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Accuracy and Rationality of Japanese Institutional Forecasters

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This paper uses the GDP forecast data of Japanese institutional forecasters, and examines the relation between their accuracy and rationality. It finds that they as a whole are pessimistic (optimistic) when their forecast revisions are positive (negative), and that they always over-react to new information. Moreover, these biases are stronger for those who release less accurate forecasts on average. Neither the rational expectations hypothesis nor reputation models with rational and strategic forecasters can explain these results consistently.

JEL Classification Codes: E37; C53; D84.

Keywords: Rational expectation; Forecast; Over-reaction; Optimism; Reputation.

1. Introduction

The recent slowdown of the U.S. economy has aroused economists' suspicion against durability of Japanese economic recovery. A consensus is now emerging that the Japanese economy will be stagnating again in 2001, and skeptics ask for further fiscal and monetary stimulation. Past records of Japanese institutional forecasters, however, reveal that their initial forecasts tend to be revised substantially later on. This paper investigates whether there is any bias in their forecast revisions.

Past literature finds that there are some biases in forecast revisions of economists. [1] Abarbanell and Bernard (1992) and Amir and Ganzach (1998) show that security analysts under-react to new information. Ehrbeck and Waldmann (1996) find that forecast revisions of short-term interest rates tend to over-react. Ashiya (forthcoming) finds that Japanese *individual* forecasters tend to over-react. However, profit-making corporations may not be subject to these biases since those who release biased forecasts will be driven out of the market. This is the reason why this paper focuses on the data of *institutional* forecasters.

The paper is organized as follows. Section 2 explains the methodology, and Section 3 explains data. Section 4 reports the results of full sample. It finds that Japanese institutional forecasters are pessimistic (optimistic) when their forecast revisions are positive (negative). Moreover, it finds that their forecast revisions have a strong tendency towards over-reaction. These results are inconsistent with the rational expectations hypothesis. Section 5 discusses whether reputation models can rationalize these results. If each forecaster's ability is private information, rational forecasters mimic what accurate forecasters will do. Thus forecasters over-react if and only if accurate forecasters tend to do so. To test this hypothesis, Section 5 divides the institutions into three groups according to their forecast accuracy. The top group contains institutions whose average forecast accuracy is the upper third of all institutions. The middle (bottom) group contains institutions whose average forecast accuracy is the middle (lower) third. Then it finds that the forecasts of the bottom group have the strongest tendency to over-react. This result is clearly inconsistent with reputation models. Section 6 considers the robustness of these results by examining normality of the residuals. Section 7 concludes.

2. Methodology

This paper follows the methodology of Ashiya (forthcoming). He considers two factors that influence forecast accuracy: optimism/pessimism and over-reaction/under-reaction. If forecasters are optimistic (pessimistic), their forecast errors tend to be positive (negative). If forecasters over-react to new information, their forecast errors tend to be positive (negative) when they obtain good (bad) news, i.e. when their forecast revisions are positive (negative). Similarly, if forecasters under-react to new information, their forecast errors tend to be negative (positive) when their forecast revisions are positive (negative).

The sign of forecast errors are affected by the combination of these factors. When forecast revisions are positive (negative),

(a) the joint effect of optimism and over-reaction on forecast errors is positive (indeterminate);

(b) the joint effect of optimism and under-reaction is indeterminate (positive);

(c) the joint effect of pessimism and over-reaction is indeterminate (negative); and

(d) the joint effect of pessimism and under-reaction is negative (indeterminate).

The arguments of Ashiya (forthcoming) demonstrate three important points. First, a positive forecast error does not necessarily indicate optimism, since pessimism plus over-reaction (under-reaction) may cause it when the forecast revision is positive (negative). Secondly, the set of a positive forecast revision and a positive forecast error needs not imply over-reaction, since under-reaction plus optimism may cause it. Thirdly, the sign of forecast revision is crucial for the analysis. Therefore this paper divides the data into two sub-samples according to the sign of forecast revisions.

