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Are the forecast errors of stock prices related to the degree of accounting conservatism?

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Abstract

Instead of existing research studying the relation between forecast errors and either of two accounting-conservatism forms (unconditional, conditional) respectively, this paper studies the relation between forecast errors and two forms simultaneously, and finds that the relation varies across industries. For large industries, when a firm adopts higher unconditional conservatism and lower conditional conservatism, forecast errors are smaller. Small industries show that a firm with lower unconditional conservatism and higher conditional conservatism has smaller forecast errors. These findings imply that forecast errors and accounting conservatism appear to be related. This information could be of interest to both investors and firm managers.

JEL classification numbers: C32, G30
Keywords: Accounting conservatism; Unconditional conservatism; Conditional conservatism; Forecast errors; Stock prices

1 Introduction

In the stock market, forecast (or prediction) errors may lead to the fluctuation in market prices, reducing shareholder wealth, inducing corporate failures because of decreases in market capitalization. Prior research studies how to improve forecast accuracy and finds that forecast errors may be affected by accounting conservative reporting. The effects of accounting conservatism on forecast (prediction) errors

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are divergent. Some argue that effect of conservatism on forecast (prediction) errors are negative (Sohn 2012; Kim et al. 2013; Pae and Thornton 2010), and positive (Mensah et al., 2004; Pae and Thornton, 2010; Callen et al., 2010). Effects of accounting conservatism on valuation are positive (Sohn, 2012; Lin et al., 2014; Cheng, 2005b; Basu, 1997; LaFond and Watts, 2008; Watts, 2003; García Lara et al., 2011; Francis et al., 2013) and negative (Chen et al. 2014; Easton and Pae, 2004; Monahan, 2005).

The above evidences are based on two forms of conservatism: news-independent and unconditional conservatism (UC); news-dependent and conditional conservatism (CC) (Beaver and Ryan, 2005). CC captures a firm's earnings' asymmetric timeliness in news recognition based on the sign of the news[2]. UC indicates immediately expensing R&D investment and expected long-run understatement of book value of net assets relative to market value (Feltham and Ohlson 1995). CC is negatively related to unconditional conservatism. Lower (Higher) unconditional conservatism leads to higher (lower) conditional conservatism (Qiang, 2007). UC pre-empts and reduces conditional conservatism (Beaver and Ryan, 2005; Qiang, 2007). In sum, two relations are confirmed respectively: forecast errors are related to UC as well as forecast errors are related to CC, negatively or positively. In addition, UC and CC are negatively related.

We observe two gaps from above studies. First, existing research finds that the relations between forecast errors and each of two conservative forms *respectively* are positive or negative. However, few studies explore the relation between forecast errors and two forms *simultaneously*. Accounting conservatism reduces a manager's discretion to manipulate earnings, decreasing the volatility of earnings, making stock price forecast errors smaller. In contrast, conservatism increases volatility of earnings, making earnings forecasts more difficult, inducing greater forecast errors of stock price. When a firm increases two forms of conservatism *simultaneously*, due to the over- conservative reporting, could the forecast errors become smaller or greater? This interesting problem motivates us to study the relation between forecast errors and two forms of conservatism *simultaneously*. Second, analysts' earnings forecast is used to predict stock return (Sohn, 2012). Existing research confirms the relation between conservatism and "analysts' earnings forecast error"; however, few studies explore the relation between conservatism and "stock price forecast error". In short, above gaps motivate us to investigate the relation between "stock price forecast error" and two forms of conservatism *simultaneously*.

In response to the above motivation, this paper makes three contributions to the literature. First, this paper investigates the relation between forecast errors of

[2] The research includes Basu (1997), Kousenidis et al. (2009) and LaFond and Watts (2008). Conditional conservatism stems from the definition of Basu (1997) that negative news (negative returns) is recognized faster in earnings than positive news (positive returns).

stock price and two forms of conservatism simultaneously, which is not explored in previous research. Second, this paper studies the relation between conservatism and "stock price forecast error", instead of the relation between conservatism and "analysts' earnings forecast error" in previous studies. Third, in practice, forecast errors and accounting conservatism appear to be related. This information could be of interest to both investors and firm managers.

This study differs from previous research in other ways. First, unlike existing studies applying Ordinary Least Squares (OLS) regression and cross-sectional (or pooled) data, this paper utilizes longitudinal data and time series methodologies - vector error correction model (VECMs) (Engle and Granger, 1987), which can identify changes in forecast errors from short-run to long-run forecast horizons. Second, although this paper applies the VECM approach as Kuo (2016), our subject is to study how to use two types of accounting conservatism to reduce forecast errors, unlike Kuo (2016) studying how to use the superiority of VECM over OLS regression to reduce forecast errors. Third, unlike prior research (Mensah et al., 2004; Pae and Thornton, 2010; Sohn, 2012) using a variety of industries, this paper chooses five industries data.

This paper models trivariate VECMs using quarterly stock market data from the Taiwan Economic Journal (TEJ) database. The stocks under investigation include five sectors: electronics and components (ETC); electric machinery (EM); tex tile (TEX); glass and ceramics (GC); and oil, gas, and electricity (OGE)[3]. We model the high-and-low level VECMs using the variables based on high-and-low conservatism proxy and conduct an out-of-sample forecasting experiment. Two tools that attract many applications in forecasting economic studies are employed to evaluate forecast errors of the VECMs. One tool is root mean squared error (RMSE) and mean absolute error (MAE) (Meese and Rogoff, 1983). The other is Diebold-Mariano test (Diebold and Mariano, 2002).

The main findings of this paper are as follows. The relation between forecast errors and the two forms of conservatism vary across industries. For large industries (ETC, EM, TEX), when a firm adopts higher unconditional conservatism and lower conditional conservatism, forecast errors are smaller, in accordance with negative effects of UC on forecast errors (Pae and Thornton, 2010) and positive effects of CC on forecast errors (Callen et al., 2010, Pae and Thornton, 2010). In contrast, for small industries (GC, OGE), a firm with lower unconditional conservatism and higher conditional conservatism has smaller forecast errors.

The above findings can be explained by the following. The large industries are likely to be more visible, have a large analyst following, and thus have less information asymmetry. Higher unconditional conservatism (UC) is likely to be

[3] The ETC, EM, and GC data cover the period from 1995Q1 to 2015Q4, while the TEX and OGE data span from 1986Q1 to 2015Q4.

interpreted properly, pre-empt and reduce the impact of any bad news. Consequently, higher UC and lower CC are associated with lower forecast error. Small industries, on the other hand, are less visible, have a small or no analyst following, and have more profound information asymmetry. Higher UC may not cause over-reaction but not necessarily reduce the impact of bad news. As a result, higher CC and lower UC may work better in reducing forecast error.

The robustness tests of using OLS regression and DM test support above findings. For the practical implications, forecast errors and accounting conservatism seem to be related. This information could be of interest to both investors and firm managers.

The remainder of this paper is organized as follows. Section 2 reviews the previous literature, section 3 presents our methodology and data, section 4 summarizes our empirical results, and the final section proposes our conclusions.

2 Literature review

2.1 Accounting conservatism and forecast as well as prediction

Prior research offers some evidence on the negative effects of conservatism on the errors of forecast or prediction. Kim et al. (2013) argue that, for highly conservative firms measured by unconditional conservatism proxies (P/B, NOACC, R&D), adjusted measure of RIM-based value predicts higher returns accuracy. Sohn (2012) posits that the return predictability of value-to-price (V/P)[4] is stronger for more conservative firms, which are measured by unconditional conservatism proxies (MB, NOACC, Q-score, SKEW, and VAR)[5] and conditional conservatism proxies (C_SCORE). Pae and Thornton (2010) find that the firms with higher unconditional conservatism (measured by market-to-book ratio, MTB) exert less earnings forecast inefficiency. Higher MTB firms have relatively lower book values to write off in response to bad news than lower MTB firms. The earnings of high MTB firms are likely to exhibit less asymmetric timeliness on earnings than those of the low MTB firms, inducing less earnings forecast inefficiency[6].

Opposing evidence that conservatism has positive effects on the errors of

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[4] The return predictability of V/P ratio means that future 36-month size-adjusted abnormal returns (SAR36) increase from low level (Q1) of V/P quintiles to high level (Q5).

[5] Sohn's (2012) sensitivity tests show that empirical results are robust after controlling for the relationship between conditional and unconditional conservatism.

[6] Based on the Basu's (1997) definition, accounting conservatism is asymmetric timeliness (AT), indicating that the incremental timelines of earnings reflect negative returns (bad news) compared with positive returns (good news). Pae and Thornton (2010) argue that the positive association between forecast inefficiency and AT is driven largely by firms with low balance sheet reserves (BSR), which are proxied by two unconditional conservatism measures: market-to- book (MTB) ratios and reserve (RES).

forecast or prediction is proposed in the literature. Using unconditional conservatism measures (reserve-RES and accruals-ACCR), Mensah et al. (2004) demonstrate that more conservative accounting has the effect of increasing forecast errors of analysts' earnings. Conservatism will decrease earnings forecast accuracy because the magnitude of R&D and advertising expensed immediately is unpredictable, and variation of the two expenditures is prone to cause greater uncertainty of reported earnings. Pae and Thornton (2010) posit that earnings of firms with higher conditional conservatism measured by C_Scores are lower relative to forecast, inducing greater earnings forecast inefficiency. Callen et al. (2010) construct a conditional conservatism measure (CR) and find that the higher the CR, the more conservative a firm. Conservatism can be viewed as asymmetric timeliness, with bad news reflected in earnings earlier than good news, similar to Basu's (1997) argument. They find that higher conservatism firms have more increased volatility of returns and earnings, and make analysts' earnings forecasts more difficult, inducing greater earnings forecast errors. Their findings are analogous to Mensah et al.'s (2004) conclusion that earnings are likely to be more volatile under conservatism than neutral accounting.

2.2 Accounting conservatism and valuation

Prior research has offered some evidence on the positive effect of accounting conservatism on valuation. It is easier for analysts to forecast earnings for more conservative firms because unconditional conservatism restricts a manager's discretion to manipulate earnings, and narrows the range of reported earnings and makes the analysts' earnings forecasts contain less noise; hence, stock values can be estimated with less noise and are more accurate because analysts' earnings forecast is a main component of estimating stock value (Sohn, 2012, p. 318). Firms with more conservative financial reporting are less likely to engage in earnings-manipulation activities (Lin et al., 2014). Abnormal returns of equity increase with unconditional conservative reporting, the unamortized portion of R&D assets (Cheng, 2005b). Existing studies have provided evidence on the positive information benefits of conditional conservatism being priced by investors. Conditional conservatism in financial reporting provides information benefits, such as reducing information asymmetry between insiders and outside investors, reducing potential litigation risk, and improving contracting efficiency (Basu, 1997; LaFond and Watts, 2008; Watts, 2003). Investors price these information benefits and increase equity valuation accuracy (García Lara et al., 2011). The significant increases in shareholder value stem from conservative reporting during financial crises (Francis et al., 2013).

Contrary evidence in previous research has shown that conservatism generates negative effects on valuation. Chen et al. (2014) adopt conditional measures (asymmetric earnings - timeliness in and CR ratio) and unconditional measures (non-operating accruals, the difference between skewness of cash-flow and earnings) to find that pricing multiples on more conservative firm's earnings is smaller than those on less conservative firm's earnings because conservatism reduces earnings persistence. Unconditional conservative accounting generates understated book values and earnings that do not fully reflect the discounted value of future expected payoffs when pricing securities (Easton and Pae, 2004). Pricing multiples is smaller for conditionally conservative earnings than for unconditionally conservative earnings. Conservatism exerts negative effects on the accuracy of value estimates when the RIM is applied to valuation (Monahan, 2005). The effects of conditional conservatism on valuation exhibit mixed directions. The value relevance of conservatism increases when moving from low conservative to medium conservative firms and decreases when moving further to high conservative firms (Kousenidis et al., 2009).

2.3 Stock return predictability and stock price forecasting

Recently, a growing number of studies have investigated stock return predictability. Xue and Zhang (2017) apply a threshold quantile autoregressive model and find that predictability exists in the Chinese stock market. Using daily Chinese panel data, Westerlund et al. (2015) argue that financial and macroeconomic variables can predict returns. Narayan and Bannigidadmath (2015) conclude that Indian stock returns are predictable by employing GLS estimators and eight economic variables as predictors. They find that combined forecasts significantly improve out-of-sample forecasting performance compared with that of individual predictive regression models. Narayan et al. (2015a) find that order imbalance predicts returns from 1-minute trading to 90-minute trading. Narayan et al. (2015b) adopt a GLS model and find that governance variables predict stock returns in countries with weak governance. Narayan et al. (2014a) use a multivariate predictive regression model and find that institution variables predict returns for 12 countries, while macroeconomic variables predict returns for 9 countries. Narayan et al. (2014b) estimate a time-series predictive regression model and show that, when market returns predict sector returns, the magnitude of predictability varies by sector. Based on a predictive regression framework, Gupta and Modise (2013) find that interest rates, money supply, and inflation rates show predictive power of stock returns. Gupta and Modise (2012) find that Treasury bill rates and term spreads, together with the stock returns of major trading partners, show predictive power of stock returns in the samples.

Unlike the above research using single-equation models, time-series multi-equation models (VECM) are applied to stock-price-forecasting research, which includes cointegration, revealing the long-term behavior. Kuo (2016) finds that the VECM statistically outperforms VAR and single-equation models (OLS, RW) in forecasting stock prices, consistent with the expectation from earlier research[7] showing that an error correction term (ECT) in the VECM system contributes to improving the forecast accuracy of stock prices because it can

[7] Granger (1986) states that “the error-correction models (ECM) should produce better short-run forecasts and will certainly produce long-run forecasts that hold together in economically meaningful ways.”

capture long-term cointegration relationships between price forecasts and predictors. Cheung et al. (2009) adopt cointegrating and VECM to model daily high prices, low prices, and associated range data. Using stock indices of eight countries, including Taiwan, they find that VECM-based low and high price forecasts offer advantages over alternative forecasts.

3 Research method

3.1 Proxies for unconditional and conditional conservatism

To compare the forecast performance between high-and low-level of accounting conservatism, this paper divides all sample firms into high-and low-level groups based on conservatism proxies. Following the prior literature, we adopt two forms of conservatism, unconditional and conditional conservatism (Beaver and Ryan, 2005), which are measured by six proxies and two proxies, respectively. Concerning six unconditional proxies, our first proxy is the price-to-book ratio (P/B), calculated as market capitalization (stock price per share multiplied by outstanding shares) in year t divided by book value in year t-1 (Kim et al., 2013). According to Feltham and Ohlson's (1995) work, an accounting system is conservative if the expected value at time t of the excess of market value over book value of a firm at time t+τ is greater than zero as τ approaches infinity (Sohn, 2012, p. 324). When accounting is more conservative, the book value is understated more relative to its true economic value (Ashton and Wang, 2013). Hence, the greater the P/B ratio, the more conservative the firm. The P/B ratio controls for a firm's growth prospects (Callen et al., 2010).

