Analysis of judgemental adjustments in the presence of promotions

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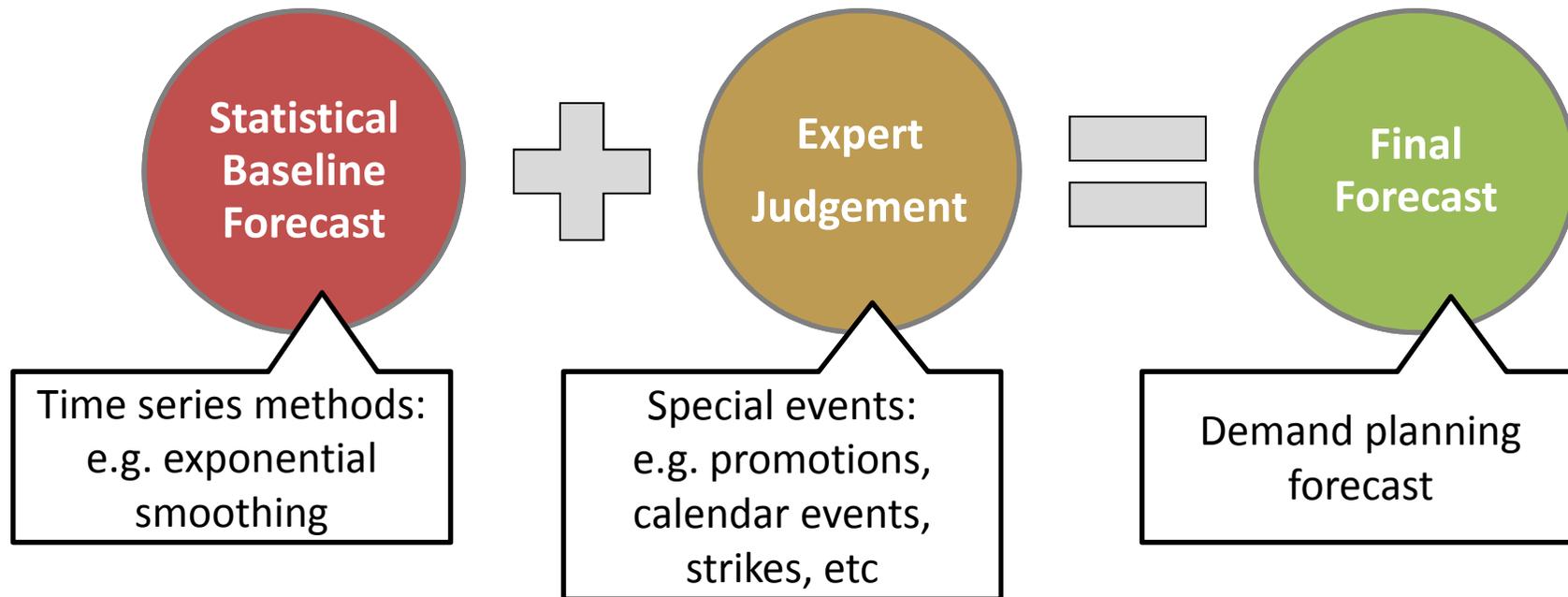International Journal of Forecasting, 29 (2013), p 234-243.

Sales forecasting relies on Forecasting Support Systems (FSS):

Statistical Baseline Forecast ➕ **Expert Judgement** 🟰 **Final Forecast**

Time series methods: e.g. exponential smoothing

Special events: e.g. promotions, calendar events, strikes, etc

Demand planning forecast

Promotional and advertising activity is one of the main reasons for adjusting statistical forecasts (Fildes and Goodwin, 2007)

Promotional modelling has been discussed before in the literature:

- PromoCast™ (Cooper et al, 1999)
- Scan*PRO (Leeflang et al., 2002)
- CHAN4CAST (Divakar et al., 2005)
- …

Common features:

- Such promotional Support Systems (PSS) are based on regression models
- Sales is a function of regular prices, price cuts, feature advertising, special displays, …

… and limitations:

