

CIRJE-F-736

Are Forecast Updates Progressive?

Chia-Lin Chang
National Chung Hsing University

Philip Hans Franses
Erasmus University Rotterdam

Michael McAleer
Erasmus University Rotterdam and Tinbergen Institute

April 2010

CIRJE Discussion Papers can be downloaded without charge from:

<http://www.e.u-tokyo.ac.jp/cirje/research/03research02dp.html>

Discussion Papers are a series of manuscripts in their draft form. They are not intended for circulation or distribution except as indicated by the author. For that reason Discussion Papers may not be reproduced or distributed without the written consent of the author.

Are Forecast Updates Progressive?*

Chia-Lin Chang

Department of Applied Economics
National Chung Hsing University
Taichung, Taiwan

Philip Hans Franses

Econometric Institute
Erasmus School of Economics
Erasmus University Rotterdam
The Netherlands

Michael McAleer

Econometric Institute
Erasmus School of Economics
Erasmus University Rotterdam
The Netherlands
and
Tinbergen Institute
The Netherlands

April 2010

* For financial support, the first author wishes to thank the National Science Council, Taiwan, and the third author wishes to thank the Australian Research Council, National Science Council, Taiwan, and the Center for International Research on the Japanese Economy (CIRJE), Faculty of Economics, University of Tokyo.

Abstract

Macro-economic forecasts typically involve both a model component, which is replicable, as well as intuition, which is non-replicable. Intuition is expert knowledge possessed by a forecaster. If forecast updates are progressive, forecast updates should become more accurate, on average, as the actual value is approached. Otherwise, forecast updates would be neutral. The paper proposes a methodology to test whether forecast updates are progressive and whether econometric models are useful in updating forecasts. The data set for the empirical analysis are for Taiwan, where we have three decades of quarterly data available of forecasts and updates of the inflation rate and real GDP growth rate. The actual series for both the inflation rate and the real GDP growth rate are always released by the government one quarter after the release of the revised forecast, and the actual values are not revised after they have been released. Our empirical results suggest that the forecast updates for Taiwan are progressive, and can be explained predominantly by intuition. Additionally, the one-, two- and three-quarter forecast errors are predictable using publicly available information for both the inflation rate and real GDP growth rate, which suggests that the forecasts can be improved.

Keywords: Macro-economic forecasts, econometric models, intuition, initial forecast, primary forecast, revised forecast, actual value, progressive forecast updates, forecast errors.

JEL Classifications: C53, C22, E27, E37.

1. Introduction

Macro-economic forecasts typically involve both an econometric model component, which is replicable, as well as intuition, which is non-replicable. Econometric models are frequently used to provide base-level forecasts in economics and business and, moreover, experts add their knowledge and modify these model forecasts. Intuition (or judgment) is expert knowledge possessed by a forecaster, and unobserved to the analyst. Macro-economic forecasts based on an econometric model are replicable, whereas the use of intuition in providing forecasts makes the ultimate forecast non-replicable. Governments typically provide non-replicable forecasts of economic fundamentals, such as the inflation rate and real GDP growth rate, as is also the case in Taiwan, the case study in our paper.

The difference over time between forecasts of a given variable, possibly based on an econometric model, denotes a forecast update, whereas the difference between the actual value and a forecast denotes a forecast error. Two key issues that warrant examination are: (i) whether intuition or publicly available information is more important in explaining forecast updates of economic fundamentals, such as the inflation rate and the real GDP growth rate; and (ii) whether intuition or publicly available information can reduce the one-, two- and three-period forecast errors for economic fundamentals.

If forecast updates are progressive, then forecasts should become more accurate, on average, as the updates approach their actual counterparts. Otherwise, forecast updates would be neutral. In this paper, the empirical application and tests of neutral forecast updates against the alternative of progressive forecast updates are based on government forecasts for Taiwan. Data for Taiwan are chosen for several reasons. First, three decades of quarterly data are available for checking the accuracy of the government forecasts of the inflation rate and the real GDP growth rate, and

hence the effects of model versus intuition, for different forecast horizons. Second, the effects of cumulative forecast errors can be examined for accuracy, and a comparison of model and intuition. Third, the actual series for both the inflation rate and the real GDP growth rate are always released by the government one quarter immediately after the release of the revised forecast. Fourth and in stark contrast to many Western countries, the government does not revise the actual values after they have been released. Finally, macroeconomic forecasts in Taiwan are typically based on both model and intuition. It would seem that there has not previously been a study that has estimated and compared the effects of intuition versus model over different forecast horizons using three forecast updates and forecast errors.

