FORECASTING SOFTWARE IN PRACTICE: USE, SATISFACTION, AND PERFORMANCE

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October, 2002

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Abstract

Using survey data from 240 US corporations we evaluate the use, satisfaction, and performance of forecasting software in practice. Despite large choices in commercial forecasting software packages only 10.8 percent of the respondents report using them. Most report using spreadsheets for forecast generation, and most software users routinely adjust software generated forecasts based upon their judgment. The majority of respondents report being dissatisfied with forecasting software, and identify *ease of use* and *easily understandable results* as the features they consider most important. However, users of commercial software packages are found to have the best forecast performance, as measured by mean absolute percentage error (MAPE). These findings may demonstrate that there are benefits to be gained in accuracy for those that decide to take advantage of the available technology.

Advancements in software and computer technology have revolutionized business, providing executives with desktop access to powerful computing capability. These advancements have also affected forecasting software capability, which has made complex algorithms accessible to practitioners through the incorporation of numerous automatic features (Tashman and Leach, l99l). The sheer number of forecasting software packages and options can be daunting for practitioners and summary reviews are published regularly in journals such as the *International Journal of Forecasting* (Hoover, l999; Ord, 2000; Tashman and Gros, 2001). For example, a recent review of microcomputer forecasting software provides summaries of as many as 51 computer programs from 33 companies (Rycroft, l999).

Despite the wide range of software choice and the enormous technical advancements, it appears that most business forecasting is still done judgmentally with the computer merely supporting the effort by providing the historical information (Lawrence, 2000). Some authors contend that many corporate analysts use spreadsheets as their primary analysis tool and choose to avoid forecasting software out of fear it would take years to master (McCarthy, l998). Even though forecasting software capability is powerful and accessible, the question is whether practitioners are taking advantage of this capability, how they are using it, and whether they are satisfied with their choices.

To answer these questions and better understand the role of forecasting software in practice we surveyed 240 US corporations. We focused on the type of forecasting software used in practice, how satisfied practitioners are with their software, and how well their software is performing.

We begin with a brief description of the method used for data collection and analysis, and then present our findings.

Methodology

To collect data for this study we used a four-page questionnaire requesting specific information on use, satisfaction, and performance of forecasting software, as well as general business information. The survey was mailed to the heads of Marketing of 2,394 US corporations. The typical respondent held the title of Vice President of Marketing or Vice President of Sales, and were representative of a wide range of manufacturing and retail firms. No specific incentives were offered for completing the survey. Reminder postcards were sent one month after the initial mailing.

Of the 2,394 surveys mailed, 54 were returned due to address errors. Of the remaining 2,340, complete and usable responses were received from 240 people. This provided a response rate of 10.3 percent, lower than for past surveys. This low response rate raised the possibility of non-response bias. In particular, those more interested are expected to be more likely to respond. To test this, we compared responses to questions on type of software used, degree of satisfaction, and forecast performance, of the first and second wave of respondents, each wave constituting a quartile of the data (Armstrong and Overton, l977). No significant differences were found between the two samples.

Software Use

We begin by looking at the types of forecasting software being used by forecasting professionals. The highest percentage of responding firms - 48.3 percent – report using spreadsheets, such as Excel, Lotus 1-2-3, or Quattro Pro, for forecasting. A smaller number - 24.6 percent- report using forecasting software developed internally. By

contrast, commercially available software packages are found to be used by a relatively small percentage of respondents (10.8 percent), as are software packages developed by an outside vendor (5.8 percent). Surprisingly, 9.6 percent report on using no software for forecasting - a fairly large number given today's wide software availability.

Specifically how software is used in practice is shown in Table 1. The majority of respondents indicate making regular managerial adjustments to software generated forecasts (61.2 percent). Also, a large percentage report that they place low reliance on automatically generated forecasts (41.1 percent). When asked how they compensate for special events, most (69.9 percent) indicate using judgment to generate a completely new forecast. A smaller percentage use judgment to adjust the software generated forecast (21.4 percent), with few changing the values of parameters in the statistical model (8.7 percent).

