}}{v}$. It is shown that the return-earnings covariance for the current year is the total covariance times the current year arrival rate.

In the contemporaneous regression, the three traditional measures of association, denoted by RRC_{ctp}, ERC_{ctp}, and R^2_{ctp}, respectively, are:

$$RRC_{ctp} = \frac{cov(y_t, R_t)}{var(R_t)} = \frac{\lambda \beta v}{\beta^2 v + e},$$

$$ERC_{ctp} = \frac{cov(y_t, R_t)}{var(y_t)} = \frac{\lambda \beta v}{v + d},$$

$$R^2_{ctp} = RRC_{ctp} \cdot ERC_{ctp} = \frac{cov^2(y_t, R_t)}{var(y_t) \cdot var(R_t)} = \frac{\lambda^2 \beta^2 v^2}{\left(\beta^2 v + e\right)(v + d)}.$$

The above equations are similar to those from the two-year return regressions. The only difference from the two-year case is that the return variance and the return-earnings covariance are truncated and the fraction λ appears in the expressions.

Appendix B: Traditional timeliness measures versus the current year arrival rate λ

Consider first a regression of y_t on R_t and R_{t-1}:

$$y_t = a + bR_t + cR_{t-1} + \epsilon_t,$$

where

$$R_t = \sum_{i=-51}^{0} [\beta(x_{t,i} + x_{t+1,i-52}) + \varepsilon_{t,i}] \text{ with } var(R_t) = \beta^2 v + e$$

and

$$R_{t-1} = \sum_{i=-51}^{0} [\beta(x_{t-1,i} + x_{t,i-52}) + \varepsilon_{t-1,i}] \text{ with } var(R_{t-1}) = \beta^2 v + e.$$

ϵ_t is white noise and $cov(R_t, R_{t-1}) = 0$. In prior studies, earnings information is considered timely if the contemporaneous association between current earnings and current return is strong, as opposed to the association between current earnings and lagged returns. Therefore, the timeliness measure from this regression, called the *RRC ratio*, can be written as the ratio of the coefficient of current return over the sum of two coefficients:

$$RRC\ ratio \equiv \frac{b}{b+c}.$$

Note that:

$$RRC\ ratio = \frac{\frac{cov(y_t,R_t)}{var(R_t)}}{\frac{cov(y_t,R_t)}{var(R_t)} + \frac{cov(y_t,R_{t-1})}{var(R_{t-1})}} = \frac{\beta \sum_{i=-51}^{0} v_i}{\beta \sum_{i=-51}^{0} (v_i + v_{i-52})} = \frac{\sum_{i=-51}^{0} v_i}{v} = \lambda.$$

Now consider a regression of R_t on y_t and y_{t+1}:

$$R_t = a' + b'y_t + c'y_{t+1} + \epsilon'_t,$$

where $y_t = x_t + \delta_t$ with $var(y_t) = v + d$ and $y_{t+1} = x_{t+1} + \delta_{t+1}$ with $var(y_{t+1}) = v + d$. ϵ'_t is white noise and $cov(y_t, y_{t+1}) = 0$. The timeliness measure from this regression, the *ERC ratio,* is defined as:

$$ERC\ ratio \equiv \frac{b'}{b' + c'}.$$

Also note that:

$$ERC\ ratio = \frac{\frac{cov(y_t,R_t)}{var(y_t)}}{\frac{cov(y_t,R_t)}{var(y_t)} + \frac{cov(y_{t+1},R_t)}{var(y_{t+1})}} = \frac{\beta \sum_{i=-51}^{0} v_i}{\beta \sum_{i=-51}^{0} (v_i + v_{i-52})} = \frac{\sum_{i=-51}^{0} v_i}{v} = \lambda.$$

Therefore, the theoretical values of the above two ratios are all λ. However, the presence of the noise in either earnings or returns would make either ratio empirically a noisier measure than the covariance-based measure, the current year information arrival rate λ.

Finally, the third timeliness measure is the R^2 *ratio*. It is defined as the ratio of the R^2 from the contemporaneous regression $y_t = a + bR_t + \epsilon_t$ to the R^2 from the regression on both returns R_t and R_{t-1}, $y_t = a + bR_t + cR_{t-1} + \epsilon_t$, as follows:

$$R^2\ ratio \equiv \frac{\frac{\lambda^2 \beta^2 v^2}{\left(\beta^2 v + e\right)(v+d)}}{\frac{\left[\lambda^2 + (1-\lambda)^2\right]\beta^2 v^2}{\left(\beta^2 v + e\right)(v+d)}} = \frac{\lambda^2}{\lambda^2 + (1-\lambda)^2}.$$

This measure is similar to the information arrival rate λ but not exactly the same.

Table 1) Description of the final pooled sample of 28,050 firm-year observations

Panel A: The number of observations based on the Fama and French (1997) industry classification

			Firm Size ($MM)		
	Nob.	%	Mean	Median	Std
Agriculture	56	0.20%	446.75	184.36	640.48
Food products	649	2.31%	2,268.89	614.16	6,962.11
Candy and soda	173	0.62%	8,173.97	1,069.08	22,562.26
Alcoholic beverages	141	0.50%	2,333.55	616.79	5,459.73
Tobacco products	93	0.33%	7,737.35	3,455.74	15,608.99
Recreational products, toys	254	0.91%	588.38	91.29	1,319.64
Entertainment, TV, movies	121	0.43%	3,991.39	637.69	10,924.19
Printing and publishing, books	454	1.62%	1,660.77	501.53	2,877.00
Consumer goods, household	946	3.37%	4,161.66	317.11	15,817.07
Apparel	363	1.29%	429.69	87.75	1,144.51
Healthcare, hospitals, clinics	91	0.32%	1,570.07	455.84	2,594.34
Medical equipment	366	1.30%	1,812.86	205.09	5,925.65
Pharmaceutical products	498	1.78%	6,208.89	956.06	20,115.12
Chemicals	1,028	3.66%	2,025.93	605.08	5,555.24
Rubber and plastic products	256	0.91%	303.14	110.08	739.58
Textiles	359	1.28%	201.93	108.05	295.73
Construction materials	1,024	3.65%	942.55	122.87	3,634.51
Construction	260	0.93%	210.39	103.07	294.62
Fabricated products	153	0.55%	167.97	65.36	316.50
Machinery	1,454	5.18%	689.69	158.49	1,633.89
Electrical equipment	548	1.95%	2,515.39	123.42	23,803.78
Miscellaneous	58	0.21%	343.87	97.07	656.56
Automobiles and trucks	840	2.99%	2,233.58	372.53	6,144.65
Aircraft	278	0.99%	2,901.70	467.61	6,616.18
Shipbuilding, railroad equip.	78	0.28%	1,127.77	461.51	1,688.39
Defense, guns	85	0.30%	2,040.19	514.96	3,689.76
Precious metals, gold	149	0.53%	612.50	265.47	1,184.26
Nonmetallic mining	223	0.80%	918.09	543.57	949.08
Coal	83	0.30%	1,240.53	378.84	4,041.78
Petroleum and natural gas	1,266	4.51%	4,397.69	702.69	13,890.71
Utilities	2,746	9.79%	1,412.91	624.58	2,135.75
Telecommunications	329	1.17%	5,415.39	596.68	19,411.62
personal services	75	0.27%	448.98	79.85	910.79
Business services	1,203	4.29%	1,308.13	155.36	14,460.86
Computers	664	2.37%	3,886.92	248.14	16,072.38
Electronic equipment, chips	1,297	4.62%	1,324.89	101.47	8,798.20
Laboratory equipment	515	1.84%	680.83	70.64	3,332.87
Business supplies	597	2.13%	1,540.65	606.83	3,186.95
Shipping containers, boxes	1,723	6.14%	868.73	210.92	2,479.89
Transportation	745	2.66%	1,109.77	373.30	2,293.85

