Do Macroeconomic Conditions Affect Firm-level Earnings Forecasts?

David C. Broadstock, Yan Shu, and Bing Xu

Abstract—**We demonstrate the importance of including macroeconomic information when forecasting firms' earnings. Taking Hou et al.'s (2010) cross-sectional model as the starting point for the analysis, we augment the model with three macroeconomic factors derived from a principal component analysis of more than 20 indicators. We find consistent evidence that macroeconomic conditions should be incorporated when predicting firms' future earnings, and particularly in the early sample period, macroeconomic factors therefore enhance the predictive accuracy of the model.**

Index Terms—**Macroeconomic factors, earnings forecast, principal component analysis.**

I. Introduction

Understanding future earnings is a strategic priority for any firm in any industry, and is often the benchmark of internal business decisions. It is well known that earnings forecast is an important tool for (i) investors who need to value stocks and also (ii) business executives who need to manage risk and control long term financial wellbeing within their enterprise. There are two main ways to obtain earnings forecasts: One is from financial analysts who issue forecast reports for specific firms periodically, See Ramnath et al. (2008) for a recent survey; The other is based on the forecasting earnings using a model based approach relying on some statistical method, common examples include Foster (1977), Ou and Penman (1989) and Abarbanell and Bushee (1997).

Previous studies show that the accuracy of both financial analysts and forecasts from pooled cross-sections tends to outperform their time-series counterparts. One reason for this as that many time-series models are purely confined to past earnings rather than including other variables, especially for short forecast horizons. Further, since analysts' forecasts are only relevant to a small sample of firms of strategically important and/or high value and are typically limited to one- or two-years, we are more interested in cross-sectional model-based earnings forecast here. This is also consistent with the wider literature in firm-level earnings forecast analysis owing to complex survival bias problems that generally preclude the use of time series methods to analyze the data.

In a recent study, Hou et al. (2010) used a pooled cross-sectional model to forecast corporate earnings for individual firms who choose to submit their accounts either because they are listed or as a managerial choice. This has been described Richardson, Tuna, and Wysocki (2010) as a promising model owing to its simplicity to estimate and strength of the empirical conclusions. Hou et al. (2010) find that their model produces earnings forecasts that are comparable, although inferior on average, to the analyst forecasts in terms of accuracy, but present much lower forecast bias and much higher earnings response coefficients. Their model is successful in plausibly describing specific components of the earnings function that may be of strategic interest to various decision makers. However, industrial and macroeconomic factors have been widely discussed to be in the analysts' information set when preparing firm specific earnings forecasts. Those factors are not considered in the work of Hou et al. (2010), creating potential for omitted variable bias to affect the accuracy of the analysis when compared with analysts' forecasts.

Fairfield et al. (2009) found no incremental explanatory power from including industry information for predicting financial performance, including macroeconomic factors remains to be a potential way to influence earnings forecasting model performance. Indeed, one of fundamental relationships in economics is that realized corporate earnings are highly pro-cyclical. Therefore, if investors are rational, macroeconomic conditions should be an important determinant of expected earnings. Thus, it is of interest to examine whether incorporating macroeconomic information into the cross-sectional earnings forecasting model can improve the model's predictive accuracy.

In this paper, we focus on the impact of macroeconomic conditions on firm-level future earnings in a cross-sectional model. More specifically, we evaluate the predictive power of macroeconomic conditions based on the modified Hou et al.'s (2010) model. The rest of the paper proceeds as follows. The next section briefly describes the data and the methodology. Section 3 presents the empirical results, while the last section concludes the paper.

II. Data and Methodology

Our sample covers U.S. firms over the period 1962 to 2010 excluding financial firms and regulated utilities. We obtain accounting variables from the Compustat North America

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Fundamental Annual database and use similar variable definitions to those given in Hou et al. (2010). As opposed to just using levels, the data are scaled by either total assets or common/ordinary equity to address the effect of scale difference, as indicated in the empirical model. To be in the analytical sample, firm-years should have no missing values for the accounting variables to be included in the regression. We exclude firms with assets less than 5 million and book value less than 3 million to avoid extreme value caused by scaling. Moreover, we also drop observations without enough information for one, two, and three-lag earnings to make one, two, and three-step-ahead prediction comparable. Doing so gives us 41,055 observations for 6,038 unique firms in total. We wincorize the data by both top 0.5% and bottom 0.5% of the distribution to mitigate the effects of any remaining extreme outliers upon the estimation.