The second proxy is research and development expenditures (R&D) scaled by sales as used by Kim et al. (2013, p. 391) and Cheng (2005b). We use the third proxy of non-operating accruals (NOACC), measured by subtracting estimated operating accruals (Δ Accounts receivable + Δ Inventories + Δ Prepaid Expenses - Δ Accounts Payable - Δ Tax payable) from total accruals (Net income + Depreciation - Cash flow from Operation) (Kim et al., 2013, p. 383). The fourth proxy is reserve (RES), the opening level of a firm's reserve deflated by net operating assets (Pae and Thornton, 2010; Penman and Zhang, 2002). RES equals the sum of capitalized R&D, capitalized advertising expense, and the LIFO reserve scaled by net operating assets (NOA). We subtract operating liability from operating assets in the NOA calculation to measure net investment in operations (Penman and Zhang, 2002). The fifth and sixth proxies are the relative skewness and variability of earnings compared to cash flows (SKEW and VAR), as suggested by previous research (Chen et al., 2014; García Lara et al., 2016; Givoly and Hayn, 2000; Sohn, 2012). We take the difference between earnings skewness (variability) and cash-flow skewness (variability) to calculate SKW (VAR). Greater SKEW and VAR mean higher unconditional conservatism. Overall, the six proxies are consistent with the mechanism that the greater the unconditional conservatism proxies, the more conservative a firm's accounting system. Sohn (2012) finds that it is easier for analysts to forecast earnings for higher conservative firms because conservatism restricts manager discretion to manipulate earnings and narrows the range of future reported earnings; hence, analysts' earnings forecasts contain less noise. Analysts' forecasts are a primary component of stock value, the estimation of which is more accurate with less noise, causing fewer forecast errors (Sohn, 2012). Therefore, we expect that the more unconditionally conservative a firm is, the smaller the forecast errors of stock prices will be.

Regarding conditional conservatism proxies, the first is C_Score, a firm-year-specific news-based measure in Khan and Watts (2009), which has been used by prior literature (Chen et al., 2014; Sohn, 2012). Following Khan and Watts (2009), we employ a two-stage procedure to calculate C_Score; the details are presented in the appendix. Firms with higher C_Score imply that the firms with longer investment cycle, higher idiosyncratic uncertainty, and higher information asymmetry have higher conservatism (Khan and Watts, 2009). The second proxy is the CR ratio developed by Callen et al. (2010). Following their work, we measure the ratio as $CR_t = \eta_{2,t}/Ne_t$, where Ne_t is earnings news measured as $Ne_t = \Delta E_t \sum_{j=0}^{\infty} \rho^j (roe_{t+j} - i_{t+j})$, and $\eta_{2,t}$ is the earnings surprise from the VAR system; the details are presented in the appendix. The ratio is defined as the ratio of unexpected current earnings to total earnings news. It measures how much of the total earnings shock is incorporated into the current period's unexpected earnings. For a given negative shock, the greater the CR ratio, the more conservative the firm because more of total negative shock to current and future cash flows is recognized in the current financial statement (Callen et al., 2010).

3.2 Theoretical model and variable measurement

Accounting conservatism is also an important determinant of abnormal return of equity (ROE) calculated by residual income scaled by book value (Feltham and Ohlson, 1995; Ohlson, 1995). Cheng (2005b) demonstrates that a firm's conservative accounting factor has the positive impact of conservatism on abnormal ROE, which increases with the factor. Inspired by this evidence, we adopt Eq. (1) as the theoretical model. The residual income valuation model[8] indicates that the firm value of equity equals the book value of equity plus the present value of future expected residual income (firm subscripts are omitted below for brevity), which is expressed as:

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[8] The residual income model is derived from the dividend discount model and the assumption of clean-surplus accounting (Edwards and Bell, 1961; Ohlson, 1995)

$$V_t = BV_t + E_t\left[\sum_{\tau=1}^{\infty}\frac{(X_{t+\tau} - r_t \cdot BV_{t+\tau-1})}{(1+r_t)^{\tau}}\right] \quad (1)$$

where V_t is intrinsic value of equity, BV_t is book value of equity, E_t (.) is the expectation operator conditional on time t information, X_t is earnings before extraordinary item for time t, and r_t is the cost of equity capital, which is employed to discount the payoffs to equity holders.

On the basis of Eq. (1), this study employs its variables (stock value, book value, earnings) to estimate empirical models –VECMs. We use stock price indices of five industries to measure stock value (V): an electronics and components sector index (ETCI); an electric machinery sector index (EMI); a textile sector index (TEXI); a glass and ceramics sector index (GCI); and an oil, gas, and electricity sector index (OGEI). This study uses accounting figures in financial statements to measure book value and earnings rather than the analysts' earnings forecasts used in previous studies (Cheng, 2005a; Elgers and Murray, 1992). Before estimating the VECMs, we treat three variables (stock price, book value, and earnings) according to the following processes:

1. The firm is high conservatism if their conservatism proxy value is higher than the mean of all firms in an industry; the firm is low-conservatism if their proxy value is less than the mean. Based on this rule, the sample firms of each industry are divided to high- and low-level conservative firms, unlike Sohn (2012) who used dummy variables to identify high and low conservatism firms in OLS regression models.
2. When using the price-to-book value ratio (P/B) as a conservatism proxy, we divide high- and low-P/B firms and then calculate the earnings of high- and low-P/B firms for each industry. We thus obtain high and low earnings: E^{hpb} and E^{lpb}. The same procedure is applied to book value; thus, we obtain high and low book value, B^{hpb} and B^{lpb}, for each industry.
3. We divide the P/B sum of high P/B firms by that of all firms and obtain the ratio of high P/B firms to all firms. The same procedure is applied to low P/B firms, and we obtain the ratio of low P/B firms to all firms. For each industry, according to the two ratios, we divide stock price index series into two groups: high and low price indices for high and low P/B firms, which are V^{hpb} and V^{lpb}, respectively.
4. In total, we obtain two sets of variables (stock price, earnings, book value) for high and low P/B firms: (V^{hpb}, E^{hpb}, B^{hpb}) and (V^{lpb}. E^{lpb}, B^{lpb}), respectively.
5. The above procedures are applied to seven other proxies of accounting conservatism: NOACC, R&D, RES, SKW, VAR, CR, and C_score. We obtain fourteen sets of variables (stock price, earnings, and book value) based on the high and low level of seven proxies. In total, sixteen sets of variables are applied to estimate the VECMs.

3.3 The econometric method

Following Kuo's (2016) study that the superiority of VECM over OLS regression in the forecast accuracy of stock prices. this paper utilizes longitudinal data and a time series methodology - VECM. The VECM system has been applied to forecast stock markets and foreign exchange markets in prior studies. This paper uses the VECM representation below:

$$\Delta y_t = \mu + \Pi\, y_{t-1} + \sum_{j=1}^{p-1} \Gamma_j\, \Delta y_{t-j} + \varepsilon_t \qquad (2)$$

where Δy_t denotes a (3 × 1) vector that includes variables, such as stock price (V), earnings (E), and book value (B). We proposed the variables that include high and low levels of eight accounting conservatism proxies in section 3.2. For example, when we use three variables (V^{hpb}, E^{hpb}, B^{hpb}) of high P/B firms, Δy_t is expressed as $\left[\Delta V_t^{hpb}, \Delta E_t^{hpb}, \Delta B_t^{hpb}\right]'$, ε_t is a (3 × 1) vector of white noise disturbance, Γ_j are parameter matrices that define short-term dynamic adjustments to non-stationary variables in the VECM, Πy_{t-1} is a long-term ECT, $\Pi = \alpha\beta'$ is a parameter matrix that contains information about long-term relationships among the variables of y_t, α is a vector that means the error correction speed of the variables adjustment toward the long-run equilibrium, and β is a cointegration vector that captures the long-run equilibrium relationship among n variables.

When we employ three variables (V^{hpb}, E^{hpb}, B^{hpb}) of high P/B firms, given that variable number n is equal to 3 and cointegration rank r equal to 2, we represent a long-run ECT as

$$ECT = \Pi y_{t-1} = \alpha\beta' y_{t-1} = \begin{bmatrix} \alpha_{1V^{hpb}} & \alpha_{2V^{hpb}} \\ \alpha_{1E^{hpb}} & \alpha_{2E^{hpb}} \\ \alpha_{1B^{hpb}} & \alpha_{2B^{hpb}} \end{bmatrix} \begin{bmatrix} \beta_{1V^{hpb}} & \beta_{1E^{hpb}} & \beta_{1B^{hpb}} \\ \beta_{2V^{hpb}} & \beta_{2E^{hpb}} & \beta_{2B^{hpb}} \end{bmatrix} \begin{bmatrix} V^{hpb}_{t-1} \\ E^{hpb}_{t-1} \\ B^{hpb}_{t-1} \end{bmatrix} \qquad (3)$$

Allowing for the possible cointegration relationships among the variables of a vector y_t, we estimate the VECMs using the variables documented in section 3.2. The estimations are performed using the data over the sample period of 1986Q1 (1995Q1) through 2003Q4. We reserve the last 48 quarters of observations (2004Q1 through 2015Q4) to conduct an out-of-sample forecasting experiment. To solve the VECM and obtain the forecasts, we perform the simulation and generate a model solution, which is *h*-steps-ahead recursive forecast of stock price. We then compare forecasted and actual prices to evaluate forecasting errors using two tools. One is forecasting error statistics, including root mean squared error (RMSE) and mean absolute error (MAE) (Meese and Rogoff, 1983)., which are calculated from one quarter ahead through 48 quarters ahead. The other is Diebold-Mariano test (Diebold and Mariano, 2002), which compare forecasting errors between two high-and-low conservatism VECMs[9]. The significant and negative values of DM statistics imply that high-level VECM generates smaller errors than low-level VECM for each conservatism proxy.

The VECM approach has three advantages over OLS regression. First, the VECM system can mitigate three statistical problems (i.e., heteroskedasticity, endogeneity, and persistency), which could improve biased coefficients and inefficiency generated by OLS regression in prediction-and-forecast stock value studies. Second, it allows investors to identify the changes in forecast errors from short-run to long-run forecast horizons and to compare the magnitude of forecast errors between two VECMs based on high-and-low conservatism variables. Third, the VECM system provides for cointegration relationships and ECTs that identify the valuation information contents of variables. For example, our findings of large industries suggest that the VECM of high-unconditional conservatism generates fewer forecast errors than those of low-unconditional conservatism, implying that the variables capturing high-unconditional conservatism contain more valuation information than those of low-unconditional conservatism.

Although this study applies the VECM approach in Kuo (2016), unlike Kuo's (2016) subject, we investigate the relationship between forecast errors and two forms of conservatism, dividing the data into high-and-low levels based on conservatism proxies. Unlike Kuo's (2016) aggregate data from three industries, which do not include firm data, our sample contains firms of five industries. Moreover, this paper employs pooled data and OLS regressions to reexamine the relationship between two forms of conservatism and forecast errors; this robustness test supports our findings using the VECM approach, which was not studied in Kuo's (2016) work.

4 Empirical results

4.1 Data and preliminary results

We chose Taiwanese data for two reasons. First, existing RIM-based studies investigated how stock values are affected by book values and earnings in Taiwan market (Lee, 2007; Tswei, 2013). However, few studies explored how two variables are used to forecast stock prices. Inspired by this, we aim to construct a series of studies on stock price forecasting of Taiwan market. Second, one of the reasons of high variation in the capitalization-weighted price index of Taiwan stocks (TAIEX) may be affected by conservative reporting, such as unconditional and conditional conservatism.

Extending the studies that choose Taiwanese data (Kuo, 2016; Lee, 2007), we collect quarterly accounting data and stock price indices from the TEJ database[10].

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[9] The RMSE and MAE formulas and the DM statistical formula are presented in Supplementary Materials Appendix A.

[10] This paper selects quarterly data because the financial reports of Taiwan-listed firms are announced by

The initial sample includes firms from five industries, ETC, EM, TEX, GC, and OGE, which are listed on the Taiwan Stock Exchange (TWSE). A firm that has complete data to measure three variables (book value, earnings, and stock price) and calculate conservatism proxies can be included in the final sample. We exclude firms with insufficient data to calculate conservatism proxies. To control for the effect of outliers on the coefficients, firms with negative book values and total assets are excluded. Data from the five sectors have different lengths of sample periods: the data for the ETC, EM, and GC sectors span 1995Q1 through 2015Q4, and the TEX and OGE sector data span 1986Q1 through 2015Q4. For each sector, because of data availability, firm size varies with the sample period: 32~365 firms for ETC, 11~70 firms for EM, 13~59 firms for TEX, 2~5 firms for GC, and 6~7 firms for OGE. Upon applying the above criteria, the total firm-quarter observations contain 32,749, including five industries: ETC (22226), EM (4304), TEX (5252), GC (378), and OGE (589).

Because empirical results may be different across different industries due to various industrial characteristics[11], we separate five industries to collect data, different from pooled data used in previous studies (Mensah et al., 2004; Pae and Thornton, 2010). Five industries are selected for two reasons. First, the percentages of their trading volumes to all listed firms' trading volumes for the most recent 5 years are 65% to 72%[12], which explains most of the trading volume of listed companies in the TWSE and is sufficient to represent the overall market. Second, to compare large and small industries[13], we select three large industries – ETC, EM, and TEX, and two small industries – GC and OGE.

Table 1 summarizes the descriptive statistics of the variables for the ETC industry.[14] The mean of earnings and book values of high conservative firms were lower than those of two variables of low conservative firms, suggesting that earnings and book values are lower for higher conservative firms, consistent with concerns of R&D expense and understating book values relative to market value

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quarter.

[11] Earlier research finds that expected stock returns are related to industry characteristics, e.g., industry size, industry concentration, and industry barriers to entry (Moskowitz and Grinblatt 1999; Cohen et al. 2003, Cheng 2005b, Hou and Robinson 2006; Hou 2007). Hou and Robinson (2006) conclude that firms in highly concentrated industries earn lower returns. Nevertheless, Cheng (2005b) finds that industry concentration and industry barriers to entry affect industry abnormal ROE.

[12] According to the stock trading statistical reports of the TWSE, the five sectors' trading volume percentages for the most recent 5 years are 65% for 2012, 66% for 2013, 72% for 2014, 72% for 2015, and 70% for 2016. The details are presented in Supplementary Materials Appendix B.

[13] The definition of large industry is that an industry has abundant firms with high market capitalization. Small industry is defined that an industry has few firms with low market capitalization. Hou (2017) used industry size as one of industry characteristics (IC), and uses market capitalization to define industry size (p.1131).

[14] We report only the ETC industry here to save space in Table 1. The results of other industries are not shown, but they are available in Supplementary Materials Appendix C.

in prior research (Feltham and Ohlson, 1995; Mensah et al., 2004). The mean and standard deviation of price-to-book value ratio (P/B) are 2.46 and 1.02, respectively, slightly less than those (2.55, 2.29) reported by Sohn (2012). The P/B (2.46) on average suggests that market price is higher than book value, indicating that the sample firms perform conservative accounting, similar to findings in previous studies (Kim et al., 2013; Sohn, 2012). The mean of NOACC* (-1) deflated by total assets is approximately 13% of total assets, slightly higher than the 6% reported by Sohn (2012) and 6-10% by Kim et al. (2013). The mean (3.6) of RES is greater than 0.57 reported by Pae and Thornton (2010) and 0.12 in Mensah et al. (2004). These results may be because that we choose one industry data rather than pooled data of multi-industries in the studies.

