Forecast Value Added

Robert Fildes,

Lancaster University Centre for Marketing Analytics and Forecasting

"Let us sit on this log at the roadside", says I, "and forget inhumanity and the ribaldry of poets. It is in the glorious columns of ascertained facts and legalized measures that beauty is to be found." O'Henry by way of Kendall, Stuart and Ord

Marketing Analytics & Forecasting

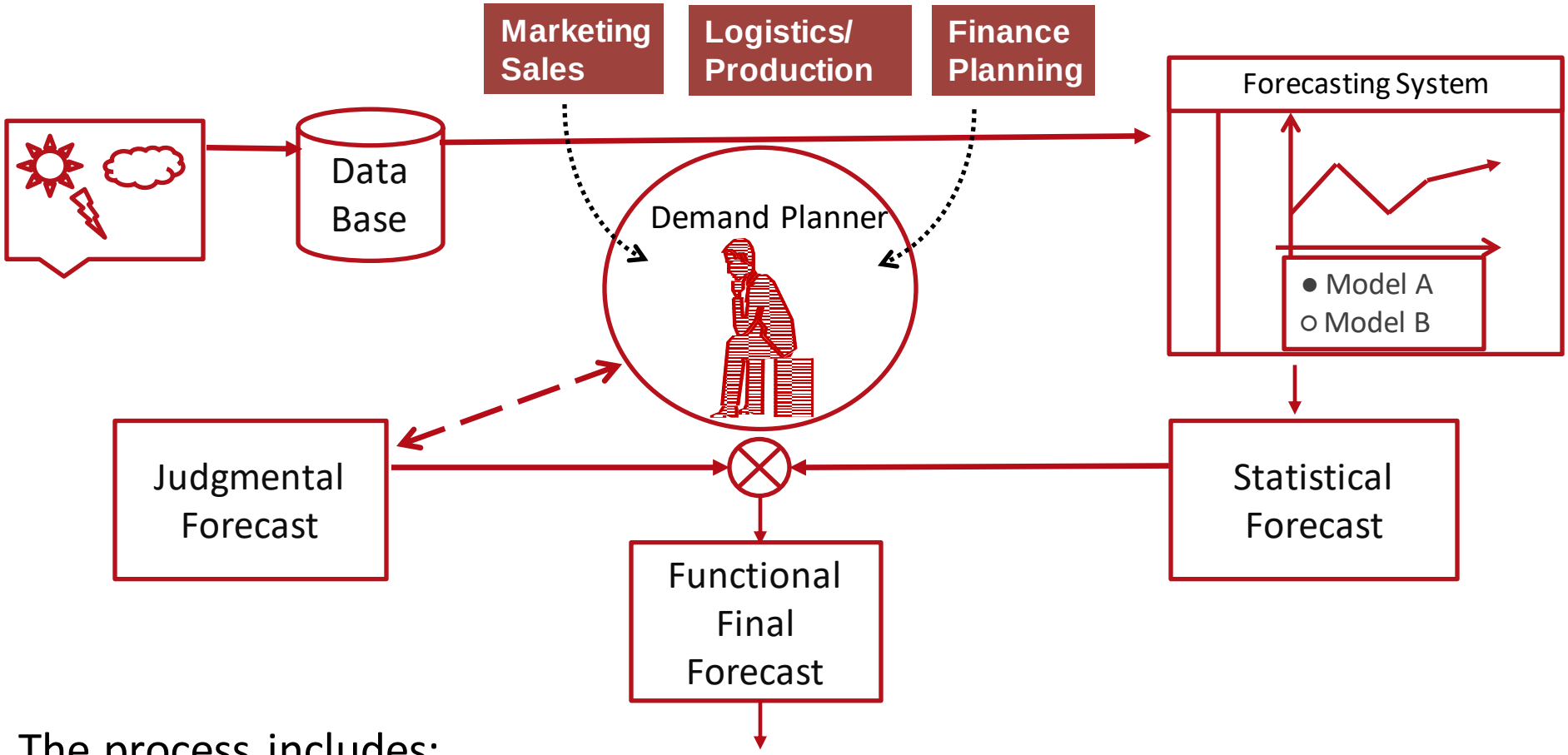
Lancaster University Management School

Outline

1. What is FVA
2. And why is it still practically important in an ML world
3. Practical Issues, Theoretical Concerns
4. The Analysis
5. Does Adjustment Add value?
   - ✓ Under what circumstances?
   - ✓ Sign and Size effects
6. And can we manage the FVA process to deliver improvements?

