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Do Forecasts Produced By Organizations Reflect Anchoring and Adjustment?

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ABSTRACT

In attempting to improve forecasting, many facets of the forecasting process may be addressed including techniques, psychological factors, and organizational factors. This research examines whether a robust psychological bias (anchoring and adjustment) can be observed in a set of organizationally-produced forecasts. Rather than a simple consistent bias, biases were found to vary across organizations and items being forecast. Such bias patterns suggest that organizational factors may be important in determining the biases found in organizationally-produced forecasts.

KEY WORDS Forecasting—organisational Behavioural decision-theory
Anchoring Adjustment

In attempting to improve forecasting, many facets of the forecasting process can be addressed. The statistical and other formal techniques used to produce the forecast can be improved. Allowance can be made for psychological biases of the individuals engaged in the forecasting process. The organizational context within which forecasts are produced can be altered. In this paper, we ask whether an extremely durable individual level forecasting bias (anchoring and adjustment) appears to characterize forecasts produced by organizations. An affirmative answer would suggest some very simple correction procedures might substantially improve forecast accuracy.

In recent years, researchers in behavioural decision theory have demonstrated some extremely robust phenomena concerning how individuals make decisions under uncertainty and these empirical phenomena have been supported by interesting and succinct psychological theories (see for instance, Kahneman, Slovic and Tversky, 1982; Kahneman and Tversky, 1979). These researchers have done both positive and normative work on forecasting including biases in forecasts (see for instance, Tversky and Kahneman, 1974), confidence in forecasts (Fischhoff and MacGregor, 1982), and the process of developing forecasting models (Einhorn and Hogarth, 1982).

In contrast to the individual focus of behavioural decision theory, this paper considers forecasts produced by organizations. Many, if not most forecasts, even if originated by individuals, are modified and approved by other members of the organization (Bromiley, 1986, Jenkins, 1982). In addition, the forecaster operates in a substantially more complex environment than the experimental subject and has access to numerous techniques and tools (e.g. statistical packages) that the experimental subject normally lacks. Organizational effects or the availability of formal tools might overwhelm behavioural decision theory phenomena in many interesting areas.

Consequently, this paper examines whether a robust behavioural decision theory phenomenon, anchoring and adjustment, can be observed in historical forecast data from several organizations. The anchoring and adjustment phenomenon (that forecasters make forecasts by taking a starting value and adjusting from there to produce the forecast with the adjustment being insufficiently extreme) was chosen for two reasons. First, it is an extremely robust phenomena at the individual level—it can be replicated readily in a variety of experimental situations. Second, it implies a specific pattern in forecast data, a pattern that allows testing with data generated by organizations in the course of their normal operations. Many behavioural decision theory phenomena refer to variables that are difficult if not impossible to measure with data routinely generated by organizations, for example, valuations of utility figure centrally in several phenomena but organizational evaluations of ‘utility’ would be difficult if not impossible to find. For additional descriptions of anchoring and adjustment and studies of anchoring and adjustment using individuals, see Tversky and Kahneman (1974) and Joyce and Biddle (1981).

In asking whether anchoring and adjustment appears to fit organizationally-produced forecasts, we use the psychological results to provide a hypothesis concerning a phenomenon which might be visible at the organizational level. As noted above, if anchoring and adjustment do characterize organizationally produced forecasts, simple techniques such as increasing the difference between the forecast provided and the anchor would offer improved forecast accuracy. Note that this does not address the use or non-use of anchoring and adjustment at the individual cognitive level but rather speaks only to forecasts produced by organizations. A variety of organizational or technical effects could create an anchoring and adjustment pattern regardless of whether individuals were evidencing anchor and adjustment. Conversely, individuals could be evidencing anchoring and adjustment but the effects might not be visible in the final forecasts if other factors produced biases of larger magnitudes.

ANALYSIS TECHNIQUES

If the forecasts produced by organizations exhibited anchoring and adjustment, with an insufficient adjustment, the following patterns would be expected:

1. On average, the forecast should lie between the anchor and the outcome that actually occurs (referred to here as ‘the actual’)—for most observations the adjustment from the anchor should not be extreme enough.
2. On average the difference between the anchor and the forecast should be less than the difference between the anchor and the actual.