Following Narayan et al. (2015b), we estimate an AR model of each variable with 12 lags. We extract the residual of the AR model to examine null hypothesis of "no ARCH" in the residual by applying a Lagrange multiplier (LM) test. Test results in Table 1 suggest that the no-ARCH null is rejected at the 1%, 5%, 10% significance level for all variables, supporting the notion that heteroskedasticity exists in each variable.

Upon plotting the data for visual screening, we compare three types of regression models (with or without an intercept, with an intercept and a time trend) and obtain a final test regression. In Table 1, for each variable in the level, the Augmented Dickey-Fuller (ADF) test results indicate that the statistics fail to reject the unit-root null, implying that variable exhibit a unit-root behavior; persistency exists in the variables. When these variables are first-differenced to test again, test results reject the null at three significant levels, showing stationary (no persistency) patterns. Thus, these first-differenced variables can be used to estimate the VECMs.

Table 1: Descriptive Statistics

	High accounting conservatism firms						Low accounting conservatism firms						
Variables	Mean	Std. Dev.	Unit-root test		ARCH	p-value	Variables	Mean	Std. Dev.	Unit-root test		ARCH	p-value
			level	first dif.						level	first dif		
V^{hpb}	131.9	43.5	-2.82	-7.49[a]	21.5	0.00	V^{lpb}	132.5	44.5	-3.31	-3.64[a]	21.5	0.00
E^{hpb}	31569142	37073509	-1.43	-4.85[a]	11.4	0.08	E^{lpb}	37331711	30873173	0.27	-4.16[a]	18.1	0.02
B^{hpb}	1.56E+0.9	9.41E+08	-0.35	-5.37[a]	64.42	0.00	B^{lpb}	1.64E+09	1.06E+09	1.83	-2.55[a]	63.3	0.00
V^{hnoacc}	219.1	72.24	0.05	-3.59[a]	16.6	0.06	V^{lnoacc}	44.8	14.8	0.05	-3.59[a]	41.2	0.00
E^{hnoacc}	11595136	19866547	1.98	-4.85[a]	33.2	0.00	E^{lnoacc}	11605266	16566713	3.37	-2.43[b]	57.5	0.00
B^{hnoacc}	2.81E+08	6.42E+08	1.78	-5.84[a]	68.2	0.00	B^{lnoacc}	3.52E+08	4.77E+08	-0.21	-3.59[a]	69.2	0.00
V^{hrd}	134.6	44.3	0.05	-3.59[a]	21.9	0.00	V^{lrd}	129.3	42.6	0.04	-3.59[a]	37.7	0.00
E^{hrd}	37062821	38531696	-0.57	-7.13[a]	16.5	0.01	E^{lrd}	51827776	32508231	1.02	-4.12[a]	11.9	0.06
B^{hrd}	1.50E+09	9.07E+08	2.16	-2.85[a]	61.8	0.00	B^{lrd}	1.70E+09	1.09E+09	0.72	-3.87[a]	63.9	0.00
V^{hres}	123.1	39.3	-2.98	-4.01[a]	5.7	0.01	V^{lres}	149.2	47	-0.22	-4.93	6.1	0.01
E^{hres}	47659981	31832540	-0.64	-5.43[a]	5.1	0.07	E^{lres}	55408265	58804135	-0.55	-6.87	13.8	0.00
B^{hres}	1.04E+09	5.76E+08	-0.72	-6.61[b]	33.8	0.00	B^{lres}	2.54E+09	1.72E+09	1.26	-2.83	29.7	0.00
V^{hskw}	128.5	41.1	0.25	-3.86[a]	10.5	0.00	V^{lskw}	143.8	45.9	0.25	-3.86	10.5	0.00
E^{hskw}	67838281	54270896	1.77	-5.43[a]	29.4	0.00	E^{lskw}	35229965	35977065	-0.91	-6.18	5.6	0.01
B^{hskw}	1.05E+09	9.29E+08	1.03	-1.78[b]	74.1	0.00	B^{lskw}	2.08E+09	1.37E+09	2.03	-3.21	79.1	0.00
V^{hvar}	142.7	45.6	0.25	-3.86[a]	23.4	0.00	V^{lvar}	129.0	41.4	-0.22	-4.93	24.6	0.00
E^{hvar}	67838281	54270896	0.04	-4.33[a]	29.4	0.03	E^{lvar}	35229965	35977065	-2.01	-7.72	5.6	0.02
B^{hvar}	1.5E+09	9.29E+08	-1.75	-1.33[a]	64.2	0.00	B^{lvar}	2.08E+09	1.37E+09	0.62	-4.32	66.5	0.00
V^{hcr}	165.6	52.8	-0.22	-4.92[a]	10.5	0.00	V^{lcr}	106.7	34.1	0.25	-3.86	24.6	0.00
E^{hcr}	55884700	39018962	-1.35	-7.06[a]	8.7	0.00	E^{lcr}	47183547	56678838	1.25	-5.01	22.9	0.00
B^{hcr}	1.53E+09	9.59E+08	1.79	-5.28[b]	70.1	0.00	B^{lcr}	2.05E+09	1.32E+09	0.75	-2.67	77.1	0.00
V^{hc}	174.3	55.6	0.25	-3.86[a]	5.8	0.02	V^{lc}	98.1	31.3	0.26	-3.95	29.7	0.00
E^{hc}	48321519	59653820	0.26	-5.13[a]	18.4	0.00	E^{lc}	54836728	37076743	-1.68	-5.98	30.6	0.00
B^{hc}	1.94E+09	1.38E+09	1.27	-3.81[a]	71.1	0.00	B^{lc}	1.65E+09	1.04E+09	-1.52	-9.91	60.3	0.00

Variables	Mean	Std. Dev.	Unit-root test		Variables	Mean	Std. Dev.	Unit-root test	
			level	first dif.				level	first dif.
Conditional Conservatism variables									
P/B	2.46	1.02	-0.96	-6.84[a]	SKW	-0.66	1.65	-2.29	-5.93[a]
NOACC * (-1)	0.13	0.06	-0.72	-4.77[a]	VAR	-485928	1932808	-3.74	-11.19[a]
R&D	0.05	0.08	-2.18	-8.83[a]	RES	3.65	0.86	-5.52[a]	-9.91[a]
Unconditional Conservatism variables									
C	352433	53976	-1.47	-14.39[a]	CR	0.11	0.13	-3.55	-5.64[a]

Notes:

1. This table shows the descriptive statistics for electronic & components (ETC) sector. To save the space, findings of other sectors are not shown here and they are available upon the request.
2. Unit-root test indicates ADF test. Eight group variables with high- and low conservatism in level were nonstationary while their first differences rejected a null hypothesis of unit root at the 1%, 5% and 10% significance level. These variables were inferred to be I (1) series.
3. a, b, c indicate the statistical significance at the 1%, 5%, 10% level, respectively.

We examine three statistical features (persistency, endogeneity, and heteroskedasticity) of time- series data, which are relevant to the specification of VECM. These features are important to the performance of the predictive model (Narayan et al., 2015b). Above findings show that first- differenced variables have no persistency in unit-root tests.

Table 2 shows results of forecast model diagnostics for the ETC industry. For each variable, the slope $\hat{\gamma}$ in VECM cannot reject the null of no endogeneity ($\gamma=0$), suggesting that no endogeneity exists in two predictors (earnings, book value)[15]. The columns 2 and 3 in Table 2 report that the null of no heteroskedasticity is not rejected because the Chi squared statistics have *p*-values greater than three statistically significant levels (1%, 5%, 10%).[16] In summary, no presence of endogeneity and heteroskedasticity is recognized in predictor variables of the VECMs. Therefore, the use of VECMs can control for three statistical features of the time-series data.

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[15] Based on the work of Westerlund and Narayan (2015) and Narayan et al. (2014a, 2014b, 2015a, 2015b), we implement forecast model diagnostics by testing the endogeneity and heteroskedasticity. For the endogeneity of two predictors, following Westerlund and Narayan's (2015) data generating process (DGP) given by Eq. (1) ~ Eq. (3): $y_t=\theta+\beta x_{t-1}+\varepsilon_{y,t}$ (1), $x_t=\mu(1-\rho)+\rho x_{t-1}+\varepsilon_{x,t}$ (2), $\varepsilon_{y,t}=\gamma\varepsilon_{x,t}+\varepsilon_{y.x,t}$ (3), we estimate Eq. (3) in Westerlund and Narayan (2015) and obtain the estimator $\hat{\gamma}$ of γ, which is slope coefficient in the regression of $\varepsilon_{y,t}$ on $\varepsilon_{x,t}$.

[16] To save space, we display the results of the ETC industry here. The results of other industries similar to ETC are not reported in the table, but they are available upon request.

Table 2: Forecast model diagnostics

Predictor	Residual Heteroskedasticity Tests		Endogeneity	
$VECM^{hpb}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{hpb}	135	0.27	0.02	0.35
B^{hpb}	127	0.44	-0.01	0.76
$VECM^{lpb}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{lpb}	123	0.55	-0.25	0.76
B^{lpb}	119	0.65	0.67	0.35
$VECM^{hnoacc}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{hnoacc}	148	0.08	-0.31	0.71
B^{hnoacc}	144	0.13	-0.17	0.32
$VECM^{lnoacc}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{lnoacc}	136	0.25	-0.76	0.31
B^{lnoacc}	162	0.23	-0.06	0.71
$VECM^{hrd}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{hrd}	137	0.22	0.03	0.14
B^{hrd}	126	0.47	-0.76	0.32
$VECM^{lrd}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{lrd}	129	0.43	-0.017	0.32
B^{lrd}	117	0.69	0.67	0.35

Predictor	Residual Heteroskedasticity Tests		Endogeneity	
$VECM^{hres}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{hres}	138	0.21	1.66	0.92
B^{hres}	124	0.52	23.8	0.10
$VECM^{lres}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{lres}	122	0.57	24.12	0.18
B^{lres}	134	0.28	19.19	0.35
$VECM^{hcr}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{hcr}	139	0.19	0.12	0.02
B^{hcr}	120	0.62	36.88	0.29
$VECM^{lcr}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{lcr}	138	0.20	2.15	0.33
B^{lcr}	129	0.40	24.18	0.10
$VECM^{hcscore}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
E^{hscore}	134	0.29	24.18	0.10
B^{hscore}	129	0.49	-5.96	0.86
$VECM^{lscore}$				
	Chi-sq	*p*-value	$\hat{\gamma}$	*p*-value
$E^{lcscore}$	126	0.47	13.48	0.28
$B^{lcscore}$	122	0.58	-8.45	0.36

Notes: this table shows the results of forecast model diagnostics by testing the endogeneity and heteroskedasticity. For all variables, the slope $\hat{\gamma}$ in VECM cannot reject the null of no endogeneity ($\gamma=0$), suggesting that no endogeneity exists in the two predictors. Examining the results in columns 2 and 3, the null of no heteroskedasticity is not rejected because the Chi squared statistics of the two predictors have *p*-values greater than three statistically significant levels (1%, 5%, 10%), except for E^{lnoacc} (*p*-value = 0.08). In summary, no presence of endogeneity and heteroskedasticity was recognized in the predictor variables of the forecast models (VECMs). Therefore, the use of VECMs can control for three statistical features of the time-series data.

To conduct the out-of-sample forecasting, we divide the full sample into two groups: an in-sample (estimation) period from 1986Q1 (1995Q1) through 2003Q4, and an out-of-sample (forecasting) period from 2004Q1 through 2015Q4. We reserve 48 quarterly observations as forecasting samples. For each industry, using three variables (price, earnings, book value) described in section 3.2, we estimate each VECM and solve the model by conducting a simulation over a forecasting period, generating solutions, which are the forecasts. The trace test proposed by Johansen (1991) and Johansen and Juselius (1992) is employed to conduct the cointegration rank test, and test findings show that two cointegration relationships exist among three variables. To save space, the cointegration rank test and estimation of VECMs are presented in Supplementary Materials Appendix D.

4.2 Do the VECMs based on high conservatism firms generate smaller forecast error than the VECMs based on low conservatism firms?

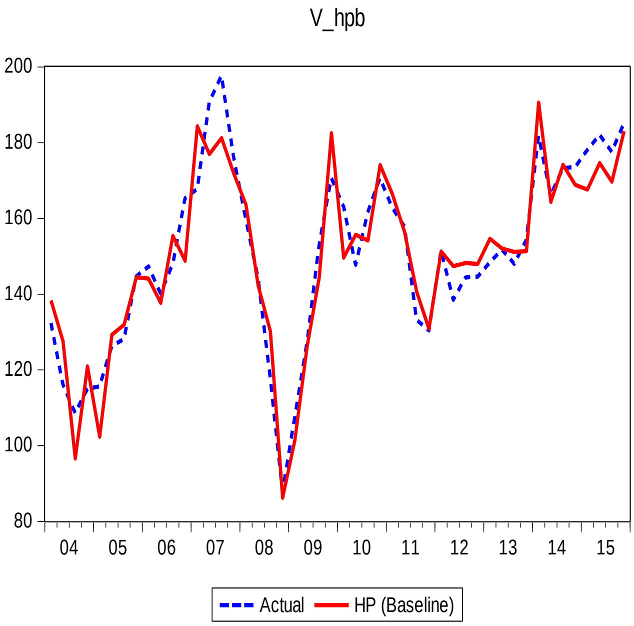
Figure 1 and Figure 2 display the plots of actual series and forecast of stock prices based unconditional conservatism (UC) and conditional conservatism (CC) proxies for ETC and GC industries[17]. Large sector (ETC, EM, TEX) suggest that the forecasts of stock price of high UC firms are closer to actual series than those of price of low UC firms., whereas forecasts of stock price on low CC firms are nearer to actual series than those of stock price of high CC firms. For example, for UC proxies - P/B, the forecasts of the V^{hpb} are closer to actual series than those of the V^{lpb}, suggesting that $VECM^{hpb}$ generates smaller forecasting errors than $VECM^{lpb}$. Similar patterns are found in other UC proxies (NOACC, RD, RES, SKW, and VAR). In contrast, for CC proxies – CR, the forecasts of the V^{lcr} are closer to actual series than those of the V^{hcr}, suggesting that $VECM^{lcr}$ has smaller forecasting errors than $VECM^{hcr}$. Similar patterns are found in C_score.. Small industries (GC and OGE) exhibit patterns opposite to large industries. The forecasts of stock price of low UC firms are closer to actual series than those of price on high-UC firms, whereas forecasts of stock price of high CC firms are nearer actual series than those of low-CC firms.

[17] To save space, the figures of other sectors are not shown but are presented in Supplementary Materials Appendix E.