The plan of the remainder of the paper is as follows. Section 2 presents the simple regression models, forecasts, forecast updates, forecast errors and intuition. Section 3 presents the data set for the empirical analysis. Section 4 analyses the empirical results. Finally, Section 5 gives some concluding comments.

2. Model Specification

In this section we present an econometric model to obtain replicable forecasts and an estimate of intuition, conditional on the information set. Existing forecasts can be used to obtain one-period forecast updates, and one-, two-, three-, and more forecast errors, so that the information set expands with the availability of forecasts.

Consider the variable of interest, X_t , and the availability of two sets of multi-period forecasts, $F_{1,t}$ and $F_{2,t}$, for $t = n+1, n+2, \dots, n+N$. If the forecasts are based on linear econometric models, these models may be given as

$$X_t = W_{1,t}\beta_1 + \varepsilon_{1,t} \quad (1)$$

$$X_t = W_{2,t}\beta_2 + \varepsilon_{2,t} \quad (2)$$

When OLS is used to estimate the unknown parameters, the unbiased forecasts are given as

$$F_{1,t} = W_{1,t}\hat{\beta}_1 \quad (3)$$

$$F_{2,t} = W_{2,t}\hat{\beta}_2 \quad (4)$$

In practice, it is likely that only the outcomes $F_{1,t}$ and $F_{2,t}$ are available, but the information sets, $W_{1,t}$ and $W_{2,t}$, are not, in which case the publicly available information set, W_t , may be used. Note that W_t may include both $W_{1,t}$ and $W_{2,t}$, but this is unknown to the analyst. When $W_{2,t}$ nests $W_{1,t}$, such as when the one-period forecast $F_{1,t} = W_{1,t}\hat{\beta}_1$ is included in $W_{2,t}$, the techniques developed in Clark and McCracken (2001) are useful to evaluate the quality of the forecasts. Such updating of the information set with currently available forecasts is one of the illustrative cases of forecast updates considered in this paper.

The inclusion of a one-period forecast in the information set to calculate a one-period forecast for the following period, as in (3) and (4), can be shown to contain measurement errors through the use of generated variables (see Pagan (1984) and Oxley and McAleer (1993)), in which case standard econometric analysis needs to be modified. The measurement error ensures that the covariance matrix is not proportional to the identity matrix, as the errors are serially correlated and heteroskedastic. In such cases, Franses et al. (2009) demonstrate that OLS estimation can

nevertheless be consistent and efficient.

Where forecasts are used to explain the variables of interest, Franses et al. (2009) established the conditions under which OLS estimation of the parameters is efficient by appealing to Kruskal's Theorem, which is necessary and sufficient for OLS to be efficient (see McAleer and McKenzie (1991), McAleer (1992), Fiebig et al (1992), and Chang et al (2009) for further details). Moreover, as the presence of such measurement errors suggests that OLS yields biased standard errors, the Newey-West HAC standard errors should be calculated (see Smith and McAleer (1994)).

3. Data

In this section we examine the accuracy of three sets of macro-economic forecasts and the effects of intuition for different forecast horizons. The data are obtained from the Quarterly National Economic Trends, Directorate-General of Budget, Accounting and Statistics, Executive Yuan, Taiwan, 1980-2009. Since 1978, actual data and initial, primary and revised forecasts of the inflation rate and real GDP growth rate have been released by the Government of Taiwan, as follows (for further details, see Chang et al. (2009)):

- (i) In Q1 (February), release initial forecasts for Q1, Q2, Q3 and Q4 in the same year; release primary forecast for Q3 in the previous year; and release revised forecast for Q4 in the previous year;
- (ii) In Q2 (May), release initial forecasts for Q2, Q3 and Q4 in the same year; release initial forecasts for Q1 and Q2 for the following year; release primary forecast for Q4 in the previous year; and release revised forecast for Q1 in the same year;
- (iii) In Q3 (August), release initial forecasts for Q3 and Q4 in the same year; release primary forecast for Q1 in the same year; and release revised forecast for Q2 in the same year;

(iv) In Q4 (November), release initial forecasts for Q4 in the same year and Q1, Q2, Q3 and Q4 in the following year; release primary forecast for Q2 in the same year; and release revised forecast for Q3 in the same year.

