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### Abstract

The purpose of this paper is to determine whether time weighted consensus estimates offer a more effective method for predicting company actual EPS figures than simple mean or median analysis. The study aims to construct a more comprehensive earnings forecast signal using analyst earnings forecasts that have been weighted based on the timeliness of updates. Aimed at extracting valuable information from timely analyst forecasts, the time weighted earnings signal (TWES) methodology allows extracting valuable information from analysts who possess some unique insights about the market and issue their updates more frequently. One would expect the time signal to reflect a more realistic representation of analyst estimate changes and thus be more effective in predicting the companies' reported EPS than the mean and median.

### Keywords

australia, analyst, study, forecast, reliability

### Disciplines

Business

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# A STUDY OF ANALYST FORECAST RELIABILITY IN AUSTRALIA

ALINA MAYDYBURA, DIONIGI GERACE & BRIAN ANDREW

The purpose of this paper is to determine whether time weighted consensus estimates offer a more effective method for predicting company actual EPS figures than simple mean or median analysis. The study aims to construct a more comprehensive earnings forecast signal using analyst earnings forecasts that have been weighted based on the timeliness of updates. Aimed at extracting valuable information from timely analyst forecasts, the time weighted earnings signal (TWES) methodology allows extracting valuable information from analysts who possess some unique insights about the market and issue their updates more frequently. One would expect the time signal to reflect a more realistic representation of analyst estimate changes and thus be more effective in predicting the companies' reported EPS than the mean and median.

## INTRODUCTION

Accountants are interested in the production and use of financial information. Consequently, a large number of accounting and finance studies are concerned about whether sophisticated users of financial data understand such information and how they apply this knowledge (Bradshaw, 2011). Traditionally, analysts use fundamental analysis as an integral part of conducting an evaluation of the market environment. The underlying hypothesis of this study that fundamental stock analysis reflects a proposition that investors tend to buy companies with particular characteristics, where these characteristics are reflected in fundamental accounting factors, such as earnings per share, or EPS. Analysts obtain information by studying public records and filings by the company. Financial analysts also collect information by participating in public conference calls and asking direct questions to the company management as well as through small group or one-on-one meetings with senior members of management teams.

The role of financial analysts is to assist their employers and/or clients in making successful investment decisions. In doing so analysts evaluate company financial statements and assess commodity prices, sales, costs, expenses and tax rates in order to determine a company's fair value along with its projected future earnings. They also use a range of financial ratios calculated from the data obtained from the financial statements that helps clients to evaluate the bottom line of the company. Usually, as stated by Dunn and Nathan (2005), financial analysts generally specialise by sector or industry, which allows them to more closely follow recent trends in business practices, products, as well as industry competition. It is crucial that analysts keep abreast of new regulations or policies that may affect the industry, as well as monitor the economy to estimate its effect on earnings.

Research interest in analysts is great as a deeper understanding of analysts' behaviour is of interest to both academics concerned with a working framework that describes capital markets and practitioners who operate in these markets. Investors with limited abilities or time to analyse individual securities tend to rely on analysts' reports. Finally, regulators are interested in the flow of information that facilitates functional and liquid markets, and analysts are critical to this flow of information (Bradshaw, 2011). The initial reason investors began examining analysts' earnings forecasts was to gauge their usefulness as a surrogate for time-series forecasts in the studies on capital market efficiency. Today financial analysts are inherently perceived as an interesting economic agent in their own right (Bradshaw, 2011).

Typically, earnings revision models are formed by a simple average of all analyst estimates and this is a well-known strategy based on sell-side analyst forecasts. Importantly, the aim of this paper is to use appropriate statistical methods in order to extract additional information from detailed analyst forecasts as they are updated.

The earnings revision signal adopted in this research attempts to delve deeper into the detailed analyst forecasts to detect early changes in the consensus by combining a time weighted earnings signal (TWES) which favours more recent revisions. Earnings revisions are an effective signal due to the trending nature of analyst revisions and analysts are likely to revise in steps in order to reduce reputation risk. A change in the consensus earnings estimate will generally lead to a share price rise or fall as the market digests the information. This in turn leads other analysts in the market to re-evaluate their estimates and herd towards the new consensus. Earnings revisions are an attempt to detect when this trend is underway. This paper attempts to pre-empt the earnings revision signal and detect these changes early. We therefore take advantage of the existing behavioural biases in the earnings revision signal. The hypothesis being that older earnings estimates contain less information than the more recent earnings estimates. In the other models, when following a mean or median approach, analyst earnings estimates which have not changed for some time still contribute the same weight towards the consensus as more recent earnings estimates.

The remainder of the study is organised as follows. Section 2 includes a summary of some of the literature that provides the background for this study. The data and methodology used in the empirical tests are described in Section 3. In Section 4 we report the results of the study and draw some of the tentative conclusions as to the effectiveness of the alternative consensus methodology in forecasting EPS. Notably, Section 5 contains robustness tests to support the results presented earlier in the paper. Finally, some of the concluding remarks and possible future research directions are suggested in Section 6 of the paper.

## LITERATURE REVIEW

This paper adds to the literature in three major ways. First, as a matter of fact, most studies conducted on analyst forecasts relate to US firms and only a handful cover the topic of analysts' forecasting in other countries. This study extends earlier research on evaluating analysts' forecasts of EPS for firms and does so by including a wide range of Australian firms.

A second contribution of this study is such that it spans a large sample period of twelve years, thus providing a comprehensive historical coverage of the available data. In addition, we include a much larger sample of companies than any other previous academic study known to us. This allows us to obtain more reliable and meaningful results possibly generalisable to a wide range of other countries.

Third, in this piece of research we propose a more sophisticated methodology for deriving estimated EPS figures, as compared to simply relying on a mean or median. As mentioned earlier, a fundamental assumption behind the mean and/or median approach is that the available forecasts impartially reflect the analysts' private information.

However, as evidence suggests, this is not always the case (Trueman, 1994). Sometimes analysts choose to release earnings forecasts that do not differ greatly from their own prior expectations, even though their private information justifies the more extreme earnings forecasts. In other scenarios, analysts tend to report forecasts similar to those previously released by other analysts, even when this is not justified by the information they currently possess; that is, analysts exhibit herding behaviour (Trueman, 1994). In fact, Givoly and Lakonishok (1979) reveal that revisions of various forecasters generally move together. These results are shown to have interesting empirical implications. This therefore goes to suggest that naively calculating a consensus analyst forecast by either averaging or alternatively taking the median of individual analyst forecasts is inappropriate. Not all analysts are characterised by the same level of skills, experience and frequency of updates. It is therefore crucial to devise a more sophisticated distinguishing technique for calculating predicted EPS consensus.

