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Against your better judgment? How organizations can improve their use of management judgment in forecasting

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Against your better judgment? How organizations can improve their use of management judgment in forecasting

Abstract

Accurate forecasts are crucial to successful planning in many organizations and in 2001 forty international experts published a set of principles to guide best practice in forecasting. Some of the principles relate to the use management judgment. Almost all organisations use judgment at some stage in their forecasting process, but do they do so effectively? While judgment can lead to significant improvements in forecasting accuracy, it can also suffer from biases and inconsistency. The principles therefore indicate how forecasters should use judgment and how they should assess its effectiveness. The question we examine is whether judgment is used according to these established principles. We conducted a survey of 120 forecasters to investigate whether their forecasting procedures were consistent with the principles. In addition, we conducted four in-depth case studies. We found examples of good practice. However, many organizations could improve forecast accuracy if they followed basic principles like limiting judgmental adjustments of quantitative forecasts, asking managers to justify their adjustments in writing and assessing the track record of judgmental interventions.

Against your better judgment? How organizations can improve their use of management judgment in forecasting

Accurate short-term forecasts are a key driver of success in many organisations. They provide guidance for decisions ranging from human resource planning to inventory control and from call centre planning to cash flow management. Despite, or perhaps because of, their importance many of these forecasts are based on management judgment. While academic research has focussed heavily on improving statistical methods of forecasting (for the evidence see Fildes (2006)) surveys of forecasting practice, most recently summarised by McCarthy et al. (2006), typically show the heavy use of purely judgmental approaches to forecasting. At the disaggregate SKU level, where typically a statistical forecasting method is employed, managers will still use their judgment to adjust the statistical forecasts if they appear to be unreasonable (Sanders and Manrodt 2003). A key question is: are these judgmental inputs effective in improving accuracy and can their effectiveness be improved?

Most researchers agree that management judgment can play a valuable role in forecasting (Lawrence et al. 2006). For example, managers can estimate the effects of special events like new sales promotion campaigns, international conflicts, or strikes while a statistical method would struggle because of lack of historical data. However, research by psychologists has also shown that judgment is subject to a number of biases. For example, people have a tendency to see false patterns in the random movements in time series. As a result, they tend to make damaging adjustments to reliable statistical forecasts even when no special events are expected (Goodwin and Fildes 1999). Over-optimism and over-reaction to recent events have also been widely

documented; examples include forecasting earnings (Helbok and Walker 2004) and sales forecasting (Fildes et al. 2006). Fildes et al examine in detail forecasts and forecast adjustments from four companies and found forecast errors increased from 10% to 33% percentage points through adjustment in some situations, while in others there were improvements of a similar magnitude. This demonstrates that making the most effective use of management adjustment is critical to improving forecasting, more critical in fact than the much smaller adjustments gained by improved statistical modelling.

Concerns like this led to the publication in 2001 of *The Principles of Forecasting* Handbook (Armstrong 2001, Armstrong and Pagell 2003) in which forty international researchers identified a set of *principles* for best practice in forecasting. (These *principles* can also be found on: www.forecastingprinciples.com). But to what extent do forecasting processes in organisations follow best practice when it comes to applying management judgment in forecasting? We identified a subset of 11 *principles* from the Handbook which are relevant to the application of judgment and examined whether the *principles* were being applied. This was done through a survey of 120, mainly US, forecasters.

The survey was supplemented by four detailed organisational case studies where the processes by which the forecasts were produced were observed, interviews with the personnel carried out and forecasts were analysed to identify the errors that were incurred. These four case studies contributed to our understanding of the survey data and ensured the questions asked were grounded in the organisations' forecasting

activities. We also obtained the respondents' assessments of the levels of accuracy that they were achieving.

Details of our respondents

We surveyed 115 forecasters attending four international forecasting practitioner conferences in the United States and also obtained responses from forecasters in 5 other companies including our case organisations, making a total of 120 responses. A wide range of industries were represented including food manufacturing, telecoms, insurance, banking, pharmaceuticals, heavy-duty transportation, real-estate, cosmetics, home-videos, publishing, greetings cards and electronics. The forecasters were responsible for producing forecasts for between 1 item and 34 million different items with a median of 350 different items. (The highest number was supplied by a retail forecaster who had to forecast demand for 75000 items in 450 different stores.) Table 1 shows how frequently the respondents made their forecasts while table 2 shows the percentage of respondents who indicated particular lead times for their forecasts.