Panel A: (continued)

	Nob.	%	Firm Size ($MM) Mean	Median	Std
Wholesale	904	3.22%	645.88	138.99	1,502.41
Retail	1,170	4.17%	1,525.01	269.13	4,092.47
Restaurants, hotel, motel	441	1.57%	1,019.96	243.70	4,455.55
Banking	674	2.40%	3,510.03	768.77	9,149.07
Insurance	531	1.89%	2,990.70	1,045.11	8,831.58
Real estate	175	0.62%	276.41	127.46	391.40
Trading	1,744	6.22%	2,354.63	477.50	6,451.52
	27,880	99.39%			
Missing SIC number	170	0.61%	232.35	105.77	395.58
	28,050	100.00%	1,927.15	298.34	8,876.54

Panel B: The number of observations based on the fiscal year end month

	Nob.	%
January	1,031	3.68%
February	429	1.53%
March	882	3.14%
April	544	1.94%
May	580	2.07%
June	1,949	6.95%
July	542	1.93%
August	540	1.93%
September	1,753	6.25%
October	859	3.06%
November	476	1.70%
December	18,465	65.83%
	28,050	100.00%

Panel C: The number of observations of each year from 1973 to 2001

	Nob.	% of losses	% of negative AR(1) earnings surprise y_t	% of negative earnings change ΔY_t
1973	421	1.43%	14.73%	9.26%
1974	486	2.26%	43.83%	30.25%
1975	592	3.55%	58.61%	45.27%
1976	607	1.81%	28.17%	14.83%
1977	647	2.01%	31.07%	23.80%
1978	700	0.57%	28.71%	16.86%
1979	713	1.40%	28.33%	19.35%
1980	774	2.45%	49.10%	37.34%
1981	827	3.51%	46.67%	34.95%
1982	798	9.02%	63.03%	54.64%
1983	907	7.50%	42.12%	31.75%
1984	1,006	5.07%	28.03%	21.67%
1985	1,101	9.26%	54.77%	45.59%
1986	1,077	12.63%	55.25%	41.78%
1987	1,048	8.11%	37.98%	29.96%
1988	978	9.10%	37.98%	27.51%
1989	998	7.72%	45.39%	38.08%
1990	1,046	10.04%	55.45%	47.32%
1991	1,093	15.83%	57.09%	50.50%
1992	1,167	13.45%	40.62%	35.82%
1993	1,207	13.01%	34.47%	31.07%
1994	1,246	8.27%	34.75%	30.02%
1995	1,316	9.80%	35.41%	31.16%
1996	1,285	9.26%	37.59%	32.45%
1997	1,304	10.58%	38.80%	32.82%
1998	1,283	88.54%	45.28%	39.20%
1999	1,188	10.69%	44.61%	39.31%
2000	1,109	9.74%	44.54%	38.95%
2001	1,126	17.67%	59.41%	55.68%
	28,050	8.79%	42.60%	35.25%

Table 2) Descriptive statistics of log returns and earnings variables [a]

	Year	Quarter	Mean	Median	Variance
Quarterly returns:	*t-1*	1	0.031	0.031	0.023
		2	0.025	0.027	0.027
		3	-0.003	0.001	0.032
		4	0.050	0.049	0.034
	t	1	0.030	0.031	0.023
		2	0.025	0.028	0.027
		3	-0.008	0.000	0.032
		4	0.048	0.049	0.035
Annual returns:	*t-1*		0.103	0.110	0.103
	t		0.094	0.105	0.102
Two year return:			0.197	0.214	0.181
AR(1) earnings surprise y_t	*t*		0.010	0.005	0.008
	t+1		0.005	0.004	0.009
Earnings change ΔY_t:	*t*		0.011	0.011	0.011
	t+1		0.007	0.007	0.007

[a] AR(1) earnings surprise y_t and earnings change ΔY_t are scaled by the beginning price of year *t-1*.

Table 3) Pearson correlation among earnings and return variables

Panel A: Pearson correlation between earnings variables [a]

	y_{t+1}	ΔY_t	ΔY_{t+1}
y_t	0.024	0.878	-0.111
(p-value)	<.0001	<.0001	<.0001
y_{t+1}		0.035	0.899
(p-value)		<.0001	<.0001
ΔY_t			-0.130
(p-value)			<.0001

Panel B: Pearson correlation among quarterly log returns [b]

	R(t-1,Q2)	R(t-1,Q3)	R(t-1,Q4)	R(t,Q1)	R(t,Q2)	R(t,Q3)	R(t,Q4)
R(t-1,Q1)	-0.032	-0.035	-0.005	-0.035	-0.041	-0.009	-0.035
(p-value)	<.0001	<.0001	0.376	<.0001	<.0001	0.116	<.0001
R(t-1,Q2)		-0.020	-0.034	0.009	-0.072	-0.049	-0.048
(p-value)		0.001	<.0001	0.116	<.0001	<.0001	<.0001
R(t-1,Q3)			-0.095	-0.014	0.021	-0.020	-0.101
(p-value)			<.0001	0.020	0.001	0.001	<.0001
R(t-1,Q4)				-0.054	0.056	-0.004	-0.014
(p-value)				<.0001	<.0001	0.504	0.017
R(t,Q1)					-0.051	-0.034	0.001
(p-value)					<.0001	<.0001	0.820
R(t,Q2)						-0.025	-0.037
(p-value)						<.0001	<.0001
R(t,Q3)							-0.102
(p-value)							<.0001

[a] AR(1) earnings surprise y_t and earnings change ΔY_t are scaled by the beginning price of year *t-1*.

[b] R(t,Q1) is the log return of first quarter in year t. Other quarterly returns are similarly defined.

Table 4) Summary of the information arrival rates [a]

Panel A: Information arrival rates obtained with AR(1) earnings surprise

	Year	Quarter	Notation	Arrival rate	Sum
Quarterly arrival rates:	*t-1*	1		1.23%	
		2		2.84%	
		3		10.90%	
		4		18.96%	
			$1\text{-}\lambda$		33.93%
	t	1		20.00%	
		2		22.46%	
		3		14.79%	
		4		8.82%	
Current year arrival rate:			λ		66.07%
Announcement week arrival rates:	*t*	1	λ_{-39}	6.45%	
		2	λ_{-27}	7.68%	
		3	λ_{-13}	4.17%	
		4	λ_{0}	3.98%	22.27%
Announcement period rate			θ		33.72%

Panel B: Information arrival rates obtained with earnings change

	Year	Quarter	Notation	Arrival rate	Sum
Quarterly arrival rates:	*t-1*	1		-0.49%	
		2		0.78%	
		3		10.22%	
		4		17.53%	
			$1\text{-}\lambda$		28.04%
	t	1		21.32%	
		2		23.95%	
		3		16.85%	
		4		9.83%	71.96%
Current year arrival rate:			λ		
Announcement week arrival rates:	*t*	1	λ_{-39}	7.21%	
		2	λ_{-27}	8.08%	
		3	λ_{-13}	4.87%	
		4	λ_{0}	3.99%	24.15%
θ =24.15%÷71.96%			θ		33.56%

[a] The information arrival rate for each period is the ratio of the covariance between earnings variable and return of the period to the $TC = cov(y_t,R_{t-1}+R_t)$. $\lambda = cov(y_t,R_t)/cov(y_t,R_{t-1}+R_t)$ is the current year arrival rate, the ratio of the contemporaneous covariance to the total covariance *TC*.
$\theta = (\lambda_{-39}+\lambda_{-26}+\lambda_{-13}+\lambda_0)/\lambda$ is the announcement period arrival rate, the sum of the weekly arrival rates of the four quarterly announcement weeks in year t divided by the current year arrival rate.