### **Behavioural Finance**

In 2008–2009, 'as financial markets responded to the economic crisis fuelled by the collapse of subprime mortgage backed securities, it appeared that finance theories could not explain the vast fluctuations' in the market (Stefan, 2009, p.1). 'Explanations of the random nature of the stock market emerged from the field of behavioural finance, citing panic and other investor sentiments as the key factors driving the irrational state of the market' (Stefan, 2009, p.1). Despite the emphasis on the EMH in finance, there seems to be increasing evidence of substantial anomalies in financial markets. These suggest that the underlying principles of rational behaviour underpinning the EMH may, in fact, be flawed. Some have therefore begun to look into other elements present in financial markets, including human behaviour. This has in turn prompted the development of what is now known as behavioural finance (Dargham, 2009). Behavioural finance challenges the efficient markets perspective and focuses on how various market participants interpret and act upon information readily available to them.

According to Arnold and Orthman (2011), behavioural finance is about the influence of psychology on market participants and the subsequent effect thereof on the financial markets. The notion behind human behaviour driving the markets is not novel (Arnold and Orthman, 2011). Several classical economists, including Adam Smith, Irving Fisher and John Maynard Keynes emphasised the importance of psychological factors in human decision-making, and how these factors could change the analysis of economic issues (Pech and Milan, 2009). Since then studies appear to confirm the significance of the irrational human emotion — a phenomenon so widely observed in the markets today and which appears to be the key driver of the market. According to Sewell (2011, p.1), 'behavioural finance is the study of the influence of psychology on the behaviour of financial practitioners and the subsequent effect on markets'. Sewell (2011) notes that behavioural finance is of interest because

it helps to explain why and how markets might be inefficient. Importantly, the behavioural finance literature falls into two primary areas: the identification of anomalies in the EMH that behavioural models may explain (DeBondt and Thaler, 1985) and the identification of individual investor behaviour or bias inconsistent with classical economic theories of rational behaviour (Odean, 1999).

Consistent with the EMH, it is argued that the anomalies are chance results; apparent over-reaction to information is as common as under-reaction (Sewell, 2011). In particular, Kahneman and Tversky (1979, 1996, 2000) empirically show that people are irrational in a consistent and correlated manner. Importantly, Arnold and Orthman (2011, 7 Sep) postulate that "a contributor to emotional behaviour" is short-termism as (especially when under pressure) humans tend to have an inherent preference for short-term activity and outcomes". For example, much of the behavioural finance literature is pointing to people having a tendency of being over-confident and over-emphasising the importance of recent events (Arnold and Orthman, 2011). This can lead to analysts using present conditions and recent trends to make forecasts, even when they are unlikely to be normal. This would effectively result in inaccurate forecasts. Further, human liking for immediate gratification might mean that we prefer observing positive outcomes sooner rather than later, which may cause analysts and investors to track company performance in the smallest time segments practicable (Arnold and Orthman, 2011). This may, in turn, lead to an unrealistic extreme short-term emphasis on performance, and as a result, market participants would be likely to make decisions based on a short-term fall or gain that is unlikely to endure in the longer term (Arnold and Orthman, 2011). As a result, irrational investors will lose money and incompetent analysts will lose their credibility and clientele, and as a result, eventually exit the market (Sewell, 2011).

Advocates of behavioural finance say that market inefficiencies are driven by human psychology. Clearly, it would be impractical to assume that humans are 100% rational 100% of the time. This is particularly evident through people's attitude to risk and the way they assess probabilities. Psychologists have observed that when making risky decisions, humans are particularly reluctant to incur losses. Not surprisingly, most investors and analysts do not hold a PhD in probability theory, neither can they with absolute certainty predict the future. Therefore, they may systematically make errors in assessing the probability of uncertain events. Psychologists have found that when judging possible future outcomes, individuals tend to look back at what happened in a few similar situations and, as a result, place too much weight on a small number of recent events (Brealey et al, 2008). However, market participants of this sort seem to forget how little one can learn about the true market conditions purely on the basis of a short-term glimpse. The tendency to place too much emphasis on recent events, and therefore the underlying predisposition to overreact to recent news, could explain some of the

most abrupt fluctuations in the market. In turn, behavioural finance may offer some reasonable explanation of some of the puzzles and anomalies surrounding the market. In fact, the advocates of behavioural finance suggest that these patterns of investor behaviour can explain why markets are not always efficient.

Kahneman and Riepe (1998) find that market deviations from the maxims of economic rationality are pervasive and systematic. So market participants tend to deviate from rationality. Further, according to Conlisk (1996), the concept of rationality in the context of capital markets is empirically very important because 'there is a mountain of experiments in which people may display intransitivity, ignore relevant information or use irrelevant information'. In his book, Shiller (2000) explains the irrational behaviour of market participants. Importantly, the book was published just before the most serious market collapse since the Great Depression — the dot.com bubble. Among a number of important factors, Shiller (2000) lists analysts' optimistic forecasts as a factor contributing to the irrational exuberance of the recent bull market from August 1982 to. Notably, Trammel (2006) argues that "theories about rational behaviour are conspicuous targets for both practitioners and professors of finance".

### **Information Advantage of Financial Analysts**

In the past couple of decades, financial analysts' forecasts have received increased attention in the finance and accounting literature (Givoly and Lakonishok, 1979). They have been widely used in empirical research to proxy for investors' earnings expectations (Hughes and Ricks, 1987; McNichols, 1989). Other empirical research has focused on comparing analysts' forecast accuracy to that of both time-series and publicly announced managerial forecasts (Brown et al, 1987a; Brown and Rozeff, 1978; O'Brien, 1988). An implicit assumption underlying much of this research is that the forecasts publicly released by analysts reflect their private information in an unbiased manner.

Security analysts are a type of financial intermediary whose immediate concern is the valuation of assets. Thus, they are primarily investment advisors. Because of possible conflicts of interest between investors (principals) and corporate management (agents), analysts also have a stewardship role and may at times serve as corporate critics (De Bondt, 1991). Security analysts prepare detailed studies of individual stocks, make careful comparisons between companies (resulting in industry reports), and form expert opinions on their likely future earnings and investment performance. At the company level, the principal source of information for analysts is financial statement analysis. As a rule, they tend to access a wide array of information, including security prices, firm-specific financial and operating information, industry data and macroeconomic factors. As the name itself suggests, the value-added activity of the analyst is analysis, which encompasses the process through which analysts consider a company's strategy, accounting policies, financial

performance, future prospects for sales and earnings growth, and ultimately a valuation. Based on this, analysts draw conclusions in the form of earnings forecasts.