These two patterns both reflect insufficient adjustment but with slightly different metrics. Pattern One ignores the size of the discrepancy between forecast and actual outcome whereas Pattern Two ignores the frequency of the anchoring and adjustment pattern by estimating the average size of the discrepancy. Depending on the loss function associated with forecast errors, either pattern may be more critical. In the data analyzed below, the two approaches provide extremely similar results.

Given a set of data consisting of anchors, forecasts, and actual outcomes, separate tests will be executed for each of the two patterns. For both approaches, all observations where the forecast and actual do not lie on the same side of the anchor are eliminated. Given our interest in seeing whether the aggregate pattern in the forecasts fits anchoring and adjustment (i.e. the adjustment from the anchor was insufficiently extreme) these observations cannot inform us since they were in the wrong direction. Observations where forecast and actual do not lie on the same side of the

anchor can be explained in numerous ways but correcting for insufficient adjustment by increasing the difference between anchor and forecast will only increase the error for these forecasts.

For the first test the data are classified into two categories: (i) where the forecast lies between the anchor and the actual; and (ii) where the forecast lies outside the region bounded by the anchor and the actual. In other words, if

$$\text{Anchor} < \text{Forecast} < \text{Actual}$$

or

$$\text{Anchor} > \text{Forecast} > \text{Actual}$$

the observation is counted as a type (i) event, and otherwise it is type (ii). Events of type (ii) are inconsistent with the anchoring and adjustment pattern. Thus the question can be phrased as: is the probability of outcomes of type (i) significantly higher than 50 percent? This hypothesis can be tested based on the binominal distribution.

The second test checks whether the magnitude of the difference between anchor and forecast is significantly less than the magnitude of the difference between the anchor and the actual. Test number two subtracts the absolute value of the difference between anchor and forecast from the absolute value of the difference between anchor and actual, i.e.

$$\text{Difference} = |\text{Anchor} - \text{Forecast}| - |\text{Anchor} - \text{Actual}|$$

If the adjustments are insufficiently extreme, the calculated difference should be significantly less than zero. For example, if anchor = 2, forecast = 4, and actual = 6, then the difference between anchor and forecast is less than the difference between anchor and actual, a pattern consistent with anchoring and adjustment. Likewise, anchor = 2, forecast = 1, and actual = 0 would also be consistent with anchoring and adjustment. Finally, if the anchor = 2, forecast = 6, and actual = 4, the absolute difference between anchor and forecast would be greater than the absolute difference between anchor and actual, a pattern not consistent with anchoring and adjustment. The hypothesis can be tested using the standard *t*-test. Whereas the first test considers only the direction of forecast errors (i.e. it only counted how often the forecast fell on which side of the actual), test two weights the size of the discrepancy.

The data set described below consists of a number of forecasts from a number of different organizations. If organizational effects are important in generating biases, the biases examined by the two procedures described above should vary across organizations and perhaps items being forecast. Intra-organizational differences in biases can be checked by looking at the biases or lack thereof in the various forecasts produced by a given organization. For example, due to differing organizational incentives forecasts of income might tend to be low while forecasts of capital investment might tend to be high. Looking across organizations one can ask, do organizations differ in their tendency to produce extreme or insufficiently extreme forecasts? Finally, looking at the data set as a whole, does anchoring and adjustment seem to be a good characterization of the entire data set, i.e. should researchers start to act on the premise that anchoring and adjustment is a general characteristic of organizationally generated forecasts?

DATA

To execute the tests described above, the data must include three points: the anchor, the forecast, and the actual outcome. The sample of forecasts was chosen to reflect substantial diversity in source, items being forecast, and planning horizons. The data consist of forecasts from a plant's

operational reporting to headquarters, corporate financial planning, corporate strategic planning, and governmental budgetary forecasts. Other sample selection criteria were considered but not employed largely due to the inability to specify what would constitute a 'representative' sample of organizational forecasts. This is of course a problem in any study that uses actual forecasts.