Thus, for the one-quarter forecasts, there are several forecasts for each period, namely the initial (I) forecast made in the same period, the primary (P) forecast that is made available one quarter later, and the revised (R) forecast that is available two quarters later. Only the initial forecast is a one-quarter forecast, with both the primary and revised forecasts being revisions of the initial forecast. In sum, there are three types of forecasts of interest. There is the initial forecast, which is the first forecast for a particular quarter. Then there is the primary forecast, which is the one quarter update of an initial forecast. The revised forecast is a one-quarter update of a primary forecast. Finally, one quarter after the revised forecast is made available, the government reports the actual values of the variables, against which the accuracy of the initial, primary and revised forecasts, as well as the effects of intuition, can be checked over different forecast horizons.

In the context of equations (3) and (4), the initial forecast and the primary forecast, which includes the initial forecast in the updated information set, are such that $I = F_{1,t}$ and $P = F_{2,t}$. When the primary forecast is included in the updated information set to obtain the revised forecast, it follows that $P = F_{1,t}$ and $R = F_{2,t}$.

The variables P-I and R-P denote one-quarter forecast updates, A-R denotes a one-quarter forecast error, A-P (= A-R + R-P) denotes a two-quarter forecast error, and A-I (= A-R + R-P + P-I) denotes a three-quarter forecast error. An analysis of A-R, A-P and A-I permits a comparison of the effects of intuition of the expert forecaster versus the usefulness of publicly available information over forecast horizons of one, two and three quarters.

The sample period used for the actual values and the three sets of government forecasts of seasonally unadjusted quarterly inflation rate and real growth rate of GDP is 1980Q1 to 2009Q2, for a total of 118 observations. Actual data on the inflation rate and real growth rate, as well as the initial, primary and revised forecasts, are used in the empirical analysis.

4. Empirical Results

We have analyzed the data on unit roots and structural breaks. The diagnostics for unit roots (which are unreported) indicate that we can work with the growth rates data, as in Figures 1 and 2. Visual inspection from the same graphs does not suggest potential structural breaks, and there is also no evidence of structural breaks caused by any changes in measurement methods at the government agency in Taiwan.

The initial, primary and revised forecasts of the inflation rate, as well as the actual data, are given in Figure 1, while the real GDP growth rate counterparts are shown in Figure 2. Both figures show that the actual data, and initial, primary and revised forecasts of the inflation rate and real growth rate, are reasonably similar, with most turning points being forecast accurately. The correlations among the three forecasts and the actual values for the inflation rate and real GDP growth rate are given in Tables 1 and 2. It is clear that the four variables are highly correlated, with the lowest correlations being the initial forecasts and the actual values for both the inflation rate and real GDP growth rate, and the highest correlations being the revised forecasts and actual values of the inflation rate and real GDP growth rate. The primary and revised forecasts are very highly correlated, namely 0.999 for the inflation rate, and 0.994 for the real GDP growth rate.

The similarities in the three forecasts and actual values of the inflation rate and real GDP growth rate can also be seen in the root mean squared prediction errors (RMSPE) and mean absolute deviations (MAD) in Table 3. On the basis of both goodness-of-fit measures, it is clear for both the inflation rate and the real GDP growth rate that the revised forecast is more accurate than the primary forecast which, in turn, is more accurate than the initial forecast. However, the primary and revised forecasts are very similar, especially for the inflation rate, as can also be seen from the correlations in Tables 1 and 2.

The one-quarter forecast updates, namely P-I and R-P, one-quarter forecast errors, A-R, two-quarter forecast errors, A-P, and three-quarter forecast errors, A-I, are given in Figures 3 and 4 for the inflation rate and real GDP growth rate, respectively. These five variables are generally not highly correlated, as can be seen in Tables 4 and 5. The two exceptions for both the inflation rate and real GDP growth rate are between the pairs (A-R, A-P) and (A-I, P-I). The first pair is highly correlated as the primary and revised forecasts are highly correlated, while the second pair is highly correlated because $A-I = (A-R) + (R-P) + (P-I)$, and P-I has low correlations with both A-R and R-P.

A comparison of intuition versus publicly available information in explaining forecast updates is given in Table 6 for the inflation rate and real GDP growth rate. This table examines whether forecasters rely on models or on their intuition, and whether they should continue to do so. If publicly available information is able to predict the one-quarter forecast updates, intuition would be less important than the use of econometric models in forecasting.

The publicly available information (and available to the analyst) that is used to forecast the one-quarter forecast updates includes the one- and two-quarter lagged values of both the inflation rate and real GDP growth rate. It can be seen from Table 6 that the one-quarter forecast update,

R-P, for the inflation rate and real GDP growth rate, cannot be explained using publicly available information. However, P-I (though only at the 10% level for the inflation rate) can be explained using publicly available information, specifically lagged values of the respective variables. Thus, publicly available information is significant in forecasting the one-quarter forecast update, P-I, for both the inflation rate and the real GDP growth rate, while intuition alone is paramount in explaining the one-quarter forecast update, R-P, for both variables.