The abundance of literature on financial analysts ultimately points to the difference between the historical academic perspective and investor interest in future events (O'Brien, 1985). The research question addressed by this study is motivated by a common academic use of analyst forecast data which is as a proxy for the market expectation of a firm's earnings at a given point in time. Accurate measurement of earnings expectations is crucial for firm valuation, determining cost of capital and understanding the relationship between unanticipated earnings and stock price changes. Research on financial analysts has developed as a by-product of capital markets research focused on the correlation between accounting earnings and stock prices. In fact, a lot of studies on financial forecasting focus on examining the correlation between inputs (prices and financial statement information) and outputs (earnings forecasts and recommendations) (Fried and Givoly, 1982; Brown et al, 1987b). The two methods of estimating expected earnings data that are generally used in studies of divergent earnings are analysts' forecasts and time series models.

The interest in tests of market efficiency and value relevance of accounting earnings has prompted a significant amount of research on time-series modelling of earnings. In this respect, Fried and Givoly (1982) are often given credit as their research supports the conclusion that analysts are a better proxy for expected earnings than time-series models. On one hand, as noted by Brown et al (1987a), if analysts are efficient in any sense, it has to be the case that analysts' forecasts are more accurate than time-series model forecasts, because analysts have both the timing and the information advantages. In this regard, Grossman and Stiglitz (1980) observe that market prices cannot fully reflect all available information; otherwise, information gatherers like security analysts would not be rewarded for their costly activities. One would assume that analysts can easily obtain a time-series model and incorporate that information into their overall information set (Bradshaw, 2011).

The rational expectations hypothesis suggests that market earnings expectations should be measured by the best available earnings forecasts (Brown and Rozeff, 1978). Meanwhile, both basic economic theory and the equilibrium employment of analysts imply that being a higher cost than time series models, analysts must produce better forecasts (Brown and Rozeff, 1978). Since security analysts process substantially more data than the time series of past earnings, their earnings forecasts should be superior to time series forecasts and provide better measures of market earnings expectations. Aggregate analyst earnings forecasts have been found to be more accurate than forecasts from time-series models in numerous studies (Fried and Givoly, 1982; Brown and Rozeff, 1978; Brown et al, 1987a; Philbrick and Ricks,



1991). In that regard, Brown et al (1987a) agree with the rest of the literature but point out that even though analysts' forecasts are more reliable than time-series forecasts, the prediction errors are large in both cases. In this paper, we aim to present a method allowing one to achieve a smaller prediction error than that derived from the widely available generic consensus measures.

### Earnings Per Share

According to Schallke (1962, p.670), the "concept of income constitutes a controversial and complex part of accounting theory, being an area which has important implications for practice". It is an essential characteristic of our economy that results often do not accord with expectations. Any plan, no matter how well conceived, can be disrupted by unforeseen events and circumstances. Thus, plans are made and the economy moves on the basis of expectations, but actual results may differ from the predicted ones (Schallke, 1962, p.670). As said by a well-known economist Adam Smith, it is expectations which are controlling, rather than results. From this follows the significance of ex ante, or expected income in the eyes of economists. One important feature is the fact that ex ante calculations are not irrevocable as they can be revised and changed from time to time in order to conform to actual conditions (Schallke, 1962, p.671).

Inevitably, the subject of forecasting financial variables has received wide attention in the last few decades (Crichfield et al, 1978). In fact, "continuing effort is being directed toward the improvement of accounting practices in order to present more meaningful financial statements" (Axelson, 1975, p.43). Expected income is a valuable tool in predicting the direction of a firm, an industry, and taken collectively, the economy. In terms of its impact on capital markets, empirically the annual earnings number is the single most important piece of information that the firm releases (Brown et al, 1985). Similarly, according to Richards (1976), the most common security valuation technique employed today involves an expected future earnings figure which is capitalised at an appropriate rate (multiplier) to provide an expected future price for a security. As said by Francis (1972), the true economic value of the firm depends on its earnings prospects, in light of anticipated economic conditions. There has been growing concern by both the regulators and the private investment community over the earnings forecasts which are the basis of these valuation models.

According to Axelson (1975, p.42), "the two numbers most used by equity investors today are earnings per share and the price-to-earnings ratio", which are essentially the inverse of each other. As Axelson (1975, p.42), further highlights, "trends in these two numbers are carefully analysed, and predictions of future trends often play a decisive role in investment decisions". These numbers are important tools enabling one to quantify the evaluation of investment value (Axelson, 1975). In fact, the earnings per share figure serves as a common language for describing the securities of different companies (Axelson, 1975). It seems that this

figure is so widely followed that small changes in the trend of earnings can have an immediate and significant impact on the market value of securities.

The overwhelming mass of detail that ends up being published in annual reports is often so technical that it ultimately tends to confuse rather than clarify the company's performance for individual investors (Axelson, 1975). Forecasts are currently available from professional security analysts and from company management. In addition, recent growth in detailed disclosure has increased the interest in simplistic measures of investment value and, as a result, placed even greater reliance on such accounting measure of performance as EPS (Axelson, 1975). An extensive body of literature has examined the information content of earnings. In fact, Givoly and Lakonishok (1979, p.165) find that financial analysts' forecast revisions convey or reflect information. Furthermore, the authors provide evidence to suggest that the "information on revisions in forecasts of EPS is valuable to investors". According to Crichfield et al (1978, p.652), "an implied purpose of EPS forecasts provided by security analysts is to yield unbiased estimates of future earnings per share which would be useful for investors in assessing firms' equilibrium values".

### Analysts and the Agency Problem

Following the development and increasing accessibility of databases containing analysts' EPS forecasts, many studies have analysed their quality. An implicit assumption underlying much of this research is that the forecasts publicly released by analysts reflect their private information in an unbiased manner. In contrast, numerous studies document that analysts' forecasts of earnings, on average, exhibit over-optimism and end up being too high (Abarbanell and Bernard, 1992; Easterwood and Nutt, 1999; McDonald, 1973; Barefield and Comiskey, 1975; Fried and Givoly, 1982; Stickel, 1990; Lys and Sohn, 1990). A panel of previous researchers has documented that analyst forecasts are optimistically biased (O'Brien, 1988; Butler and Lang, 1991; Philbrick and Ricks, 1991; Abarbanell, 1991).

In a study of whether security analysts overreact, De Bondt and Thaler (1990) found that analysts' forecasts are prone to be too optimistic and too extreme. The authors concluded that analysts over-react to past earnings changes, resulting in forecasts that are over-optimistic. De Bondt and Thaler (1990) provide evidence to suggest that analysts' earnings forecasts are indeed consistent with "generalised overreaction". Specifically, the authors show that earnings changes forecasted by analysts are significantly more extreme than actual realisations, and conclude that the forecasts seem too extreme to be considered rational (De Bondt and Thaler, 1990). Naturally, the optimism bias may simply reflect an economic incentive to encourage trading. Alternatively, the bias may be due to pressure from company management. Importantly, the overreaction bias is more severe for long-term forecasts (Graham, 1959). Further, in their investigation of earnings forecasts for 100 companies,

Barefield and Comiskey (1975) concluded that forecast earnings have exceeded actual earnings in 64% of the cases (Barefield and Comiskey, 1975). The study by Jaggi and Jain (1998) shows that, on an overall basis, analyst forecasts are generally biased towards overstatement.