- Estimated at brand level and not SKU level
- Require extensive model inputs → feasibility and cost considerations
- Complex input variable selection is required → which are the relevant promotions?
- Possibility that inputs are multicollinear → impossible to estimate impact of promotion
- These models require past promotion history
- These models do not capture the demand dynamics adequately
- Require extensive statistical expertise

These limitations explain the observed reliance on expert adjustments
(Lawrence et al., 2000; Fildes and Goodwin, 2007)

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A manufacturing company specialized in household detergent products → data available:

- Shipments
- One-step-ahead system forecasts (SF)
- One-step-ahead adjusted or final forecasts (FF)
- Promotional information:
    1. Price cuts
    2. Shelf display
    3. Feature advertising
    4. Days promoted in each week

The data contains 169 SKUs (with and without promotions)

Research questions:

Q1. Are judgmental forecasts more accurate than statistical forecasts when there are promotions?

Q2. Are judgmental forecast adjustments biased in the presence of promotions?
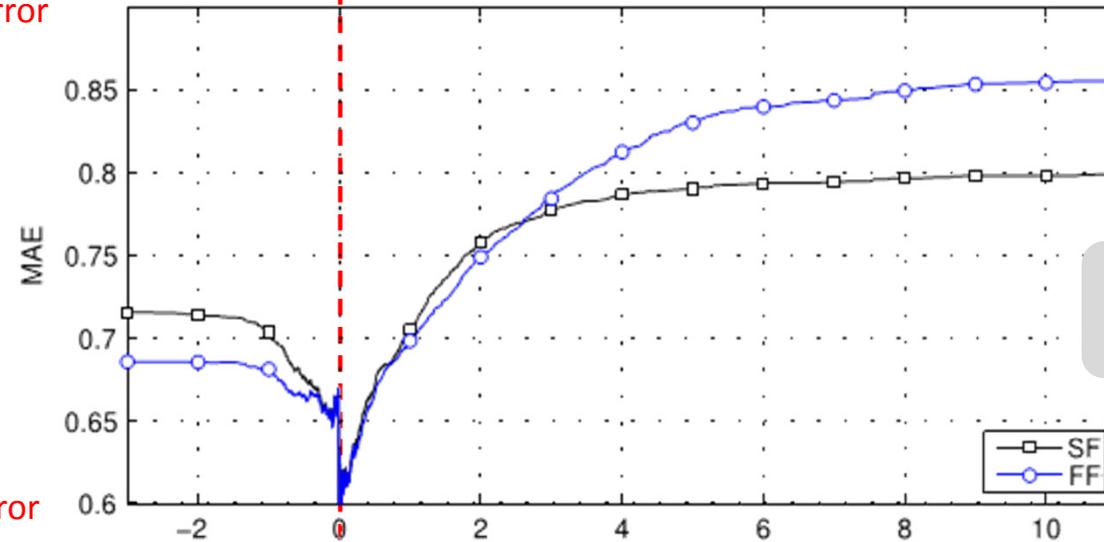
Comparison of judgement against baseline
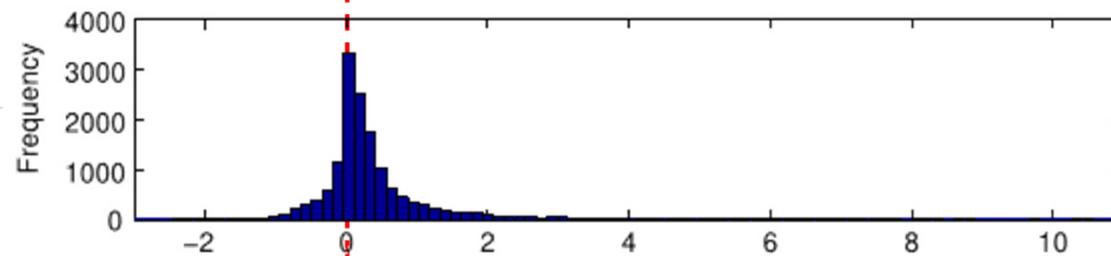
Let's explain the graph...