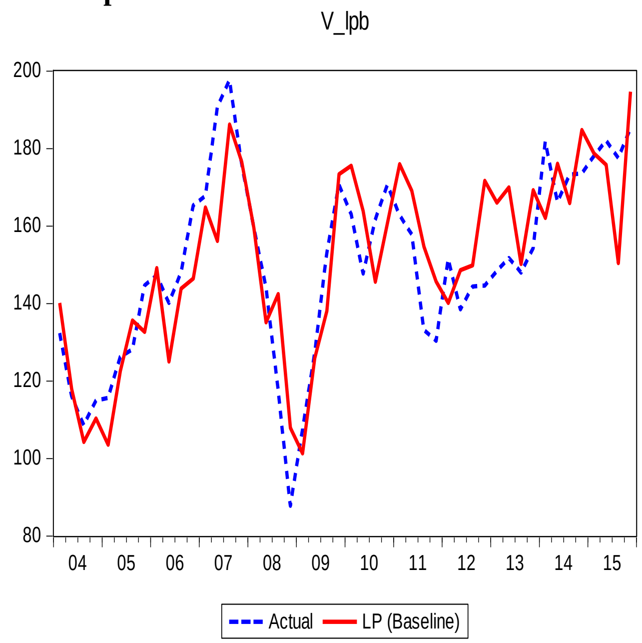
Electronic & Components Industry (ETC)

Unconditional conservatism proxy

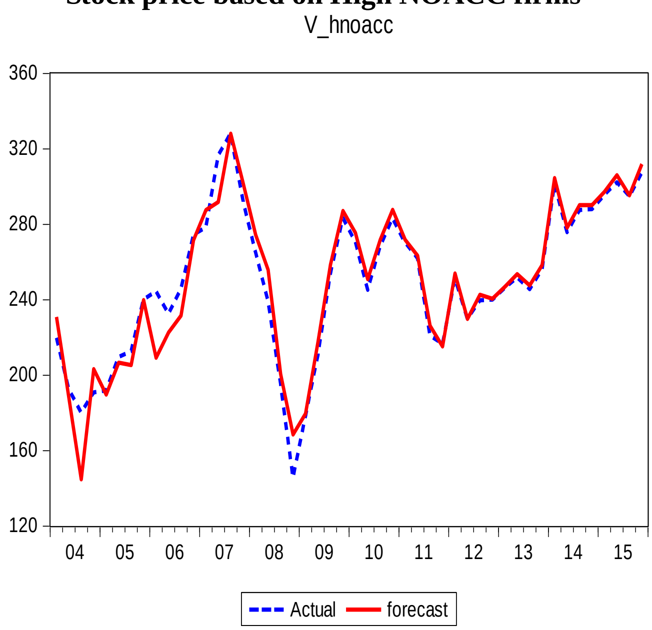
Stock price based on High P/B firms



Stock price based on Low P/B firms



Stock price based on High NOACC firms



Stock price based on Low NOACC firms

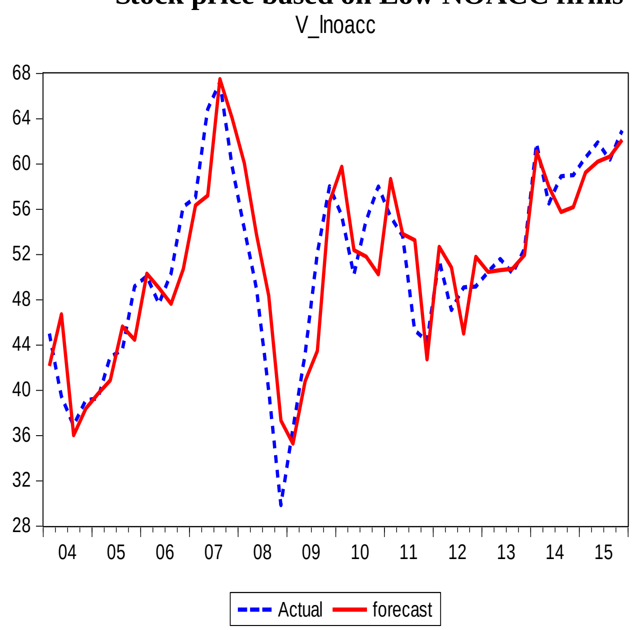
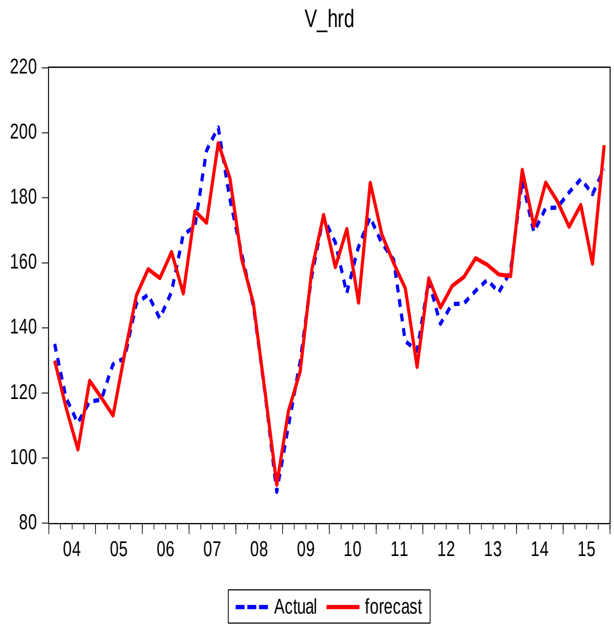


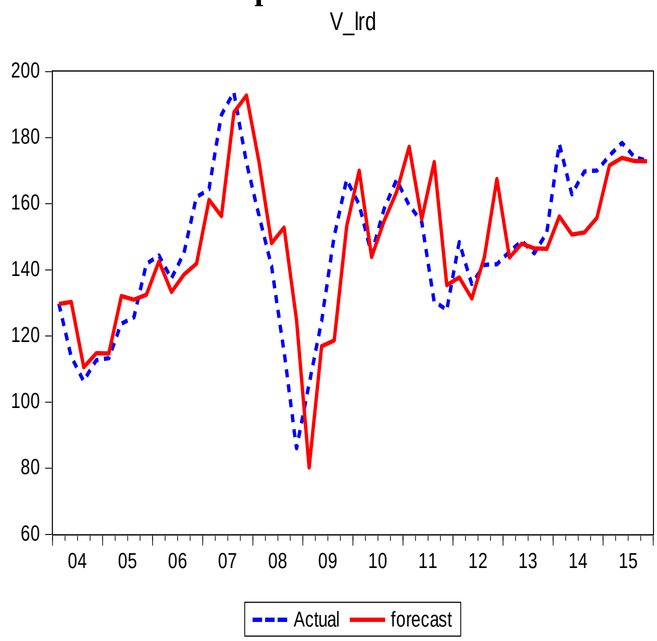
Fig.1. Forecasts and actual series of six stock prices based on high and low conservatism proxies over the forecasting horizons 2004Q1~2015Q4 for Taiwan electronic & components stock.

. Unconditional conservatism proxy

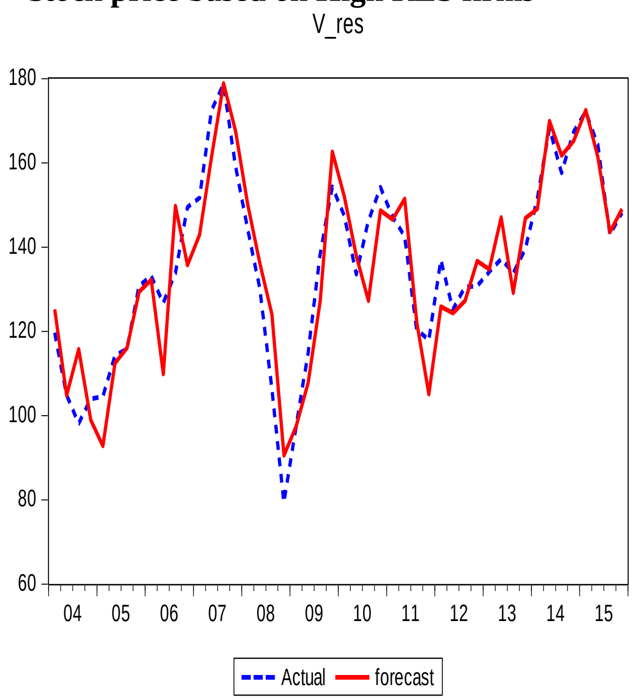
Stock price based on High RD firms



Stock price based on Low RD firms



Stock price based on High RES firms



Stock price based on Low RES firms

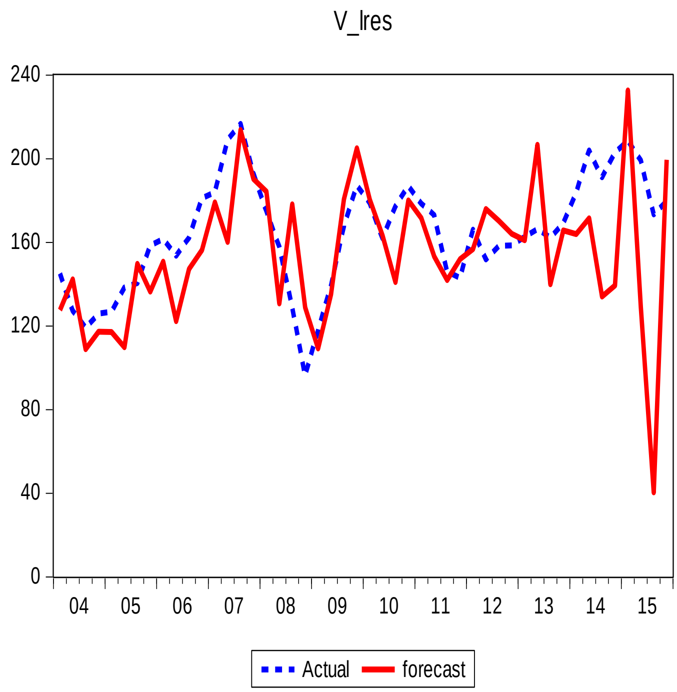
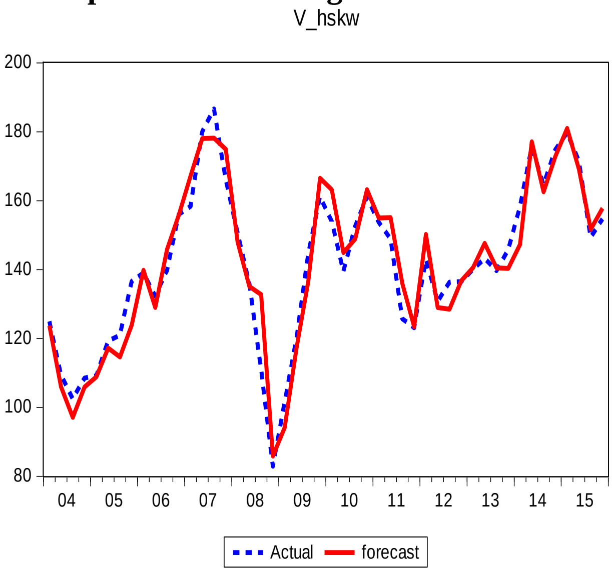


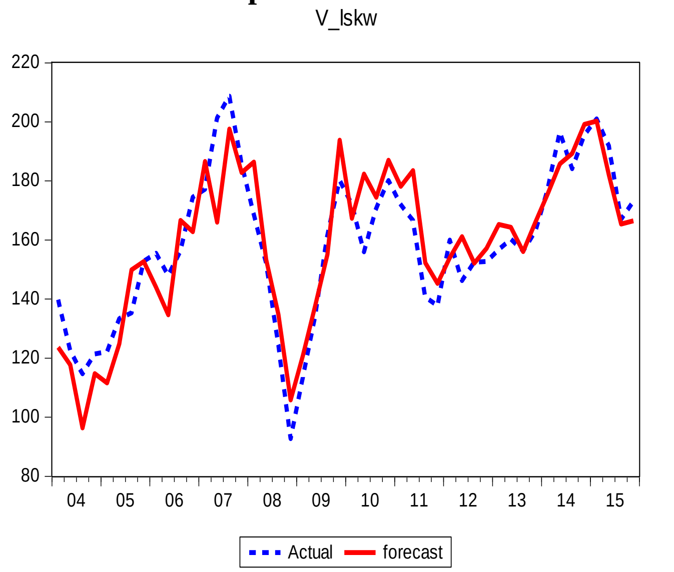
Fig.1. Forecasts and actual series of six stock prices based on high and low conservatism proxies over the forecasting horizons 2004Q1~2015Q4 for Taiwan electronic & components industry stock.

Unconditional conservatism proxy

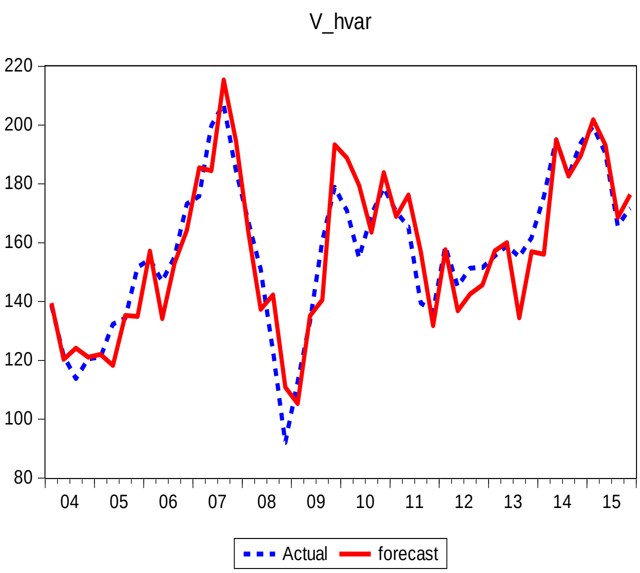
Stock price based on High SKW firms



Stock price based on Low SKW firms



Stock price based on High VAR firms



Stock price based on Low VAR firms

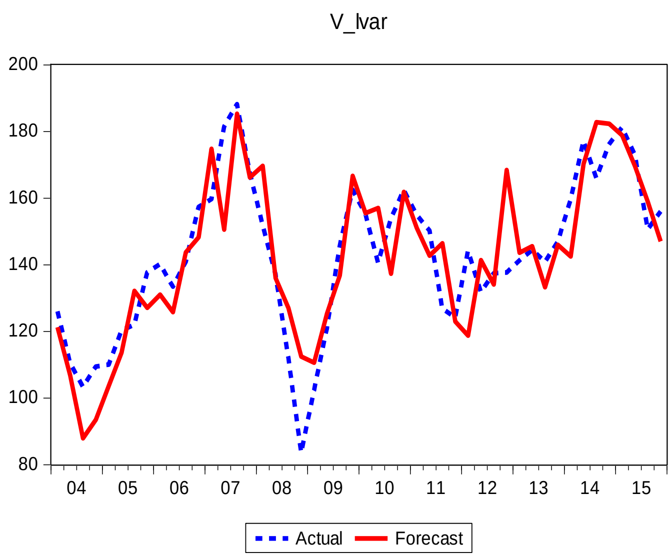
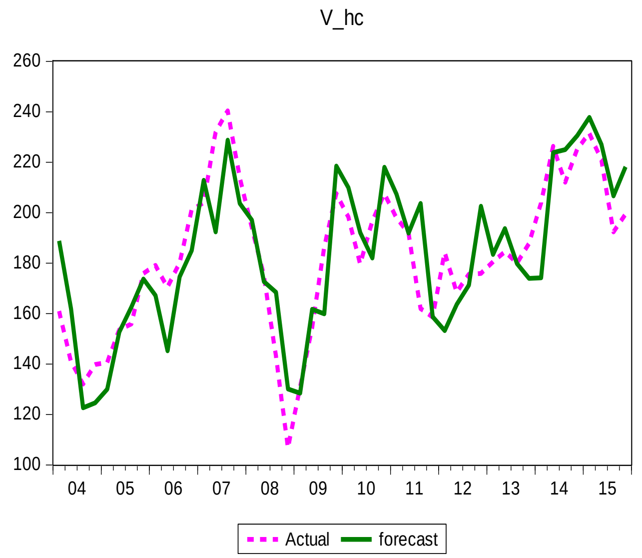


Fig.1. Forecasts and actual series of six stock prices based on high and low conservatism proxies over the forecasting horizons 2004Q1~2015Q4 for Taiwan electronic & components stock.