In order to distinguish the effect of optimism/pessimism from the effect of over-/under-reaction, forecast errors are regressed on forecast revisions. Define $f_i^{t-2,t}$ as forecaster *i*'s initial forecast for year *t* in year $t-2$, $f_i^{t-1,t}$ as *i*'s revised forecast for year *t* in year $t-1$, and g^t as the actual growth rate of Japanese real GDP in year *t*. Then $FE_i^t \equiv f_i^{t-1,t} - g^t$ is *i*'s forecast error for year *t*, and $FR_i^t \equiv f_i^{t-1,t} - f_i^{t-2,t}$ is *i*'s forecast revision for year *t*. The regression is

(1) $$FE_i^t = \alpha + \beta \cdot FR_i^t + u_i^t$$

(Ehrbeck and Waldmann (1996), Amir and Ganzach (1998), and Ashiya (forthcoming) use the same equation). The null hypothesis of rationality is $\alpha = \beta = 0$. Positive α implies optimism, while negative α implies pessimism. Positive (negative) β implies over-reaction (under-reaction) to new information.

When we test the above null hypothesis, we must take account of error correlation across forecasters. Keane and Runkle (1990) and Ehrbeck and Waldmann (1996) argue that shocks to the aggregate economy produce forecast errors that are correlated across forecasters. Hence we estimate the variance-covariance matrix in the same way as Ehrbeck and Waldmann (1996). The estimated matrix V is

(2) $$V = (X'X)^{-1}\left(\sum_t^T\left[\left(\sum_i^N X_i^t \hat{u}_i^t\right)'\left(\sum_i^N X_i^t \hat{u}_i^t\right)\right]\right)(X'X)^{-1}$$

where X_i^t is $(1, FR_i^t)$ if FR_i^t is available and $(0,0)$ otherwise, X is the $TN \times 2$-stack of X_i^t, and $\hat{u}_i^t$ is the residual. Ehrbeck and Waldmann (1996, p.31) point out that "the resulting estimate of the variance-covariance matrix of beta [i.e. V] is unbiased under the null of rational expectations and a quadratic loss function. On the other hand, if forecast errors are predictable, the resulting estimate will be biased upward by a positive definite matrix. … They provide extremely robust tests with extremely low power."

3. Data

Toyo Keizai Inc. has published the forecasts of about 70 Japanese institutions in the February or March issue of "Monthly Statistics (Tokei Geppo)" since 1970's. [2] Each institution makes forecasts of the Japanese real GDP growth rate for the ongoing fiscal year and that for the next fiscal year. For example, February 2000 issue contains forecasts for fiscal year 1999 (from April 1999 to March 2000) and fiscal year 2000 (from April 2000 to March 2001). We treat the former as $f_i^{t-1,t}$ and the latter as $f_i^{t-1,t+1}$. We use the forecasts for the fiscal years 1981 to 1999 in order to avoid the effect of the second Oil Shock. We exclude institutions that participate in less than six consecutive surveys, leaving 63 institutions. The total number of forecast sets ($\left(f_i^{t-2,t}, f_i^{t-1,t}\right)$) is 839, and the average number of observations per institution is 13.32.

Among them, the forecast revision is positive in 404 observations, zero in 17 observations, and negative in 418 observations. We split the data into two subgroups, $FR_i^t \geq 0$ and $FR_i^t \leq 0$. The observations with $FR_i^t = 0$ are classified according to the sign of the average forecast revision for year *t*. [3] The subgroup of $FR_i^t \geq 0$ consists of 413 observations, while the subgroup of $FR_i^t \leq 0$ consists of 426 observations. The first rows of Table 1, 2, and 3 show the summary statistics (Other rows are explained in Section 5. The skewness and kurtosis are reported in Table A1, A2, and A3).

As for the actual growth rate g^t, Keane and Runkle (1990) argue that the revised data introduces a systematic bias because the extent of revision is unpredictable for the forecasters. For this reason we use the initial announcement of Japanese government usually released in June. Japanese economy experienced three business cycles in our sample period: the peaks were 1984, 1990, and 1996, and the troughs were 1981, 1986, 1993, and 1998. [4]

4. Results

First we check the relation between forecast revisions and forecast errors. Table 1 shows that forecast errors tend to be negative, which appears to indicate pessimism. The argument in Section 2 demonstrates, however, that under-reaction (over-reaction) might be the cause of negative forecast errors when forecast revisions are positive (negative). Hence we use regression analysis below.