High error
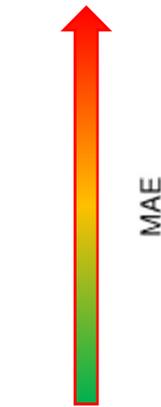
Low error

Statistical baseline forecast

Final forecast: Statistical + Judgment

Number of forecasts

Size of adjustment

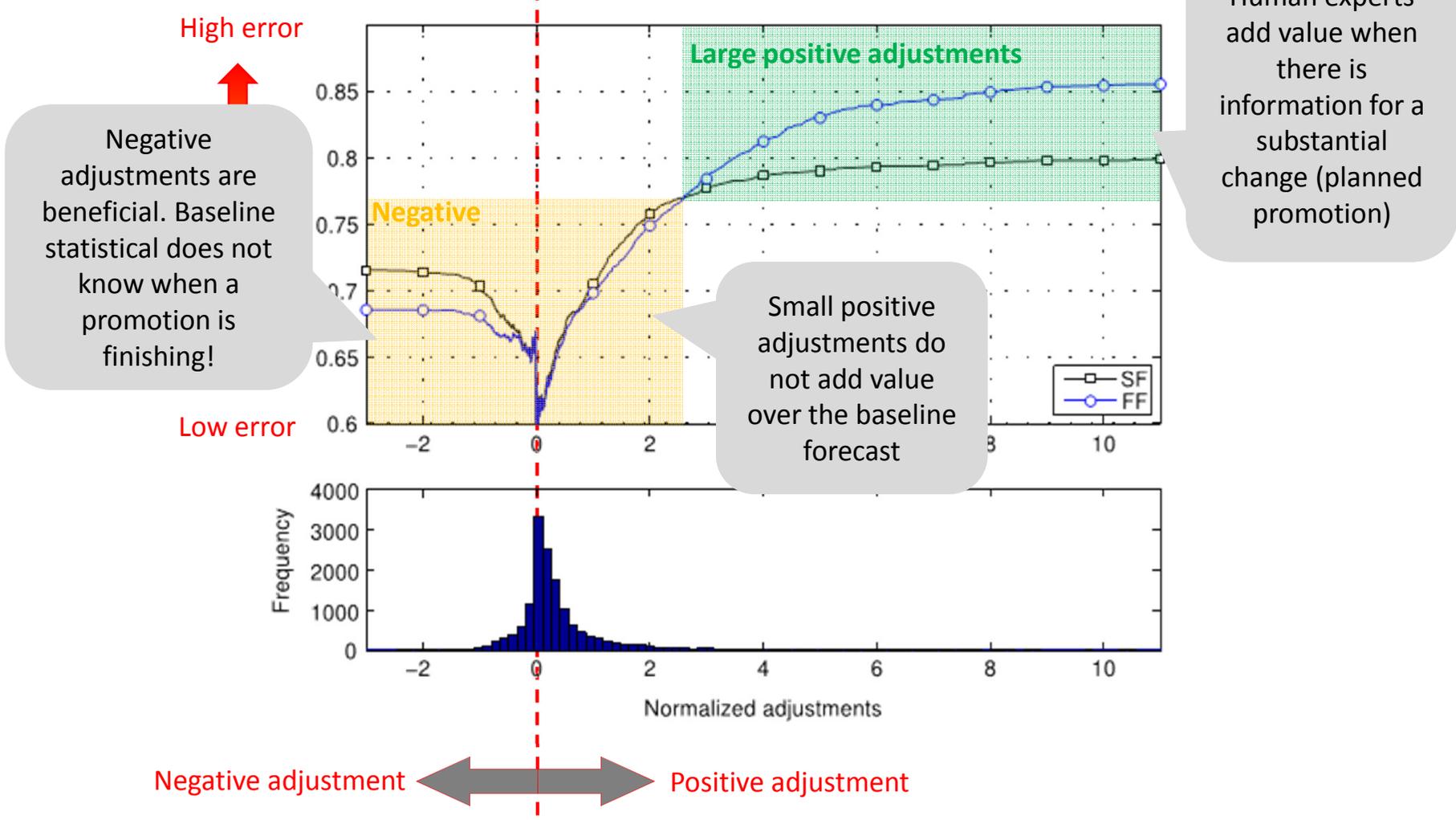Negative adjustment: the baseline forecast is adjusted downwards

Positive adjustment: the baseline forecast is adjusted upwards

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Comparison of judgement against baseline

What are the findings?