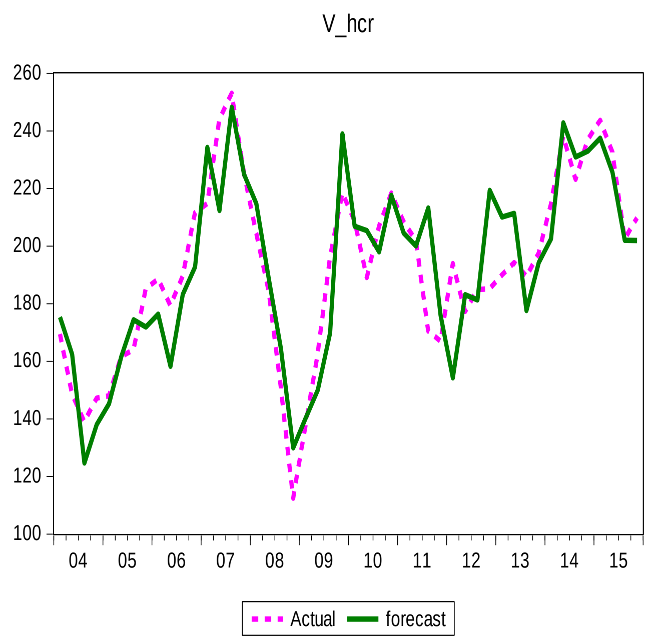
Conditional conservatism proxy

Stock price based on High C_sore firms



Stock price based on Low C_sore firms

Stock price based on High CR firms



Stock price based on Low CR firms

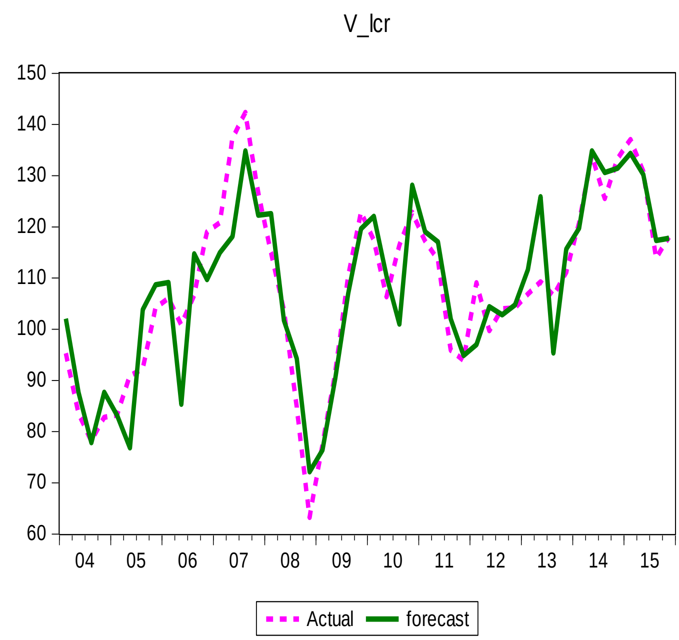
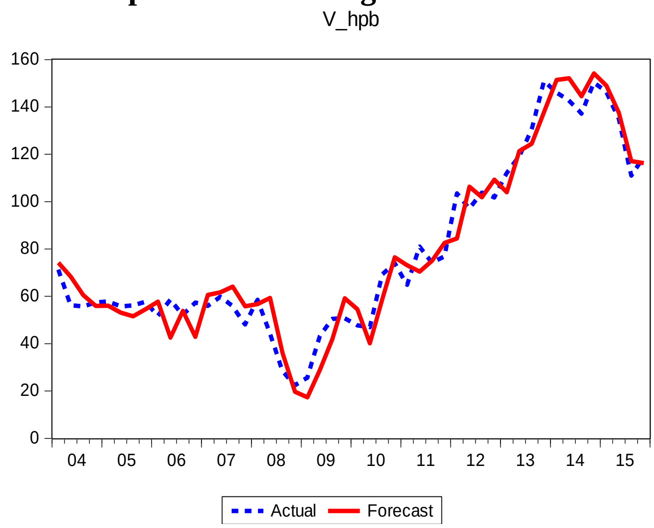


Fig.1. Forecasts and actual series of six stock prices based on high and low conservatism proxies over the forecasting horizons 2004Q1~2015Q4 for Taiwan **electronic & component**s stock.

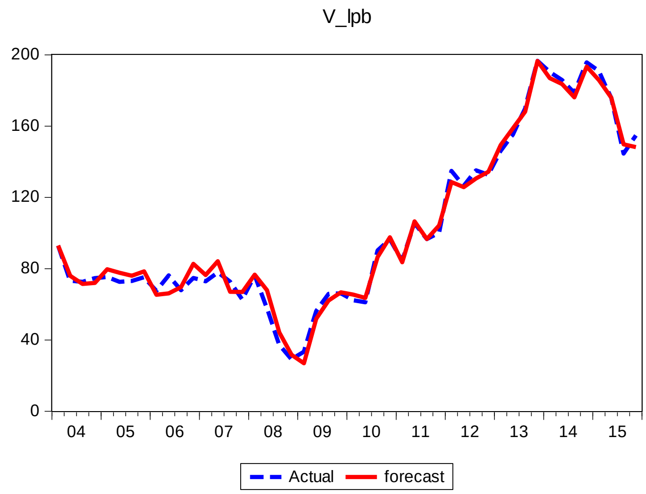
Glass & Ceramics Industry (GC)

Unconditional conservatism proxy

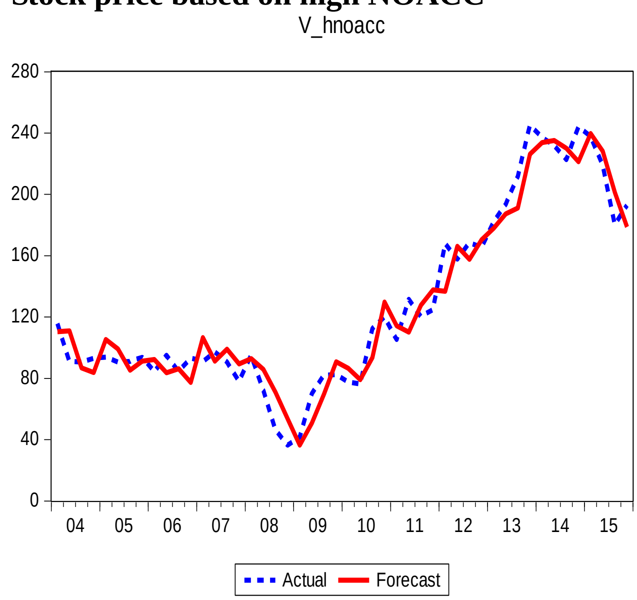
Stock price based on high P/B



Stock price based on low P/B



Stock price based on high NOACC



Stock price based on low NOACC

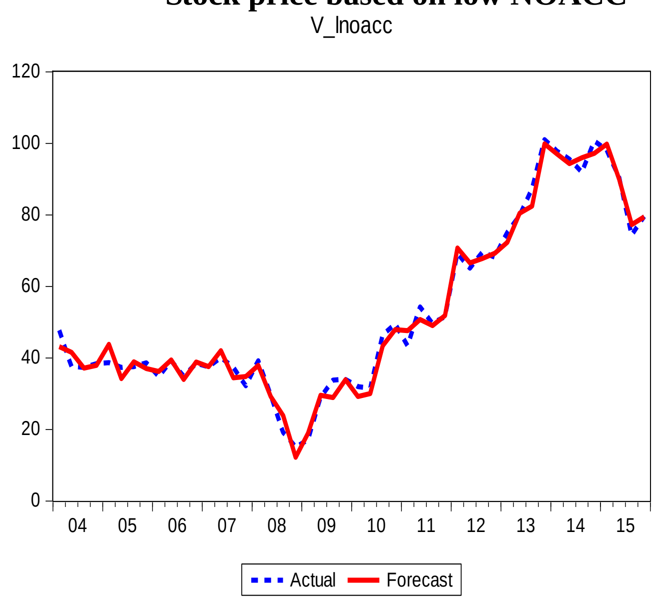
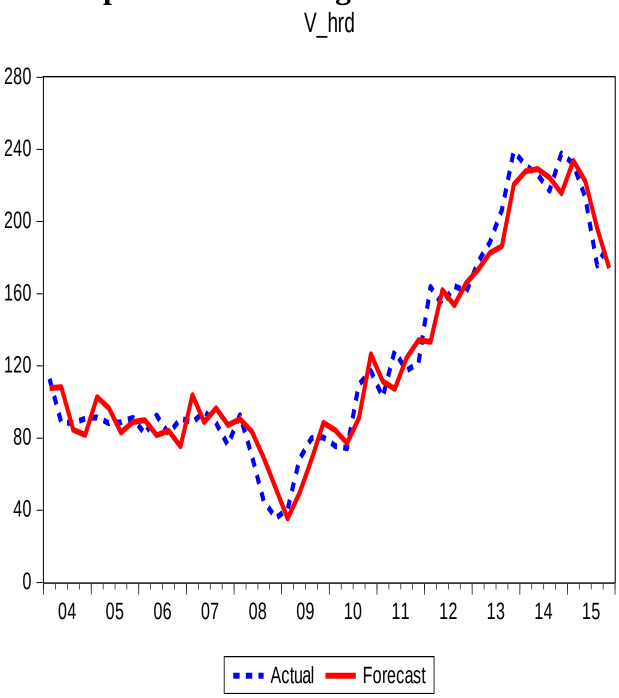


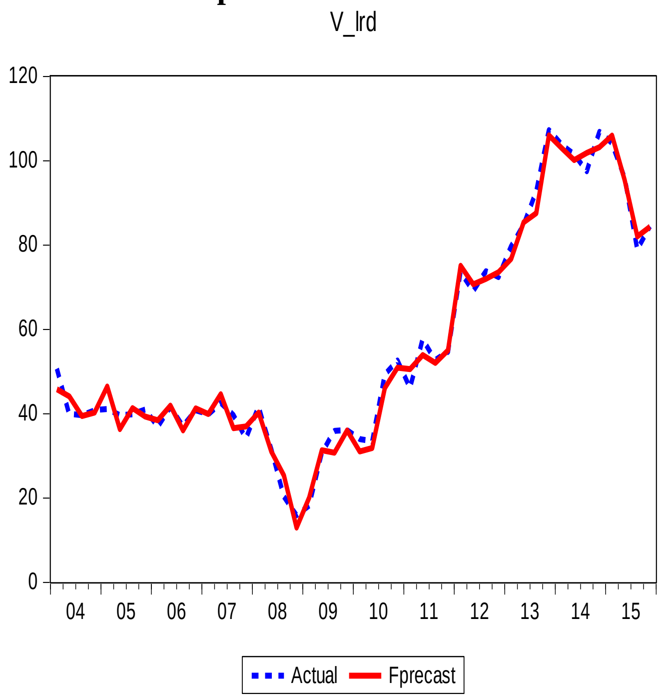
Fig.2. Forecasts and actual series of six stock prices based on high and low conservatism proxies over the forecasting horizons 2004Q1~2015Q4 for **glass & ceramics** stock.

Unconditional conservatism proxy

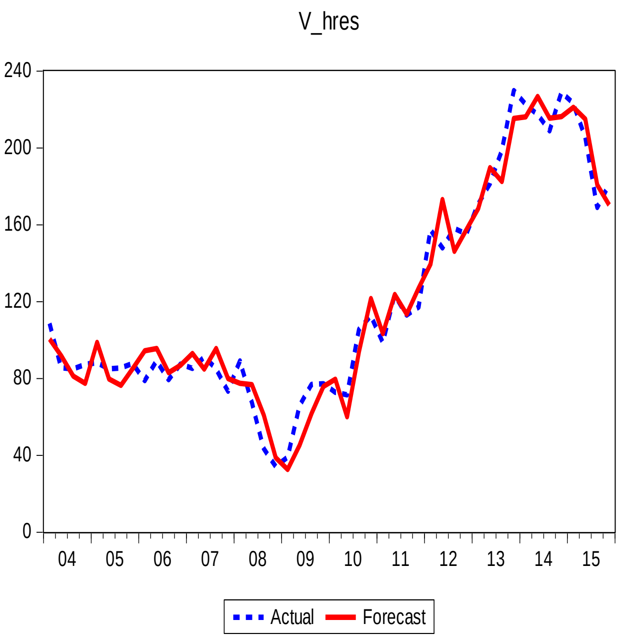
Stock price based on high RD



Stock price based on low RD



Stock price based on high RES



Stock price based on low RES

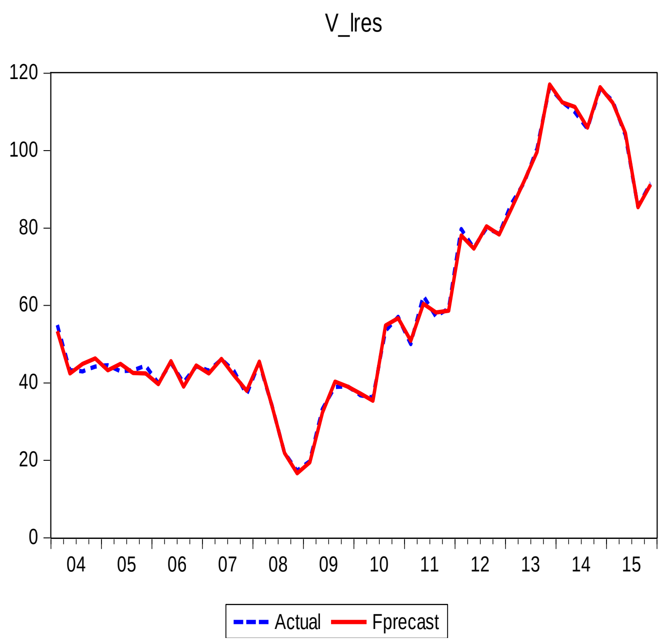
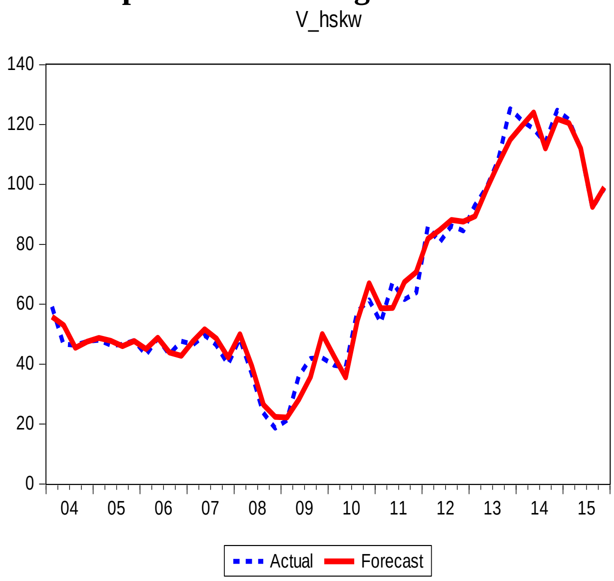


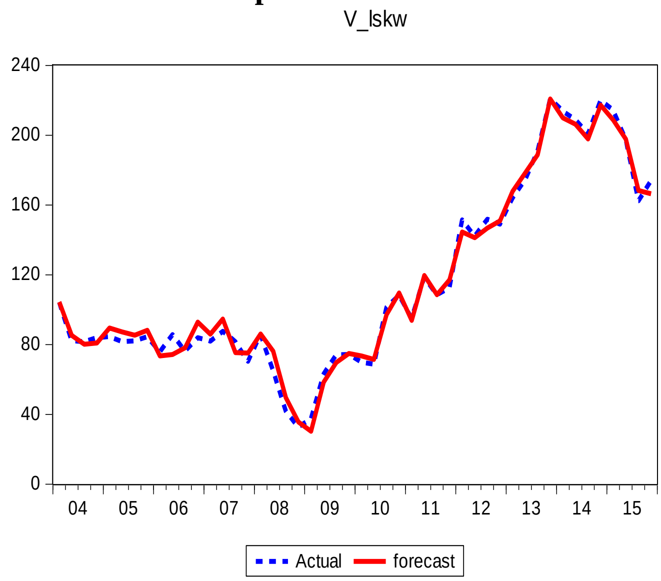
Fig.2. Forecasts and actual series of six stock prices based on high and low conservatism proxies over the forecasting horizons 2004Q1~2015Q4 for **glass & ceramics** stock.