Moreover, on the basis of taking the adjusted R^2 value as capturing the model contribution to goodness-of-fit and the remainder coming from intuition, Table 6 shows that updates for the inflation rate are 0.958/0.042 for intuition versus model for the P-I update, and 0.978/0.022 for the R-P update. For the real GDP growth rate, the ratios of intuition to model are 0.687/0.313 and 0.978/0.022 for P-I and R-P, respectively. Combining these results with the RMSPE and MAD statistics in Table 3 suggests that forecast accuracy can be improved more substantially when forecast updates are based more heavily on a replicable model component rather than on an intuition component.

There is a substantial literature which suggests that forecasts based on intuition, or judgment, are typically biased. One cause of this bias is that forecasters rely on judgment when it is known that models suffer from omitted variables, see Bunn and Salo (1996). It has been found that relying on casual adjustments in practice may lead to a double-counting bias, whereas the use of model-based forecasts may be able to accommodate the omitted variables. In order to sketch one of the implications, consider an autoregressive model of order 1 [AR(1)] for the variable X_t , namely

$$X_t = \rho X_{t-1} + \varepsilon_t \quad (5)$$

OLS will provide an estimate $\hat{\rho}$, and an unbiased forecast for X_{n+1} is $\hat{\rho}X_n$. Suppose the forecaster adds intuition, believing that the value of X_n is exceptional and needs further accommodation. Adding such intuition based on X_n makes the forecast $\hat{\rho}^*X_n$. It is straightforward to see that this expert forecast will be biased (although it may be more accurate in terms of RMSPE). Furthermore, the forecast error computed as $X_{n+1} - \hat{\rho}^*X_n$ will depend on X_n , and thereby will be predictable.

To see whether such a situation also holds for Taiwan, consider the results in Table 7. This table presents a comparison of intuition versus publicly available information in explaining the forecast errors for the inflation rate and real GDP growth rate. This table examines to what extent forecasters should rely on models or on their intuition. If publicly available information that is used judiciously in a model is able to predict the one-, two- and three-quarter forecast errors for the inflation rate and/or real GDP growth rate, intuition would be less important in explaining forecast errors than the use of an econometric model. It can be seen from Table 7 that the one-, two- and three-quarter forecast errors, A-R, A-P and A-I, respectively, for the inflation rate and real GDP growth rate, can be explained using publicly available information, specifically the lagged values of the respective variables. Thus, publicly available information is significant in explaining the forecast errors for both the inflation rate and the real GDP growth rate, which shows that the intuition part of the forecasts must also include the same regressors as in the model forecast, and hence forecasters can be seen to double count..

Thus, there is substantial room for improving the forecasts of the inflation rate and real GDP growth rate for Taiwan. Such a strategy would entail downplaying the role of intuition and relying more heavily on the replicable econometric model component, which would also reduce the chance of double counting.

The null hypothesis of Neutral Forecast Updates, that is, tests of equality of means between the forecast updates, is tested in Tables 8 and 9 for the inflation rate and real GDP growth rate, respectively. The null hypothesis can be expressed as $H_0: P-I = R-P$, in which case the one-quarter forecast updates are equivalent, on average. The alternative hypothesis of Progressive Forecast Updates is $H_1: P-I > R-P$, which states that the accuracy of forecast updates increases, on average, as the forecasts approach the actual value.

The results in Tables 8 and 9 show that the Anova and Welch (1951) tests reject the null hypothesis of Neutral Forecast Updates for the inflation rate at the 5% level of significance, but do not reject the null hypothesis for the real GDP growth rate. As seen in Table 3, the primary and revised forecasts are very similar for the inflation rate, whereas the initial and primary forecasts are not, so that $P-I$ is not close to $R-P$. However, the three forecasts are not very close to each other for the real GDP growth rate, so that it is more likely that $P-I$ and $R-P$ might be equivalent. Moreover, the one-quarter forecast updates suggest that $P-I > R-P$, so that additional information is helpful in forecasting as the initial forecast is updated to the primary forecast, and subsequently to the revised forecast, for both the inflation rate and the real GDP growth rate.

5. Concluding Remarks

As macro-economic forecasts typically involve both a model component, which is replicable, as well as intuition, which is non-replicable, it is important to differentiate between their respective contributions to obtain accurate forecasts and improved forecast updates. If forecast updates are progressive, forecasts should become more accurate as the forecast horizon increases. Otherwise, forecast updates would be neutral.