Table 4 summarizes the results of equation (1). The first row is the estimates of the pooled data. The second and the third rows are the estimates of the sub-samples with positive forecast revisions ($FR_i^t > 0$) and negative forecast revisions ($FR_i^t < 0$) respectively. OLS estimates of standard errors are in the upper parentheses, and the modified standard errors calculated by equation (2), which are biased upward, are in the lower parentheses.

Row (b) of Table 4 demonstrates strong pessimism and strong over-reaction when the forecast revision is positive, and Row (c) demonstrates strong optimism and strong over-reaction when the forecast revision is negative, although α and β become insignificant when we use the standard errors estimated by equation (2). [5] Overall, the regression results of equation (1) clearly reject the rational expectations hypothesis.

5. Rationality

Section 4 has shown that Japanese institutional forecasters have a tendency to over-react. An open question is whether they over-react for strategic reasons. When each forecaster’s ability is private information, rational forecasters mimic what accurate forecasters will do in order to maintain their reputations. Thus forecasters over-react if and only if accurate forecasters tend to do so. This section inquires into the relation between forecast accuracy and forecast biases.

Let us divide the institutions into three groups according to their forecast accuracy. The top group contains twenty-one institutions whose average forecast accuracy is the upper third of all institutions. The middle (bottom) group contains twenty-one institutions whose average forecast accuracy is the middle (lower) third. The second to the fourth rows of Table 1, 2, and 3 show their summary statistics. If concern for reputation is the main reason for the over-reaction found in Section 4, the top group ought to have the strongest tendency to over-react. We test this implication by estimating equation (1) for each group separately.

Table 5, 6, and 7 describe the estimates of equation (1) for these three groups. Table 5 shows the estimates of the pooled data, Table 6 is the estimates of sub-samples with positive forecast revisions, and Table 7 is those with negative forecast revisions. The first (second/third) rows show the results of the top (middle/bottom) group. Among these tables, Table 6 and 7 are important because of the reasons explained in Section 2. Remember that positive (negative) α implies optimism (pessimism), and positive β implies over-reaction to new information.

Row (g) of Table 6 shows that the forecasts of the top group have almost no bias when their forecast revisions are positive. Row (h) shows that the forecasts of the middle group have moderate biases of pessimism and over-reaction, and Row (i) shows the forecasts of the bottom group have the largest biases. Table 7 shows that the top group and the middle group do not have a tendency to over-react when their forecast revisions are negative. In contrast, the bottom group has a strong tendency to over-react.

In sum, the forecasts of the bottom group have the strongest tendency to over-react. Consequently, over-reaction indicates inability of the forecaster. This result is obviously inconsistent with reputation models.

To confirm the above conclusion, we estimate the following regression:

$$\text{(3)} \qquad \overline{FE}_i = \alpha + \beta \cdot \overline{FR}_i + u_i$$

where $\overline{FE}_i$ ($\overline{FR}_i$) is the mean absolute forecast error (forecast revision) of forecaster *i*. Reputation models call for negative correlation between $\overline{FE}_i$ and $\overline{FR}_i$, since forecasters make excessive revisions if and only if abler forecasters have a stronger tendency to do so.

Table 8 reports the OLS estimates of this regression. It also reports the rank correlation coefficient of $\overline{FE}_i$ and $\overline{FR}_i$ since u_i in equation (3) is not normally distributed. As shown in Table 8, there is *positive* correlation between $\overline{FE}_i$ and $\overline{FR}_i$ when forecast revision is negative, and there is no relation when forecast revision is positive. [6] Namely, forecasters who change their forecasts by a large amount have *large* forecast errors on average. This result indicates that forecasters' strategic behavior is not the cause of over-reaction.

6. Robustness

This section checks normality and serial correlation of the residuals of regression (1). Although forecast revisions and forecast errors are clearly not normally distributed (See Table A1, A2, and A3), the residuals can take both positive and negative values. Table 9 indicates, however, that the residuals from regression equations (b), (g), and (h) are highly leptokurtic, and the null hypothesis that the residuals come from a normal distribution is rejected at levels smaller than 0.01. The extremely fat tails of the residual distributions indicate too frequent rejection of null hypothesis ($\alpha = \beta = 0$) in these equations.