Unconditional conservatism proxy

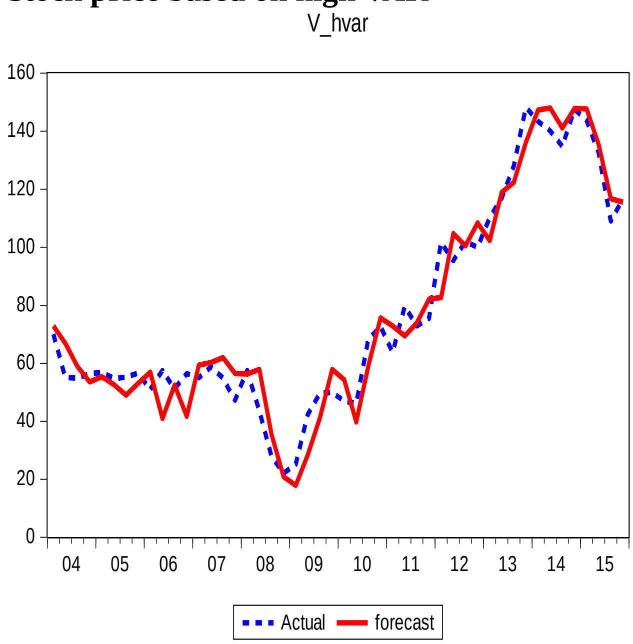
Stock price based on high SKW



Stock price based on low SKW



Stock price based on high VAR



Stock price based on low VAR

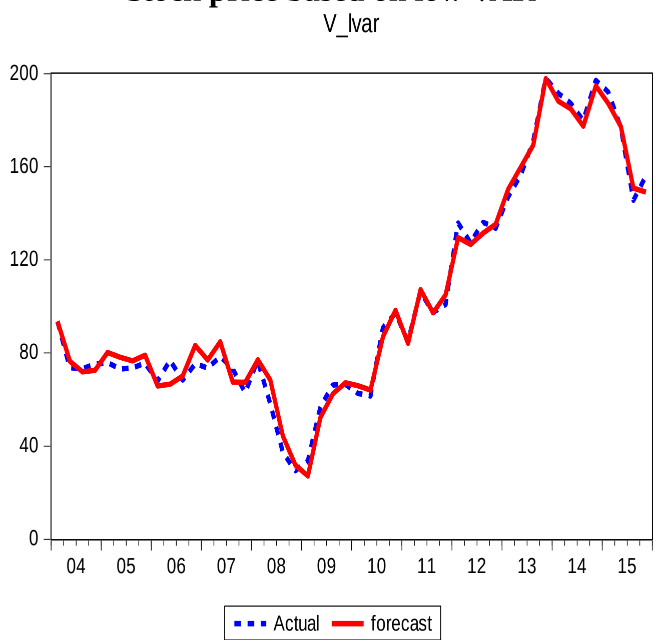
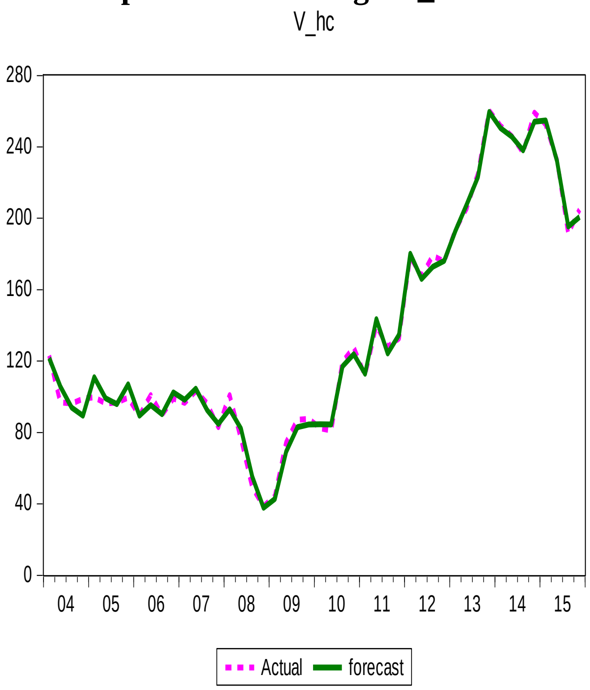


Fig.2. Forecasts and actual series of six stock prices based on high and low conservatism proxies over the forecasting horizons 2004Q1~2015Q4 for **glass & ceramics** stock.

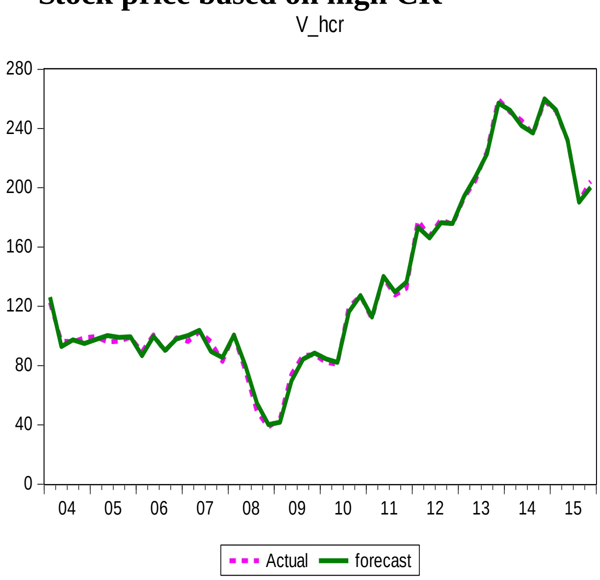
Conditional conservatism proxy

Stock price based on high C_score



Stock price based on low C_score

Stock price based on high CR



Stock price based on low CR

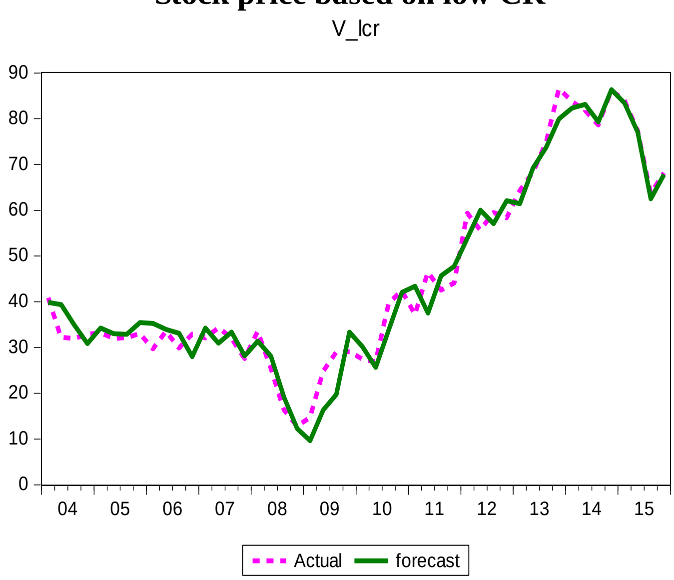


Fig.2. Forecasts and actual series of six stock prices based on high and low conservatism proxies over the forecasting horizons 2004Q1~2015Q4 for **glass & ceramics** stock.

This paper estimates the VECMs based on high-and-low UC firms and high-and-low CC firms. We compare forecast errors (RMSE and MAE) of the VECMs. Table 3 shows that the directions of relation between conservatism and forecast errors vary across industries. For large sectors (ETC, EM, TEX), high-UC VECM generates smaller RMSE and MAE than low-UC VECM. In contrast, low-CC VECM yields smaller RMSE and MAE than high-CC VECM. In sum, for large industries, VECMs of high-UC and low-CC firms generate smaller forecast errors. In contrast, small industries display that VECMs of low-UC and high-CC have smaller forecast errors. The findings imply that for large industries, when a firm adopts higher unconditional conservatism and lower conditional conservatism, forecast errors are smaller; for small industries, a firm with lower unconditional conservatism and higher conditional conservatism has smaller forecast errors.

For large industries, forecast errors of high-UC VECM gradually decrease when the horizon is extended. For example, based on P/B proxy, RMSEs are [10.6 to 7.7] for ETC, [1.9 to 1.5] for EM, and [17.3 to 12.7] for TEX from 20 to 48 quarters ahead. VECMs estimated using other proxies exhibit similar patterns. For example, based on C_score, RMSEs of VECM are [9.2 to 6.9] for ETC, [1.3 to 1.2] for EM, and [6.3 to 5.3] for TEX from 20 to 48 quarters ahead, consistent with Engle and Yoo's (1987) argument that VECM produces smaller errors when forecast horizon is lengthened. Small industries (GC, OGE) generate the same findings as large industries.

For large industries, the reduced percentages in forecast errors of high-UC (low-CC) VECM relative to those of low-UC (high-CC) VECM become greater when the horizon is lengthened. For example, based on P/B proxy, the reduced percentages of RMSE from 10 to 48 quarters ahead are [-2% to -43%] for ETC, [-0.4% to -0.6%] for EM, and [-0.1% to -0.4%] for TEX. These findings imply that the superiority of high-UC VECM relative to low-UC VECM in improving forecast ability increases with lengthened horizons. VECM estimated using other proxies exhibit similar patterns. For example, based on C_score, the reduction in percentages of RMSE from 10 to 48 quarters ahead are [-0.46% to -0.62%] for ETC, [-0.66% to -0.84%] for EM, and [-.0.54% to -0.83%] for TEX. Small industries (GC, OGE) have the same findings as large industries.

Table 3: Evaluation of forecast errors

Electronics & Components Stock (ETC)

	Unconditional																									Conditional								
VECM	PB					NOACC				RD				RES				SKEW				VAR				C_score					CR			
	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%
High	10	10.04	(1.86)	8.35	(0.36)	7.16	(7.13)	6.09	(0.01)	11.21	(0.21)	9.69	(0.19)	8.91	(0.02)	6.13	(0.11)	7.84	(0.33)	5.51	(0.47)	8.70	(0.12)	6.11	(0.32)	10	15.70		13.07		11.85		10.30	
level	20	10.62	(20.27)	8.82	(8.98)	7.69	(43.46)	6.34	(0.40)	10.21	(0.30)	8.16	(0.33)	10.01	(0.14)	7.98	(0.09)	9.55	(0.30)	7.67	(0.33)	10.60	(0.21)	8.52	(0.21)	20	17.07		13.82		13.82		11.52	
	30	9.04	(27.62)	7.17	(21.98)	6.35	(48.95)	4.66	(0.52)	8.93	(0.32)	6.98	(0.36)	9.57	(0.10)	7.63	(0.08)	10.43	(0.21)	8.41	(0.22)	11.58	(0.05)	9.34	(0.02)	30	15.69		12.72		13.49		10.87	
	40	8.01	(40.53)	6.05	(40.16)	5.53	(49.91)	3.76	(0.55)	8.91	(0.25)	6.87	(0.28)	9.03	(0.05)	7.18	(0.01)	10.05	(0.15)	7.99	(0.17)	11.16	(0.13)	8.87	(0.09)	40	16.68		12.91		16.59		12.83	
	48	7.77	(42.57)	5.96	(42.36)	3.84	(61.79)	2.91	(0.55)	9.06	(0.19)	7.02	(0.22)	8.29	(0.90)	6.30	(0.84)	10.49	(0.06)	8.81	(0.00)	11.56	(0.07)	9.78	0.02	48	17.92		15.31		16.88		14.08	
Low	10	10.23		8.38		7.71		6.14		14.11		11.96		9.10		6.89		11.71		10.45		9.87		9.05		10	6.54	(0.58)	4.97	(0.62)	8.31	(0.30)	6.49	(0.37)
level	20	13.32		9.69		13.60		10.52		14.57		12.24		11.70		8.78		13.58		11.41		13.48		10.77		20	9.19	(0.46)	6.60	(0.52)	8.81	(0.36)	7.37	(0.36)
	30	12.49		9.19		12.44		9.70		13.12		10.87		10.63		8.26		13.12		10.80		12.16		9.55		30	7.93	(0.49)	5.66	(0.56)	7.95	(0.41)	6.35	(0.42)
	40	13.47		10.11		11.04		8.33		11.83		9.49		9.53		7.22		11.89		9.62		12.83		9.71		40	7.33	(0.56)	5.35	(0.59)	7.98	(0.52)	6.34	(0.51)
	48	13.53		10.34		10.05		6.50		11.22		8.99		82.36		39.13		11.14		8.85		12.43		9.55		48	6.87	(0.62)	4.95	(0.68)	7.36	(0.56)	5.61	(0.60)

Electric Machinery Stock (EM)

	Unconditional																									Conditional								
VECM	PB					NOACC				RD				RES				SKEW				VAR				C_score					CR			
	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%
High	10	1.50	(0.40)	1.17	(0.46)	0.73	(0.89)	0.57	(0.89)	1.18	(0.68)	1.07	(0.66)	1.82	(0.29)	1.43	(0.27)	3.62	0.86	2.91	0.95	2.66	(0.33)	2.30	(0.32)	10	3.69		2.77		3.75		2.81	
level	20	1.89	(0.62)	1.57	(0.61)	1.11	(0.81)	0.80	(0.83)	1.33	(0.70)	1.09	(0.70)	2.68	(0.42)	1.89	(0.46)	4.35	0.30	3.56	0.35	2.87	(0.38)	2.29	(0.43)	20	6.33		4.68		6.44		4.75	
	30	1.77	(0.61)	1.47	(0.59)	1.07	(0.80)	0.82	(0.81)	1.16	(0.72)	0.92	(0.74)	2.60	(0.39)	1.96	(0.44)	3.81	0.12	3.00	0.07	2.50	(0.45)	1.96	(0.51)	30	6.42		5.14		6.53		5.22	
	40	1.64	(0.62)	1.30	(0.61)	1.05	(0.80)	0.83	(0.80)	1.17	(0.71)	0.94	(0.72)	2.41	(0.46)	1.80	(0.47)	3.82	0.02	3.08	0.04	2.37	(0.50)	1.87	(0.53)	40	6.76		5.33		6.87		5.42	
	48	1.50	(0.63)	1.09	(0.66)	0.97	(0.82)	0.75	(0.84)	1.13	(0.69)	0.93	(0.67)	2.69	(0.42)	2.26	(0.38)	4.05	0.09	3.53	0.22	2.40	(0.45)	2.00	(0.42)	48	7.13		6.13		7.25		6.23	
Low	10	2.48		2.17		6.55		5.23		3.68		3.19		2.56		1.97		1.95		1.49		3.96		3.37		10	1.25	(0.66)	1.06	(0.62)	1.19	(0.68)	1.00	(0.64)
level	20	5.03		4.04		5.99		4.82		4.37		3.66		4.66		3.51		3.34		2.64		4.64		4.02		20	1.20	(0.81)	1.04	(0.78)	1.14	(0.82)	0.99	(0.79)
	30	4.59		3.61		5.32		4.21		4.21		3.54		4.26		3.48		3.40		2.80		4.58		3.97		30	1.25	(0.81)	1.09	(0.79)	1.18	(0.82)	1.03	(0.80)
	40	4.27		3.33		5.14		4.11		4.05		3.34		4.45		3.38		3.74		2.95		4.73		3.97		40	1.16	(0.83)	0.99	(0.81)	1.10	(0.84)	0.94	(0.83)
	48	4.02		3.17		5.52		4.61		3.70		2.80		4.65		3.63		3.72		2.89		4.35		3.47		48	1.16	(0.84)	0.98	(0.84)	1.10	(0.85)	0.93	(0.85)

