

Interpreting algorithmic and qualitative information when making judgmental forecast adjustments

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Marketing Analytics
and Forecasting

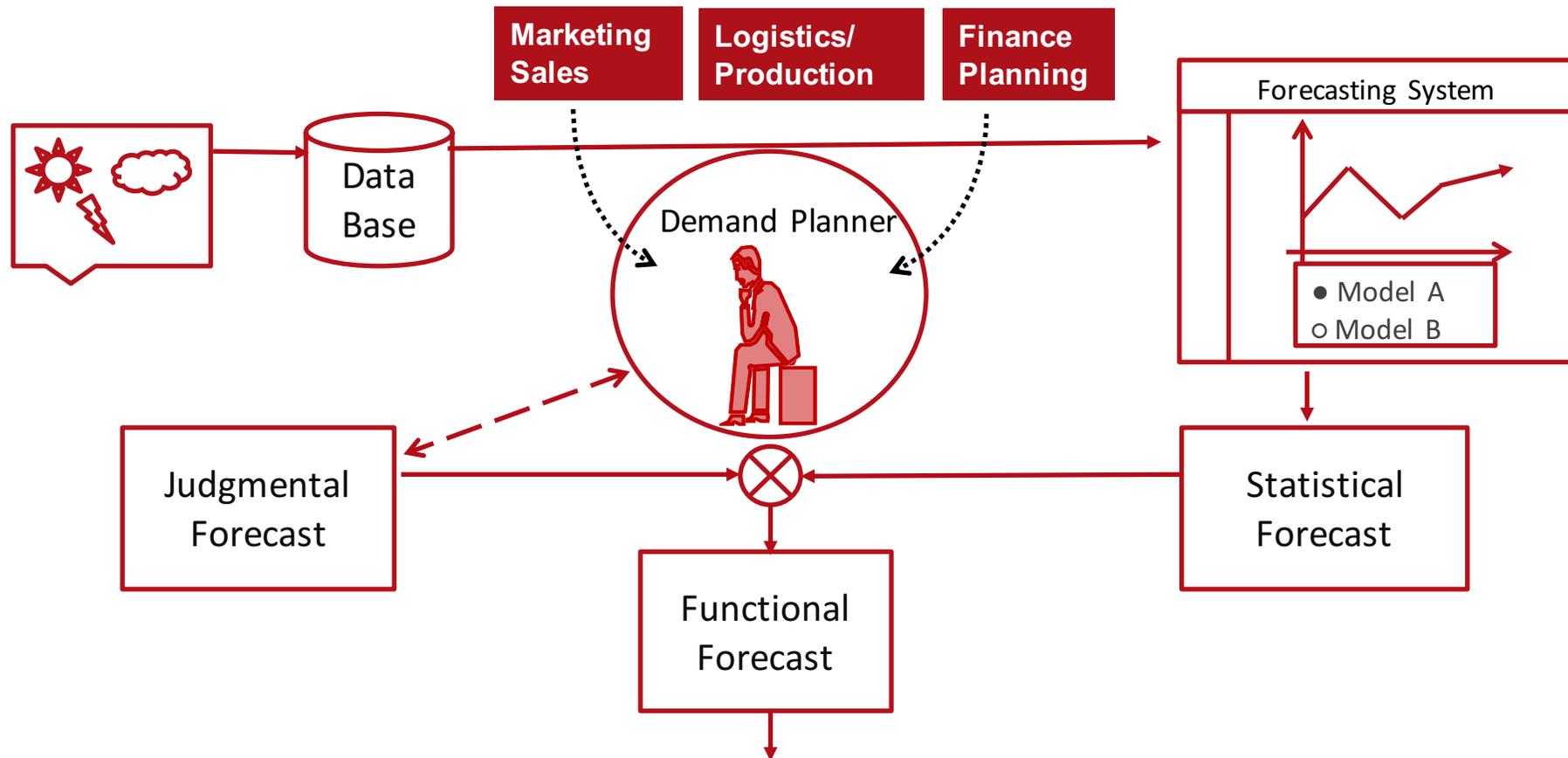


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Agenda

- Introduction:
 - Forecasting process in S&OP
 - Why judgmental adjustments?
- Forecasting issues:
 - Biases and heuristics
 - Reasons for using judgment
- Literature: incorporating domain knowledge
- Our experiment: setting and hypotheses
- Modelling results and discussion
- Future plans

Forecasting process in S&OP



The process (Sales and Operations Planning):

- Statistical forecast
- Information from sales, market research, planning and logistics, finance
- Incorporated into a final forecast
- Judgment is a key component for integration

Why judgmental adjustments?