The paper examined whether intuition or publicly available information was more important in explaining one-quarter forecast updates and one-, two- and three-quarter forecast errors for two economic fundamentals for Taiwan, namely the inflation rate and the real GDP growth rate, and whether intuition could reduce forecast updates and forecast errors. The one-quarter forecast update could be explained for the first update, but not the second update, for both the inflation rate and real GDP growth rate, whereas the one-, two- and three-quarter forecast errors could be explained for both the inflation rate and real GDP growth rate. As the primary and revised updates were very similar, the one-quarter forecast update based on these two forecasts could not be explained using publicly available information. It was found that forecast updates were progressive. Moreover, the one-, two- and three-quarter forecast errors could be explained using publicly available information, so that the importance of intuition was less important.

For policy purposes, the finding that forecast updates were progressive, and essentially depended on intuition, means that econometric models may not be useful in updating forecasts. However, when they did so, a greater gain in forecast accuracy was observed. As the one-, two- and three-quarter forecast errors were predictable on the basis of their own past values, it can be seen that forecasters include these same regressors again in forming their intuition, and hence are double counting. Thus, there is substantial room for improvement in the macro-economic forecasts for Taiwan. It is strongly recommended that intuition should play a lesser role, with greater emphasis on using the available information set and an appropriate econometric model.

References

- Bunn, D.W. and A.A. Salo (1996), Adjustment of forecasts with model consistent expectations, *International Journal of Forecasting*, 12, 163-170.
- Chang, C.-L., P.H. Franses and M. McAleer (2009), How accurate are government forecasts of economic fundamentals? The case of Taiwan, Available at SSRN: <http://ssrn.com/abstract=1431007>.
- Clark, T.E. and M.W. McCracken (2001), Tests of equal forecast accuracy and encompassing for nested models, *Journal of Econometrics*, 105, 85-110.
- Fiebig, D.G., M. McAleer and R. Bartels (1992), Properties of ordinary least squares estimators in regression models with non-spherical disturbances, *Journal of Econometrics*, 54, 321-334.
- Franses, P.H., M. McAleer and R. Legerstee (2009), Expert opinion versus expertise in forecasting, *Statistica Neerlandica*, 63, 334-346.
- McAleer, M. (1992), Efficient estimation: the Rao-Zyskind condition, Kruskal's theorem and ordinary least squares, *Economic Record*, 68, 65-72.
- McAleer, M. and C. McKenzie (1991), When are two step estimators efficient?, *Econometric Reviews*, 10, 235-252.
- Oxley, L. and M. McAleer (1993), Econometric issues in macroeconomic models with generated regressors, *Journal of Economic Surveys*, 7, 1-40.
- Pagan, A.R. (1984), Econometric issues in the analysis of regressions with generated regressors, *International Economic Review*, 25, 221-247.
- Smith, J. and M. McAleer (1994), Newey-West covariance matrix estimates for models with generated regressors, *Applied Economics*, 26, 635-640.
- Welch, B.L. (1951). On the comparison of several mean values: An alternative approach, *Biometrika*, 38, 330-336.

Figure 1
Inflation rate (1980Q1-2009Q2)

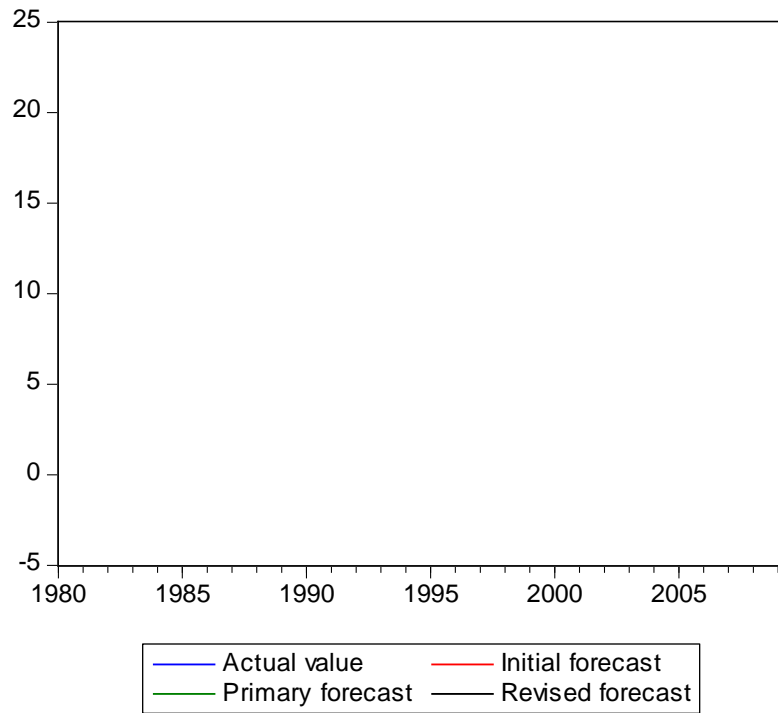


Figure 2
Real GDP growth (1980Q1-2009Q2)