Textile Stock (TEX)

	Unconditional																									Conditional								
VECM	PB					NOACC				RD				RES				SKEW				VAR				C_score					CR			
	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%
High	10	12.20	(0.10)	10.49	(0.08)	6.50	(0.68)	5.59	(0.67)	8.02	(0.19)	6.71	(0.07)	9.68	(0.48)	7.01	(0.42)	9.95	(0.27)	8.10	(0.19)	9.95	(0.05)	9.21	(0.39)	10	12.86		11.96		12.41		10.16	
level	20	17.33	(0.25)	13.79	(0.24)	10.83	(0.64)	8.98	(0.64)	7.28	(0.66)	6.15	(0.59)	9.29	(0.59)	7.24	(0.56)	10.93	(0.23)	8.49	(0.18)	8.87	(0.63)	7.89	(0.55)	20	33.70		25.27		31.30		22.01	
	30	15.62	(0.28)	12.82	(0.26)	9.89	(0.66)	8.32	(0.64)	6.60	(0.66)	5.57	(0.60)	8.51	(0.60)	6.87	(0.58)	10.58	(0.33)	8.39	(0.32)	7.83	(0.64)	6.79	(0.58)	30	31.48		24.40		29.33		21.70	
	40	13.92	(0.37)	10.83	(0.41)	8.95	(0.69)	7.44	(0.68)	6.01	(0.67)	4.98	(0.62)	8.14	(0.59)	6.75	(0.55)	9.88	(0.33)	7.67	(0.33)	7.52	(0.63)	6.43	(0.58)	40	30.86		24.69		27.87		21.35	
	48	12.71	(0.43)	9.16	(0.52)	8.36	(0.70)	6.91	(0.70)	5.69	(0.66)	4.76	(0.58)	8.18	(0.59)	7.07	(0.54)	10.58	(0.30)	8.73	(0.31)	8.01	(0.60)	7.09	(0.54)	48	31.07		26.04		25.62		18.83	
Low	10	13.52		11.46		20.58		16.91		9.93		7.19		18.75		12.15		13.62		10.05		10.42		15.06		10	5.94	(0.54)	4.75	(0.60)	4.00	(0.68)	3.07	(0.70)
level	20	23.16		18.14		30.50		24.61		21.67		14.93		22.77		16.51		14.24		10.38		23.69		17.63		20	6.29	(0.81)	4.63	(0.82)	4.99	(0.84)	3.92	(0.82)
	30	21.72		17.28		28.93		23.11		19.54		13.83		21.29		16.19		15.84		12.26		21.57		16.22		30	5.56	(0.82)	4.00	(0.84)	5.19	(0.82)	4.12	(0.81)
	40	22.27		18.22		28.67		22.90		18.17		12.98		19.72		14.91		14.82		11.49		20.17		15.23		40	5.23	(0.83)	3.95	(0.84)	4.84	(0.83)	3.81	(0.82)
	48	22.46		19.08		28.03		23.19		16.67		11.46		19.76		15.37		15.15		12.61		20.20		15.56		48	5.25	(0.83)	4.08	(0.84)	4.94	(0.81)	4.13	(0.78)

Glass & Ceramics Stock (GC)

Unconditional																										Conditional								
VECM	PB					NOACC				RD				RES				SKEW				VAR				C_score					CR			
	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%
High	10	7.13		5.49		9.81		8.60		9.56		9.38		8.52		7.73		6.18		4.82		7.31		5.70		10	5.13	(0.01)	4.16	(0.18)	2.79	(0.14)	2.48	(0.02)
level	20	7.63		6.03		11.79		10.12		11.49		9.86		8.76		7.77		6.47		5.04		7.65		5.96		20	5.23	(0.02)	4.14	(0.03)	2.97	(0.03)	2.45	(0.80)
	30	8.11		6.85		12.22		10.61		11.91		10.34		9.38		8.08		6.76		5.68		7.99		6.72		30	4.75	(0.28)	3.78	(0.29)	2.82	(0.33)	2.33	(0.30)
	40	8.34		6.97		12.96		11.09		12.64		10.81		10.48		8.79		6.98		5.81		8.25		6.87		40	4.32	(0.34)	3.35	(0.35)	2.75	(0.33)	2.30	(0.32)
	48	7.95		6.65		12.95		10.98		12.62		10.70		10.27		8.75		7.23		6.53		8.55		7.72		48	4.51	(0.38)	3.83	(0.39)	2.65	(0.36)	2.19	(0.38)
Low	10	4.34	(0.39)	3.48	(0.37)	2.99	(0.70)	2.36	(0.73)	2.99	(0.69)	2.36	(0.75)	1.47	(0.83)	1.31	(0.83)	4.87	(0.21)	3.90	(0.19)	4.37	(0.40)	3.50	(0.39)	10	5.16		5.05		3.24		2.54	
level	20	5.04	(0.34)	4.19	(0.31)	2.72	(0.77)	2.15	(0.79)	2.72	(0.76)	2.15	(0.78)	1.14	(0.87)	0.93	(0.88)	5.67	(0.12)	4.70	(0.07)	5.08	(0.34)	4.21	(0.29)	20	5.33		4.25		3.06		12.54	
	30	4.53	(0.44)	3.71	(0.46)	2.81	(0.77)	2.28	(0.79)	2.81	(0.76)	2.28	(0.78)	1.11	(0.88)	0.91	(0.89)	5.09	(0.25)	4.16	(0.27)	4.56	(0.43)	3.73	(0.44)	30	6.62		5.33		4.24		3.35	
	40	4.25	(0.49)	3.43	(0.51)	2.67	(0.79)	2.14	(0.81)	2.67	(0.79)	2.14	(0.80)	1.05	(0.90)	0.86	(0.90)	4.77	(0.32)	3.85	(0.34)	4.28	(0.48)	3.46	(0.50)	40	6.53		5.15		4.13		3.37	
	48	4.20	(0.47)	3.43	(0.48)	2.63	(0.80)	2.11	(0.81)	2.63	(0.79)	2.11	(0.80)	1.08	(0.89)	0.95	(0.89)	5.17	(0.28)	4.62	(0.29)	4.63	(0.46)	4.15	(0.46)	48	7.27		6.30		4.15		3.51	

Oil, Gas & Electricity Stock (OGE)

	Unconditional																									Conditional								
VECM	PB					NOACC				RD				RES				SKEW				VAR				C_score					CR			
	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	RMSE	%	MAE	%	hotizon	RMSE	%	MAE	%	RMSE	%	MAE	%
High	10	19.03		16.49		14.28		11.03		9.58		7.77		10.70		8.30		16.50		11.75		16.73		15.24		10	5.94	(0.01)	4.65	(0.05)	5.08	(0.01)	4.48	(0.00)
level	20	33.24		20.12		15.51		13.17		13.28		10.56		14.07		11.03		18.80		15.00		17.16		15.02		20	6.54	(0.18)	5.36	(0.13)	6.67	(0.13)	5.17	(0.02)
	30	15.86		19.38		15.55		12.90		12.76		10.12		12.76		9.66		19.10		15.05		16.50		14.06		30	5.58	(0.27)	4.32	(0.28)	7.11	(0.07)	5.47	(0.07)
	40	15.96		19.58		14.75		12.32		12.23		9.64		12.81		9.89		17.91		14.28		15.65		13.23		40	4.97	(0.37)	3.74	(0.40)	6.72	(0.17)	5.41	(0.10)
	48	19.83		18.70		31.06		21.45		69.81		37.69		13.78		11.84		19.80		17.54		16.28		14.93		48	5.31	(0.42)	4.45	(0.44)	6.23	(0.28)	4.87	(0.30)
Low	10	3.38	(0.82)	2.85	(0.83)	2.76	(0.81)	2.25	(0.80)	3.85	(0.60)	3.06	(0.61)	4.83	(0.55)	3.97	(0.52)	5.42	(0.67)	4.53	(0.61)	4.67	(0.72)	3.72	(0.76)	10	5.99		4.90		5.14		4.49	
level	20	3.92	(0.88)	3.29	(0.84)	3.19	(0.79)	2.71	(0.79)	4.05	(0.70)	3.32	(0.69)	5.56	(0.60)	4.04	(0.63)	7.38	(0.61)	6.15	(0.59)	5.15	(0.70)	4.09	(0.73)	20	8.01		6.19		7.65		5.27	
	30	4.08	(0.74)	3.39	(0.83)	3.62	(0.77)	2.96	(0.77)	4.93	(0.61)	4.20	(0.58)	5.20	(0.59)	4.03	(0.58)	6.85	(0.64)	5.64	(0.63)	4.53	(0.73)	3.40	(0.76)	30	7.64		6.04		7.61		5.87	
	40	3.69	(0.77)	3.12	(0.84)	3.73	(0.75)	3.01	(0.76)	4.82	(0.61)	4.08	(0.58)	4.87	(0.62)	3.79	(0.62)	6.26	(0.65)	5.01	(0.65)	4.16	(0.73)	3.13	(0.76)	40	7.84		6.25		8.11		6.04	
	48	4.83	(0.76)	3.88	(0.79)	3.83	(0.88)	4.01	(0.81)	4.59	(0.93)	3.85	(0.90)	5.07	(0.63)	4.32	(0.64)	6.38	(0.68)	5.47	(0.69)	4.34	(0.73)	3.56	(0.76)	48	9.12		7.88		8.71		6.97	

Note:

1. unconditional conservatism proxies P/B, NOACC, RD, RES, SKW, VAR, denote price-to-book ratio, non-operating accruals, research and development & expenditure (RD) scaled by sales, reserve, the difference between earnings skewness (variability) and cash-flow skewness (variability), respectively. Other two conditional conservatism proxies, C , CR, stand for C_Score and CR ratio.
2. For three large industries (ETC, EM, TEX), when we use unconditional proxies and compare forecast errors of high-level VECM with those of low-level VECM, high-level VECM shows the smaller RMSE and MAE for each of k^{th} step-ahead forecasting horizon. The reduced percentages in forecasting errors of high-level VECM relative to those of low-level VECM are calculated by the equation: [(RMSE (MAE) of high-level VECM– RMSE (MAE) of low-level VECM)/RMSE (MAE) of high-level VECM]. In contrast, when conditional proxies are used, the smaller forecast errors occur in low-level VECM. The reduced percentages in forecasting errors of low-level VECM relative to those of high-level VECM are calculated by the equation: [(RMSE (MAE) of low-level VECM– RMSE (MAE) of high-level VECM)/RMSE (MAE) of low-level VECM]. Two small industries (GC,OGE) use similar calculation methods and show the findings contrary to large three industries.

4.3 Diebold-Mariano test

Table 4 reports DM test results based on conservatism proxies. For large industries, null hypothesis that forecast errors of high- and low-UC (CC) VECMs are equal is significantly rejected by negative statistics. For example, for $VECM^{hpb}$ and $VECM^{lpb}$, DM_{RMSE} [-1.92 to -9.46] and *p*-value [0.000 ~ 0.062], DM_{MAE} [-3.47 to -10.47] and *p*-value [0.000 ~ 0.001], which support alternative hypothesis that forecast errors of $VECM^{hpb}$ are smaller than those of $VECM^{lpb}$; test results of $VECM^{hcr}$ and $VECM^{lcr}$ indicate that the null is significantly rejected by positive statistics, in favor of alternative hypothesis that forecast errors of $VECM^{hcr}$ are greater than those of $VECM^{lcr}$.

For small industries, DM test results show that high- and low-UC VECMs reject the null hypothesis, in favor of alternative hypothesis that forecast errors of high-UC VECM are greater than those of low-UC VECM. High- and low-CC VECMs generate negative statistics, which supports alternative hypothesis that forecast errors of high-CC VECM are smaller than those of low-CC VECM. In sum, test results are consistent with those in section 4.2 indicating that for large industries, VECMs of high-UC and low-CC firms generate smaller forecast errors. In contrast, small industries display that VECMs of low-UC and high-CC have smaller forecast errors.