Table 5) Changes in the measures of the earnings usefulness over 1977~2001

Panel A: Traditional measures of the contemporaneous association [a]

	1977~1983	1984~1989	1990~1995	1996~2001	Intercept	τ [b]	Adj. R^2
R^2_{ctp}	13.74%	8.45%	10.10%	8.88%	0.136	-0.002	13.75%
					7.209	-1.915	
ERC_{ctp}	1.215	0.798	1.048	1.299	1.008	0.007	1.79%
					6.585	0.647	
RRC_{ctp}	0.112	0.090	0.096	0.068	0.123	-0.002	23.58%
					11.833	-2.664	

Panel B: The magnitude of price response to earnings information in current year

	1977~1983	1984~1989	1990~1995	1996~2001	Intercept	τ [b]	Adj. R^2
C_{ctp}	0.008	0.006	0.008	0.009	0.006	0.000	9.66%
					7.147	1.569	
$var(y_t)$	0.007	0.008	0.008	0.007	0.007	0.000	1.61%
					11.784	0.613	
$var(R_t)$	0.074	0.068	0.081	0.140	0.045	0.003	45.55%
					3.863	4.386	

Panel C: Covariance-based measures: *TC*, λ, and *θ*

	1977~1983	1984~1989	1990~1995	1996~2001	Intercept	τ [b]	Adj. R^2
TC	0.012	0.009	0.011	0.010	0.011	0.000	0.28%
					10.993	-0.252	
λ	67.28%	70.65%	71.76%	87.00%	0.620	0.009	12.01%
					8.095	1.772	
θ	34.06%	51.81%	29.18%	29.91%	0.706	0.000	0.02%
					10.058	0.073	

[a] The ERC_{ctp} is the coefficient of earnings *b'* from the regression $R_t = a' + b' y_t + \varepsilon_t'$. The RRC_{ctp} is the coefficient of return *b* from the regression: $y_t = a + bR_t + \varepsilon_t$. The R^2_{ctp} is its R^2. The R_t is the natural log transformed annual return for year *t*.

[b] τ is a trend variable defined as one for 1977 to 25 for 2001. The results of the trend regression: *Estimated variable for year t* $= a + b\,\tau + \varepsilon_t$ are presented.

Table 6) Descriptive statistics for size portfolios [a]

Panel A: Small firms

	Year	Quarter	Mean	Median	Variance [c]
Firm size ($MM) [b]			53	47	34
Quarterly returns [d]	*t-1*	1	0.029	0.025	0.030
		2	0.026	0.022	0.036
		3	-0.002	-0.002	0.041
		4	0.060	0.055	0.048
	t	1	0.026	0.024	0.030
		2	0.023	0.022	0.035
		3	-0.011	-0.005	0.040
		4	0.054	0.051	0.048
Annual returns	*t-1*		0.113	0.114	0.138
	t		0.092	0.102	0.136
Two year return			0.205	0.221	0.233
AR(1) earnings surprise [e]	*t*		0.018	0.010	0.013
	t+1		0.008	0.007	0.014

Panel B: Medium firms

	Year	Quarter	Mean	Median	Variance [c]
Firm size ($MM) [b]			337	298	165
Quarterly returns [d]	*t-1*	1	0.031	0.030	0.022
		2	0.023	0.027	0.025
		3	-0.002	0.005	0.031
		4	0.045	0.048	0.031
	t	1	0.031	0.032	0.022
		2	0.026	0.030	0.025
		3	-0.006	0.002	0.032
		4	0.047	0.051	0.033
Annual returns	*t-1*		0.097	0.109	0.099
	t		0.098	0.109	0.097
Two year return			0.195	0.218	0.178
AR(1) earnings surprise [e]	*t*		0.007	0.005	0.006
	t+1		0.005	0.004	0.007

Panel C: Large firms

	Year	Quarter	Mean	Median	Variance [c]
Firm size ($MM) [b]			5,391	2,006	14,776
Quarterly returns [d]	*t-1*	1	0.033	0.036	0.017
		2	0.025	0.032	0.019
		3	-0.005	0.006	0.024
		4	0.044	0.046	0.023
	t	1	0.033	0.035	0.017
		2	0.025	0.032	0.020
		3	-0.008	0.004	0.025
		4	0.043	0.046	0.023
Annual returns	*t-1*		0.097	0.107	0.072
	t		0.093	0.105	0.073
Two year return			0.190	0.205	0.133
AR(1) earnings surprise [e]	*t*		0.003	0.003	0.004
	t+1		0.002	0.002	0.005

[a] Each size portfolio consists of 9,350 observations.

[b] Firm size is the product of the stock price and the number of outstanding shares at the beginning of year *t-1*.

[c] For firm size, standard deviation is presented instead of variance.

[d] Returns are natural log transformed for additivity.

[e] AR(1) earnings surprise is scaled by the beginning price of year *t-1*.

Table 7) Covariance-based measures: *λ, θ* and *TC* with respect to firm size [a]

Panel A: Results of firm size portfolios

	λ	θ	*TC*
Pooled sample	66.07%	33.72%	0.011
Small firms	72.80%	38.47%	0.017
Medium firms	61.32%	29.14%	0.009
Large firms	54.80%	22.22%	0.006

Panel B: Results of rank regression of firm size on the covariance-based measures [b]

	λ	θ	*TC*	Adj. R^2
Model 1	-0.734			53.91%
(t-stat)	-4.589			
Model 2		-0.744		55.32%
(t-stat)		-4.721		
Model 3			-0.977	95.40%
(t-stat)			-19.323	
Model 4	-0.451	-0.475		68.48%
(t-stat)	-2.664	-2.803		
Model 5	-0.067	-0.130	-0.841	96.72%
(t-stat)	-0.940	-1.982	-11.116	

[a] Firm size is the product of the stock price and the number of outstanding shares at the beginning of year *t-1*. $TC = cov(y_t, R_{t-1}+R_t)$ is the covariance between annual earnings and the two-year return. $\lambda = cov(y_t, R_t)/cov(y_t, R_{t-1}+R_t)$ is the current year arrival rate, the ratio of the contemporaneous covariance to the total covariance *TC*. $\theta = (\lambda_{-39}+\lambda_{-26}+\lambda_{-13}+\lambda_0)/\lambda$ is the announcement period arrival rate, the sum of the weekly arrival rates of the four quarterly earnings announcement weeks in year t divided by the current year arrival rate.

[b] For the rank regression, 20 portfolios based on firm size are constructed. Median firm size and all related variables are estimated for each firm size portfolio. Intercepts are omitted because they are set to zero by transforming all variables into normal score variables using Blom (1958)'s formula.

Table 8) Descriptive statistics of the number of analysts following [a]

	Nob.	Mean	Median	Variance
Low NOA	3,552	3.2	3.3	1.0
Medium NOA	3,797	7.3	7.3	2.3
High NOA	3,742	15.3	14.0	19.8

[a] The NOA is the average of the four quarterly number of analysts following of year t-1 for each firm.