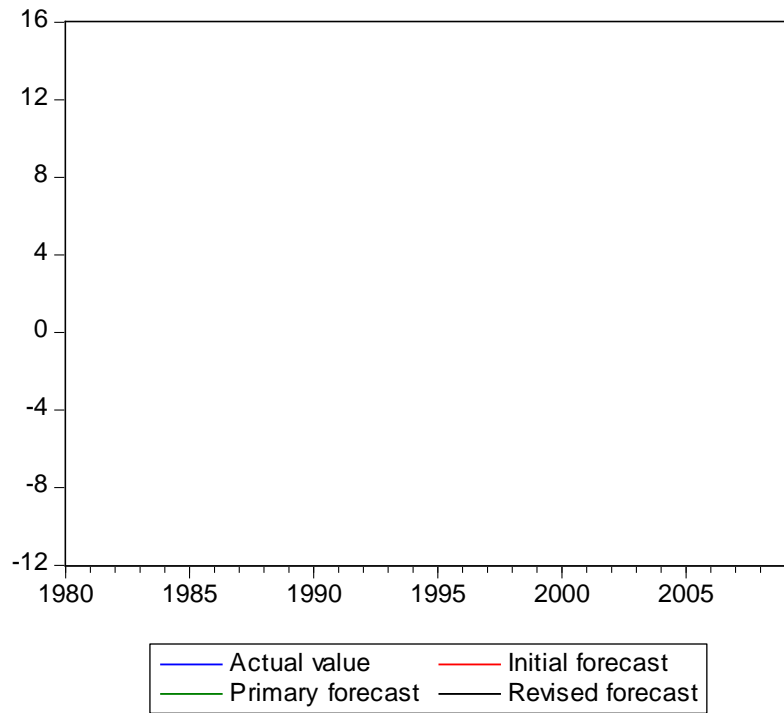
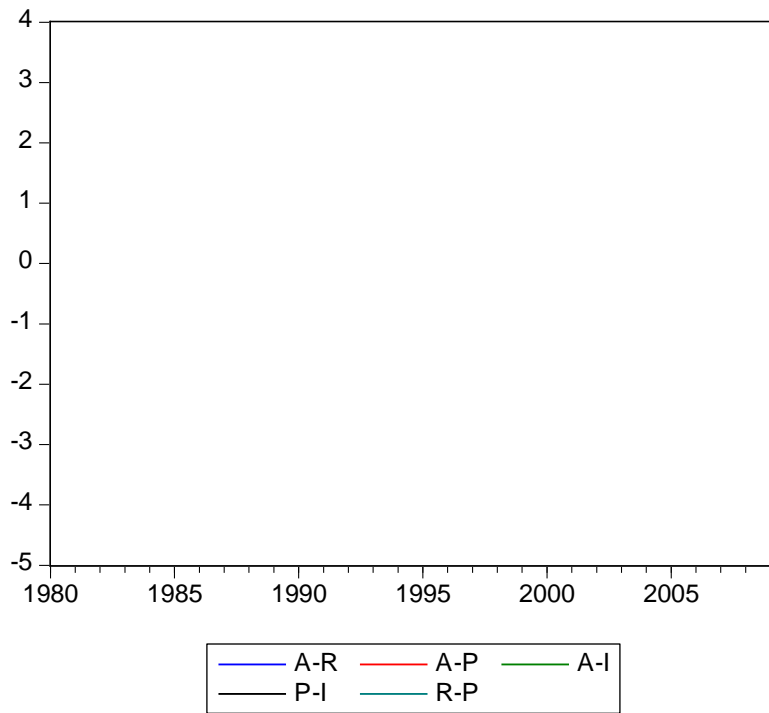
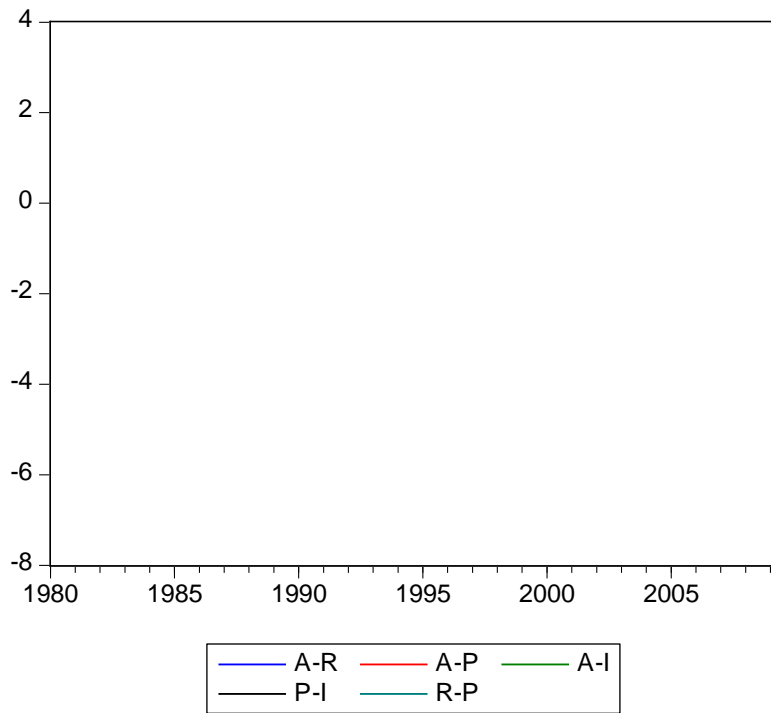