CMAF

Forecasting process in S&OP



The process includes:

- ✓ Statistical forecast
- ✓ Information from sales, market research, logistics, finance
- ✓ Incorporated into a final forecast

Judgment is a key component for integration

CMAF

What is Forecast Value Added (FVA)

Loosely, it is the improved/ diminished accuracy from using method B compared to method A.

Most companies adjust their baseline statistical forecasts in support of operations.

- Here, method A is the final forecast after expert adjustment, method B a prior statistical forecast (Gilliland, 2009)

$$SY_t = \alpha Y_{t-1} + (1-\alpha)SY_{t-1} + \lambda X_t +$$

CMAF

Evidence from surveys

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).

Even for retailers, adjustments are common

CMAF

What do we know so far about FVA?

- Most organizations judgmentally adjust
- Define a final forecast as FFC, compared to a statistical forecast, SFC
- Many interventions fail to add value

Net information can be positive when adjustments are upward (FFC>SFC) or negative

- Positive adjustments are on average damaging
  - ✓ Negative adjustments add value
- Small adjustments do not (and cannot) have much effect
- Extraneous information detracts from value
  - ✓ And there's a lot of it in the forecasting process

CMAF

But analysis has been inconsistent: no clear picture

Why understanding and enhancing FVA expert adjustment is important: for practice, for theory

- Typical adjustments in companies from 70% to 90% of forecasts
  - Common in other domains (e.g. macro forecasts, Franses, 2013)
  - Time consuming/ complex organizational process
  - Evidence mixed on effectiveness (Fildes et al., 2009; Franses & Legerstee, 2013; Franses, 2014; Den Broeke et al., 2018))
- We do not know how or what makes expert adjustment effective
  - Some speculative hypotheses
  - Experimental evidence of underweighting/ overweighting key pieces of evidence
  - Mis-interpretation of historical data

CMAF

Measuring FVA

- Measuring error – a controversial subject! (Davydenko and Fildes, 2011)
- **FVA=$^{MAE_B}/_{MAE_A}$** comparing method B with method A over a (sub)set of data

  Where MAE_A is the mean absolute error over an out-of-sample data set.

  $e_A = Actual - Forecast$ and $MAE_A = \frac{1}{n}\sum_1^n abs(e_A)$

Alternatively,

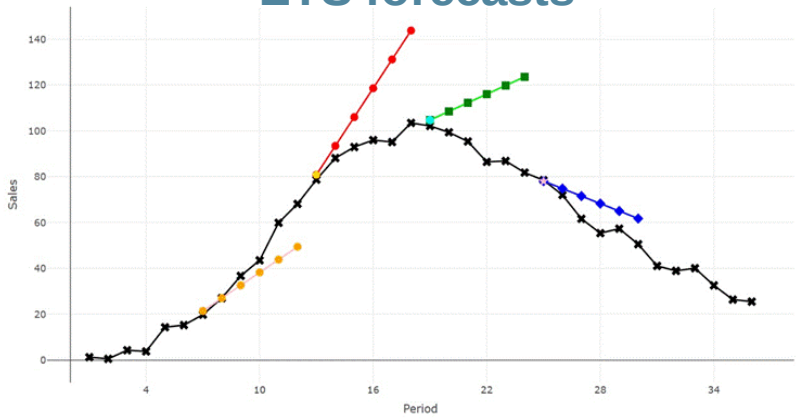
- Define r_i=**abs**($^{e_{Bi}}/_{e_{Ai}}$)
- FVA1=$(\prod_1^n r_i)^{1/n}$ - the geometric mean of the relative errors
- Both used with similar results – for small subsets, FVA may be less robust
- To summarize *FVA* over series (SKUs) use a geometric mean
- Bias=*abs*($^{ME_B}/_{ME_A}$)

CMAF

Why do most organizations use FVA?