Table 1: Survey studies of methods used in practice

Method	Study				Average
	A	B	C	D	
Judgment alone	30%	25%	24%	14%	23%
Statistical methods exclusively	29%	25%	32%	30%	29%
Average statistical & judgment	41%	17%	–	19%	18%
Adjusted statistical forecast		33%	44%	37%	38%
Sample size	240	149	59	42	

A: Sanders and Manrodt (2003); B: Fildes and Goodwin (2007); C: Weller and Crone (2012); D: Fildes and Petropoulos (2015).

Forecasting issues

- We know that there are many heuristics and biases (e.g. anchoring, overconfidence, illusion of control) (Tversky and Kahneman, 1974; Kahneman, 2012)
- One of the main reasons for adjusting sales forecasts in practice is promotional and advertising activities (Fildes and Goodwin, 2007)
- Several features of promotions are needed to be considered:
 - a length and frequency of promotional period,
 - possible lag and lead effects;
 - a main method for forecasting:
 - judgment (Trapero et al., 2013)
 - multivariate statistical models (Trapero et al., 2015)
 - VAR models (Hanssens et al., 1990).

Literature: incorporating domain knowledge

Study	Domain information	Results
A	Marketing, production and sales information	<ul style="list-style-type: none">• The relatively larger adjustments - greater average improvements in accuracy, the smaller adjustments often damaged it.• General bias towards optimism
B	Promotions	May enhance the forecast accuracy when the adjustment size is not too large
C	Expertise knowledge	<ul style="list-style-type: none">• Comparing three methods of expert knowledge elicitation (adjustments, 50%-50% and divide-and-conquer), judgmental adjustments show higher improvements in accuracy.• Only negative adjustments led to an improvement in accuracy
D	Promotional, marketing, weather	Participants <ul style="list-style-type: none">• Underestimate promotional uplifts• Misweight relevant information

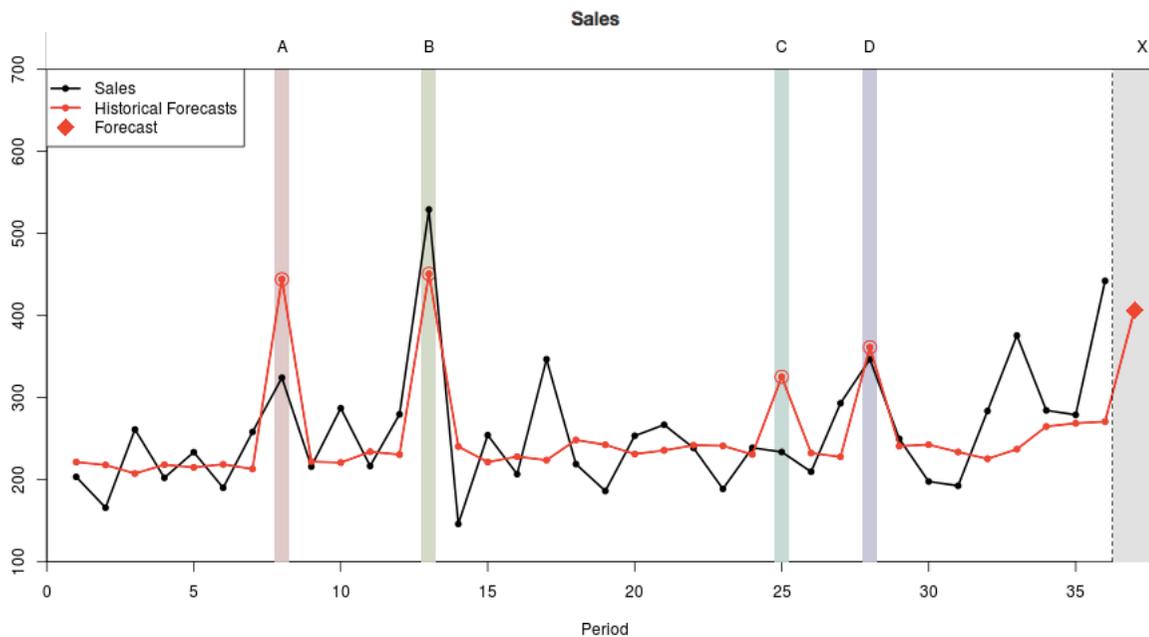
A: Fildes et al. (2009); **B:** Trapero et al. (2013); **C:** Alvarado-Valencia et al. (2017); **D:** Fildes et al. (2018)