Table 9) Covariance-based measures: *λ, θ* and *TC* with respect to the number of analysts following [a]

Panel A: Results of firm size portfolios

	λ	*θ*	*TC*
Low NOA	33.97%	0.012	70.52%
Medium NOA	24.75%	0.009	58.84%
High NOA	19.71%	0.008	54.17%

Panel B: Results of rank regression of firm size on the covariance-based measures [b]

	λ	*θ*	*TC*	Adj. R^2
Model 1	-0.400			15.98%
(t-stat)	-1.851			
Model 2		-0.371		13.79%
(t-stat)		-1.697		
Model 3			-0.587	34.49%
(t-stat)			-3.079	
Model 4	-0.349	-0.315		25.64%
(t-stat)	-1.646	-1.486		
Model 5	-0.176	-0.358	-0.544	52.27%
(t-stat)	-0.955	-2.039	-2.988	

[a] The NOA is the average of the four quarterly number of analysts following of year t-1 for each firm. $TC = cov(y_t, R_{t-1}+R_t)$ is the covariance between annual earnings and the two-year return. $\lambda = cov(y_t, R_t)/cov(y_t, R_{t-1}+R_t)$ is the current year arrival rate, the ratio of the contemporaneous covariance to the total covariance *TC*. $\theta = (\lambda_{-39}+ \lambda_{-26}+ \lambda_{-13}+ \lambda_0)/ \lambda$ is the announcement period arrival rate, the sum of the weekly arrival rates of the four quarterly earnings announcement weeks in year t divided by the current year arrival rate.

[b] For the rank regression, 20 portfolios based on the NOA are constructed. Median NOA and all related variables are estimated for each NOA portfolio. Intercepts are omitted because they are set to zero by transforming all variables into normal score variables using Blom (1958)'s formula.

Figure 1) Dissemination of earnings information to the market over 104 weeks

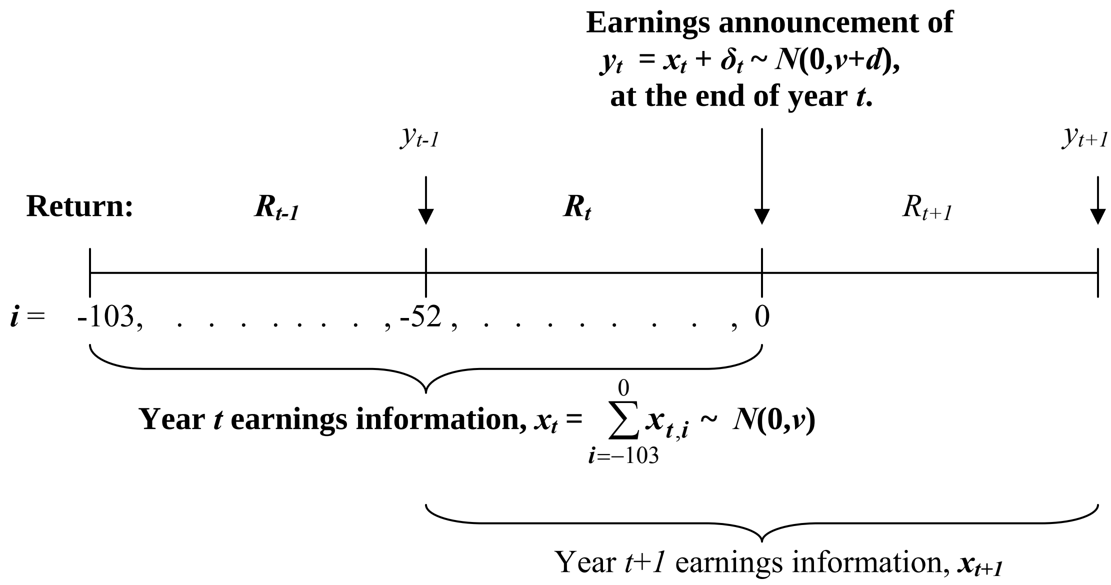
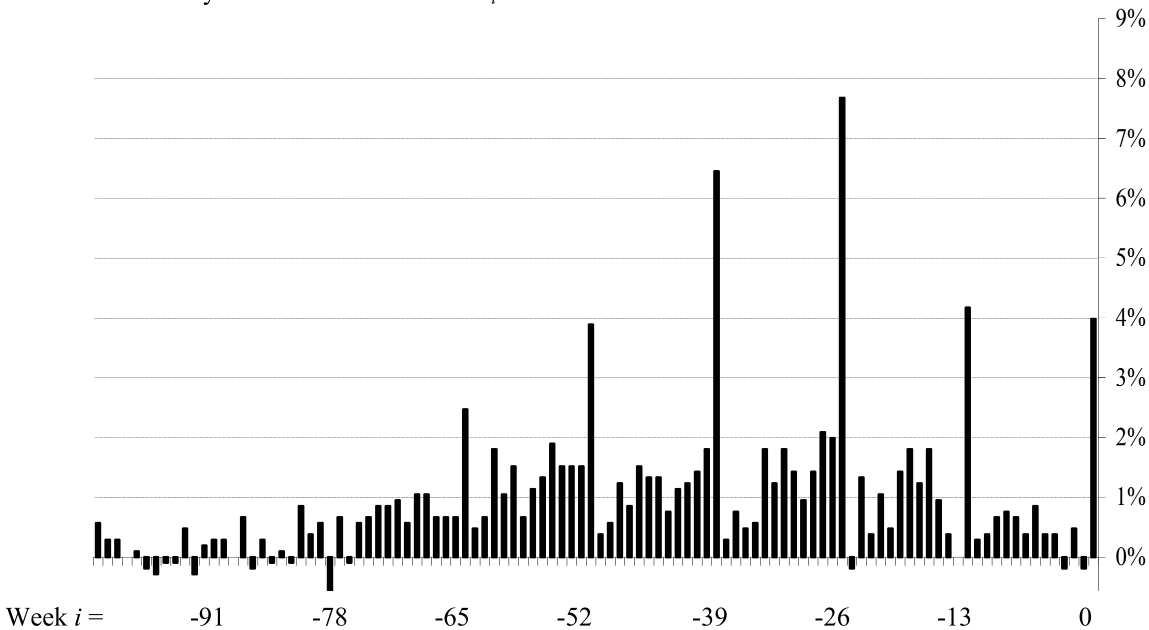
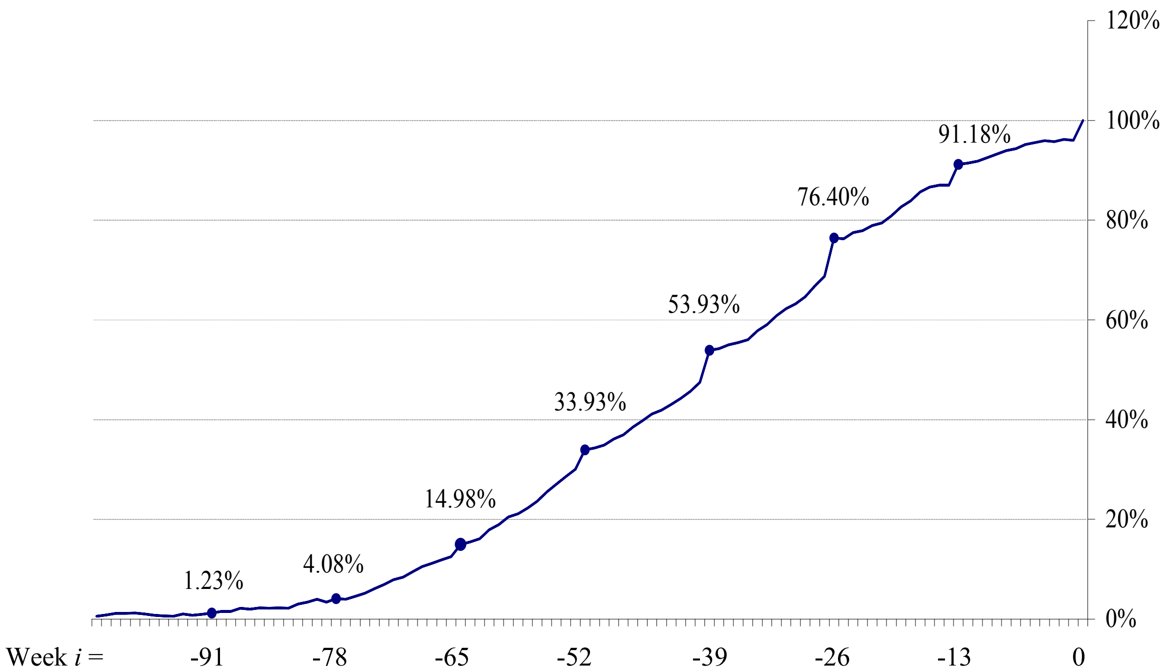