Importantly, we acknowledge the apparently disparate conclusions in the literature (Abarbanell and Bernard, 1992). In particular, studies involving earnings forecasts that are not consistent with the apparently persistent optimistic bias include Theil (1966), Lys and Sohn (1990), Abarbanell (1991), Easterwood and Nutt (1999) as well as Lys and Sohn (1990) who found that analysts' forecasts underreact to information in issuing financial forecasts. Similarly, Brown and Rozeff (1978), Fried and Givoly (1982), Brown et al (1985 and 1987), O'Brien (1988) and Brown et al (1985) also found that analysts underestimate actual EPS. Notably, Theil (1966, p.14), states that "generally speaking, forecasters tend to underestimate changes more frequently than they overestimate them."

Overall, there does not appear to be consensus in the financial literature on whether analysts over- or under-react to information. Thus, it could be argued that analysts tend to be fairly inefficient in processing numerous pieces of information. Such evidence of inefficient analysts' earnings forecasts by DeBondt and Thaler (1990) and Mendenhall (1991) raises an overall question of analysts' forecast reliability.

### **Analysts' Forecast Reliability**

Analyst forecasting accuracy is of importance not only to investors willing to invest in those stocks, but also to the underlying companies themselves. If the estimates for a particular company are not accurate, this would affect that stock's liquidity, as not many investors would be willing to trade in such stocks. Essentially, the association between security returns and analyst forecast revisions suggests that investors extract relevant information about upcoming earnings from analyst forecasts. Unsurprisingly, a vast majority of research on analysts is focused on their ability to forecast earnings (Clement and Tse, 2005; Mikhail et al, 1987). Existing research indicates that the most important trait valued by institutional investors is industry knowledge, which explains why most analysts specialise by industry. Clearly, analysts are valued for their ability to see individual companies within the context of the industry. As Mikhail et al (1987) highlight, individual analyst experience increases forecast accuracy. According to Clement and Tse (2005), the likelihood of analyst earnings forecasts increases with the analyst's prior accuracy and experience, and declines with the number of industries the analyst follows.

An implicit assumption behind much of the empirical research involving security analyst earnings forecasts is such that these forecasts reflect the analysts' private information in an unbiased manner. However, Trueman (1994) shows that this much desired assumption may not necessarily

be valid. In this regard, Clement and Tse (2005) classify forecasts as bold if they are away from both the analyst's own prior forecast and the consensus forecast or below both. The authors classify all other forecasts that move away from the analyst's own prior forecast and toward the consensus as herding forecasts. Clement and Tse (2005) find that bold forecasts are on average more accurate than herding forecasts, as bold forecasts incorporate analysts' private information and are more informative to investors than herding forecasts. Herding happens when analysts revise their forecasts simply to be closer to the consensus forecast, or other analysts, or both and not because of new private information (Clement and Tse, 2005; Gleason and Lee, 2003). In fact, Givoly and Lakonishok (1979, p.171) "reveal that revisions of various forecasters do generally move together". These results are shown to have interesting empirical implications. In related research, Trueman (1990) shows that, upon obtaining new information, analysts may also be reluctant to revise previously issued forecasts. This is because a forecast revision would signal to the market that the analyst's original information was inaccurate, which as a result may lower the perceived assessment of the analyst's forecasting ability. This therefore goes to suggest that naively calculating a consensus analyst forecast by averaging individual analyst forecasts is inappropriate.

An interesting artefact in regard to herding is the persistent trending in forecast earnings revisions. Upward revisions tend to be followed by additional revisions in the same direction, and the same is true for downgrades. For example, when analysts first raise their forecasts for a stock, some investors will buy and the price will rise. When secondary analysts follow, there will be more buying and a further price rise. As stated by Jacobs and Levy (1989, p.6), "this persistence of estimate revisions leads to persistence" in market moves. The reasoning behind trending in forecast earnings revisions is addressed next.

First, due to credibility concerns, individual analysts tend to be averse to forecast reversals, especially when their current view differs from consensus. Suppose an analyst had been forecasting \$2 of earnings per share, but now believes the best estimate to be \$1. Rather than admitting to a bad forecast, the analyst will be motivated to reduce the forecast in smaller increments. Second, analysts who suffer from conservatism do not adjust their earnings forecasts sufficiently in response to new information contained in earnings announcements. Third and important, analysts are more concerned about how accurate their forecast is relative to other analysts, rather than how close their individual forecast is to reality. Thus, revising their forecast to a more conservative number will ensure that all upside will be captured if the information is correct, without losing much credibility if the information is wrong.

Relating analysts' tendency to herd to their experience, Hong et al (2000) find that more experienced analysts are less likely to herd. Similarly, research finds that analysts issuing



bold forecasts are on average employed by large brokerages, issue more frequent forecasts, and have greater firm-specific and general experience (Hong and Kubik, 2003; Trueman, 1994; Clement, 1999). In contrast, analysts issuing herding forecasts tend to cover more companies and industries. Consistent with empirical evidence, Hong et al (2000), Scharfstein and Stein (1990) and Stickel (1990) find that experienced analysts are more likely to issue bold forecasts than their less experienced colleagues. In particular, Trueman (1994) proposes that herding declines with the analyst's experience. This suggests that inexperienced analysts are less likely to provide extreme forecasts and tend to herd more frequently. In turn, investors view bold forecasts as more informative than the more generic herding forecasts.

As it became generally accepted that analysts have status of an important economic agent in the capital markets, academics became interested in a deeper understanding of analysts' forecasts and their underlying reliability. Forecasting company earnings is difficult but very important (De Bondt, 1991). Numerous studies examine the differences between actual and expected or divergent earnings (Doran, 2000; Brown and Rozeff, 1978; Fried and Givoly, 1982; Brown et al, 1987b; Phibrick and Ricks, 1991; Barefield and Comiskey, 1975; Basi et al, 1976; Crichfield et al, 1978). The study by Lui (1992) evaluates the ability of security analysts to forecast the EPS for firms in Hong Kong and concludes that analysts' forecasts are significantly biased and inaccurate. The study by McDonald (1973) provides additional empirical information on the reliability of earnings predictions. Reliability was examined by comparing predicted earnings with actual earnings for the same period. Reliability in this study was based on the degree of agreement between predicted earnings and actual earnings. Therefore, reliability was not used by McDonald (1973) in the sense of declaring predicted earnings reliable or unreliable, but was used in the sense of the degree of closeness to being right.