Experimental setting

Research question:

What is the effect of contextual information of unknown diagnosticity on human adjustments during promotional periods?

Trial series - Product 1 of 12
Apples: exotic fruits such as mangos have been gaining share



Information for Forecast Period

Market research suggests: In a qualitative discussion we exposed people to competitors' newspaper advertisements and our own promotional advertisements. Most said they'd choose our product after seeing these ads.

Click box if this information is useful

Advertising are also suggesting "We'll party to celebrate the success of this promotion. I just know each pound we spend on it will cause sales to rocket."

Click box if this information is useful

Description of Historical Promotions

We have this information about the promotional campaign: Advertising is co-ordinating a major campaign at the same time as the promotion, featuring a special offer on this product.

Market research suggests: In a qualitative discussion we exposed people to competitors' newspaper advertisements and our own promotional advertisements. Most said they'd choose our product after seeing these ads.

Market research suggests: It's too late to change the TV advertisements, but our latest market research found that most people thought they were uninteresting.

We have this information about the promotional campaign: As back-up for the campaign, the promotion is going to be featured in the local newspapers.

Market research suggests: Focus groups have been quite negative about the promotional packs, but we can't change these at this late stage.

Forecast Adjustment

System Forecast: 406.08

Adjusted Final Forecast: 406.08

Adjustment: 0 units (0 %)

Adjustment as a % of system forecast

Submit

Design features

- We assume that the average uplift for promotional periods is **50%**
- Promotional, marketing and hypothetical information for the upcoming period is provided:
 - “Our spending on this campaign is only 20% of our normal spend” (Promo)
 - “The promotion is supported by a complimentary trial offer in store to overcome consumer resistance” (Promo)
 - “Based on market research, the Marketing Manager suggests there will be a positive reaction to the promotion campaign” (Market)
 - “Focus groups were excited by the benefits of the promotion” (Market)
 - “Sales has no doubts at all. “We've got a winning promotion formula here” (Hype)
- Hype and marketing information have unknown diagnosticity for forecasters, while promotional information was relevant in cases when Enhanced time series were provided
- 4 past promotions, each of them lasts for only one period

*Thanks to Prof Paul Goodwin for the contribution

Hypotheses

- **H1:** Providing forecasters with additional qualitative information with unknown diagnosticity influences their adjustments.
 - H1a: Presenting contextual information about **past promotions**
 - H1b: Additional qualitative statements about **the upcoming period**
- **H2:** Forecasters accept statistical forecasts with integrated promotional effects in the presence of contextual information.
- **H3:** The final forecast accuracy is effected when contextual information of unknown diagnosticity is presented.

Participants

- Students who completed 'Business Forecasting' module with one lecture about judgmental forecasting
- The experiment was an voluntary exercise
- Different incentives: private tokens for participation, one-two prizes for the best performance and just verbal encouragement (no difference in performance was identified)

Implementation of the experiment

	Exper1	Exper2	Exper3	Exper4
Historical Demand	Not Enhanced		Enhanced*	
Stat forecast	Baseline*	Including promo	Baseline	Including promo
Anchor	50%	0%	50%	0%
Example	<p>Exper1</p>	<p>Exper2</p>	<p>Exper3</p>	<p>Exper4</p>

Data Generating Process: $Sales_t = PromoEffect_t^{c_t} \cdot (\alpha Sales_{t-1} + (1 - \alpha) BaseSales_{t-1}) \cdot \varepsilon_t$

*Enhanced demand have +25% uplift in cases of promotions with a positive contextual information

*Baseline statistical forecast is SES(0.2)