High error

Negative adjustments are beneficial. Baseline statistical does not know when a promotion is finishing!

Low error

Large positive adjustments

Negative

Human experts add value when there is information for a substantial change (planned promotion)

Small positive adjustments do not add value over the baseline forecast

Negative adjustment ←→ Positive adjustment

Human judgment can add value to the baseline forecasts when clear promotional information is available; small adjustments are not beneficial

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Statistical Promotional Model

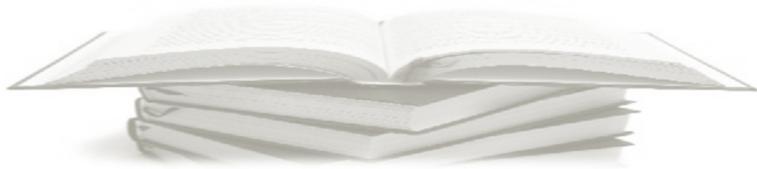Baseline statistical forecast does not consider promotional information

Let us build a simple statistical promotional model of the form:

Forecast = (Past Demand Dynamics) + (Effect of promotions*)
*all promotions are modelled to have the same effect

Time series dynamics are captured using exponential smoothing (same as baseline model)

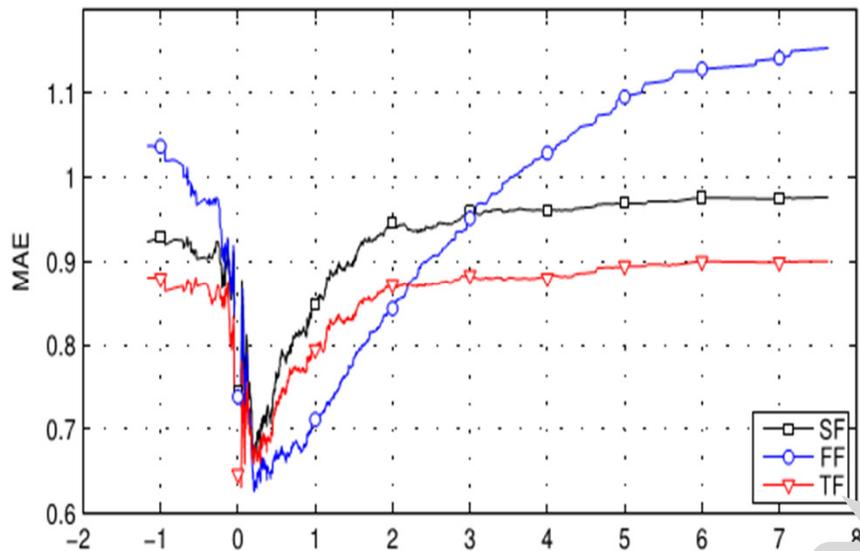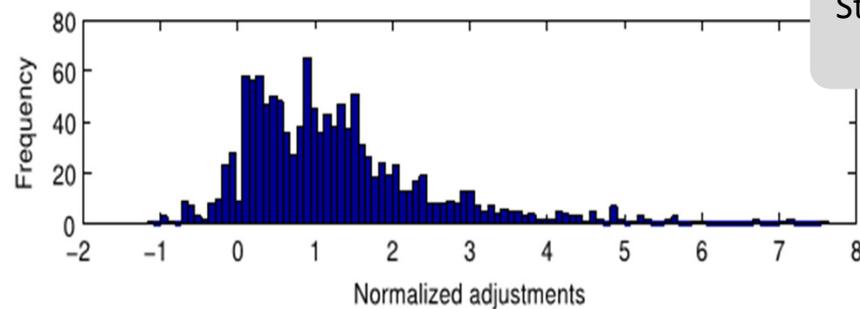We evaluate the performance of the different models on out-of-sample future predictions (valid empirical evaluation)
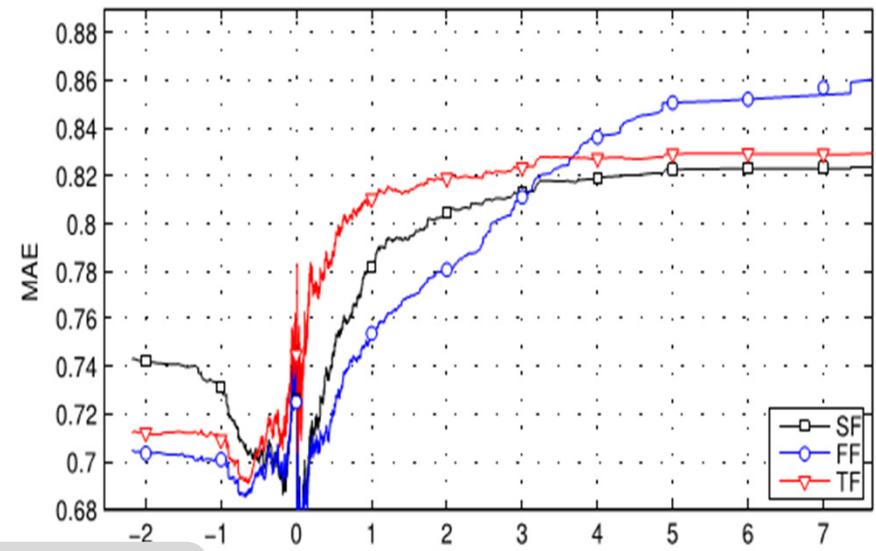
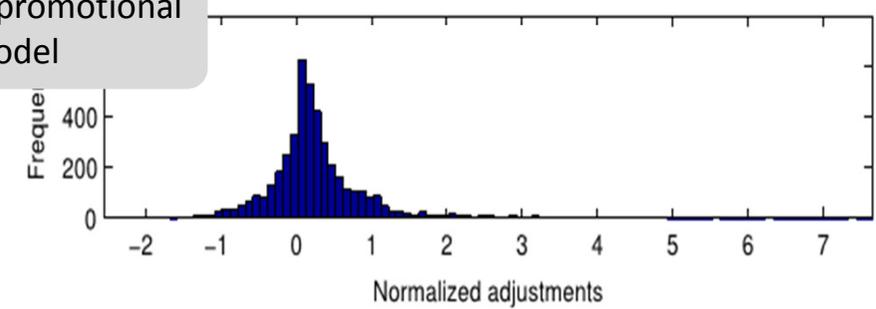**Graphs have the same layout as before**

Forecast error on promotional periods

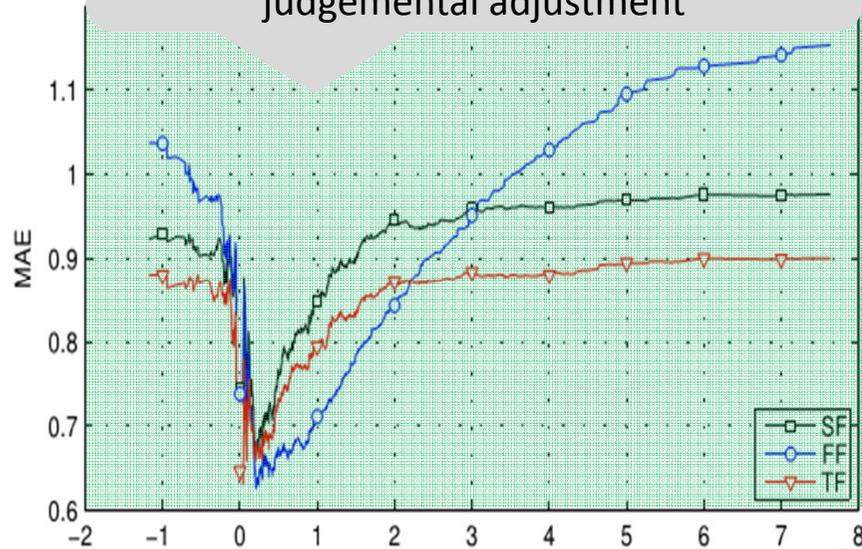Forecast error on non-promotional periods