We shall deal with this problem using the square root transformations. More precisely, we consider the following equation:

$$dum_i^t \sqrt{\left|FE_i^t\right|} = \alpha + \beta\sqrt{FR_i^t} + u_i^t ,$$

$$\text{where}\quad dum_i^t = \begin{cases} 1 & \text{if} \quad FE_i^t \geq 0 \\ -1 & \text{otherwise} \end{cases}$$

(Remember that $FR_i^t \geq 0$ for all observations in equation (b), (g), and (h)).

Table 10 shows the results, and Table 11 shows the distributions of the residuals. Now the kurtosis becomes negative, which indicates *thin* tails of the residual distribution and thus too *infrequent* rejection of the null hypothesis. Nevertheless, we obtain clearer results than we did in Section 4 and 5: equation (b') and (h') show strong pessimism and strong over-reaction, while equation (g'), the forecasts of the top group, shows no bias. Furthermore, both coefficients of equation (h') remain significant even if modified standard errors calculated by equation (2) are used. Therefore our conclusions that Japanese institutional forecasters have a tendency to over-react and that over-reaction indicates inability of the forecaster are unaffected by the non-normality of the residuals.

As for serial correlation of the residuals, Table A4 shows that the Durbin-Watson statistic is very close to two in each equation, and that none is significantly different from two at the 0.10 level. This indicates no first-order serial correlation.

7. Conclusions

This paper investigated the GDP forecast data of Japanese institutional economists, and obtained the following results. First, they are pessimistic when their forecast revisions are positive, and they are optimistic when their forecast revisions are negative. Secondly, they always revise their forecasts excessively. Thirdly, the forecasts of the less accurate institutions have the strongest tendency to over-react. The first and the second results contradict the rational expectations hypothesis, and reputation models fail to explain the second and the third results consistently. These findings are positive evidence for behavioral explanations.

Notes

1. As for the rationality of forecasts, Aggarwal et al. (1995) examine the median forecasts of American survey forecasts of eleven macroeconomic variables, and find that only five of them are rational. Aggarwal and Mohanty (2000) investigate the median forecasts of Japanese survey forecasts, and find the median forecasts of the trade balance and retail sales are rational but that of industrial production are biased.
2. Ashiya (forthcoming) and Ashiya and Doi (2001) also use the data from “Monthly Statistics (Tokei Geppo)”.
3. We obtain similar results when we exclude the observations with $FR_i^t = 0$ from the data.
4. The initial announcements of the actual growth rates for fiscal years 1981 to 1999 were 2.7%, 3.3%, 3.7%, 5.7%, 4.2%, 2.6%, 4.9%, 5.1%, 5.0%, 5.7%, 3.5%, 0.8%, 0.0%, 0.6%, 2.3%, 3.0%, -0.7%, -2.0%, and 0.5%.
5. Ashiya (forthcoming) finds the same biases in the forecast data of Japanese individual forecasters. Ehrbeck and Waldmann (1996) find over-reaction but do not find either optimism or pessimism in the U.S. bond market (They do not investigate the divided data). Amir and Ganzach (1998) investigate the earnings forecasts and find (a) over-reaction in the sub-sample of $FR_i^t > 0$, and (b) optimism and *strong under-reaction* in the sub-sample of $FR_i^t < 0$. One reason why only security analysts in the sub-sample of $FR_i^t < 0$ tend to under-react is that, when they receive negative information, they have an incentive to shade their forecasts to retain good relation with company management (Francis and Philbrick (1993) find evidence that supports this argument). GDP forecasters in our sample are free from such pressures.
6. We obtain similar results when we use mean squared forecast errors and mean squared forecast revisions.

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Table 1: The outcome of forecast errors (full sample)

	Obs.	$FE_i^t < 0$	$FE_i^t = 0$	$FE_i^t > 0$	avg$\lvert FE_i^t \rvert$	std$\lvert FE_{\mathrm{i}}^{\mathrm{t}} \rvert$	avg$\lvert FR_i^t \rvert$	std$\lvert FR_{\mathrm{i}}^{\mathrm{t}} \rvert$
Total	839	490	68	281	0.4949	0.4157	1.1542	0.8607
Top	275	163	28	84	0.4113	0.3633	1.1236	0.7809
Middle	348	202	29	117	0.4891	0.4019	1.1483	0.8514
Bottom	216	125	11	80	0.6107	0.4695	1.2028	0.9641