Earnings forecasts by professionals are generally believed to be valuable information and their accuracy is a matter of concern to a wide range of market participants. The primary use of analyst earnings forecasts in academic work is to provide a proxy for the market expectation of a future earnings realisation (O'Brien 1985). Forecast aggregations, such as the mean or median, are often used for this purpose. These proxies, however, assume that analysts have identical forecasting abilities, so the identity of the individual analyst is ignored in defining the consensus (O'Brien, 1985). However, if some analysts produce consistently superior or inferior forecasts, then such knowledge can be used to improve the accuracy of the consensus measure. If analysts update at different times and do not differ in their forecasting ability, then under mild assumptions the most recent forecast available may be more meaningful. However, if analysts differ systematically in forecasting ability, there will be a trade-off between the age of the forecast and the ability of the forecaster (O'Brien, 1985).

Existing research shows that forecast accuracy generally improves as the forecasting horizon decreases (Brown et al, 1985; O'Brien, 1988 and 1990). So if analyst forecasts are non-synchronous, then the more recent forecasts may incorporate more information and should be more accurate than their out-dated precedents (O'Brien 1985). If the older forecasts are simply irrelevant, then discarding them is appropriate (O'Brien, 1985). Thus, it would flow that the longer the forecast horizon, the greater the disagreement among security analysts in their earnings forecasts (Lui, 1992). This is reasonable because the more distant the future the more difficult it is to make accurate forecasts. Jaggi and Jain (1998) also show that analyst forecasts with shorter time horizons are more accurate than forecasts with longer time horizons. Another interesting factor possibly affecting the outcome of our research is the notion that forecast age varies in significance from sector to sector. Moreover, prior literature suggests that analysts' forecasts become more accurate as the reporting date is approaching thus further pointing to the increasing forecast accuracy with time.

## Data and Methodology

### Data

The data used in this study includes primary earnings per share (EPS) before extraordinary items, and where necessary, these EPS figures have been adjusted for stock splits and dividends. To calculate basic EPS, the company's net income is divided by the number of shares outstanding. We empirically test which one of the following consensus estimates is the closest predictor of company actual EPS figures: mean, median, or the time weighted consensus. In pursuit of the more effective consensus estimates, we use longitudinal time series daily individual analyst reports for 12 financial years covering 2000 to 2011. We are concerned with the performance of security analysts over a relatively long period of time. This differs from most published studies of forecasts which deal with a smaller number of years.

The original dataset for each country comprises 1121 Australian companies for 12 years from 2000 to 2011. The average number of analysts per company is 5.31 (mean) and 4.45 (median). "The number of forecasts per company varies considerably and, in general, is a positive function of the size and investment interest" (Barefield and Comiskey, 1975, p.242). This study covers Australia for 12 years and we believe this provides a good testing ground for a more advanced EPS forecast signal. The data for the purpose of this research came from the Thompson Reuters database. The testing sample of companies is limited to stocks covered by a minimum of three analysts. It is assumed that updates by at least three analysts are required to provide a reasonable consensus.

### Methodology

Analysts provide various forecast estimates for listed companies. One would expect that these estimates will differ as each analyst holds differing outlooks and assumptions

about the company. These individual forecasts are often aggregated to form a market consensus for each company. Traditional earnings revision models measure changes in the equal weighted average consensus of analyst estimates over time. Thus, the standard earnings consensus is formed from an equally weighted consensus of all the latest analyst estimates. However, not all estimates are equal. To improve on the standard earnings revision models, we adjust the individual analyst estimates to form the time weighted earnings signal (TWES) by placing a greater weighting on the more recent forecasts. With the aim of extracting extra information from the analyst forecasts, this measure aims to enhance the reliability of analyst consensus estimates of company EPS.

Increased interest in corporate earnings forecasts has encouraged the flow of forecast information from a variety of sources. A primary problem encountered in the use of this information is determining who among the forecasters is a better performer. In situations where multiple forecasts are available for a given corporation, investors have a choice of strategies. One such strategy would be to use the mean of all available forecasts. At the other extreme, investors could try to determine which of the forecasts is most reliable and only use that one. The purpose of this paper is to detect which one of the following techniques – mean, median, or time weighted – consensus estimate offers the most reliable method for predicting company actual EPS figures.

The study focuses on the more comprehensive earnings forecast signal using analyst earnings forecasts to detect early changes in analysts' revisions. To extract valuable information from timely analyst forecasts, the time signal methodology allows delving deeper into the analyst forecasts to detect early changes in the consensus signal and produce a robust time weighted earnings estimate. In particular, the study examines the effectiveness of analyst earnings forecasts that have been weighted based on a time period of 100 days. Spanning over 12 years from 2000 to 2011, the mean time that an average analyst takes to update their EPS forecast estimate is 91 days. With the mean being 91 days and considering that one would expect some leeway for earnings updates by analysts, we believe that adopting the 100 day "cut-off" benchmark is a reasonable assumption. Notably, the average number of days required by an analyst to issue a new forecast was 95 days in the first half of the tested period, spanning from 2000 to 2005, it then decreased to 84 days in the second half of the tested period, lasting from 2006 to 2011. We therefore observe a decline in the number of days it takes an analyst to update their forecast, when moving from the first half of observations to the second. Possible explanations for this could be technological advances, increased media coverage and greater data availability.

One would expect the time signal to reflect a more realistic representation of analyst estimate changes and thus be more effective in predicting company reported EPS than the mean and median-based consensus. Considering that FE

is a forecast error, the two hypotheses laid out in the paper are described below. They postulate that time-weighted consensus estimates are a more robust alternative to mean and median consensus figures.

$$(1) \quad \begin{array}{l} H_0 : FE_{\text{Time weighted}} \leq FE_{\text{Mean}} \\ H_1 : FE_{\text{Time weighted}} > FE_{\text{Mean}} \end{array}$$

$$(2) \quad \begin{array}{l} H_0 : FE_{\text{Time weighted}} \leq FE_{\text{Median}} \\ H_1 : FE_{\text{Time weighted}} > FE_{\text{Median}} \end{array}$$

The focus of the study is on quantitative data analysis techniques. The paper investigates the field of security analysis where the main emphasis is on the quantifiable aspects of the stock screening process, while attempting to minimise the importance of the more qualitative factors of corporate performance. Accordingly, a combination of empirical studies and statistical analysis tools will be implemented as the principal methodologies for conducting this research.

Effectively, this paper builds on research on the time and directional signal in Australia. The study presents an analysis of 11 sectors: Basic Materials, Capital Goods, Cyclical, Energy, Financials, Health, Non-Cyclical, Services, Technology, Transport and Utilities. Table 1 provides a sector composition by the number of companies per sector. The sectors considered in this study are categorised using the Thomson Reuters methodology known as the Reuters Business Sector Schema (RBSS). Notably, RBSS is a classification system designed to track and display the primary business of a corporation and grouping highly related products and services into a single industry category. Appendix A elaborates on the sector classification by industry to provide a better understanding of the range of companies belonging to each sector.