For the additional macroeconomic data, the Federal Reserve Economic Database (FRED) and Bank for International Settlement (BIS) are used to obtain 23 main macro-variables from all categories on its website for the relevant time period and frequency, which contain all important macroeconomic relations. Often it is assumed that the key macroeconomic variables are measures such as GDP or inflation, perhaps sometimes also unemployment. Including such measures could not be said to be unrepresentative of the macro-economy, however there are many other factors which help to define the nature of an economy to a greater or lesser extent. We therefore conduct the principal component analysis to extract three macro factors to absorb 90% of the macroeconomic information. The first factor is a composite score of almost all macroeconomic variables except for the unemployment rate. The second factor is a composite score of several macro-variables with the highest loading on the unemployment rate. And the last factor has the highest loading in the federal fund rate.

Our scaled earnings forecasting model is therefore consistent with the framework developed in Hou and van Dijk (2010) but we augment it by incorporating three macro factors. The purpose of taking a factor augmented approach to including the macroeconomic information is to avoid subjectivity. This results in the following unrestricted and restricted models:

TABLE 1: RESULTS OF FAMA AND MACBETH (1973) TYPE CROSS-SECTIONAL REGRESSIONS.

	Constant	*Value*	*Dividend*	*Accruals*	*Div. paid*	*Neg. earn*	*As. Gr.*	*PAM*	*PC1*	*PC2*	*PC3*	R^2
Model 1												
Coefficient values												
One-step	0.024	0.012	0.070	-0.008	-0.006	0.002	-0.026	0.550	0.045	0.116	-0.041	0.388
Two-step	0.040	0.008	0.131	-0.012	-0.006	0.005	-0.030	0.402	0.046	0.166	-0.072	0.214
Three-step	0.047	0.006	0.178	-0.012	-0.008	0.005	-0.029	0.310	0.015	0.033	-0.086	0.138
Time series t-statistics												
One-step	21.712	16.715	8.758	-9.368	-9.643	0.374	-11.396	20.418	1.477	1.684	-2.150	
Two-step	23.062	14.127	17.736	-12.971	-6.395	1.343	-17.327	18.712	1.036	1.804	-2.387	
Three-step	26.606	14.137	23.092	-13.670	-5.804	1.930	-21.657	20.877	0.501	0.546	-3.274	
Model 2												
Coefficient values												
One-step	0.025	0.012	0.064	-0.007	-0.005	0.002	-0.027	0.555				0.386
Two-step	0.041	0.008	0.121	-0.011	-0.005	0.005	-0.031	0.407				0.209
Three-step	0.048	0.006	0.166	-0.010	-0.007	0.006	-0.031	0.317				0.132
Time series t-statistics												
One-step	21.846	16.660	7.307	-7.840	-7.694	0.454	-11.377	20.190				
Two-step	23.316	13.309	16.057	-11.592	-5.004	1.431	-16.629	18.039				
Three-step	26.044	11.996	21.331	-10.940	-4.815	1.982	-19.499	19.376				

Unrestricted model (Model 1)

$$\frac{E_{it+\tau}}{A_{it}} = \beta_0 + \theta_1 \frac{E_{it}}{A_{it-1}} + \beta_1 \frac{V_{it}}{A_{it}} + \beta_2 \frac{D_{it}}{A_{it}} + \beta_3 \frac{AC_{it}}{A_{it}} + \beta_4 \frac{A_{it} - A_{it-1}}{A_{it}} + \delta_1 DD_{it} + \delta_2 NegE_{it} + \gamma_1 \frac{PC1_t}{A_{it}} + \gamma_2 \frac{PC2_t}{A_{it}} + \gamma_3 \frac{PC3_t}{A_{it}} + \eta_{it+\tau}$$

Restricted model (Model 2)

$$\frac{E_{it+\tau}}{A_{it}} = \beta_0 + \theta_1 \frac{E_{it}}{A_{it-1}} + \beta_1 \frac{V_{it}}{A_{it}} + \beta_2 \frac{D_{it}}{A_{it}} + \beta_3 \frac{AC_{it}}{A_{it}} + \beta_4 \frac{A_{it} - A_{it-1}}{A_{it}} + \delta_1 DD_{it} + \delta_2 NegE_{it} + \eta_{it+\tau}$$

where (τ =1, 2, or 3) denotes the net earnings before extraordinary items of firm *i* in year $t+\tau$, A_{it} is the total assets, B_{it} is the common/ordinary book equity, V_{it} is the firm value defined as its total assets plus market equity (stock price times outstanding share numbers) minus book equity, D_{it} is the common stock dividends, AC_{it} is the operating accruals calculate as in Sloan (1996), DD_{it} is the dividend paid dummy that equals 0 for dividend payers and 1 for non-payers, and $NegE_{it}$ is the negative earnings dummy that equals 1 for firms with negative earnings and 0 otherwise. We include the asset growth to control for variation in the scaling variable. Lagged earnings are also included in the model to identify possible mean-reverting property of

earnings (this is often referred to as a partial adjustment mechanism or PAM). We divide three macro factors by firm specific total assets since there is no obvious reason why macroeconomic conditions should have the same impact on all firms.