Figure 2) Time distribution of covariance between weekly returns and AR(1) earnings surprise

Panel A: Weekly information arrival rate λ_i [a]



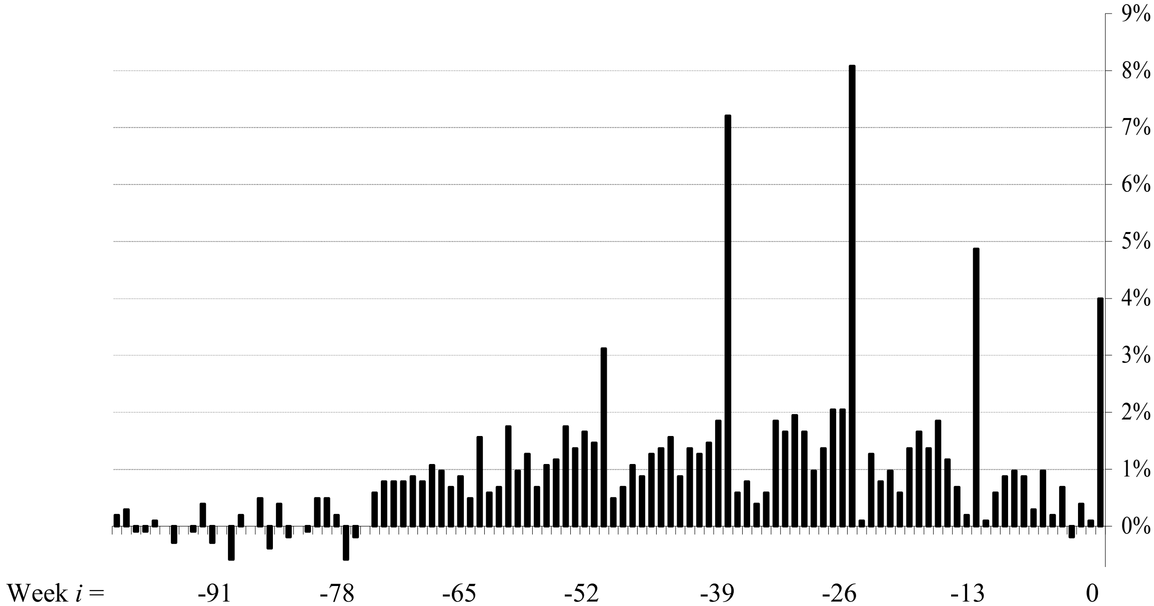
Panel B: Cumulative information arrival rate



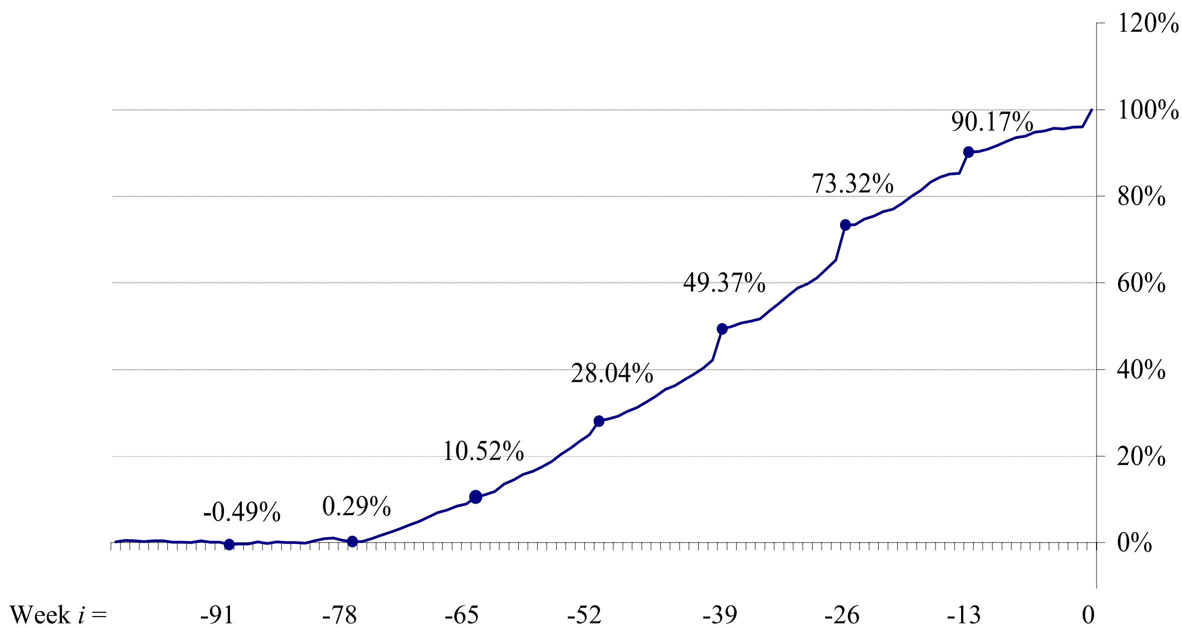
[a] The information arrival rate λ_i is the ratio of covariance between AR(1) earnings surprise and natural log transformed weekly return, $cov(y_t,R_{t,i})$, divided by the total covariance $TC = cov(y_t,R_{t-1}+R_t)$. AR(1) earnings surprise is scaled by the beginning price of year *t-1*.

Figure 3) Time distribution of covariance between weekly returns and earnings change

Panel A: Weekly information arrival rate λ_i [a]

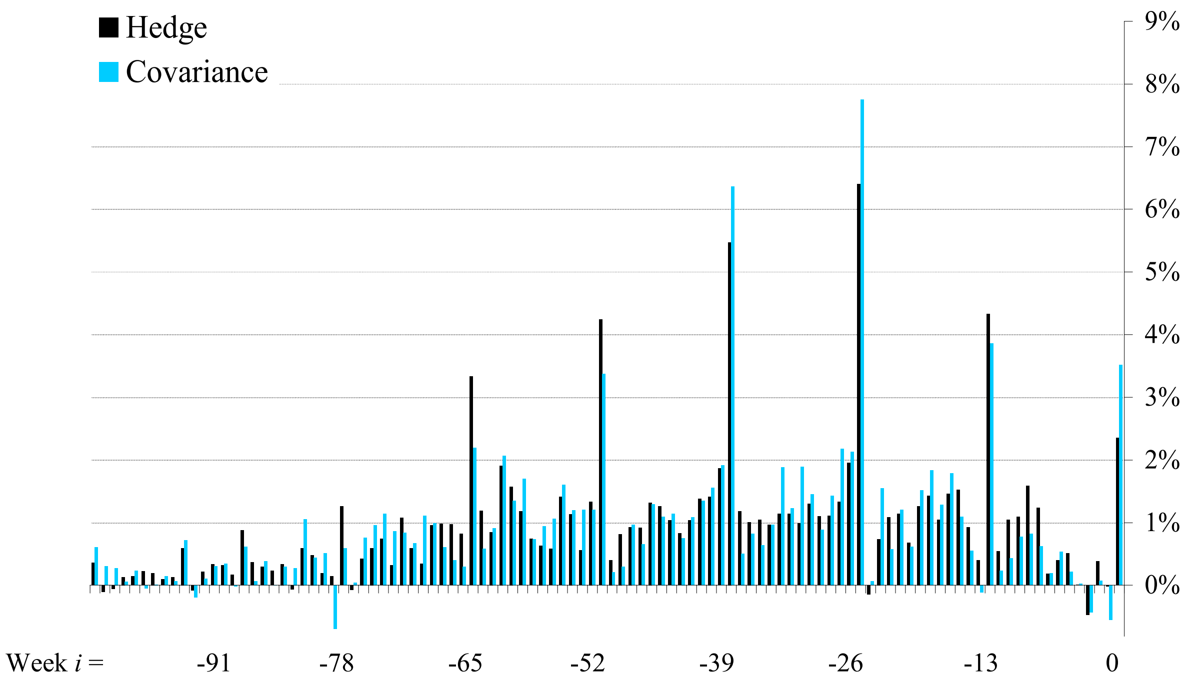


Panel B: Cumulative information arrival rate



[a] The information arrival rate λ_i is the ratio of covariance between earnings change and natural log transformed weekly return, $cov(\Delta Y_t, R_{t,i})$, divided by the total covariance $TC = cov(\Delta Y_t, R_{t-1}+R_t)$. Earnings change is scaled by the beginning price of year *t-1*.