Note: $FE_i^t \equiv f_i^{t-1,t} - g^t$, $FR_i^t \equiv f_i^{t-1,t} - f_i^{t-2,t}$, avg$\lvert FE_i^t \rvert$ is the average of $\lvert FE_i^t \rvert$, and std$\lvert FE_{\mathrm{i}}^{\mathrm{t}} \rvert$ is the standard deviation of $\lvert FE_{\mathrm{i}}^{\mathrm{t}} \rvert$. The first row shows the statistics of all institutions. The second row shows the statistics of the top 21 institutions, whose average forecast accuracy is the upper third of all (63) institutions. The third (fourth) row shows that of the middle (bottom) 21 institutions, whose average forecast accuracy is the middle (lower) third.

Table 2: The outcome of forecast errors ($FR_i^t > 0$)

	Obs.	$FE_i^t < 0$	$FE_i^t = 0$	$FE_i^t > 0$	avg$\lvert FE_i^t \rvert$	std$\lvert FE_i^t \rvert$	avg$\lvert FR_i^t \rvert$	std$\lvert FR_i^t \rvert$
Total	413	249	40	124	0.3903	0.3520	0.8981	0.5367
Top	143	85	16	42	0.3252	0.3062	0.9385	0.5246
Middle	175	107	17	51	0.4040	0.3696	0.8891	0.5372
Bottom	95	57	7	31	0.4632	0.3659	0.8537	0.5494

Note: $FE_i^t \equiv f_i^{t-1,t} - g^t$, $FR_i^t \equiv f_i^{t-1,t} - f_i^{t-2,t}$, avg$\lvert FE_i^t \rvert$ is the average of $\lvert FE_i^t \rvert$, and std$\lvert FE_i^t \rvert$ is the standard deviation of $\lvert FE_i^t \rvert$. The first row shows the statistics of all institutions. The second row shows the statistics of the top 21 institutions, whose average forecast accuracy is the upper third of all (63) institutions. The third (fourth) row shows that of the middle (bottom) 21 institutions, whose average forecast accuracy is the middle (lower) third.

Table 3: The outcome of forecast errors ($FR_i^t < 0$)

	Obs.	$FE_i^t < 0$	$FE_i^t = 0$	$FE_i^t > 0$	avg$\lvert FE_i^t \rvert$	std$\lvert FE_{\mathrm{i}}^{\mathrm{t}} \rvert$	avg$\lvert FR_i^t \rvert$	std$\lvert FR_{\mathrm{i}}^{\mathrm{t}} \rvert$
Total	426	241	28	157	0.5962	0.4464	1.4026	1.0268
Top	132	78	12	42	0.5046	0.3958	1.3242	0.9459
Middle	173	95	12	66	0.5751	0.4148	1.4104	1.0146
Bottom	121	68	4	49	0.7265	0.5078	1.4769	1.1186

Note: $FE_i^t \equiv f_i^{t-1,t} - g^t$, $FR_i^t \equiv f_i^{t-1,t} - f_i^{t-2,t}$, avg$\lvert FE_i^t \rvert$ is the average of $\lvert FE_i^t \rvert$, and std$\lvert FE_{\mathrm{i}}^{\mathrm{t}} \rvert$ is the standard deviation of $\lvert FE_{\mathrm{i}}^{\mathrm{t}} \rvert$. The first row shows the statistics of all institutions. The second row shows the statistics of the top 21 institutions, whose average forecast accuracy is the upper third of all (63) institutions. The third (fourth) row shows that of the middle (bottom) 21 institutions, whose average forecast accuracy is the middle (lower) third.

Table 4: The effect of forecast revision (FR_i^t) on forecast error (FE_i^t)

Model: $FE_i^t = \alpha + \beta FR_i^t$

		α	(s.e.)	β	(s.e.)	$\bar{R}^2$	Obs.
(a)	Total	0.035	(0.030)[a]	0.028	(0.021)[a]	0.001	839
			(0.141)[b]		(0.073)[b]		
(b)	$FR_i^t > 0$	-0.175	(0.080)**[a]	0.181	(0.073)**[a]	0.012	413
			(0.187)[b]		(0.169)[b]		
(c)	$FR_i^t < 0$	0.210	(0.069)***[a]	0.110	(0.039)***[a]	0.016	426
			(0.354)[b]		(0.100)[b]		

Notes

a: OLS estimates.

b: Calculated without imposing restrictions on the variance-covariance matrix of forecast errors, except that forecast errors at different times are assumed to be uncorrelated.