Please insert Table 1 about here

Please insert Table 2 about here

The *forecasting principles* focus primarily on how to achieve improved accuracy. But is accuracy important to our respondents? Previous surveys have found it to be the most important criterion for evaluating forecasting effectiveness; McCarthy et al. (2006) found that 82% of their respondents regarded it as 'important'; or extremely important while an earlier study by Mentzer and Kahn (1995) found 92% in this category. A concurrent summary of earlier research by Yokum and Armstrong (1995)

also confirmed the dominance of accuracy, particular from the perspective of forecasters who had many series to forecast. In our survey 93.3% of respondents agreed that the principal objective of their forecasting process is to produce as accurate forecasts as possible with the resources they have available. (Note that this question was only posed to 60 respondents at the most recent two conferences) and 83.3% indicated that achieving accurate forecasts at the stock keeping unit (SKU) or disaggregated product or service level was important or very important (this question was only posed to 20 respondents).

Did forecasters stick to the 'Forecasting *Principles*'?

The *principles* provide guidance on three aspects of the use of judgment in forecasting: i) *when* to use judgment ii) *how* to use judgment and iii) *how to assess* the effectiveness of judgment.

When to use judgment

Principle 1 Use quantitative rather than qualitative methods

This principle is based on the finding that quantitative methods tend to be less biased and make more efficient use of data (Armstrong 2001), though, of course the methods are only useful when relevant data is available. This rationale also underlies the second and third *principles*.

Principle 2: Limit subjective adjustments of quantitative forecasts

Principle 3: Adjust for events expected in the future

These two *principles* imply that judgmental adjustments should only be applied to statistical forecasts when the manager has important information about events that is not available to the statistical method.

We asked our respondents to estimate the percentage of their forecasts that were based on i) judgment alone ii) statistical methods exclusively, iii) an average of a statistical forecast and a management judgment forecast and iv) a statistical forecast judgmentally adjusted by the company forecaster(s). Table 3 summarises the responses.

Please insert Table 3 about here

On average, three quarters of the forecasts were based on some sort of statistical approach. This is a higher figure than has been found in earlier surveys such as Sanders and Manrodt (1994). However, despite Principle 1, on average only a quarter of the forecasts were based exclusively on quantitative methods and, despite principle 2, subjective adjustments of quantitative forecasts was extremely common. (Where we have been able directly to observe the frequency of adjustments they ranged across the four case organisations from 10% to 90% approximately.) However, our experience of observing forecasting in companies caused us to be surprised by the high percentage of forecasts that were apparently based on an average of statistical and judgment methods (though companies like Brooks Sports have formalised this approach (Ross 2005)). As we show later, this practice is consistent with a later principle. We also asked the respondents to rate the importance of judgment, compared to statistical methods, in their forecasting on a 1 to 5 scale (1=not used, 5 =

very important). Their mean response was 4.1, with 35.4% indicated that judgment was 'very important', suggesting that they considered judgment to be more important than the *Principles* 1 and 2 would suggest.

Why did people apply judgment to forecasts? Table 4 shows the percentage of respondents who indicated that particular types of event were important or extremely important in influencing their use of judgment. At the time of making the forecast the forecasters will know that some of these events, such as holidays or price changes, are certain to occur at a known date in the future. Other events, such as the weather, will have uncertainty associated with them. However, in all cases, the impacts of these drivers on sales will be unknown at the time when the forecast is made.

Please insert Table 4 about here

86.7% of respondents indicated that at least one of the specific events listed in table 4 (i.e., excluding 'other') was an important, or extremely important, influence on the use of judgment. Company promotion and pricing proved the most important influence, with competitive activity regarded as less important, perhaps because this is seldom known ahead of time. Other stated reasons for using judgment included local knowledge, past forecast performance, changes in technology, capacity constraints, new accounts, and the health of the market. The results accord with principle 3 in that people were prepared to apply their judgment to take into account events that were expected in the future.