Figure 4) Time distributions of the hedge portfolio return and covariance [a]

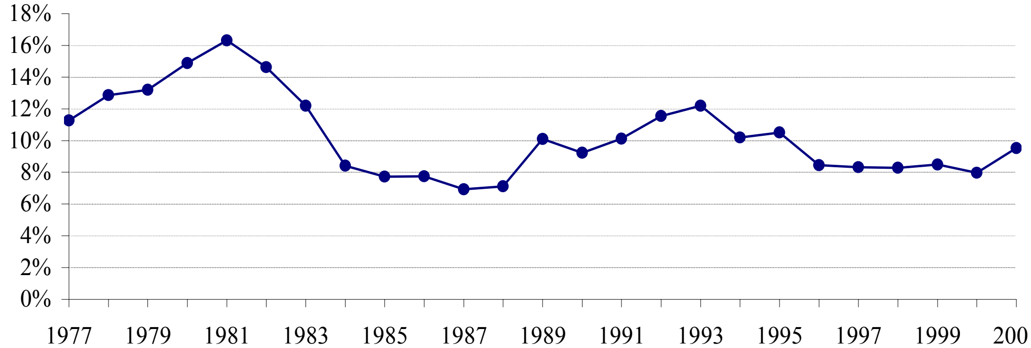


[a] The time distribution of hedge portfolio return is depicted with the weekly information arrival rate η_i, which is the weekly hedge portfolio return divided by the two-year hedge portfolio return. The hedge portfolio is constructed based on the foreknowledge of the AR(1) earnings surprise and the hedge portfolio return for a period is the average of the difference between the market model abnormal returns of the top 40% earnings surprise firms and that of the bottom 40% earnings surprise firms.
The time distribution of covariance is depicted with the weekly information arrival rate λ_i, which is the covariance between AR(1) earnings surprise and natural log transformed weekly return, $cov(y_t,R_{t,i})$, divided by the total covariance $TC = cov(y_t,R_{t-1}+R_t)$.

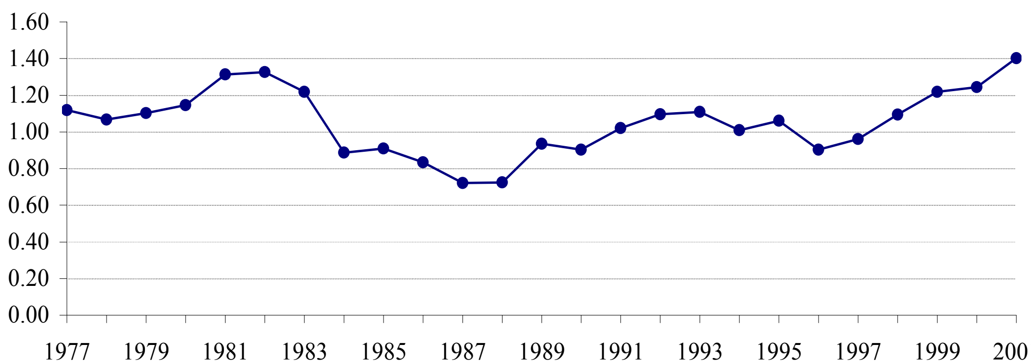
Figure 5) Changes in measures of the return-earnings association: 1977-2001 [a]

Panel A: Traditional measures of the contemporaneous association [b]