Descriptive statistics

Table 3: Descriptive statistics

	Mean	Experiment type			
		1	2	3	4
Time Series		Not Enhanced	Not Enhanced	Enhanced	Enhanced
Statistical forecast		Baseline	with Promotions	Baseline	with Promotions
Participants	88	17	24	26	21
Adjustments (%)	12.75	16.08	1.42	29.01	2.88
Initial MAPE (%)	22.46	29.89	12.22	35.32	12.22
Final MAPE (%)	20.04	23.92	16.72	24.37	15.33
FVA (%)	2.42	5.97	-4.50	10.95	-3.11

*FVA (Forecast Value Added) = Initial MAPE – Final MAPE

MultiLevel modelling

- Includes fixed and random effects:
 - Fixed effects: conventional effects in linear regression
 - Mixed effects: give random intercept/slope to uncontrolled grouping variable
- Random effects for us:
 - Time series (ts)
 - Three groups of students: Undergraduate/Masters 2016 or 2017
- Dependent variables:
 - Relative adjustments in logarithms
 - FVA, where FVA (Forecast Value Added) = Statistical MAPE – Final MAPE (after adjustments)

Variables to consider

Technical part (quantitative)	Contextual information (qualitative)
Last promotional effect	Promotional, marketing information for the forecasting period
Current statistical forecast	Hype for the forecasting period
Low/high data noise	Promotional, marketing information for past promotions
Average promotional effect	
Last actual	

Other: order of time series, experiment type, expert prior estimates, usefulness of presented qualitative information, timer

Log-log model

Fixed effects

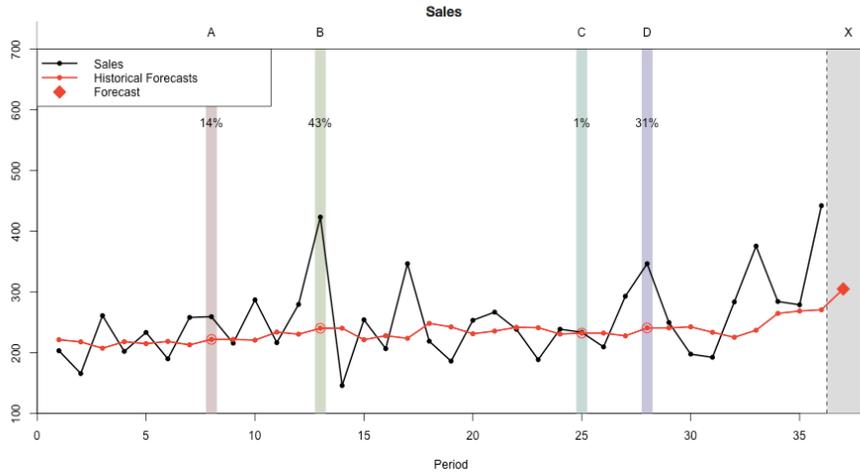
		Estimate	Standard Error
	Intercept	0.5446	0.4955
H2	Exper2	-0.5909	0.2886
	Exper3	0.1038	0.0164
	Exper4	-0.5498	0.2883
H1	Marketing reasons useful	-0.0366	0.0178
	Hype useful	0.0432	0.0180
	Promo reasons useful, positive	0.0708	0.0180
	Market reasons useful, positive	0.1092	0.0270
	Expert prior	0.0170	0.0064
	Last promotional uplift	0.2212	0.0864
	Current forecast	-0.2303	0.0518
	Current forecast, Exper 1 and 3	-0.1060	0.0513
	Low noise, Exper 1 and 3	0.0628	0.0282

Random effects

	Standard Deviation
Participant group (intercept)	0.0101
Time series (intercept)	0.0589
Residual	0.1620

Exploration of possible information overload

Trial series - Product 1 of 12
Apples: exotic fruits such as mangos have been gaining share



Information for Forecast Period

Market research suggests: Our television advertisements for the product were very well received by potential customers according to our market research.

Click box if this information is useful

"Our team all left the promotion planning meeting on a high. Everything about the promotion feels great. Let's look forward to a great boost in sales."