Some of these drivers, such as holidays, and more controversially, promotional activity, could have been incorporated into quantitative forecasting models. Principle 1 of using quantitative models wherever possible was again ignored. Other drivers such as novel sporting events could not be easily included.

We also asked respondents whether they made adjustments to reflect the relative benefits of over and under forecasting. 62.7% said that they did. Such adjustments would suggest a blurring of the distinction between a forecast (a genuine expectation of what is likely to occur in the future based on information available at the time) and a decision or plan (an estimate which is acted upon with the intention of minimizing loss) (Goodwin 1996). For example, our expectation (*forecast*) of next week's demand for a product might be 106 units. However, we might *decide* to hold 116 units in stock, in case of higher than expected demand, because for a given unit, a stock out is costlier than overstocking. Interestingly, of those who judged that under and over forecasting were not equally bad, 64% indicated that under forecasting was the most costly (this contrasts with the finding of Sanders and Manrodt (1994)- 70.4% of their respondents said they preferred to under forecast). 7% of our respondents indicated that the direction of loss depended on what they were forecasting. Stewart in Fildes et al.(2003) found conflicting preferences which will depend both on the role of the respondent and the time within the budget year However, the broad thrust of evidence supports the existence of optimism bias and this is certainly confirmed in the detailed case evidence we have collected (Fildes et al. 2006).***to here** While not an explicit forecasting principle the observed effects of the forecaster's preference on the forecast breaks one of the fundamental tenets of decision analysis – the need to distinguish between what we prefer and what we forecast.

More worrying, however, is our finding that 57% of our respondents indicated that their forecasts were changed by senior management and in 29% of cases this was done without consultation. This would be consistent with a large number of forecasts being judgmentally adjusted for political reasons, a finding compatible with those found in earlier studies by Galbraith and Merrill (1996) in the US and Fildes and Hastings (1994) in the UK. Galbraith and Merrill, for example, found over 60% of their respondents reported less accurate forecasts as a result of adjustments for political reasons, while only 15% saw an improvements. While the adjustments reported in our study could conceivably could be based on senior management's knowledge of future events that were not available to the forecaster, this seems unlikely, particularly when there was no consultation and the adjustments would therefore transgress principle 3..

How to apply judgment

Principle 4: Ask experts to justify their forecasts in writing

Principle 5: Use structured procedures to integrate judgmental and quantitative methods

Asking people to justify their judgments in writing has a number of advantages. Goodwin (2000b) found that it reduced the number of unnecessary and damaging judgmental adjustments to statistical forecasts from 85% to 35%. As a result, the median absolute percentage error of the forecasts improved, on average, from 10.0% to 3.6%. There are a number of possible reasons for this. People may feel more accountable for their judgments and hence make them more carefully. Alternatively,

the need to specify explicit reasons may help them to reflect on their rationale. Also, because the application of judgment requires more effort, people may be more reluctant to apply it in circumstances where its potential benefits are questionable. In addition, documenting the rationale for judgment can allow people to learn about when the use of judgment is appropriate.

We asked our respondents whether they documented the reasons for judgmental adjustments to forecasts. 68.8% claimed that they did which suggests widespread adherence to the principle. Of course, much depends on the quality of the documentation and whether it is ever reviewed. In our company-based research we have found many examples of reasons recorded in unintelligible shorthand and none where the reasons had been codified into retrievable categories.

Once the information is structured using *Principle 4*, *Principle 5* suggests that judgment and statistical methods should be integrated according to pre-specified rules. Formalising the integration should reduce the chances of judgment being used inconsistently or according to the forecaster's whim. They also allow the process that produced the forecast to be disclosed more easily and reduce the chances of political interference with the forecasts (Armstrong 2001). Armstrong and Collopy (1998) specify a number of possible rules. One of the simplest is to take an average of independent judgmental and statistical forecasts None of the case organisations produced independent forecasts, rather the adjustment was decided upon once the statistical forecast had been considered. Moreover, none of these organisations used structured procedures to determine when to adjust, or what the size of the adjustment should be.