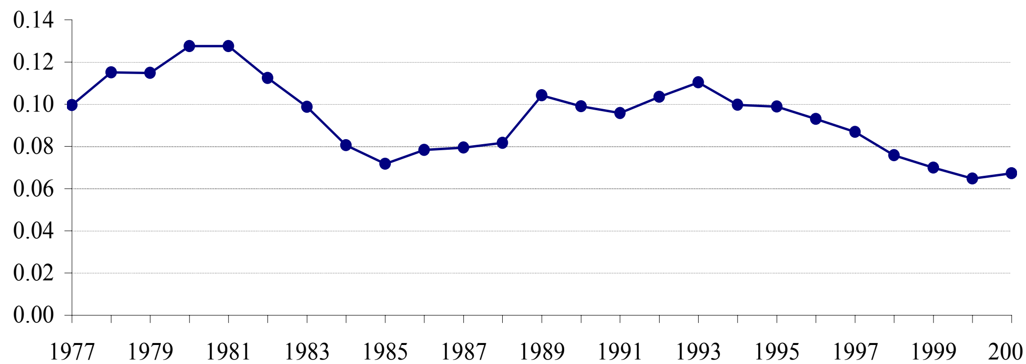
The contemporaneous R^2_{ctp}



The contemporaneous ERC_{ctp}



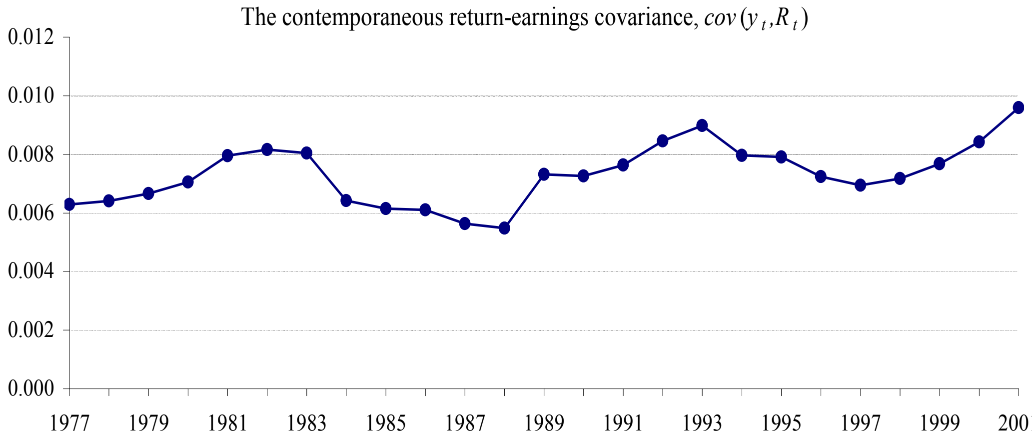
The contemporaneous RRC_{ctp}

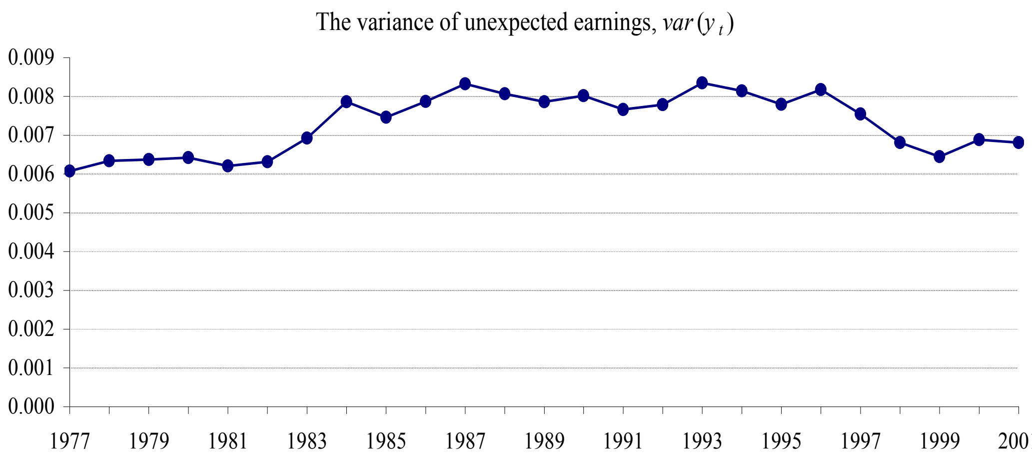


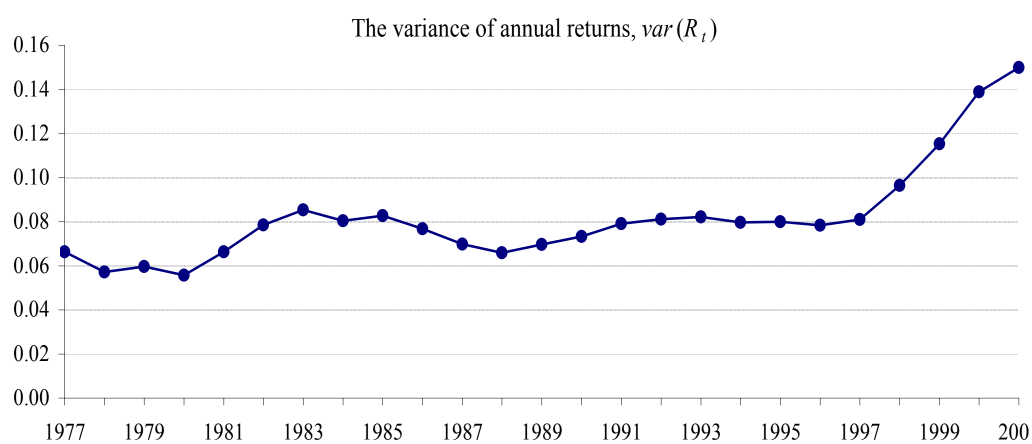
[a] Each data point for each year is the average of the corresponding variable for the past 5 years including the current year. AR(1) earnings surprise y_t is used for figure 5.

[b] The RRC_{ctp} is the coefficient of return b from the regression: $y_t = a + bR_t + \varepsilon_t$. The R^2_{ctp} is its R^2. The ERC_{ctp} is the coefficient of earnings b' from the regression $R_t = a' + b' y_t + \varepsilon_t'$.

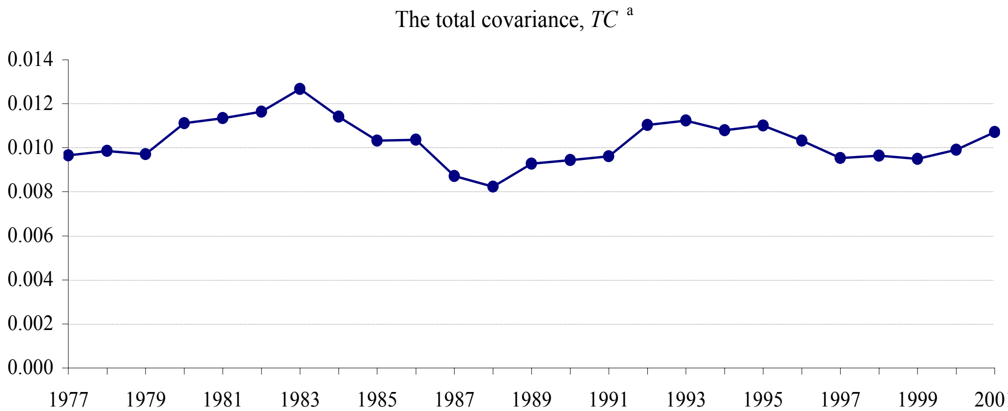
Panel B: Contemporaneous covariance and variances of earnings and annual return