The descriptive literature on forecasting and planning is extremely consistent in finding that forecasters and budgeters work from the current actual numbers (often called the base) to produce their forecasts (Bromiley, 1986; Crecine, 1969; Davis, Dempster and Wildavsky, 1966; Gerwin, 1969; Kamlet and Mowery, 1980; Kanter, 1979; Schiff and Lewin, 1968; Wildavsky, 1979). Interviews were conducted with managers involved in producing these forecasts in each of the four organizations. All indicated that current outcomes formed the primary base from which forecasts were generated. Indeed, in all these organizations, the forecasts are presented on forms which align current outcomes next to the forecast. For the plant operational reporting forecasts, two sets of anchors were examined, the most previous actual outcome and the forecast from the annual plan but the results were almost identical so only those using the most recent actual outcome are reported here.

Plant operational reporting

Monthly reporting data were obtained from a steel mill. The data were taken from a monthly report that the mill sends to its parent company. The report includes actual results for many operations in the mill as well as forecasts of the outcomes for the next 3 months. Thus, for the operational reporting data three forecast horizons were available—1, 2, and 3 months. Two of the reported forecasts were chosen as the least interdependent—the number of tons of steel to be shipped and the forecast of income before taxes. Although shipments and income are somewhat related, a large number of other forecasts influence the transition from shipments to income so that the two forecasts may have different biases. The data covered the months from January 1975 to April 1979.

U.S. Navy Stock Fund

The Navy Stock Fund is a revolving fund which is used to acquire a number of products from contractors and then 'resell' them to the operating elements of the Navy which will actually use them. As part of the budget process, the managers of the fund forecast a number of items including orders from end users to purchase materials from the fund (new materials orders), commitments to private suppliers to purchase goods or services (obligations), material sent to users (disbursements), and cash value of inventories. The fund is divided into a number of separate categories dealing with different kinds of materials. The budget categories used here are ship's parts (budget project 14), commissary and ship's stores (budget project 21), retail fuel (budget project 38), and financing of certain repairs to be executed by Navy personnel (depot level repairs, budget project 81). Separate analyses will be conducted for each item being forecast in each budget project. The agency's annual report includes both quarterly budget figures for the current year and budget forecasts for each quarter in the subsequent year. The data consist of these quarterly forecasts for the years 1981 to 1983 (with the exception of budget project 81 which started forecasts in 1982). For all of these forecasts the anchor used was the approved quarterly budget for the year in which the forecast was generated. The data were taken from the annual 'Navy Stock Fund Report and Reapportionment Request'.

Corporate strategic plan

Data from the final strategic planning figures in a large (sales approximately \$1 billion per year) corporation were obtained. The forecasts available in this corporation covered a 5 year horizon.

Three forecast variables were chosen as somewhat independent—sales, capital expenditures, and changes in debt. The data were analyzed independently using the 1 year forecasts through 5 years forecasts for each of the three output variables. For all the forecasts, the anchor used was the actual value for the variable in the year in which the forecasts were generated. The data covered the years 1970 to 1980.

Corporate financial plan

Data on capital spending forecasts and actual spending were obtained from the corporate financial plan of a large (greater than \$5 billion per year in sales) corporation. The anchor used was the actual spending in the year in which the forecasts were generated. The data covered the years 1972 to 1980.

The data set can be seen to include forecasts from four very different sources, in four different organizations. The data include public and private sector forecasts. The forecast horizons vary from 1 month to 5 years. The forecasts cover budgeting, operational reporting, financial planning, and strategic planning. In addition, the quality of the forecasts varies enormously from average percent errors of 5 percent to average percent errors of 84 percent. Although the sample can by no means claim to be representative of the normal forecasts produced in organizations, it does include a substantial degree of variation which may widen the generality of the findings.