**Table I. Sector Composition by the Number of Companies Per Sector**

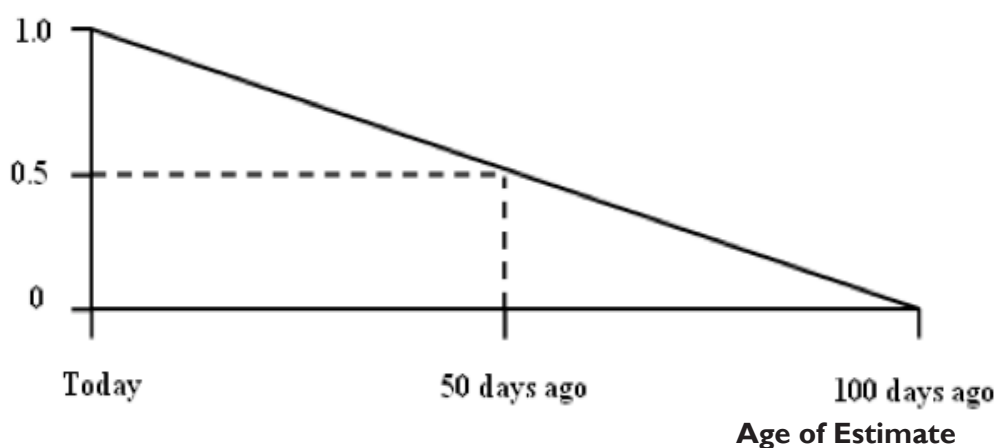
Sector	No of Companies
Basic Materials	239
Capital Goods	82
Cyclical	24
Energy	116
Financials	101
Health	86
Non-Cyclical	48
Services	305
Technology	79
Transport	20
Utilities	21
<b>TOTAL</b>	<b>1121</b>

### Methods

In constructing the time weighted earnings signal (TWES), the idea is to place more weight on the more recent earnings estimates. The rationale for adopting the time weighting method in the study is that the most recent revisions are more reflective of where the market sees the stocks. For different reasons, not all analysts are as timely in updating their forecasts. Time weighting may also act as a data cleaning exercise for stocks where the analyst has left their brokerage firm or dropped coverage. One would assume that the average time between analysts updating their estimates varies throughout the year and can be different depending on the size of the company and its geographical location. In constructing the time weighted EPS signal, the weights of analyst forecasts are based on the amount of time that has passed since the analyst has last changed their forecasts. Fig. 1 is an illustration of this process.

**Figure I. Time-weighted Consensus Signal with the Application of a Linear Weighting Scale**

### Weight



A linear time period going back 100 days is used. For example, if an analyst revised today, their EPS forecast receives a weight of one; if an analyst last revision was 100 days ago, they receive zero weight; if analyst revised 50 days ago, they receive half weight etc. Appendix B provides more insight into how the time-weighted measures are calculated.

Forecasting is one useful means for estimating the values of important variables under uncertainty. A forecast, or prediction, is simply a statement about an unknown event and typically, as appears in our case, they are future events. In the present study, we are concerned with security analyst predictions of EPS figures for major corporations. There is likely to be some sample bias due to the limited coverage of firms by companies providing forecast data. This bias is toward a greater coverage of large and somewhat more mature firms that likely have had a sufficient number of analysts covering them. For this reason, any conclusions to different populations should be made with care. We will evaluate the accuracy of these forecasts as compared to predictions from alternative statistical models in terms of the magnitude of the forecast error.

The time period selected for this study is for years 2000 through to 2011. This time frame exhibits differing economic conditions, which aids in making the results of the study more generalisable. As part of data requirements, only companies covered by at least three analysts are included in the study. Importantly, a similar parameter is adopted by Lui (1992). Thus, the analysis begins from the date when there are at least three analysts until the day when the company announces its end of financial year results.

The accuracy of forecasts in this study is examined by using the forecast error measures to reflect the difference between forecast and actual values of EPS. To measure the accuracy of forecasts on an average basis, the absolute forecast error measure is used, which is deflated by an absolute amount of actual values. Therefore, the forecast error is defined as the absolute value of the percentage difference between actual and forecasted earnings, such that:

$$FE\% = |(F_{cons} - A)/A|$$

where A is the actual EPS, and  $F_{cons}$  is the EPS consensus forecast.

To account for the effect that some of the extreme observations would have on the summary statistics, we adjust the data for outliers. Accordingly, observations with absolute forecast errors above 100% are removed from the analysis. Similarly, in discussing the research design of their study, Jaggi and Jain (1998) and Foster (1986) argue that firms with forecast errors over 200% should be dropped from further analysis.

Importantly, standard statistical tools invariably require the successive elements in any summation to be independent. This assumption, however, is unrealistic if the forecast errors are measured in terms of levels of EPS. As the level of EPS increases in absolute magnitude, we should likewise expect analysts' forecast errors to increase in absolute magnitude. In a cross-sectional sense, performance measures which evaluate differences between the levels of forecast EPS and the levels of actual EPS would be biased against firms with high absolute levels of EPS and biased in favour of firms with low absolute levels of EPS. This would make empirical results based upon such measures difficult to interpret. Thus, to avoid asymmetry problems, we chose to work in terms of percentage changes in EPS. If one does not use absolute values for both the numerator and the denominator, then the use of this measurement scheme produces a positive number for over-predictions and a negative number for under-predictions. This can be seen in McDonald (1973) who refers to the forecast error as the 'relative prediction error', defined as  $FE\% = [A - F]/F$ .

According to Doran (2000, p.125), "divergent earnings are those that differ from expected". Divergent earnings (DE) is the undeflated measure where  $DE = A - F$ , and  $DE\%$  is divergent earnings deflated by the absolute value of the

EPS forecast, where  $DE\% = [A - F]/F$  (Doran, 2000). Studies that scrutinise divergent earnings (or forecast error) commonly employ the methodology of deflating divergent earnings measures (Brown and Kim, 1991; Bowen et al, 1992; Doran, 1995). This indicates that the common practice of deflating earnings data is necessary. As explained above, we believe that the need to use deflated and absolute values in determining the forecast error across a large sample of companies with varying levels of EPS.

The ultimate question the study attempts to address is whether alternative consensus methodology is superior to the usual mean and median scenario so widely adopted in the financial industry, but learning about the different results on a sector basis as well as analysing year-by-year variations in the countries' economic cycles would provide the reader with a deeper understanding of the results obtained from the study.

## RESULTS

In this section we examine whether the time weighted consensus estimates provide a better alternative to the mean and median consensus estimates. Reflecting on the methodology section, technically, there is a scale problem in measuring analysts' forecast errors when using the data measured in its level form. This problem can persist across firms and over time. So a firm with the same total earnings as another but half as many shares outstanding will have an EPS that is twice as large. To adjust for differences in the magnitude of EPS and forecast errors across firms, it is necessary to use a deflator, such as dividing the forecast error by the actual value.