- ‘Fits’ with the organizational process
  - ✓ Information is collected from various sources
    - S&OP delivering supply chain info
    - New plans not part of the forecast
    - Need to reflect financial targets
- Statistical models seem as inadequate (Fildes and Goodwin, 2020)
- ‘Unique’ Events
  - ✓ Promotions
  - ✓ Moving Holidays etc

A typical product life cycle, with ETS forecasts



CMAF

What's the Evidence? -The data bases

- Fildes et al. (2009): 4 companies, 3 manufacturing, 1 retailer (not yet analysed)
- Franses (2009, 2013): 1 company, 7 product groups
- Van den Broeke,De Baets et al. (2018): 3 companies analyzed, each with product groups, 8 in all
- Others to be added

Consistent analysis: Analyzes previously undertaken incompatible

- ✓ Outliers (here all trimmed at a symmetric 1% wrt APE_Final)
- ✓ Each sku required to have 6 or more observations
  - Experience with the SKU
- ✓ Low level included: dropped only if both final and system forecast=0

CMAF

Two prior hypotheses

- Negative information (down adjustments) expected to prove effective
  - ✓ Known constraints in supply
  - ✓ Limited by a maximum of 100%, thereby damping over-pessimism
- The size of the adjustment signals the expert's confidence in the information
  - ✓ NB: but you can be very certain of a small effect

And the practical questions?

- Can the series (and processes) where FVA is positive by predicted
  - ✓ When should adjustments be made?
  - ✓ Can the adjustments be made more effective?
- And how large should be the adjustment?

CMAF

And can the proposed adjustment process be implemented?

Key question – Does Adjustment add value?

Data Set	SKUSs (No Observations)	% Adjusted	Bias	FVA	FVA1
1	585 (7346)	71%	0.738	0.884	0.854
2	1101 (25863)	97%	1.335	1.010	1.043
3	1410 (45596)	93%	0.89875	0.964	0.948
(3.3)	36 (568)	100%	0.438	0.381	0.330

Well – sometimes!

x but usually not very much

The search for an explanation

CMAF

Effect of adjustment direction

Data Set	Adjustment	Direction %	No. Obs.	Average improvement in bias (relative to system forecast)	Average Improvement of adjusted forecasts: FVA	Average Improvement of adjusted forecasts: FVA1
Set 1	Positive	49.8	4117	0.760	0.910	0.880
	Negative	31.2	3229	0.708	0.858	0.834
Set 2	Positive	56.9	25345	1.530	1.060	1.110
	Negative	40.4	14413	1.130	0.950	0.970
Set 3	Positive	48.4	22080	0.861	0.972	0.957
	Negative	44.3	20193	0.926	0.952	0.938

Conclusions:

- More positive than negative adjustments
- Bias is (usually) improved by adjustment
- FVA is (usually) improved by adjustment
    - ✓ Negative adjustments more beneficial

In more detail:

- Improvements substantial (not data set 2: Franses, pharmaceutical company)

Effect of Adjustment Size – an appraisal

Methodology:

- Adjustment size measured by (Final_forecast)/System_forecast)
  - But should it take into account variation in the underlying series
- Adjustment classes

<10%
10% to <50%
50% to <100%
100% to <250%
> 250%

		Positive Info			
Adjustment Size	<10	10 to 50	50 -100	100-250	>250
% obs	32.5	40.1	11.6	8.62	3.91
Bias	0.95	1.01	0.94	1.03	0.84
FVA	0.97	1.04	1.14	1.21	0.96
FVA1	0.96	1.03	1.15	1.22	1.01
	Negative info			100%	
% obs	41.90	50.70	8.14	0.30	
Bias	0.95	0.67	0.46	1.04	
FVA	0.96	0.80	0.44	1.17	
FVA1	0.97	0.79	0.42	1.20	