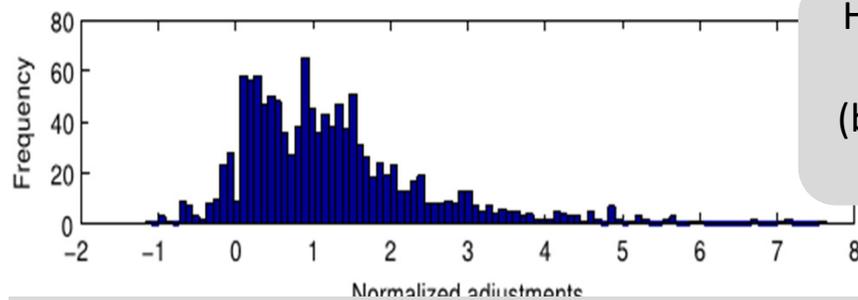Statistical promotional model
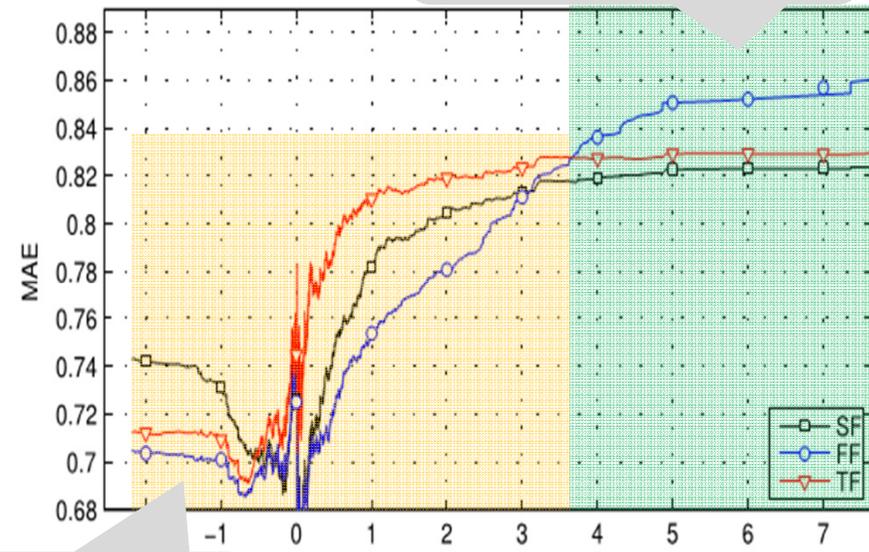
Case Study
Statistical Promotional Model

Forecast error on promotional periods

Forecast error on non-promotional periods

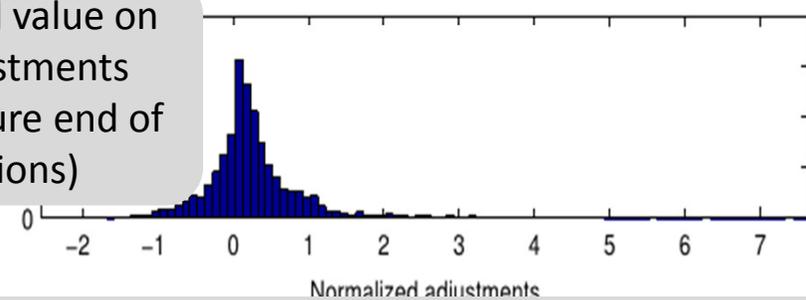Statistical promotional model always better; improvement 21% over judgemental adjustment

Wrong large positive adjustments by humans

Humans add value on small adjustments (better capture end of promotions)