The principal components *PC1*, *PC2* and *PC3* require further discussion. As discussed, 23 separate macroeconomic indicators, as shown in the Appendix, were included into a standard principal component analysis, conducted in the normal way using an Eigen-value based assessment of factor loadings. All analysis is done using standardized variables, allowing the factor loadings to define the relative importance of the initial indicators. In this regard, this element of the estimation is effectively an exploratory form of factor analysis. By construction the factors should not be too highly correlated, and generally should result in a small set of common factors that in effect describe the behavior of the larger set of indicators.

The inclusion of principal components into forecast functions is a relatively new feature of forecasting, and one of the seminal papers in this field is Stock and Watson (2002)

Following Hou et al.'s (2010) methodology, we perform the pooled cross-sectional regression using the previous ten years (three years minimum) of data for each year between 1962 and 2010. The resulting time-series of yearly coefficients are averaged and the significances of these average coefficients are based on the time-series standard deviations of the yearly coefficients, which comply with Fama and MacBeth's (1973) approach.

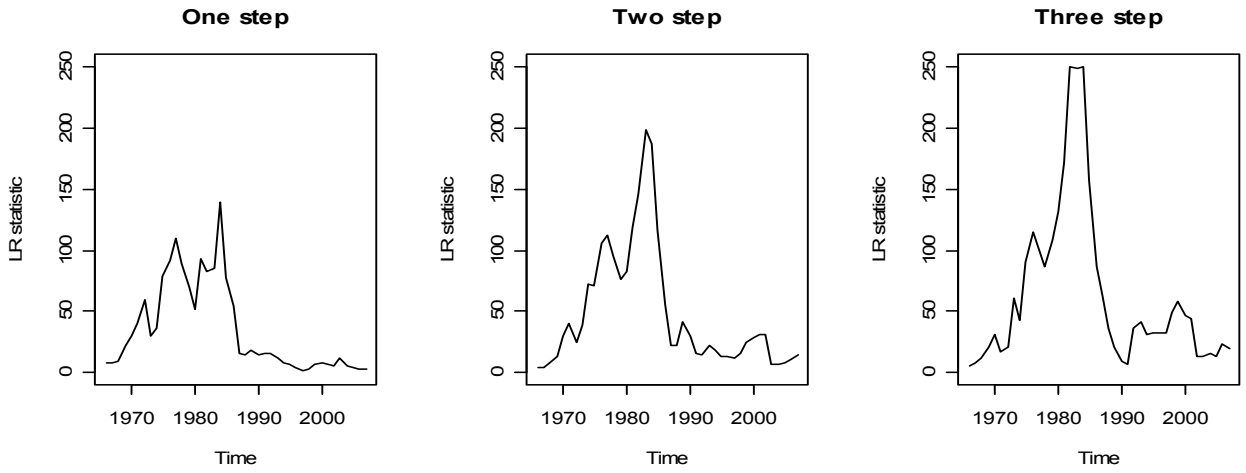

Fig. 1. lr test statistics for excluding macro factors from the model.

III. Empirical Results

The empirical regression results are summarized in Table 1, which presents average coefficients and their time-series t-statistics of the regression for the model with and without macro factors respectively. All coefficients for the explanatory variables have the same sign for the one, two, and three-year-ahead earnings regressions.

The coefficients for the financial explanatory variables are qualitatively similar to those in Hou and van Dijk (2010). Book value and dividends both have positive and significant impacts on future firms' earnings. Accruals and asset growth on the other hand are negative and significant, suggesting that as the value of these variables rises, the level of future firms' earnings will decrease.

The coefficients of the first two macro factors are relatively insignificant on average but exhibit significance in several sample periods. The coefficients of the macro factor PC3 are significantly negative for all one, two, and three-year-ahead earnings, suggesting that the interest rate information has a negative impact on firms' future earnings which has an intuitive appeal.