RESULTS

As noted above, there are a number of different ways to look at the results. Let us first consider the results for each organization to determine (i) whether the results for that organization appear to be consistent with anchoring and adjustment overall, and (ii) whether the various forecasts from that organization appear to differ in their degree of consistency with anchoring and adjustment. Next, the differences across organizations will be considered. Finally, the data as a whole will be analyzed. The numerical results appear in Table 1.¹

Plant operational forecasting

The plant forecasts appear to be consistent with anchoring and adjustment. For all the variables, more forecasts lay between the anchor and the actual than lay outside that region. For four out of six forecasts, the hypothesis that the probability of a forecast lying between the anchor and actual equals 0.5 can be rejected using a binomial test (two forecasts yield $\alpha < 0.1$ and another two, $\alpha < 0.01$). The overall pattern is clearly consistent with a greater than 0.5 probability of the forecast lying between the anchor and the actual. In addition, all the means of the difference variables (the absolute value of the anchor minus the forecast, minus the absolute value of the anchor minus the actual) are negative. For five out of six of the items, under the maintained hypothesis that the forecasts are normally distributed, the hypothesis that the mean equals zero can be rejected (two yielded $\alpha < 0.1$, two $\alpha < 0.05$, and one $\alpha < 0.01$). Overall, it seems safe to conclude that these results are consistent with anchoring and adjustment. Only a small, statistically insignificant difference exists between the shipments forecasts and the income before taxes forecasts with 61 percent of the shipments forecasts being between the anchor and the actual compared to 70 percent of the income before taxes forecasts. The Plant forecasts appear to adjust insufficiently from the anchor but there appears to be no substantial difference in that tendency between the two different items being forecast.

¹ Out of 595 original observations, 114 were eliminated because the forecast was not on the same side of the anchor as the actual. Of these 114 observations, 63 were in the plant operational forecasting data. Additional details on observations eliminated and average percent errors by forecast are available from the author.

Table 1. Results¹

Data	Forecast	Net Obs.	Proportion with forecast between anchor and actual	Mean of difference	Consistent with anchoring and adjustment ²
Plant, shipments (tons)	1 month	47	0.62*	-521**	Y
	2 months	37	0.59	-681*	Y
	3 months	35	0.63*	-265	Y
Plant, income before taxes (\$'000)	1 month	41	0.76***	-381**	Y
	2 months	36	0.75***	-367***	Y
	3 months	35	0.57	-307*	Y
Navy Stock Fund, by quarters, up to one year (\$'000)	Project 14	6	0.17	16,439**	N
	Project 21	9	0.11*	7,545**	N
	Project 38	6	0.33	2,800	N
	Project 81	5	0.20	28,677	N
Navy Stock Fund, by quarters, up to one year (\$'000)	Project 14	8	0.13**	30,196**	N
	Project 21	9	0.11**	11,760**	N
	Project 38	9	0.11**	41,218***	N
	Project 81	6	0**	82,447*	N
Navy Stock Fund, by quarters, up to one year (\$'000)	Project 14	8	0.25	16,811	N
	Project 21	9	0.11**	11,305**	N
	Project 38	9	0.11**	33,139**	N
	Project 81	6	0**	90,384***	N
Navy Stock Fund, by quarters, up to one year (\$'000)	Project 14	10	0***	253,158***	N
	Project 21	11	0***	5,836***	N
	Project 38	9	0.11**	42,985**	N
	Project 81	7	0***	588,676***	N
Corporate Strategic Plan, sales (\$'000)	1 year	10	0.50	4,690	N
	2 years	9	0.44	-3,189	—
	3 years	8	0.38	725	N
	4 years	7	0.57	-31,229	Y
	5 years	6	0.67	-123,883	Y
Corporate Strategic Plan, capital expenditures (\$'000)	1 year	9	0.56	980	—
	2 years	8	0.63	-14,110	Y
	3 years	7	0.57	-22,188	Y
	4 years	6	0.67	-31,043	Y
	5 years	5	0.80	-58,450*	Y
Corporate Strategic Plan, total debt (\$'000)	1 year	6	0.33	4,900	N
	2 years	8	0.38	5,233	N
	3 years	7	0.29	14,888	N
	4 years	7	0.29	20,543	N
	5 years	5	0.60	-5,850	Y
Corporate Financial Plan, capital expenditures (\$'000)	1 year	6	0**	42,113**	N
	2 years	6	0**	39,671**	N
	3 years	5	0.60	15,083	—
TOTAL		481	0.46		