In applying the parameters described in the methodology section, by including only stocks covered by at least three analysts and removing the outliers whose absolute percentage error exceeds 100%, we find that the number of companies decreases by 40%, from 1121 to 668.

In using the t-test in the context of larger samples involving 50 or more observations, the distribution is approximately normal. To further strengthen the results of the study, we test the statistical significance of the differences using the paired t-test method. As the t-statistic in all cases was greater than 2, we can conclude that there is a statistically significant difference between the variables observed.

In using a linear time period going back 100 days and placing greater weight on the more recent analyst EPS forecast estimates, the results of the study indicate that on average, the 100 day time weighted consensus measure (from now on we shall refer to it as the 100 day TWES) is superior to both median and mean. In fact, across all the years studied, the 100 day TWES ranks as the number one consensus approach (average FE = 24.3%), followed by the median (average FE = 25.9%), and the mean (average FE = 28.0%) which ranks as the least accurate technique for calculating consensus.

Overall on a sector basis, the 100 day TWES (average FE = 24.3%) acts as the closest predictor of company EPS in all sectors. The only exception is Utilities where the median is the most reliable prediction method of corporate earnings (average FE = 22.4%), followed closely by the mean (average FE = 22.6%) and the 100 day TWES (average FE = 22.4%) comes last (average FE = 24.4%). In this one case, it is the median that acts as a better proxy of reported EPS than the 100 day TWES. The utilities sector has a very small number of companies, thus reducing the significance of this result. Table 2 below summarises these findings.

**Table 2. Time-Weighted Consensus Results By Sector**

Sector	Number of Companies	Mean	Median	100 Day TWES
Basic Materials	116	38.3%	33.7%	32.1%
Capital Goods	54	24.1%	23.6%	21.1%
Cyclical	12	29.7%	26.9%	24.5%
Energy	65	38.7%	36.7%	33.7%
Financials	63	22.6%	22.1%	21.2%
Health	35	29.1%	26.2%	24.5%
Non-Cyclical	38	24.7%	23.2%	22.0%
Service	219	22.5%	20.9%	19.2%
Technology	34	26.9%	22.6%	22.3%
Transport	16	32.1%	32.9%	32.0%
Utilities	16	22.6%	22.4%	24.4%
Total/Average	668	28.3%	26.5%	25.2%

## ROBUSTNESS TESTS

To strengthen our research results, we performed a number of additional tests. Our aim was to make sure that the time weighted methodology is superior to simple benchmarks such as mean or median regardless of the chosen cut-off age of the estimate. To add to the 100 day benchmark established throughout the study, we also ran tests where the maximum age of the estimate was 50 and 150 days. Such tests supported our earlier proposition that the time weighted methodology was in fact a more reliable predictor of the actual EPS than simple arithmetic benchmarks. Interestingly, the statistical differences between the 50, 100 and 150 day results are not significant.

In addition to testing the linear model with the time period going back 100 days, we also tested a number of exponential models. The robustness tests based on the exponential models tended to support the superiority of the time weighted approach over the mean and median method but did not result in lower forecast errors. We thus conclude that using the linear time weighted consensus model allows the achievement of a more reliable consensus overall than that derived from the exponential time weighted consensus models.

Interestingly, Clement and Tse (2005) found that analysts have difficulty forecasting earnings for firms that are currently reporting losses. To further strengthen our results, we examined the potential effects of some of the major economic turmoils of the 21st century, such as the GFC of 2008-2009 and the dot.com bubble of 2000-2001, on the forecasting accuracy and the magnitude of the forecast

error. Not surprisingly, the results of the study show that in 2000 as well as 2008-2009, the percentage forecast error was higher than in other years. A valuable conclusion for our study here is that despite the variations in the size of the forecast error and in spite of the different economic regimes around, the 100 day TWES (average FE = 23.9%) continues to provide robust consensus methodology, and in fact outperforms the median (average FE = 26.0%) and mean average (FE = 28.0%) throughout the twelve-year period considered in the study.

It has been well documented in the finance literature that in times of economic downturns when EPS tends to be negative, analysts' forecast errors become larger than under the business-as-usual scenario. Continuing from the previous findings, we make an attempt to ensure that the time weighted methodology remains a more reliable alternative to the mean and median methods at times when EPS is negative and go on to conduct some additional testing. The results show that 132 companies out of the original 1121 firms have cases when an EPS is negative. When this is the case, the consensus forecast errors tend to sky-rocket, with the mean showing an average FE of 52.6%, median average FE = 46.4% and the 100 day TWES reaching an average FE of 44.1%.

Such empirical evidence goes to suggest two things when EPS is negative. First, the time weighted methodology continues to be a more reliable alternative to the mean and median methods. The second finding is such that analysts' forecast errors are significantly larger when earnings are negative. In fact, in times of significant economic hardships,



the 100 day TWES forecast error is significantly lower than the forecast error derived from the mean or median.

The robustness tests performed provide evidence in favour of the superiority of the time weighted consensus method over the mean and the median consensus approach. This outcome holds true across most sectors and financial years, as well as during the times of economic downturns, such as the GFC or the dot.com bubble, for example. This supports the results presented earlier in the paper.

## DISCUSSION AND CONCLUDING REMARKS

Security analysts play an important role in capital markets. As information intermediaries, they provide quantitative outputs for investors in the form of earnings forecasts. Believed to be the proxy of rational expectations, analysts' forecasts of firms' earnings and the related forecast errors are issues widely discussed in finance and accounting literature. By underlining the critical role of estimated earnings in stock valuation, research suggests that analyst earnings forecast revisions convey significant information to the market. In fact, earnings forecast accuracy is described by the Institutional Investor and the Wall Street Journal as the determining quality of top-ranked analysts. Importantly, as highlighted by Schipper (1991), an accurate earnings forecast is not merely an end in itself but a tool to gauge the investment potential of a company's stock.

Importantly, the timeliness of the forecasts and forecast accuracy are an interesting trade-off faced by analysts who issue forecasts. They need to choose between either promptly releasing forecasts with respect to new information or waiting in order to produce more accurate forecasts at some point in the future by obtaining additional information. In this paper we examine the analysts forecast error, defined as the difference between actual and forecast earnings. We compare whether – in measuring the forecast error – the time weighted consensus methodology based on a 100-day time window is superior to the mean and median consensus approach. As the results of the study demonstrate, across the Asia-Pacific region, the time weighted consensus signal seems to be a more accurate and reliable measure in forecasting company EPS. This result is true across sectors as well as throughout different time periods and varying economic conditions. We may therefore conclude that in Asia-Pacific, the time weighted forecast EPS signal tends to exhibit valuable predictive properties. Such evidence is consistent with our earlier proposition that naively calculating analyst forecast consensus by averaging individual analyst forecasts is, to say the least, inappropriate. Not all analysts are the same; in fact they are characterised by a varying level of skills, experience, coverage and frequency of updates. Thus, proposing a more sophisticated technique for calculating EPS consensus estimates is crucial.