***: Significant at the 0.01 level.
**: Significant at the 0.05 level.
*: Significant at the 0.10 level.

Table 5: The effect of forecast revision (FR_i^t) on forecast error (FE_i^t): Full sample

Model: $FE_i^t = \alpha + \beta FR_i^t$

		α	(s.e.)	β	(s.e.)	$\bar{R}^2$	Obs.
(d)	Top	0.073	(0.051)[a]	0.021	(0.034)[a]	0.000	275
			(0.117)[b]		(0.074)[b]		
(e)	Middle	0.031	(0.047)[a]	0.008	(0.034)[a]	0.000	348
			(0.137)[b]		(0.077)[b]		
(f)	Bottom	-0.004	(0.065)[a]	0.057	(0.032)*[a]	0.005	216
			(0.196)[b]		(0.070)[b]		

Notes

The first row shows the results of the top 21 institutions, whose average forecast accuracy is the upper third of 63 institutions. The second (third) row shows that of the middle (bottom) 21 institutions, whose average forecast accuracy is the middle (lower) third.

a: OLS estimates.

b: Calculated without imposing restrictions on the variance-covariance matrix of forecast errors, except that forecast errors at different times are assumed to be uncorrelated.

***: Significant at the 0.01 level.
**: Significant at the 0.05 level.
*: Significant at the 0.10 level.

Table 6: The effect of forecast revision (FR_i^t) on forecast error (FE_i^t): $FR_i^t > 0$

Model: $FE_i^t = \alpha + \beta FR_i^t$

		α	(s.e.)	β	(s.e.)	$\bar{R}^2$	Obs.
(g)	Top	0.072	(0.139)[a] (0.210)[b]	-0.014	(0.130)[a] (0.207)[b]	0.000	143
(h)	Middle	-0.231	(0.112)**[a] (0.165)[b]	0.239	(0.113)**[a] (0.127)*[b]	0.019	175
(i)	Bottom	-0.397	(0.131)***[a] (0.306)[b]	0.331	(0.146)**[a] (0.248)[b]	0.045	95

Notes

The first row shows the results of the top 21 institutions, whose average forecast accuracy is the upper third of 63 institutions. The second (third) row shows that of the middle (bottom) 21 institutions, whose average forecast accuracy is the middle (lower) third.

a: OLS estimates.

b: Calculated without imposing restrictions on the variance-covariance matrix of forecast errors, except that forecast errors at different times are assumed to be uncorrelated.

***: Significant at the 0.01 level.
**: Significant at the 0.05 level.
*: Significant at the 0.10 level.

Table 7: The effect of forecast revision (FR_i^t) on forecast error (FE_i^t): $FR_i^t < 0$

Model: $FE_i^t = \alpha + \beta FR_i^t$

		α	(s.e.)	β	(s.e.)	$\bar{R}^2$	Obs.
(j)	Top	0.224	(0.131)*[a] (0.292)[b]	0.109	(0.069)[a] (0.095)[b]	0.010	132
(k)	Middle	0.130	(0.119)[a] (0.325)[b]	0.044	(0.069)[a] (0.111)[b]	0.000	173
(l)	Bottom	0.292	(0.152)*[a] (0.499)[b]	0.188	(0.056)***[a] (0.133)[b]	0.047	121

Notes

The first row shows the results of the top 21 institutions, whose average forecast accuracy is the upper third of 63 institutions. The second (third) row shows that of the middle (bottom) 21 institutions, whose average forecast accuracy is the middle (lower) third.

a: OLS estimates.

b: Calculated without imposing restrictions on the variance-covariance matrix of forecast errors, except that forecast errors at different times are assumed to be uncorrelated.