PC2 becomes significant at marginally lower levels of significance, further supporting the importance of macroeconomic information.

Table 1 also reports the average regression adjusted R2. A quick look at the increase in R2 from 38.6% to 38.8% might not suggest a significant improvement in model performance i.e. very little incremental explanatory power of macroeconomic conditions on the predicted earnings on average. However, to ensure this judgment is made on the grounds of objective testing, rather than subjective perception, we conducting a likelihood ratio test (LR) for jointly excluding the three macro-factors from the model. The results are plotted in Figure 1 for all one, two, and three-step models. The critical value of the test statistic with 3 degrees of freedom at a 95% level of confidence is 7.815. Values on the graph which are greater than this number indicate that macro factors should not be excluded. Therefore, the results give the evidence that macro factors should be present in the forecasting model most of the time. In light of these seemingly contrasting conclusions, it is surmised that while the gain in absolute forecast performance is small in absolute terms, it is a persistent effect, and it is the persistence over such a large sample that cause the small absolute gain to statistically non-ignorable.

The coefficient on the partial adjustment mechanism is moderately large at 0.5 for the one-step ahead model, and decreasing for the two and three-step ahead models to 0.4 and 0.3 respectively. These variables are highly significant. This implies a difference between short run and long run adjustment, which is relevant for both Model 1 and Model 2.

These long run adjustments therefore hold for all variables, both macroeconomic and financial. These values imply that in the long-run the coefficient values for the one-step ahead model are effectively double the values reported in Table 1.

As a conventional measure of forecasting accuracy and for consistency with Hou et al. (2010), the Root Mean Squared Errors (RMSE) are calculated and reported in Table 2 for both models, and for each of the three forecast horizons.

Unsurprisingly the RMSEs fail to demonstrate a discernable forecast improvement when incorporating macroeconomic conditions into the earnings forecasting model. However, looking at the averages is arguably in incomplete perspective, and in this regard we inspect the calculated RMSEs for each individual regression window over time. We find that prior to 1986 including macro factors to the model does generate substantially lower RMSE, as shown in Figure 2, but not after this. The line across the charts presents the average percentage reduction in RMSEs for model including macro factors relative to the model excluding macro factors.

TABLE A1: MACROECONOMIC INDICATORS USED.

Variable (FRED series)	Description	PC1	PC2	PC3
UNEMPLOY	Civilian Unemployment Rate		♦	♦
CPI	Consumer Price Index for All Urban Consumers: All Items	♦		
BOPBCAA	Balance on Current Account	♦	♦	
OPHNFB	Nonfarm Business Sector: Output Per Hour of All Persons	♦		
DSPIC96	Real Disposable Personal Income	♦		
M2SL	M2 Money Stock	♦		
FYGFD	Gross Federal Debt	♦		
GDPC1	Real Gross Domestic Product	♦		
FEDFUNDS	Effective Federal Funds Rate	♦	♦	♦
BUSLOANS	Commercial and Industrial Loans at All Commercial Banks	♦		
PPIACO	Producer Price Index: All Commodities	♦	♦	♦
OPHPBS	Business Sector: Output Per Hour of All Persons	♦		
AMBSL	St. Louis Adjusted Monetary Base	♦		♦
OILPRICE	Spot Oil Price: West Texas Intermediate	♦	♦	
GDP	Gross Domestic Product	♦		
SP500	S&P 500 Index	♦	♦	♦
FYFSD	Federal Surplus or Deficit	♦	♦	♦
INDPRO	Industrial Production Index	♦		♦
PCE	Personal Consumption Expenditures	♦		
TB3MS	3-Month Treasury Bill: Secondary Market Rate	♦	♦	♦
EXRAT-R	BIS Effective Exchange Rates (real)	♦	♦	♦
PSAVERT	Personal Saving Rate	♦	♦	♦
EXRAT-N	BIS Effective Exchange Rates (nominal)	♦	♦	