As the topic of analysts' forecasts is rather vast, there are a number of areas for further research. We outline some possible future research directions below. As noted by

Barefield and Comiskey (1975), little research effort has been directed to either the nature or the role of analysts' forecasts of EPS, although such forecasts seem to be a key element in the formulation of investment decisions. Additional research efforts could focus on a variety of issues related to earnings forecasts. Although the time weighting approach seems to be an effective proxy for conviction in analyst views, a number of other analyst variables could also be explored and include the following.

First, it would be meaningful to construct consensus made up of the most active forecasters. According to Givoly and Lakonishok (1979), the selection of the revisions produced by the most active forecaster for each company (the one with the greatest number of revisions) as the representative of the group of forecasters. The most active forecaster is likely to specialise in the stock and be the first to respond to new information. Second, it would also be useful to investigate forecast accuracy by industry, thus further breaking down the sectors. It may be the case that different industries pose different forecasting problems for analysts. There may be significant differences in forecast errors for different industries and even for different firms within the same industry. In fact, there are analysts who focus their attention on specific industries and who release forecasts only for firms within those industries. As one would reasonably expect, "such specialisation would enable the analyst to focus their resources in a narrow area with the aim of producing more accurate forecasts" (Richards, 1976, p.356). Third, one could find valuable the study of the correlation between broker/analyst 'celebrity' status or high survey ranking and their forecast accuracy. Fourth, taking into account the analysts' historical forecast accuracy could also generate meaningful implications for deriving a robust consensus measure for forecasting EPS. Fifth, examining the forecast error by large brokers/analysts over that of the small brokers/analysts could produce important inferences for effective consensus construction. This could include, among other topics, the number of stocks covered by the analyst as well as the level of industry experience. Last but not least, the magnitude of the revision would be studied.

## ACKNOWLEDGEMENTS

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**Appendix A. Industry Classification by Sector**

<b>Sector</b>	<b>Industry</b>
<b>Basic Materials</b>	Chemical Manufacturing, Chemicals – Plastics and Rubber, Containers and Packaging, Fabricated Plastic and Rubber, Forestry and Wood Products, Gold and Silver, Iron and Steel, Metal Mining, Non-Metallic Mining, Paper and Paper Products, Miscellaneous Fabricated Products.
<b>Capital Goods</b>	Aerospace & Defence, Construction – Supplies & Fixtures, Construction and Agricultural Machinery, Construction – Raw Materials, Construction Services, Mobile Homes & RVs, Miscellaneous Capital Goods.
<b>Cyclical</b>	Apparel and Accessories, Tools and Appliances, Audio and Video Equipment, Auto and Truck Manufacturers, Auto and Truck Parts, Footwear, Furniture and Fixtures, Jewellery and Silverware, Photography, Recreational Products, Non-Apparel Textiles, Tires.
<b>Energy</b>	Coal, Oil and Gas (Integrated), Oil and Gas Operations, Oil Well Services and Equipment.
<b>Financials</b>	Consumer Financial Services, Insurance (Accident and Health, Life, Property and Casualty, Miscellaneous), Investment Services, Miscellaneous Financial Services, Money Centre Banks, Regional Banks, S&Ls/Savings Banks.
<b>Health</b>	Biotechnology and Drugs, Healthcare Facilities, Major Drugs, Medical Equipment and Supplies.
<b>Non-Cyclical</b>	Beverages (Alcoholic and Non-alcoholic), Crops, Fish and Livestock, Food Processing, Office Supplies, Personal and Household Prods, Tobacco.
<b>Services</b>	Advertising, Broadcasting and Cable TV, Business Services, Casinos and Gaming, Communications Services, Hotels and Motels, Motion Pictures, Personal Services, Printing and Publishing, Printing Services, Real Estate Operations, Recreational Activities, Rental and Leasing, Restaurants, Retail (Apparel, Catalogue and Mail Order, Department and Discount, Drugs, Grocery, Specialty, Technology), Schools, Security Systems and Services, Waste Management Services.
<b>Technology</b>	Communications Equipment, Computer Hardware, Computer Networks, Computer Peripherals, Computer Services, Computer Storage Devices, Electronic Instruments and Controls, Office Equipment, Scientific and Technical Instruments, Semiconductors, Software and Programming.
<b>Transport</b>	Air Courier, Airline, Miscellaneous Transportation, Railroads, Trucking, Water Transportation.
<b>Utilities</b>	Electric Utilities, Natural Gas Utilities, Water Utilities.

## Appendix B. Calculating the Time-Weighted Consensus Estimate

The time weighted estimate is calculated by multiplying the individual analyst estimate on the day by its respective weight. The older the estimate, the smaller its allocated weight.

For example, if the last estimate by analyst A was \$3.48 and was issued 56 days ago, then the weight assigned to this estimate =  $(100 - 56) / 100 = 0.44$ .

The time weighted estimate for this day is obtained by multiplying an EPS estimate of \$3.48 by its weight 0.44, which returns \$1.53.

Thus, in obtaining the consensus figure for the day, the 56 day old measure will be given less priority than a measure that is, for example, only 4 days old.

In an attempt to avoid confusion, we provide the following scenario as an example.

Analyst	Estimate	Age of Estimate	Weight of Estimate
Analyst A	\$3.48	56 days old	0.44
Analyst B	\$3.45	4 days old	0.96
Analyst C	\$4.02	22 days old	0.78
Analyst D	\$4.15	103 days old	0

As mentioned in the paper, any analyst forecast that is more than 100 days old shall be considered too old, assigned the value of zero and is eliminated from the consensus calculation. Therefore, under the given scenario, the time weighted consensus figure for a given day is calculated in the following way:

Step	Task	Example	
1	Calculate the time weighted estimate for each analyst on the day	Analyst A: $\$3.48 \times 0.44 = \$1.53$ Analyst B: $\$3.45 \times 0.96 = \$3.31$ Analyst C: $\$4.02 \times 0.78 = \$3.14$ Analyst D: $\$4.15 \times 0 = \$0$	
2	Calculate the sum of the time weighted estimates for all analysts on the day	$\$1.53 + \$3.31 + \$3.14 + \$0 = \$7.98$	
3	Calculate the sum of weights of all analysts on the day	$0.44 + 0.96 + 0.78 + 0 = 2.18$	
4	Calculate the time weighted consensus figure on the day	$\$7.98 / 2.18 = \$3.66$	

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