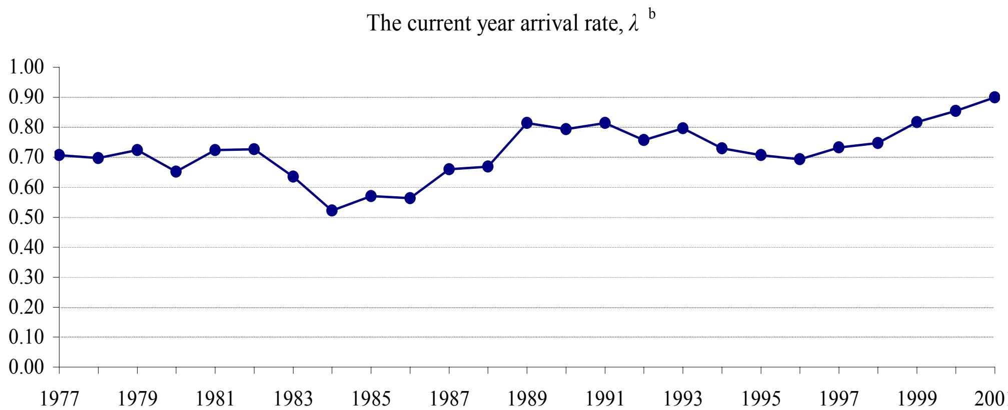


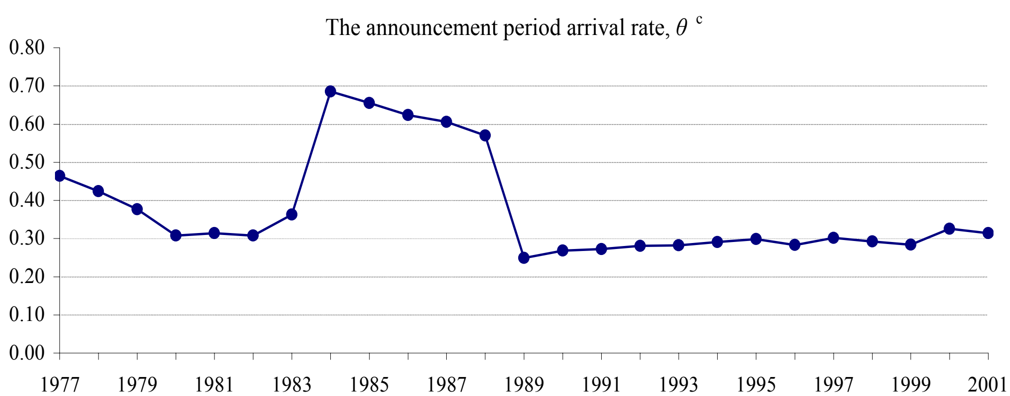




Panel C: The covariance-based measures





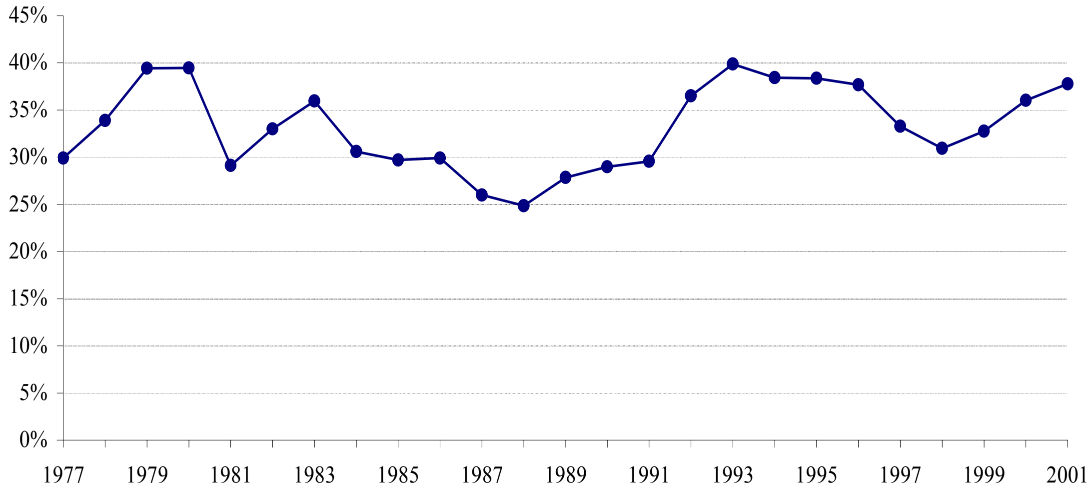


[a] $TC = cov(y_t, R_{t-1}+R_t)$ is the covariance between annual earnings and the two-year return.

[b] $\lambda = cov(y_t, R_t)/cov(y_t, R_{t-1}+R_t)$ is the current year arrival rate, the ratio of the contemporaneous covariance to the total covariance *TC*.

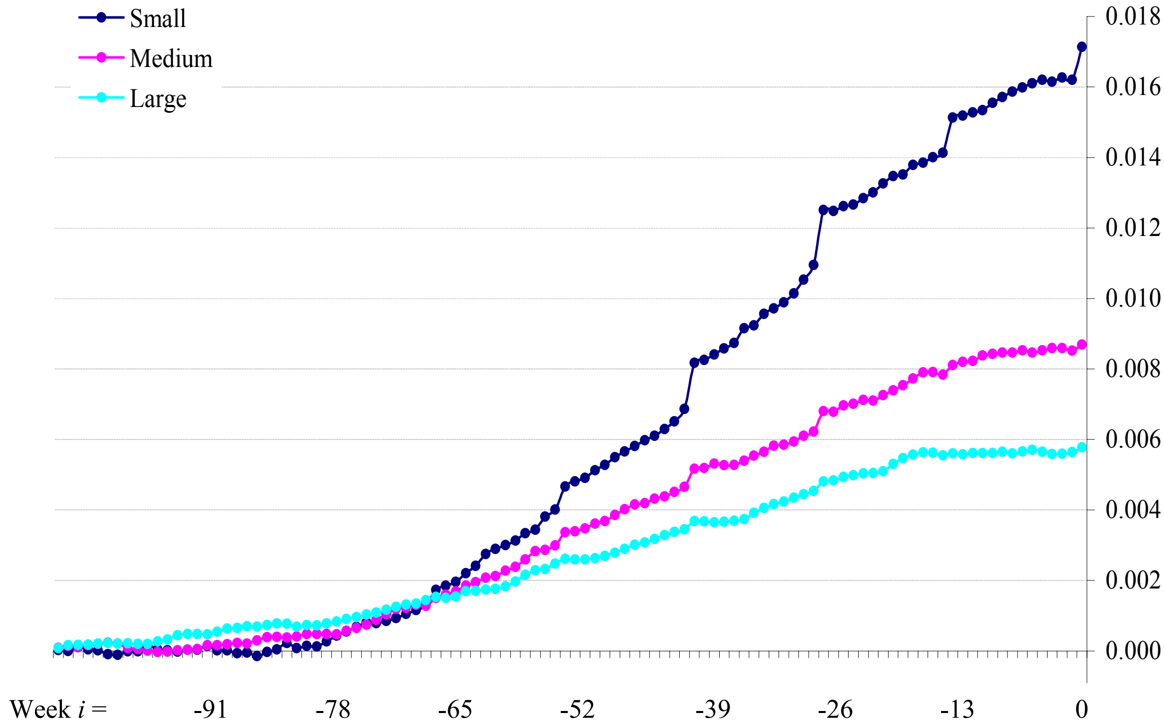
[c] $\theta = (\lambda_{-39} + \lambda_{-26} + \lambda_{-13} + \lambda_0)/\lambda$ is the announcement period arrival rate, the sum of the weekly arrival rates of the four quarterly announcement weeks in year *t* divided by the current year arrival rate.

Figure 6) Changes in the two-year hedge portfolio return and the *TC*: 1977-2001[a]



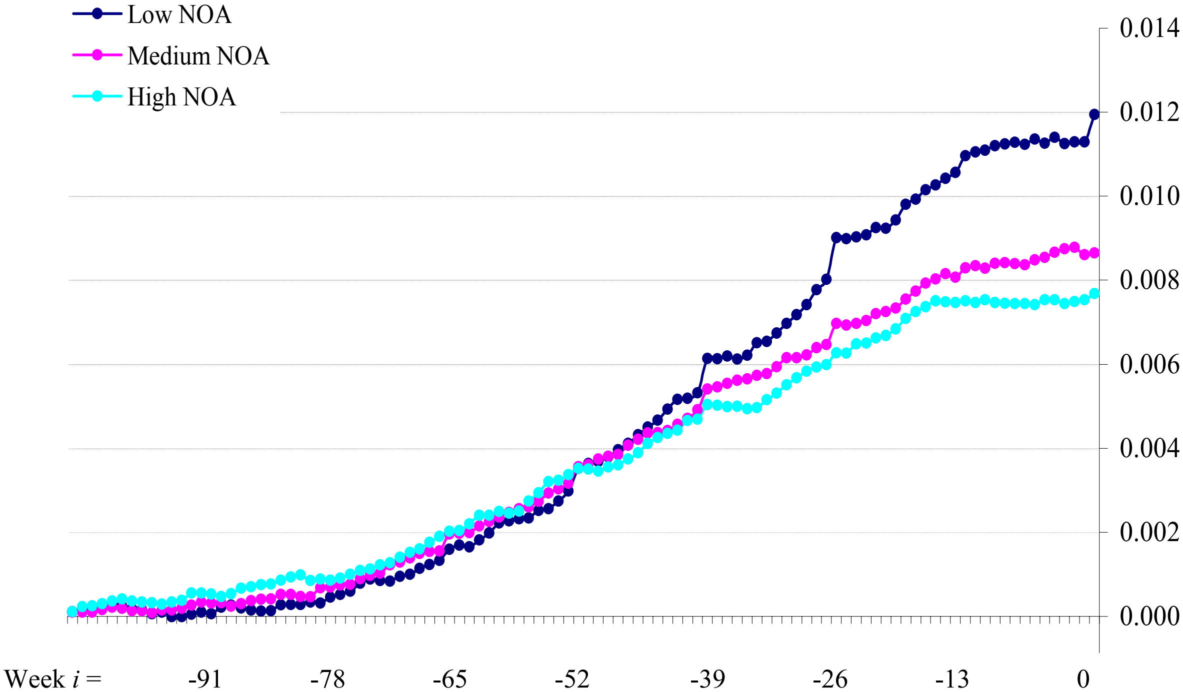
[a] Each data point for each year is the average of the corresponding variable for the past 5 years including the current year. The hedge portfolio is constructed based on the foreknowledge of the AR(1) earnings surprise. The market model abnormal returns are used for the two-year hedge portfolio return for each year.

Figure 7) Cumulative weekly covariance for firm size portfolios [a]



[a] Firm size is the market value at the beginning of year t-1 calculated by the product of the stock price and the outstanding number of shares.

Figure 8) Cumulative weekly covariance for portfolios based of the number of analysts following [a]



[a] The NOA is the average of the four quarterly number of analysts following of year t-1 for each firm.

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