(Table 1 here)

An analysis of how software is used by type of software user provides more detail and is shown in Table 2. A high percentage of users of commercially available software and those that use software developed by an outside vendor are found to place strong reliance on automated forecasts. In contrast, users of spreadsheets and those that have software developed internally do not place as great reliance on the forecast output. In fact, a correlation coefficient computed between type of software and degree of reliance on automated forecasts is significant (.516). We speculate that firms that make the financial investment in purchasing software technology feel a greater commitment to use it.

(Table 2 here)

Satisfaction with Software

The majority of the respondents (60.3 percent) report being dissatisfied with the currently used software. A much smaller percentage (35.5 percent) report being satisfied, and only 4.2 percent are neutral, revealing a high degree of polarization regarding this issue.

We further analyzed these findings according to type of software used. According to Table 3, degree of satisfaction appears related to type of software use. The highest rate of dissatisfaction is found among respondents who use no software for forecasting, followed by those who use spreadsheets. In contrast, those who use commercially available forecasting software packages have significantly more satisfied than dissatisfied respondents. A correlation coefficient computed between degree of satisfaction and type of software used is moderately significant (.328), further supporting this relationship. However, even at this greater level of detail, the findings still suggest a polarization between respondents along this issue.

(Table 3 here)

Respondents were then asked to identify only the forecasting software features they considered most important, or critical. This is shown in Table 4. The percentages show the number of respondents that indicated that they considered a particular feature critical. The top two features identified were *ease of use*, and *easily understandable results*. In contrast, the least important were *low cost* and ability to *generate forecasts automatically*.

The importance of having easily understandable results is consistent with the argument made by authors in the past that the ability to present and support the forecast

persuasively to corporate executives is an important element of forecasting software (Adams, l986). In a review of automatic forecasting software packages, Tashman and Leach (l991) found the ability for this type of presentation to be surprisingly lacking.

(Table 4 here)

Next, we look at forecast performance achieved through software use.

Software Performance

Although a number of factors contribute to forecast performance, such as data variability and product type, we consider average performance of firms measured as reported quarterly mean absolute percentage error. Mean absolute percentage error (MAPE) is the average of the sum of all the percentage errors for a given data set. This measure was chosen because some studies have shown it to be the most frequently used forecast error measure in practice (Mentzer and Kahn, l995). Also, MAPE is a measure that is easy to communicate and useful in comparing forecasts from different situations (Armstrong, l985).

Respondents in our study were asked to indicate the quarterly mean absolute percentage error for their major product group, which was presented in increments ranging from less than 5% to greater than 20%. Also, those that were using forecasting software were asked to indicate their MAPE values for before and after software implementation.

Average MAPE values by software type are shown in Figure 1. The lowest (and best) average MAPE is associated with the use of commercial forecasting software packages, closely followed by software developed internally. Although the use of spreadsheets resulted in improvements over using no software, these results are not dramatic.

Performance of software packages developed by outside vendors resulted in the highest average MAPE. In contrast to commercial packages that can be viewed as “off the shelf,” outside vendors provide some degree of customization. This finding is puzzling and warrants greater future investigation.

Our findings on the average MAPE values for those using no software is quite consistent with typical MAPE values reported in past studies which were roughly 10-15 for the same forecast horizon and level (Armstrong, l985; Metzer and Cox, l984). MAPE values for those using commercial software packages, internally developed software, and even spreadsheets surpassed this value.

(Figure 1 here)

Also shown in the figure are standard deviations of MAPE values, computed after plots of the data revealed differences in degree of dispersion. MAPE values for users of commercial software packages showed visibly less dispersion than that for other categories, demonstrating more consistent performance. This is confirmed by the computed standard deviations and provides support for the performance of commercial software. Similarly, the use of spreadsheets and internally developed software shows more consistency in performance over using no forecasting software. However, software developed by outside vendors shows greater variability in performance compared to the other software categories.

Figure 2 compares average MAPE values before and after software implementation. Although these findings do not take into account the amount of adjustment made to the software output or how the generated forecast is used, they do show that there are gains to be made in forecast accuracy through the use of forecasting software. On the average

implementation of forecasting software resulted in significant improvements in MAPE. Average values before software implementation are consistent with those reported in earlier studies (Armstrong, l985; Metzer and Cox, l984), but are surpassed after implementation.