Figure 3
A-R, A-P, A-I, P-I and R-P for the Inflation Rate



Note: I denotes initial forecast, P primary forecast, R revised forecast, and A actual value.

Figure 4
A-R, A-P, A-I, P-I and R-P for the Real GDP Growth Rate



Note: I denotes initial forecast, P primary forecast, R revised forecast, and A actual value.

Table 1
Correlations of Forecasts and Actual Value for Inflation Rate

Variable	Actual value	Initial forecast	Primary forecast	Revised forecast
Actual value	1.000	0.980	0.995	0.995
Initial forecast	0.980	1.000	0.987	0.987
Primary forecast	0.995	0.987	1.000	0.999
Revised forecast	0.995	0.987	0.999	1.000

Table 2
Correlations of Forecasts and Actual Value for Real GDP Growth Rate

Variable	Actual value	Initial forecast	Primary forecast	Revised forecast
Actual value	1.000	0.917	0.986	0.991
Initial forecast	0.917	1.000	0.937	0.924
Primary forecast	0.986	0.937	1.000	0.994
Revised forecast	0.991	0.924	0.994	1.000

Table 3
Forecast Accuracy for Inflation Rate and Real GDP Growth Rate

Forecast	Inflation		Real Growth Rate	
	RMSPE	MAD	RMSPE	MAD
Initial	0.89	0.65	3.03	1.26
Primary	0.21	0.15	0.78	0.69
Revised	0.20	0.12	0.52	0.55

Note: The forecast accuracy measures are root mean squared prediction error (RMSPE) and mean absolute deviation (MAD).

Table 4
Correlations of A-R, A-P, A-I, P-I and R-P for the Inflation Rate

Variables	A-R	A-P	A-I	P-I	R-P
A-R	1.000	0.925	0.595	0.166	-0.123
A-P	0.925	1.000	0.609	0.137	0.262
A-I	0.595	0.609	1.000	0.869	0.080
P-I	0.166	0.137	0.869	1.000	-0.064
R-P	-0.123	0.262	0.080	-0.064	1.000

Notes: I denotes initial forecast, P primary forecast, R revised forecast, and A actual value. P-I, R-P and A-R denote one-quarter forecast updates, A-P denotes a two-quarter forecast update, and A-I denotes a three-quarter forecast update.

Table 5
Correlations of A-R, A-P, A-I, P-I and R-P for the Real GDP Growth Rate

Variables	A-R	A-P	A-I	P-I	R-P
A-R	1.000	0.813	0.470	0.173	0.055
A-P	0.813	1.000	0.658	0.314	0.626
A-I	0.470	0.658	1.000	0.921	0.499
P-I	0.173	0.314	0.921	1.000	0.307
R-P	0.055	0.626	0.499	0.307	1.000

Notes: I denotes initial forecast, P primary forecast, R revised forecast, and A actual value. P-I, R-P and A-R denote one-quarter forecast updates, A-P denotes a two-quarter forecast update, and A-I denotes a three-quarter forecast update.