Statistical model forecasts promotional periods significantly more accurate
More consistent behaviour than human experts → especially for large positive adjustments
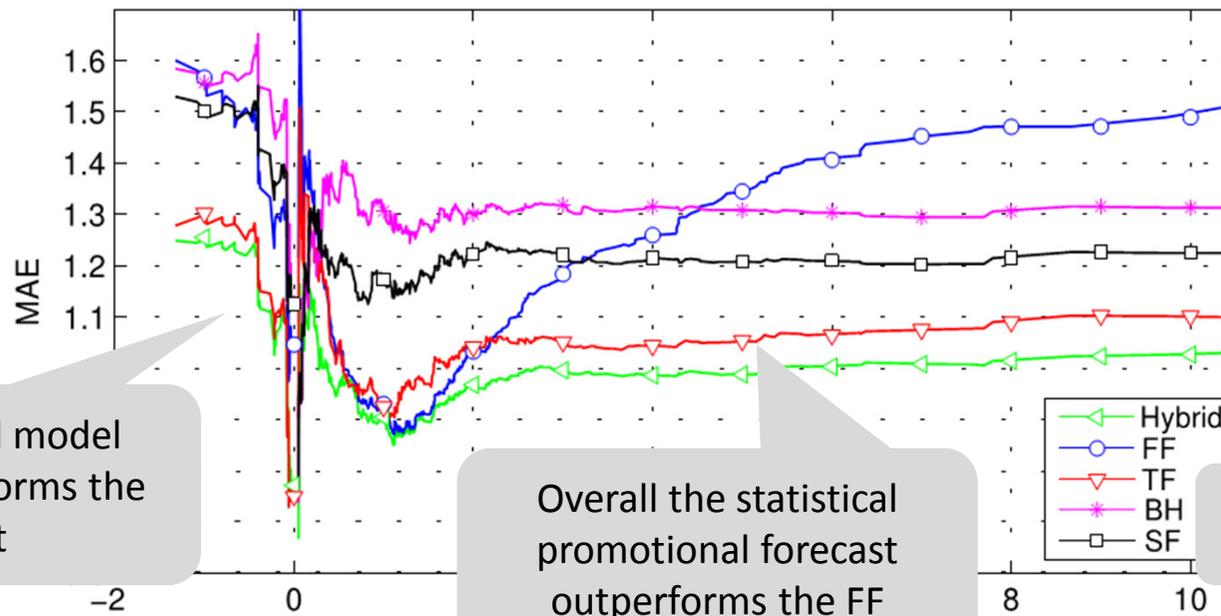
Statistical + Judgement Promotional Model

We build a hybrid model:

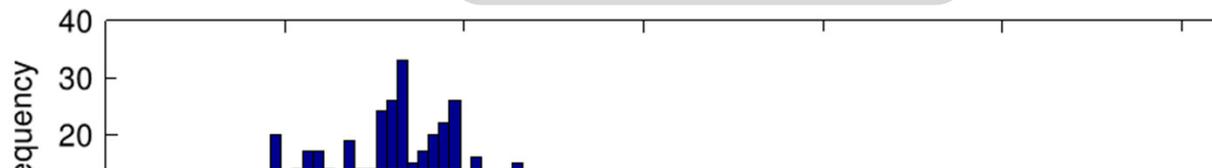**Forecast = Combination of (Statistical Promotional Model) and (Final Forecast)**

Forecasts for promotional and non-promotional periods

The hybrid model always performs the best

Overall the statistical promotional forecast outperforms the FF

Proposed Hybrid model

Human expert judgment contains information that simple promotional models cannot capture. The Hybrid model takes advantage of both and achieves best performance

Conclusions

1. Judgmentally adjusted forecasts can improve forecasting accuracy <u>under circumstances</u>

2. Positive and negative adjustments behave differently

3. When adjustment is not too large experts improve accuracy → good evidence/reason for adjustment

4. Positive adjustments were over-optimistic → biased

5. Simple statistical promotional model enough to outperform on average the (baseline + judgmental adjustment) forecast. However, not all information captured → <u>motivation for advanced promotional models</u>

Detailed analysis, findings and references in the paper:

http://kourentzes.com/forecasting/2013/04/19/analysis-of-judgmental-adjustments-in-the-presence-of-promotions/