(Figure 2 here)

Conclusion

Our survey of 240 US companies on the role of forecasting software in practice reveals a number of findings. *First*, findings on the use of forecasting software in practice show a large disparity between software use and software capability, with most practitioners using spreadsheets for forecast generation. *Second*, the majority of respondents routinely adjust software generated forecasts, suggesting an overall lack of confidence in the software output. *Third*, most respondents are dissatisfied with current software, and identify ease of use and easily understandable results as the software features they consider most important. *Finally*, our results reveal that users of most formal forecasting software experience improved performance. In fact, those that use commercial software had the best and most consistent performance in this study.

Our study does not directly identify causes of user dissatisfaction. However, the high use of spreadsheets and the expressed importance of easily understandable results suggest a need for further software simplification and improved results reporting. The noted improvements in forecast performance due to software use suggest a payoff for those that overcome the initial hurdle of using forecasting software.

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Table 1: Percentage of managers reporting on software use (n=240).

SOFTWARE USE	Not At All/ Somewhat (%)	Moderate (%)	Strongly/ Highly (%)
Reliance on software generated forecasts.	41.1	37.9	21.0
Managerial adjustment made to software generated forecasts.	20.5	18.3	**61.2**

- Boldface indicates observation is significantly higher than other observations in the row, at the 0.05 level, using t-test for equality of means and Levene's test for equality of variances.

Table 2: Reliance on software generated forecasts (n=240).

SOFTWARE TYPE	RELIANCE ON AUTOMATED FORECASTS		
	Not At All/ Somewhat (%)	***Moderate (%)***	***Strongly/ Highly (%)***
Spreadsheet use	49	12	40
Software internally developed	29	29	42
Commercially available software	1	10	**89**
Software developed by outside vendor	0	13	**87**

- Boldface indicates observation is significantly higher than other observations in category, at the 0.05 level, using t-test for equality of means and Levene's test for equality of variances.

Table 3: Degree of satisfaction with forecasting software (n=240).

Software Type	DEGREE OF SATISFACTION		
	Not At All/ Somewhat (%)	*Moderate (%)*	*Strongly/ Highly (%)*
No software used	63	6	**31**
Spreadsheets use	65	5	**30**
Software internally developed	51	7	42
Commercially available software	40	9	**51**
Software developed by outside vendor	46	12	42

- Boldface indicates observation is significantly higher than other observations in category, at the 0.05 level, using t-test for equality of means and Levene's test for equality of variances.

Table 4: Percentage of respondents identifying most important software features (n=240).

SOFTWARE FEATURES	PERCENTAGE RESPONDENTS
1. Ease of use	**85.8**
2. Easily understandable results	**83.3**
3. User can interact with system forecast	**68.3**
4. High accuracy	**62.5**
5. Available technical support	**59.6**
6. Ability to combine multiple forecasts	**42.1**
7. Low cost	**34.6**
8. Forecasts generated without user intervention	**13.8**

Figure 1: Average reported MAPE by type of software used.

Software Type	AVERAGE MAPE	Standard Deviation (σ)
No software used	**10.15**	**6.14**
Spreadsheet use	**9.01**	**6.01**
Software internally developed	**8.62**	**6.29**
Commercially available software	**8.41**	**4.45**
Software developed by outside vendor	**11.00**	**6.92**

Figure 2: Average MAPE values before and after software implementation

MEAN ABSOLUTE PERCENTAGE ERROR (MAPE)	BEFORE IMPLEMENTATION (Percentage Respondents)	AFTER IMPLEMENTATION (Percentage Respondents)
1. < 5 %	4.3	**27.1**
2. 5-10 %	32.3	**40.1**
3. 11-15 %	32.3	**19.5**
4. 16 – 20 %	21.9	**9.0**
5. > 20 %	27.2	**4.3**

- Boldface indicates significant differences between judgment focused and quantitative focused firms at 0.05 level based on t-test for equality of means and Levene's test for equality of variances.