¹ * $\alpha \leq 0.1$, ** $\alpha \leq 0.05$, *** $\alpha \leq 0.01$. If the significance level appears in the Proportion of Observations column, the test is against the hypothesis that there is a 0.5 probability of the forecast being beyond the actual. If associated with Mean of Difference column, the test is against the hypothesis that the mean equals zero.

² Y indicates proportion > 0.50 and mean of difference < 0 . N indicates proportion < 0.50 and mean of difference > 0 .

U.S. Navy Stock Fund

On the other hand, the Navy Stock Fund forecasts are consistently beyond the actual. No forecast variable has more than one third of its observations falling within the anchor to actual region and some variables had no observations in that region. For twelve of the sixteen forecasts, the hypothesis that $p = 0.5$ can be rejected using a binomial test (one at $\alpha < 0.1$, eight at $\alpha < 0.05$, and three at $\alpha < 0.01$). The difference variables all have positive means. For thirteen of the sixteen forecasts, one can reject the hypothesis that the mean equals zero using the standard t -test (one yields $\alpha < 0.1$, seven $\alpha < 0.05$, and five $\alpha < 0.01$). Thus, overall, the Navy Stock Fund forecasts are too extreme, just the opposite of the anchoring and adjustment hypothesis.

Two forms of intra-organizational effects might be found in the Stock Fund forecasts. The forecasts might vary by the item being forecast (new materials orders, obligations, etc.) or by the budget project producing the forecast. Using a contingency table approach with a chi-square test one cannot reject the hypothesis that the probabilities of being between the anchor and the actual are constant across the items being forecast (new materials orders, obligations, disbursements, and inventory), nor can one reject equality of probabilities across the budget projects. Note that the inability to reject the equality of probabilities across budget projects appears in spite of the widely differing qualities of the forecasts which one might think would be related to biases. Budget Project 81 has an average percent error of 56 percent compared to average percent errors of 27, 9 and 8 percent for Projects 14, 38 and 21 respectively.

Overall, the Navy Stock Fund forecasts are significantly too extreme. In spite of large variations in the overall quality of the predictions, the probability that forecasts are too extreme did not vary significantly across items or budget projects.

Corporate strategic plan

Whereas the plant forecasts are insufficiently extreme, and the Navy Stock Fund forecasts are too extreme, the Corporate Strategic Plan forecasts balance very closely around the 50 percent mark—half the forecasts over and half under the actual outcome. None of the forecasts has significantly more observations between the anchor and the actual than beyond the actual. The means for the difference variable are both positive (seven forecasts) and negative (eight forecasts) and only one differs significantly from zero (at the $\alpha < 0.1$ level). Aggregating by item being forecast, sales split evenly between over and under forecasts, capital expenditures are significantly insufficiently extreme (binomial test, $\alpha < 0.05$), and debt is significantly too extreme (binomial test, $\alpha < 0.1$). The hypothesis that the probability of forecasts being inside vs outside the actual-anchor region is equal across the three items (sales, capital expenditure, and total debt forecasts) can be rejected (chi-squared (2) = 4.8, $\alpha < 0.1$). Looking at these strategic plan forecasts as a whole, they appear to have neither consistent overestimation nor consistent underestimation (54 observations were over and 54 under), but significant differences are apparent across the various items being forecast.

Corporate financial plan

Overall, the corporate financial plan figures for capital expenditures are substantially too extreme with all twelve of the 1 and 2 year forecasts exceeding the actual (both being statistically significant). The 3 year forecasts split three observations between and two beyond. All the difference variable means are positive, the one and two year forecasts both significantly so (t -test, respectively $\alpha < 0.05$ and 0.01). Thus the corporate financial plan forecasts err significantly in being too extreme, just the opposite of the anchoring and adjustment hypothesis.