Table 4 Diebold-Mariano Test

Electronics & Components Stock (ETC)

proxy	PB	NOACC	RD	RES	SKW	VAR	C	CR
Model	$VECM^{hpb}$ $VECM^{lpb}$	$VECM^{hnoacc}$ $VECM^{lnoacc}$	$VECM^{hrd}$ $VECM^{lrd}$	$VECM^{hres}$ $VECM^{lres}$	$VECM^{hskw}$ $VECM^{lvskw}$	$VECM^{hvar}$ $VECM^{lvar}$	$VECM^{hc}$ $VECM^{lc}$	$VECM^{hcr}$ $VECM^{lcr}$
DM_{RMSE}	-1.92 (0.062)*	-3.69 (0.000)***	-5.81 (0.000)***	-2.41 (0.021)**	-3.63 (0.000)***	-3.98 (0.000)***	21.01 (0.000)***	6.34 (0.000)***
DM_{MAE}	-1.57 (0.123)	-2.76 (0.008)***	-5.41 (0.000)***	-4.66 (0.000)***	-2.58 (0.013)***	-2.46 (0.018)***	23.36 (0.006)***	12.67 (0.000)***

Electric Machinery Stock (EM)

	PB	NOACC	RD	RES	SKW	VAR	C	CR
DM_{RMSE}	-9.46 (0.000)***	-10.41 (0.000)***	-12.35 (0.000)***	-10.78 (0.000)***	-4.09 (0.000)***	-18.45 (0.000)***	5.85 (0.000)***	5.97 (0.000)***
DM_{MAE}	-10.47 (0.000)***	-12.07 (0.000)***	-10.25 (0.000)***	-11.80 (0.000)***	-3.96 (0.000)***	-14.57 (0.000)***	5.30 (0.000)***	5.41 (0.000)***

Textile Stock (TEX)

	PB	NOACC	RD	RES	SKW	VAR	C	CR
DM_{RMSE}	-4.74 (0.000)***	-21.62 (0.000)***	-7.11 (0.000)***	-1.99 (0.052)**	-0.19 (0.842)	-1.28 (0.207)	4.88 (0.000)***	2.93 (0.005)***
DM_{MAE}	-3.47 (0.001)***	-27.58 (0.000)***	-6.49 (0.000)***	-0.91 (0.091)*	-0.09 (0.921)	-2.21 (0.033)**	6.35 (0.000)***	6.68 (0.000)***

Glass & Ceramics (GC)

	PB	NOACC	RD	RES	SKW	VAR	C	CR
DM_{RMSE}	13.12 (0.000)***	19.16 (0.000)***	18.92 (0.000)***	6.73 (0.000)***	8.43 (0.000)***	14.69 (0.000)***	-1.39 (0.171)	-2.15 (0.038)**
DM_{MAE}	8.93 (0.000)***	20.13 (0.000)***	20.08 (0.000)***	12.08 (0.000)***	5.44 (0.000)***	9.55 (0.000)***	-2.18 (0.041)**	-0.81 (0.427)

Oil, Gas & Electricity (OGE)

DM_{RMSE}	18.62 (0.000)***	22.89 (0.000)***	11.25 (0.000)***	14.91 (0.000)***	18.28 (0.009)***	54.82 (0.000)***	-5.42 (0.000)***	-1.95 (0.058)**
DM_{MAE}	12.42 (0.000)***	14.32 (0.000)***	12.37 (0.000)***	14.96 (0.000)***	19.89 (0.000)***	43.15 (0.000)***	-5.78 (0.000)***	-2.62 (0.012)***

Notes: DM test indicates the comparison between forecast errors of two VECMs estimated based on each proxy. Using price-book ratio (PB) proxy as an example, we test the null hypothesis H_0 : forecast error of stock price based on $VECM^{hpb}$ is equal to that of $VECM^{lpb}$. Alternative hypothesis H_1: forecast error of stock prices based on preferred model $VECM^{hpb}$ is smaller (greater) than that of $VECM^{lpb}$. The same hypotheses are applied to the VECMs based on other conservatism proxies. The figure in parenthesis indicates *p* value. The entries with asterisk indicate the DM statistics at the 1% (***),5% (**),10% (*) significance level that reject of null hypothesis, except for some statistics, for example, ETC sector's $DM_{MAE\ (PB)}$ -1.57(0.123), TEX sector's $DM_{RMSE\ (skw)}$ -0.19(0.842), $DM_{MAE\ (skw)}$ -0.09(0.921), $DM_{RMSE\ (var)}$ -1.28(0.207), GC sector's $DM_{RMSE\ (c)}$ -1.39(0.171), $DM_{MAE\ (CR)}$ -0.81(0.427).

5. Discussion

The findings in section 4.2 suggest that the relation between forecast errors and conservatism varies across large and small industries, consistent with the concerns of Pae and Thornton (2010) that the direction of the association between conservatism and forecast errors is different across industries because of industrial characteristics (e.g., industry size).

The findings in section 4.2 imply that for large industries, when a firm adopts higher unconditional conservatism and lower conditional conservatism, forecast errors are smaller. The findings are in accordance with the argument of Pae and Thornton (2010) that forecast inefficiency is negatively associated with unconditional conservatism (measured by MTB and RES) but positively associated with conditional conservatism (measured by C_Scores), and consistent with Callen et al.'s (2010) positive effect of conditional conservatism on forecast errors. Small industries show findings contrary to large ones: a firm with lower unconditional conservatism and higher conditional conservatism has smaller forecast errors, consistent with Mensah et al.'s (2004) concern that unconditional conservatism (measured by RES, ACCR) is positively associated with forecast errors. In sum, higher unconditional-conservatism in large industries and higher conditional- conservatism in small industries lead to smaller forecast errors, in accordance with Sohn's (2012) finding that forecast error is smaller for firms with two forms of higher conservatism.

6. Robustness analysis

We further use pooled data and OLS regression to study the relation between two forms of accounting conservatism and forecast errors. We adopt three samples: large industry (ETC, EM, and TEX), small industry (GC, OGE), and full sample including large and small industries. We find that the results using OLS regression are consistent with those of VECM approach in section 4.2 showing that for large industries, when a firm adopts higher unconditional conservatism and lower conditional conservatism, forecast errors are smaller. Small industries show that a firm with lower unconditional conservatism and higher conditional conservatism has smaller forecast errors.

This study regresses forecast errors (measured by RMSE, MAE) on conservatism proxies and control variables. The estimated regressions are presented below:

$$FE_{i,t}=\alpha+\beta_1 PB_{i,t}+\beta_2 NOACC_{i,t}+\beta_3 RD_{i,t}+\beta_4 RES_{i.t}+\beta_5 SKW_{i,t}+\beta_6 VAR_{i,t}+\beta_7 CR_{i,t}+\beta_8 C\_Score_{i,t}+\lambda_1 logAGE_{i,t} \quad (4)$$

$$+\lambda_2 logMV_{i,t-1}+\lambda_3 CV\_X_{i,(t-1)-(t-5)}+Ret_{i,(t-1)-(t-5)}+u_{i,t}$$

In Eq. (4), $FE_{i,t}$ denotes forecast errors for industry i at quarter t of the fiscal year, which is measured by RMSE and MAE. PB, NOACC, RD, RES, SKW, VAR denote unconditional conservatism (UC) proxies. C_score and CR denote conditional conservatism (CC) proxies. The $logAGE_{i,t}$, $log\ MV_{i,t-1}$, $CV\_X_{i,(t-1)-(t-5)}$, $Ret_{i,(t-1)-(t-5)}$ are control variables, definition of which are shown in the Appendix.

Panel A of Table 5 show the findings of using RMSE as a dependent variable. For large industry sample, the coefficients of UC variables (PB, RD, NOACC, RES) are negative whereas those of CC variables are positive at statistically significant level, indicating that forecast errors is negatively (positively) related with unconditional (conditional) conservatism, consistent with findings of section 4.2. The negative relations between PB (or RES) and forecast errors support Pae and Thornton (2010) that forecasting optimism (errors) is greater for firms exhibiting lower MTB and RES. For small industry sample, UC variables (PB, RD, NOACC, RES, SKW) show positive and statistically significant coefficients while CC variables have negative and statistically significant coefficients, suggesting that forecast error is positively (negatively) related to unconditional (conditional) conservatism, consistent with findings in section 4.2. The positive coefficient of RES support Mensah et al. (2004) who posit a positive relation between conservatism and forecast errors. Moreover, when we add control variables into the regression, the direction and significance of the coefficients are the same as those in the regression without control variables, but R-square rises from 0.57 to 0.77 (large industry) and from 0.45 to 0.48 (small industry).

In Panel B of Table 5, we use MAE as the dependent variable. As the RMSE case, for large industry sample, the coefficients of UC variables (PB, RD, NOACC, RES) are negative and statistically significant, whereas those of CC variables are positive and statistically significant. For small industry sample, UC variables (PB, RD, NOACC, RES, SKW) exhibit positive and statistically significant coefficients, while CC variables have negative and statistically significant coefficients. The findings are consistent with the relations in section 4.2. When control variables are added into the regression, R-square rises from 0.55 to 0.74 (large industry) and from 0.53 to 0.56 (small industry). The direction and significance of coefficients in the regression are consistent with those in the regression without control variables. Regarding the results of control variables are presented in the Appendix.

Table 5. Results of relationship between forecast errors and accounting conservatism

Panel A Dependent Variable: RMSE

Variable	Expected Sign-Large(Small)	Large industry sample		Small industry sample		Full sample	
		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept		10.617	5.281	1.469	5.116	3.104	-7.889
Unconditional Conservatism variables							
PB	- (+)	-0.132***	-0.097**	0.231***	0.148**	1.022***	0.661***
NOACC	- (+)	-1.387***	-6.488***	7.928*	9.128****	-9.318***	-6.48E***
R&D	- (+)	-0.186***	-0.175***	0.108**	0.173****	0.025	0.027
RES	- (+)	-0.578***	-1.465**	0.221***	0.136*	-0.022	0.001
SKW	- (+)	-0.033	-3.349	0.462***	0.294*	0.032	-0.036
VAR	- (+)	7.408	-9.728	-5.098	-9.788	1.75E	2.12E
Conditional Conservatism variables							
CR	+ (-)	0.696***	0.096**	-0.009**	-0.008*	-0.039***	-0.004
C_score	+ (-)	2.309***	7.161*	-1.661**	-1.341**	-7.29E***	-3.52E
Control variables							
Log $AGE_{i,t}$	+		-0.009		-0.007		-0.024
Log $MV_{i,t-1}$	- (+)		1.697***		-0.223*		0.887***
$CV\_X_{i,(t-1)-(t-5)}$	+		-0.996		0.519*		-5.228***
$Ret_{i,(t-1)-(t-5)}$	-		-1.212*		0.001		-1.616***
Adjusted R^2		0.565	0.767	0.452	0.481	0.272	0.451
F statistic		24.22	40.41	9.357	7.477	12.213	17.353

Note: The dependent variables of model 1 ~ model 6 are forecast errors measured by RMSE. The entries with asterisk indicate t statistics at the 1% (***),5% (**),10% (*) significance level.

Panel B Dependent Variable: MAE

Variable	Expected Sign-Large(Small)	Large industry sample		Small industry sample		Full sample	
		Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Intercept		8.362	4.276	0.988	4.084	2.539	-4.926
Unconditional Conservatism variables							
PB	- (+)	-0.099***	-0.080**	0.187***	0.117*	0.756***	0.496***
NOACC	- (+)	-1.057***	-5.128***	6.648**	7.708***	-7.068***	-5.10E***
R&D	- (+)	-0.139***	-0.140***	0.065	0.126**	0.019	0.020
RES	- (+)	-0.469***	-1.198**	0.181***	0.109*	-0.016	0.001
SKW	- (+)	-0.014	-1.709	0.376***	0.234*	0.023	-0.023
VAR	- (+)	1.027	-5.539	-4.028	-7.958	1.817	2.077**
Conditional Conservatism variables							
CR	+ (-)	0.509***	0.083**	-0.007*	-0.007*	-0.027**	-0.002
C_score	+ (-)	1.739***	5.491	-1.561***	-1.271**	-5.581***	-2.88E**
Control variables							
Log $AGE_{i,t}$	+		-0.005		-0.004		-0.016
Log $MV_{i,t-1}$	- (+)		1.277***		-0.196*		0.618***
$CV\_X_{i,(t-1)-(t-5)}$	+		-0.755		0.540*		-4.090***
$Ret_{i,(t-1)-(t-5)}$	-		-0.971*		0.004		-1.277***
Adjusted R^2		0.547	0.742	0.531	0.557	0.250	0.417
F statistic		22.612	35.341	12.461	9.833	10.975	15.251

Note: The dependent variables of model 7 ~ model 12 are forecast errors measured by MAE. The entries with asterisk indicate the t statistics at the 1% (***),5% (**),10% (*) significance level.

7 Conclusion

Instead of the relation between forecast errors and either of two conservative forms respectively studied in prior research, this paper investigates the relation between forecast errors and two forms simultaneously. We find that the relation varies across five industries. For large industries, when a firm adopts higher unconditional conservatism and lower conditional conservatism, forecast errors are smaller. In contrast, small industries show that a firm with lower unconditional conservatism and higher conditional conservatism has smaller forecast errors.

For the practical implication, forecast errors and accounting conservatism appear to be related. This information could be of interest to both investors and firm managers. Financial reporting standards in Taiwan are consistent during our study periods. The changes in reporting standards may affect the relation between forecast errors and two forms of conservatism. In response to this limitation, future researchers are advised to investigate how the relation alters when any changes in reporting standard occur in the study periods.

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Appendix

1. Estimation of conditional conservatism proxies

1.1. Conservatism proxies (C_Score) of Khan and Watts (2009)

Following Khan and Watts (2009), we use a two-stage procedure to calculate the C_Score. In the first stage, we estimate the following cross regression for each year:

$$X_j = \beta_0 + \beta_1 D_j + R_J(\mu_1 + \mu_2 Size + \mu_3 M/B + \mu_4 Lev) + D_j R_J(\lambda_1 + \lambda_2 Size + \lambda_3 M/B + \lambda_4 Lev) + (\delta_1 Size + \delta_2 M/B + \delta_3 Lev + \delta_4 D_j Size + \delta_5 D_j M/B + \delta_6 D_j Lev) + \varepsilon_J \quad \text{(A.1)}$$

where j denotes the firm, X is earnings, R is returns (measuring news), and D is a dummy variable equal to 1 when R<0 and equal to 0 otherwise. In the second step, we calculate a firm-year measure of conservatism (C_score) at the beginning of the year using the coefficient estimates from the first-stage regression (1):

$$C\_score_j = \lambda_1 + \lambda_2 Size_j + \lambda_3 M/B_j + \lambda_4 Lev_j \quad \text{(A.2)}$$

1.2. Conditional conservatism proxies (CR) of Callen et al. (2010)

The ratio is defined as the ratio of unexpected current earnings to total earnings. It measures how much of the total earnings shock is incorporated into the current period's unexpected earnings (Callen et al., 2010). The CR is measured as $CR_t = \eta_{2,t}/Ne_t$, where Ne_T is earnings news and measured as $Ne_t = \Delta E_t \sum_{j=0}^{\infty} \rho^j (roe_{t+j} - i_{t+j})$, and $\eta_{2,t}$ is the earnings surprise from the VAR system. As designed in Callen et al. (2010), a VAR with three state variables consists of log stock returns (r), log of one plus ROE (earnings scaled by book value of equity), and the log book-to market ratio (bm_t). The VAR model can then be described as a system of equations:

$$r_t = \alpha_1 r_{t-1} + \alpha_2 roe_{t-1} + \alpha_3 bm_{t-1} + \eta_{1,t} \quad \text{(A.3a)}$$

$$roe_t = \alpha_1 r_{t-1} + \alpha_2 roe_{t-1} + \alpha_3 bm_{t-1} + \eta_{1,t} \quad \text{(A.3b)}$$

$$bm_t = \alpha_1 r_{t-1} + \alpha_2 roe_{t-1} + \alpha_3 bm_{t-1} + \eta_{1,t} \quad \text{(A.3c)}$$

2. Definition of control variables

Following the definitions of control variables of Eq. (1) in Mensah et al. (2004), based on Eq. (4) in this study, $logAGE_{i,t}$ is the natural log of the average (in day) of forecast for sector i at quarter t of the fiscal year. The log $MV_{i,t-1}$ is the natural log of total market capitalization for sector i at the beginning of the fiscal year. $CV\_X_{i,(t-1)-(t-5)}$ is the coefficient of variation of the last five years' earnings before extraordinary items ending at a period deflated by the absolute median. $Ret_{i,(t-1)-(t-5)}$ is the previous five years' cumulative stock returns.

3. Results of control variables,

For large industry, as expected from Pae and Thornton (2010), firm size (log MV), has a positive sign and is statistically significant in RMSE and MAE cases. The previous return, Ret, is negatively associated with RMSE and MAE at statistical significant level, as expected from Mensah et al. (2004). For small industry, the sign of firm size (log MV) is negative and statistically significant for RMSE and MAE cases. Variability of earnings (CV_X) has a statistically significant and positive relation with MAE and RMSE; in both cases, the results are as expected from Mensah et al. (2004). In the full-sample, the signs of the coefficients are mostly inconsistent with our expectations and could be affected by confounding effects including both large and small industries.