Principle 6: Combine forecasts from approaches that differ

Principle 7: When combining, start with equal weights

As *Principle 6* suggests, combining forecasts from different methods appears to improve forecast accuracy because the constituent forecasts draw on different aspects of the available information (Armstrong 2006, Goodwin 2000a). An average based on equal weights (*Principle 6*) has the advantage of simplicity and robustness, especially if uncertainty is high and no data are available to allow estimation of what the best unequal weights should be . As indicated earlier, nearly 18% of respondents said that they used averages of statistical and judgmental forecasts, suggesting that this principle is now being applied in some organizations.

How to assess the effectiveness of judgment.

Principle 8: Compare track records of various forecasting methods.

Principle 9: Seek feedback about forecasts

We asked: "Do you ever review the extent to which judgmental adjustments [to statistical forecasts] improve the accuracy of your forecasts?" Only 52.8% of respondents said they did. Making judgmental adjustments can involve a considerable amount of management time and effort. In many companies (including our case studies) these adjustments are made after much discussion at lengthy meetings involving several managers. It is therefore surprising that almost half of our respondents said that their organisations did not assess the value of this commitment

of resources. These organisations also missed the chance to learn about when adjustment is likely to be beneficial and when it is best avoided. None of our case organisations monitored all components of forecast accuracy, so for example one organisation's software produced forecasts less accurate than the random walk, yet the result was unknown to the company forecasters. However, the most recent forecast errors were known and highlighted to the forecasters as part of the forecasting support system's output and were one of the causes of subsequent adjustment.

Principle 10: Use error measures that adjust for scale in the data

Principle 11: Use multiple measures of forecast accuracy

When assessing whether the value of management judgment in forecasting it is important to use an appropriate error measure, particularly given the large number of series that the comparison will be made over. When there is variation in the scale between series (e.g. the demand for some products may be counted in tens or twenties while others sell in tens of thousands) error measures like the root mean square error (RMSE) will be dominated by the performance of a forecasting method on the large-valued series (Chatfield 1988). Measures like the mean absolute percentage error (MAPE) are designed to overcome this problem. However, no error measure will give a complete picture of accuracy and the use of multiple measures to assess different aspects of performance is desirable. For the case organisations (and, we speculate, most of the respondents) accuracy is measured in order to improve supply chain performance, in particular inventory levels and service.

Table 5 shows the percentage of respondents who indicated that they used each of four well known error measures that we specified. Other measures used included the

weighted absolute percentage error (WAPE), Akaike's information criterion (AIC) and the coefficient of determination (R-squared), though both the AIC and R-squared are really designed to measure the fit of a forecasting model to past data, rather than act as measures of ex-ante forecast accuracy. Note that the average error measures bias in forecasts, not accuracy, and may have been confused by some of the respondents with the mean absolute error.

Please insert Table 5 about here

It can be seen that just under half of the respondents said they were using the MAPE. This is almost exactly the same figure as that found by McCarthy et al (2006) but contrasts with an early study by Carbone and Armstrong (1982) who found RMSE to be the most preferred measure. This widespread use of the MAPE suggests that many forecasters are in accord with *Principle 10*. However, there are various ways of measuring the MAPE, some of which can lead to serious distortions. This can occur, for example, if there is intermittent demand which leads to zeros in the denominator of the absolute percentage error. These need to be removed unless the measure is to be rendered meaningless (Syntetos and Boylan 2005). Our case organisations made no adjustments for 'bad' data and therefore had no reliable measure of accuracy available to them. In addition, the software used in two of the companies use the related metric,

$$= \frac{Abs(Actual - Forecast)}{Forecast}$$

This measure suffers from the disadvantage that its value can be distorted by inflating the forecast. The survey suggests that companies have yet to recognize the dangers in

not examining the statistical and motivational properties of the measures they use, as they apply to the company's own data.

Only 27.5% of respondents reported using multiple error measures (Principle 11) and 25% did not indicate that they used any error measure at all.

How did our respondents think their forecasts were performing?