***: Significant at the 0.01 level.
**: Significant at the 0.05 level.
*: Significant at the 0.10 level.

Table 8: Cross-sectional effect of average forecast revision

Model: $\overline{FE}_i = \alpha + \beta \cdot \overline{FR}_i$ where $\overline{FE}_i \equiv \text{avg}\left|FE_i^t\right|$ and $\overline{FR}_i \equiv \text{avg}\left|FR_i^t\right|$

	α	(s.e.)	β	(s.e.)	$\bar{R}^2$	Rank correlation [a]
Total	0.353	(0.093)[b]	0.133	(0.079)[b]	0.029	0.269
$FR_i^t > 0$	0.512	(0.062)[b]	-0.133	(0.069)[b]	0.042	-0.055
$FR_i^t < 0$	0.332	(0.071)[b]	0.196	(0.049)[b]	0.192	0.405

Notes

a: Rank correlation is obtained from a separate regression replacing the variables with their ranks.

b: OLS estimates.

Table 9: Normality of the residuals

$$L \equiv \frac{\text{Obs.}}{24} \times \left[4 \times \text{skew}\left(u_i^t\right)^2 + \text{kurt}\left(u_i^t\right)^2\right]$$

Eq.	Obs.	$\text{skew}\left(u_i^t\right)$	$\text{kurt}\left(u_i^t\right)$	L
(a)	839	0.0606	0.2988*	3.6331
(b)	413	-0.4393**	1.0026**	30.581**
(c)	426	-0.1145	-0.3144	2.6846
(d)	275	-0.0332	0.6634*	5.0939
(e)	348	-0.1094	0.0496	0.7302
(f)	216	0.2117	-0.1198	1.7430
(g)	143	-0.2180	1.6968**	18.288**
(h)	175	-0.5368**	1.0805**	16.917**
(i)	95	-0.2598	-0.0473	1.0771
(j)	132	-0.1839	-0.1388	0.8497
(k)	173	-0.1414	-0.4885	2.2971
(l)	121	-0.2095	-0.5710	2.5287

Note

**: Significantly different from a normal distribution at the 0.01 level.

*: Significantly different from a normal distribution at the 0.05 level.

Table 10: The transformed regressions

Model: $dum_i^t \sqrt{|FE_i^t|} = \alpha + \beta \sqrt{FR_i^t} + u_i^t$, where $dum_i^t = \begin{cases} 1 & \text{if} \quad FE_i^t \geq 0 \\ -1 & \text{otherwise} \end{cases}$

		α	(s.e.)	β	(s.e.)	$\bar{R}^2$	Obs.
(b')	Total	-0.429	(0.120)***[a] (0.336)[b]	0.361	(0.126)***[a] (0.314)[b]	0.018	413
(g')	Top	-0.164	(0.221)[a] (0.363)[b]	0.116	(0.227)[a] (0.374)[b]	0.000	143
(h')	Middle	-0.557	(0.176)***[a] (0.254)**[b]	0.497	(0.187)***[a] (0.250)**[b]	0.032	175

Notes

The first row shows the result of all 63 institutions. The second (third) row shows that of the top (middle) 21 institutions, whose average forecast accuracy is the upper (middle) third of 63 institutions.

a: OLS estimates.

b: Calculated without imposing restrictions on the variance-covariance matrix of forecast errors, except that forecast errors at different times are assumed to be uncorrelated.

***: Significant at the 0.01 level.
**: Significant at the 0.05 level.

Table 11: Normality of the residuals

$$L \equiv \frac{\text{Obs.}}{24} \times \left[4 \times \text{skew}\left(u_i^t\right)^2 + \text{kurt}\left(u_i^t\right)^2 \right]$$

Eq.	Obs.	$\text{skew}\left(u_i^t\right)$	$\text{kurt}\left(u_i^t\right)$	L
(b')	413	0.3388**	-0.7874**	18.569**
(g')	143	0.3386*	-0.7846**	6.3994*
(h')	175	0.3268*	-0.6962**	6.6482*

Note

**: Significantly different from a normal distribution at the 0.01 level.

*: Significantly different from a normal distribution at the 0.05 level.