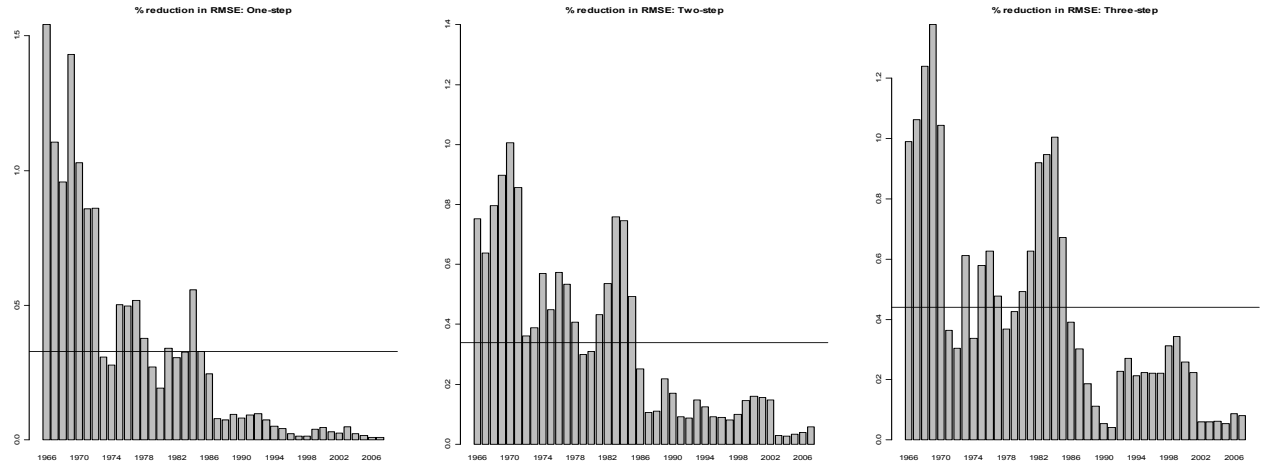

Fig. 2. lr test statistics for excluding macro factors from the model.

Taking the above findings together, the indication is that macroeconomic conditions do have predictive power for corporate future earnings in some periods but not for all periods. Using a simple average measure of forecasting accuracy just obscures the predictive power of macroeconomic information. Further, we note that the forecasting power of macro factors becomes stronger in the longer forecast horizons, indicating the long term impact of macro factors.

The overall performance of the models generally remains low with substantial amounts of variation in the data still needing to be explained, as made evident from the adjusted

R-squared. Notwithstanding the consistency of the approach used with mainstream and current literature in the field, the failure of the combination of firm-specific with a reduced dimension set of macroeconomic indicators to describe substantially more variation in future earnings could provide clues regarding general model mis-specification and/or the nature of the markets. It is possible that either the models generally applied are not flexible enough to capture the diverse behavioral characteristics of the market participants, or possibly that the market is predominantly random in its behavior. This latter concept is not however not appealing as the more random a market is the harder it is to model, and generally extant literature demonstrates rationality of markets, though often subject to constraints. Though it is further noted that there is a reasonable body of literature also looking into the volatility, and/or smoothing behavior within markets (smoothing being a response to increased volatility, which could be considered a type of randomness).

TABLE 2: RMSE FOR ONE, TWO AND THREE-STEP-AHEAD FORECASTING.

	One-step	Two-step	Three-step
Model 1	0.0608	0.0685	0.0734
Model 2	0.0610	0.0688	0.0737

IV. Conclusion

In this paper we examine the role of macroeconomic conditions on model-based corporate earnings forecasts. In doing so it was necessary to augment conventional earnings forecast functions with variables relating to macroeconomic factors, which are derived from a principal component analysis (PCA). Using the PCA is important to ensure that all potential macroeconomic variables can feature somehow in the model, without requiring the analyst to make a subjective choice on which ones.

Objectively, the empirical results based on the likelihood ratio tests demonstrate that macroeconomic information should be considered when predicting firm's future earnings; more specifically that in the early sample period macro factors help improve the predictive accuracy of the cross-sectional earnings forecasting model. These general results hold for one, two, and three-year forecast horizons, with the additional finding that the strength of impact of macroeconomic conditions increases with the length of the forecast horizon.

This study therefore contributes to current literature by narrowing the gap between the intuition and the empirical research on the role of macroeconomic conditions in forecasting firms' earnings.

There are some elements of this research that are worth further research. Firstly, the macroeconomic information used in the study is intended to describe a large amount of the economy in a parsimonious fashion. However only 23 indicators were used and it is very possible that some of the other macroeconomic information captured in the FRED database may be important also. Nonetheless the chosen indicators represent a large share of macroeconomic information. One drawback of the analysis also comes in respect of the assumed linearity of the functional relationships in the model. The presumption is that macroeconomics indicators have a direct and linear relationship with firm performance, but this may not always be so, however relaxing the assumption of linearity would considerable effort and justification.

Appendix

The macroeconomic indicators used in the study are listed in table A1, which also shows which of the principal components they are include in. It is noted that the same variable may have different weights in different components.

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