Having looked at the forecasts organization by organization, differences across the organizations are now examined. Counting for each organization the number of observations where the forecast lay between anchor and actual and the number where the forecast lay beyond

the actual gives the following between versus beyond results: Plant, 151, 80; Navy Stock Fund, 13, 112; Corporate Strategic Plan, 54, 54; Corporate Financial Plan, 3, 14. The chi-square statistic testing equality of proportion across organizations is significant ($\chi^2(3) = 105, \alpha < 0.001$) rejecting the equality across organizations. Since the scales differ, the difference variable cannot be usefully aggregated across the organizations but summarizing the difference variable results by organization indicates the following: Plant forecasts, all negative, five of six significantly so; Navy Stock Fund forecasts, all positive, thirteen of sixteen significantly so; Corporate Strategic Plan forecasts, seven positive and eight negative, one significant; Corporate Financial Plan forecasts, all positive, two of three significantly so. It is reasonable to conclude the mean of the difference variable varies substantially across these organizations. The data strongly support a conclusion that the forecasting biases differ across these organizations.

Finally, do the data as a whole fit an anchoring and adjustment pattern or not? Aggregating across all the forecasts, 221 observations lay between and 260 lay beyond the actual. Not only do more than 50 percent of the observations lie beyond the actual, but one can reject the hypothesis that the true proportion is 50 percent (normal approximation to the binomial test, $\alpha < 0.1$).

These aggregate results should be kept in context. They are contingent on the number of forecasts included in the sample from the differing organizations. Given the Plant's strong tendency to underestimate and the Navy Stock Fund's strong tendency to overestimate, changing the number of forecasts from either would alter the overall results. Since the question is, are the forecasts from all these organizations consistent with the anchoring and adjustment pattern, then the data do support a conclusion that they are not.

To summarize these results, it is concluded that:

1. The forecasts were consistent with anchoring and adjustment in only one of the four organizations.
2. The bias patterns varied across organizations and (for one organization) across items being forecast.

DISCUSSION

The results presented above suggest that the anchoring and adjustment pattern does not describe this set of organizationally produced forecasts. Although the sample used could not claim sufficient generality to demonstrate the ubiquity of the phenomenon, a demonstration that a phenomenon is not ubiquitous rests on the finding of contrary cases as was done here rather than generality of the sample. These results suggest that assuming anchoring and adjustment is not a good approach to improving organizationally produced forecasts.

On the other hand, the variance in bias patterns across these organizations suggests that efforts to improve forecasting in a particular organization may need to start with diagnosis of the causes of the biases (cognitive, organizational, or technical) before prescription. Anchoring and adjustment did appear to fit one organization. The variance in bias patterns within an organization and across organizations suggests that efforts to understand forecasting biases in terms of techniques and psychological factors might be usefully supplemented by studying biases due to organizational effects.

Cognitive and technical aspects of forecasting have been widely examined but little has been done on organizational factors. Organizational factors that might be considered include: (i) conscious policies to bias forecasts to manipulate the behaviour of the organization (e.g. make conservative revenue forecasts to restrain spending, Larkey and Smith, 1984); (ii) the direct and

indirect incentives facing managers (e.g. forecast low to look good on evaluations, Lawler, 1976; Lawler and Rhode, 1976; Lowe and Shaw, 1968); (iii) training and organizational culture which may influence managers in ways of which they are not aware (e.g. risk-taking cultures in organizations or training of accountants to be 'conservative' in judgement); and (iv) organizational routines and decision processes which may have both direct and indirect influences on decisions (see Crecine, 1969; Cyert and March, 1963).

To summarize, this research has demonstrated that the pattern of biases found in a set of organizationally produced forecasts is not generally consistent with anchoring and adjustment. Anchoring and adjustment may or may not be operating at the individual level, but other factors seem to contribute larger biases to the forecasts. This suggests the need for research on organizational effects that may lead to forecast biases.

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