Click box if this information is useful

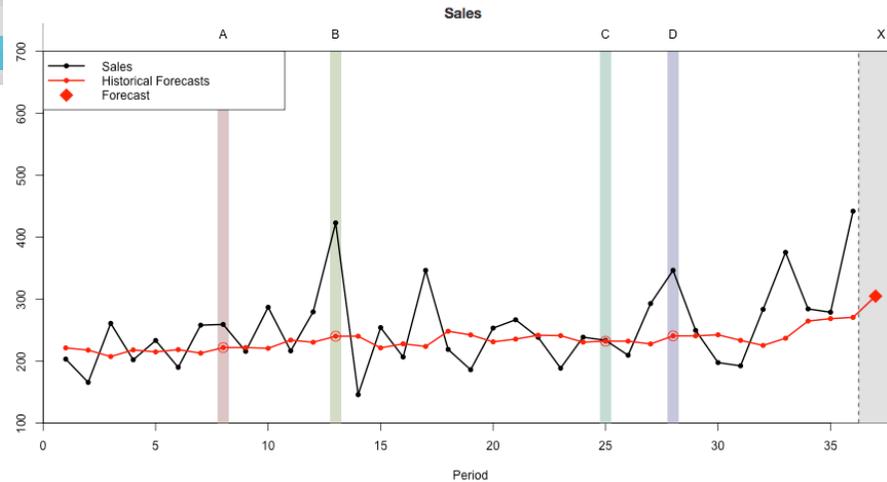
Without additional information about past promotions

Forecast Adjustment

System Forecast: 304.99 Adjusted Final Forecast: 304.99
Adjustment: 0 units (0 %)

Adjustment as a % of system forecast

Trial series - Product 1 of 12
Apples: exotic fruits such as mangos have been gaining share



Information for Forecast Period

Market research suggests: Focus groups were excited by the benefits of the promotion.

Click box if this information is useful

"The MD has said he's certain we'll soon be celebrating this campaign."

Click box if this information is useful

Mean Percentage Error for past promotional periods is 22.25%

With only one statement about past forecasts performance during promotions

Forecast Adjustment

System Forecast: 304.99 Adjusted Final Forecast: 304.99
Adjustment: 0 units (0 %)

Adjustment as a % of system forecast

Comparison of 'Full' and 'Simplified' models

H4: Simplifying the experiment setting will provide more accurate adjustments.

However, the real forecasting process is typically much more complex.

Table 8: Mixed effects model for full and simplified experiments

Fixed effects	Coefficient		p-value	
	Full	Simplified	Full	Simplified
Intercept	0.5661	0.9677	0.2913	0.0898.
Exper2	-0.5979	-1.3242	0.0393*	0.0173*
Exper3	0.1040	-0.0011	0.0000***	0.9763
Exper4	-0.5567	-1.3412	0.0547.	0.0163
Promo reasons useful	-0.0063	0.1014	0.7163	0.0046**
Market reasons useful	-0.0360	-0.0869	0.0455*	0.0234*
Hype useful	0.0431	-0.0253	0.0169*	0.5223
Promo reasons useful, positive	0.0770	-0.0600	0.0016**	0.1293
Market reasons useful, positive	0.1089	0.1640	0.0000***	0.0053**
Expert prior	0.0170	0.0550	0.0085**	0.0002***
Last promotional uplift	0.2193	0.2345	0.0311*	0.0378*
Current forecasts	-0.2307	-0.2160	0.0000***	0.0162 *
Current forecasts, Exper 1 and 3	-0.1073	-0.2235	0.0373*	0.0226*
Low noise, Exper 1 and 3	0.0626	0.0281	0.0275*	0.5371
Split		0.0199		0.4879

Signif. codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.'

R2 for fixed effects: 0.3369 for full and 0.3538 for simplified models

- When simplifying the experiment: participants get clearer picture and behave closer to optimality

Conclusions

- In order to analyse how people react to different types of information, several experiments were conducted:
 1. With qualitative information for both the upcoming promotional period and past promotions
 2. Enhancing the general anchors aiming to overcome underestimation
 3. Without any contextual information about past periods
 4. With a diagnostic statement for past promotional performance

Conclusions

- Main outcomes:
 - Participants tend to ignore contextual information about past promotions and react to given statements for the forecasting period:
 - Positive promotional, marketing and hype statements increase adjustments on average
 - We find preliminary evidence of information overload and misinterpretation of the information due to complexity of the interface
 - This is motivation for further research into judgmental adjustments in forecasting

Thank you for your attention!
Questions?

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