Table A1: The skewness and kurtosis of forecast errors and forecast revisions (full sample)

	Obs.	$\mathrm{avg}(FE_i^t)$	$\mathrm{var}(FE_i^t)$	$\mathrm{skew}(FE_i^t)$	$\mathrm{kurt}(FE_i^t)$	$\mathrm{avg}(FR_i^t)$	$\mathrm{var}(FR_i^t)$	$\mathrm{skew}(FR_i^t)$	$\mathrm{kurt}(FR_i^t)$
Total	839	-0.1335	0.3998	0.0279	0.2692	-0.2701	2.000	-0.5943	-0.2959
Top	275	-0.1327	0.2835	-0.0765	0.6453	-0.1476	1.8505	-0.5811	-0.3830
Middle	348	-0.1374	0.3819	-0.1191	0.0352	-0.2540	1.9789	-0.6137	-0.2061
Bottom	216	-0.1282	0.5768	0.1938	-0.1398	-0.4519	2.1719	-0.5525	-0.3936

Note: $FE_i^t \equiv f_i^{t-1,t} - g^t$ and $FR_i^t \equiv f_i^{t-1,t} - f_i^{t-2,t}$. The first row shows the statistics of all institutions. The second row shows the statistics of the top 21 institutions, whose average forecast accuracy is the upper third of all (63) institutions. The third (fourth) row shows that of the middle (bottom) 21 institutions, whose average forecast accuracy is the middle (lower) third.

Table A2: The skewness and kurtosis of forecast errors and forecast revisions ($FR_i^t > 0$)

	Obs.	$\text{avg}(FE_i^t)$	$\text{var}(FE_i^t)$	$\text{skew}(FE_i^t)$	$\text{kurt}(FE_i^t)$	$\text{avg}(FR_i^t)$	$\text{var}(FR_i^t)$	$\text{skew}(FR_i^t)$	$\text{kurt}(FR_i^t)$
Total	413	-0.1976	0.2372	-0.4309	0.6930	0.8981	0.2881	0.5029	0.1324
Top	143	-0.1657	0.1720	-0.2266	1.7743	0.9385	0.2752	0.3453	-0.3893
Middle	175	-0.2040	0.2582	-0.5168	0.7856	0.8891	0.2886	0.6142	0.5312
Bottom	95	-0.2337	0.2938	-0.3287	-0.4069	0.8537	0.3019	0.5686	0.3549

Note: $FE_i^t \equiv f_i^{t-1,t} - g^t$ and $FR_i^t \equiv f_i^{t-1,t} - f_i^{t-2,t}$. The first row shows the statistics of all institutions. The second row shows the statistics of the top 21 institutions, whose average forecast accuracy is the upper third of all (63) institutions. The third (fourth) row shows that of the middle (bottom) 21 institutions, whose average forecast accuracy is the middle (lower) third.

Table A3: The skewness and kurtosis of forecast errors and forecast revisions ($FR_i^t < 0$)

	Obs.	$\mathrm{avg}(FE_i^t)$	$\mathrm{var}(FE_i^t)$	$\mathrm{skew}(FE_i^t)$	$\mathrm{kurt}(FE_i^t)$	$\mathrm{avg}(FR_i^t)$	$\mathrm{var}(FR_i^t)$	$\mathrm{skew}(FR_i^t)$	$\mathrm{kurt}(FR_i^t)$
Total	426	-0.0710	0.5496	0.0093	-0.3597	-1.4026	1.0542	-0.8063	-0.4085
Top	132	-0.0970	0.4018	-0.1241	-0.1554	-1.3242	0.8947	-0.7846	-0.3913
Middle	173	-0.0699	0.4979	-0.1056	-0.5416	1.4104	1.0295	-0.8807	-0.2530
Bottom	121	-0.0455	0.7835	0.1018	-0.6583	-1.4769	1.2514	-0.6931	-0.7115

Note: $FE_i^t \equiv f_i^{t-1,t} - g^t$ and $FR_i^t \equiv f_i^{t-1,t} - f_i^{t-2,t}$. The first row shows the statistics of all institutions. The second row shows the statistics of the top 21 institutions, whose average forecast accuracy is the upper third of all (63) institutions. The third (fourth) row shows that of the middle (bottom) 21 institutions, whose average forecast accuracy is the middle (lower) third.

Table A4: The Durbin-Watson statistics

Eq.	Obs.	D.W.
(a)	839	2.0783
(b)	413	2.0321
(c)	426	1.9887
(d)	275	2.0451
(e)	348	1.9407
(f)	216	2.0808
(g)	143	1.9050
(h)	175	2.0234
(i)	95	2.0809
(j)	132	1.9982
(k)	173	1.9017
(l)	121	2.0138
(b’)	413	2.0634
(g’)	143	2.0021
(h’)	175	2.1028

Note: None is significant at the 0.10 level.