Table 6
Explaining Forecast Updates for the Inflation Rate and Real GDP Growth Rate

Variable	Inflation Rate		Real Growth Rate	
	(1) P-I	(2) R-P	(3) P-I	(4) R-P
Constant	-0.356 (0.147)** [0.115]***	-0.030 (0.036) [0.043]	-0.180 (0.223) [0.252]	0.009 (0.080) [0.125]
AI (-1)	0.095 (0.046)** [0.037]**	0.015 (0.011) [0.014]	0.001 (0.069) [0.056]	-0.013 (0.024) [0.020]
AI (-2)	-0.062 (0.045) [0.043]	-0.019 (0.011)* [0.014]	-0.023 (0.068) [0.050]	-0.0003 (0.024) [0.017]
AG (-1)	0.008 (0.035) [0.037]	0.006 (0.009) [0.006]	0.397 (0.054)*** [0.091]***	0.026 (0.019) [0.026]
AG (-2)	0.006 (0.038) [0.037]	0.001 (0.009) [0.008]	-0.354 (0.058)*** [0.100]***	-0.009 (0.021) [0.038]
Adj R^2	0.042	0.022	0.313	0.022
F-statistic	2.283*	1.663	14.33***	1.670

Notes: I denotes initial forecast, P primary forecast, R revised forecast, A actual value. P-I, R-P and A-R denote one-quarter forecast updates, A-P a two-quarter forecast update, and A-I a three-quarter forecast update. AI(- i) denotes actual inflation rate lagged i periods, and AG(- i) actual real GDP growth rate lagged i periods, $i = 1,2$. OLS standard errors are in parentheses, Newey-West HAC standard errors are in brackets. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 7
Explaining Forecast Errors for the Inflation Rate and Real GDP Growth Rate

Variable	Inflation Rate			Real Growth Rate		
	(1) A-R	(2) A-P	(3) A-I	(4) A-R	(5) A-P	(6) A-I
Constant	0.068 (0.082) [0.051]	0.038 (0.082) [0.056]	-0.318 (0.175)* [0.148]**	0.280 (0.104)*** [0.130]**	0.289 (0.132)** [0.205]	0.109 (0.280) [0.383]
AI (-1)	0.137 (0.025)*** [0.070]*	0.152 (0.025)*** [0.074]**	0.247 (0.054)*** [0.094]**	0.021 (0.032) [0.032]	0.008 (0.041) [0.035]	0.009 (0.086) [0.074]
AI (-2)	-0.140 (0.025)*** [0.069]**	-0.159 (0.025)*** [0.073]**	-0.220 (0.053)*** [0.102]**	-0.013 (0.032) [0.029]	-0.013 (0.040) [0.033]	-0.036 (0.085) [0.068]
AG (-1)	-0.026 (0.020) [0.018]	-0.021 (0.020) [0.017]	-0.012 (0.042) [0.042]	0.076 (0.025)*** [0.034]**	0.102 (0.032)*** [0.052]**	0.499 (0.067)*** [0.086]***
AG (-2)	0.013 (0.021) [0.016]	0.014 (0.021) [0.016]	0.019 (0.046) [0.043]	-0.044 (0.027) [0.034]	-0.053 (0.034) [0.054]	-0.408 (0.073)*** [0.115]***
Adj R^2	0.200	0.245	0.139	0.079	0.098	0.323
F-statistic	8.331***	10.51***	5.707***	3.509***	4.170***	14.96***

Notes: I denotes initial forecast, P primary forecast, R revised forecast, A actual value. P-I, R-P and A-R denote one-quarter forecast updates, A-P a two-quarter forecast update, and A-I a three-quarter forecast update. AI(- i) denotes actual inflation rate lagged i periods, and AG(- i) actual real GDP growth rate lagged i periods, $i = 1, 2$. OLS standard errors are in parentheses, Newey-West HAC standard errors are in brackets. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 8
Test of Neutral Forecast Updates for Inflation Rate
1980Q1-2009Q2

Method	df.	Value	Probability
t-test	234	-2.485	0.014
Welch F-test*	1, 130.28	6.173	0.014

Test for Equality of Means Ho: P-I=R-P

Included observations: 118

*The Welch (1951) test allows unequal cell variances.

Table 9
Test of Neutral Forecast Updates for Real GDP Growth Rate
1980Q1-2009Q2

Method	df.	Value	Probability
t-test	234	-0.896	0.371
Welch F-test*	1, 138.06	0.802	0.372

Test for Equality of Means Ho: P-I=R-P

Included observations: 118

*The Welch (1951) test allows unequal cell variances.