Table 6 shows the effectiveness of adjustments, as assessed by respondents who claimed to review this. Only 3.8% reported that adjustments reduced accuracy, on average, and 69.3% estimated that they led to accuracy improvements of more than 5 percentage points. Table 6 suggests a median improvement in the absolute percentage error of about 7 percentage points. This is slightly higher than results we reported in Fildes et al (2006) where we found, in our case studies, that judgmental adjustments in three manufacturing companies improved the median absolute percentage error by between 2.6 and 5 percentage points, depending on whether the adjustment was positive or negative, respectively (in our fourth company, a retailer, adjustments made accuracy worse). Accuracy in the Fildes et al study was measured directly from the forecasts and actuals, rather than being based on forecasters' perceptions of accuracy. Mathews and Diamantopoulos (1989) also found a small (but highly variable) improvement in the only earlier empirical study.

Please insert Table 6 about here

Were reported improvements in accuracy (expressed as a rank) associated with the recommended practice of recording the reasons for adjustments? We found little evidence of this (r = 0.09), but as we have pointed out, keeping a record of why forecasts were adjusted does not in itself guarantee that the records will be used, or even that they will be saved in a format that is understandable when future forecasts need to be made.

Conclusions

Our results show that, five years after the publication of the *forecasting principles*, many organisations are falling short of best practice in the production of their forecasts. They are rely too heavily on unstructured judgment and not enough on statistical methods, often blurring forecasting with their decisions and plans. Many forecasts are being adjusted by senior managers often without consultation and possibly for political reasons. Nearly half of respondents did not review whether their judgmental interventions improved accuracy and nearly a third did not record reasons for these interventions. Relatively few used multiple measures of accuracy and a quarter did not indicate that they used any error measure.

Of course, people attending forecasting practitioner conferences may be more concerned to learn about *forecasting principles* and more receptive to these ideas than other company forecasters so our survey may well be under estimating the problem. Given the huge benefits that can flow from improved forecasting (Merrick et al. 2006) and some recent, if limited, evidence that forecasting in companies has become less accurate over the last few decades (McCarthy et al. 2006), there is a clear need to make sure that the *principles* are diffused. We should therefore welcome recent initiatives by organisations like the International Institute of Forecasters to

provide training and certification for practicing forecasters and to disseminate successful practice (where this is based on sound principles) through a new practitioner journal, but much remains to be done.

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Frequency of forecasting	% of respondents indicating this frequency
Daily	9.2
Weekly	35.0
Monthly	70.0
Quarterly	20.8
Annually	26.7

Note: Several respondents indicated more than one frequency

Table 1 The frequency with which forecasts are made

Forecast lead time	% of respondents indicating this lead time
2 weeks ahead or less	10.0
Between 2 and 4 weeks ahead	15.8
Between 4 and 13 weeks ahead	40.8
3 months to 18 months ahead	56.7
More than 18 months ahead	24.2

Note: Several respondents indicated more than one lead tine

Table 2 Forecast lead times

Forecasting method	Mean % of forecasts based on this method
Judgment alone	24.5
Statistical methods exclusively	25.0
An average of a statistical & judgmental forecast	17.7
A statistical forecast judgmentally adjusted	33.1

Table 3 Forecasting approach used by respondents

Reason for using judgment	% indicating important or extremely important
Promotional & advertising activity	51.4
Price change	45.5
Holidays	36.0
Insufficient inventories	33.3
Changes in regulations	32.7
Government policy	27.9
Substitute products produced by your company	22.5
Activity by competitors (promotions, advertising etc)	20.7
International crises	18.0
Weather	16.7
Insufficient inventories of competitors	16.2
Sporting events	11.8
Strikes	9.9
Other	36.4

Table 4 Influence of drivers on the use of judgment

Measure	% Using Measure
Average error	27.5
Mean absolute error	31.7
Mean absolute percentage error	44.2
Root mean square error	9.2
Other measure	24.2

Table 5 Error measures used

Effect of adjustment measured in percentage points	% of respondents
Reduces accuracy	3.8
Improves by 0 to under 5%	26.9
Improves by 5 to under 10%	40.4
Improves by 10 to 20%	23.1
Improves by over 20%	5.8
Total	100.0

(Note that if the statistical forecasts have a mean absolute percentage accuracy of 25% and the adjusted forecasts an accuracy of 20% this implies an improvement of 5 percentage points)

Table 6 Reported effect on accuracy of judgmental adjustments to statistical forecasts