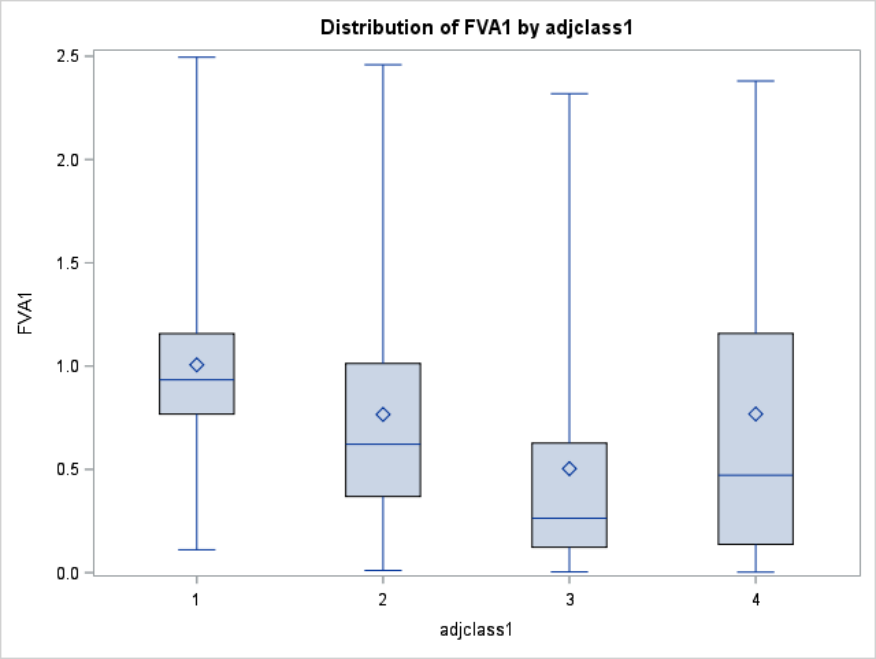
Conclusions

- Positive inf – no size effects but for the largest.
- For negative info, larger has much larger improvements
  - But for setting the final forecast = 0!

Distribution of FVA (work in progress)

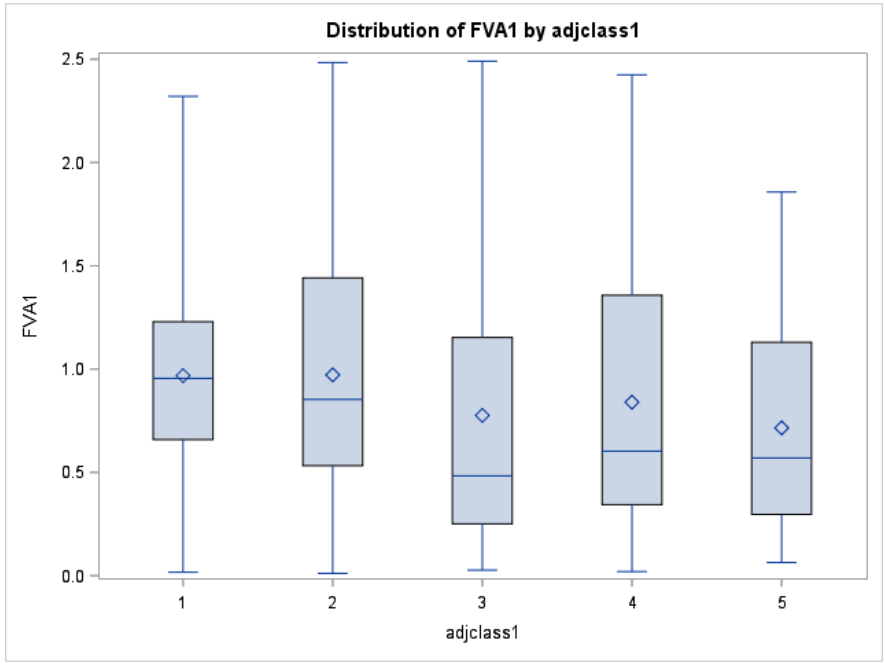
Data set 1:

Negative adjustments



	Adjustment size class				
FVA	1	2	3	4	Total
<=1	227	277	89	18	611
	58.21	74.06	83.96	66.67	68.12
>1	163	97	17	9	286
	41.79	25.94	16.04	33.33	31.88
Total	390	374	106	27	897
	43.48	41.69	11.82	3.01	100

Positive adjustments



	Adjustment size class					
FVA	1	2	3	4	5	Total
<=1	229	241	115	70	38	693
	53.76	61.48	69.28	68.63	66.67	60.63
>1	197	151	51	32	19	450
	46.24	38.52	30.72	31.37	33.33	39.37
Total	426	392	166	102	57	1143
	37.27	34.3	14.52	8.92	4.99	100

The problem: too many poor positive adjustments?

What goes wrong?

- Optimism bias
  - Final > Actual
- Over-adjustment (or under-adjustment)
  - for positive Final> Actual

    For negative, Final <Actual
- Failure to account for consistent errors in the system forecast, e.g. dynamics
- Mis-weighting/ mis-understanding of the system forecast
  - Overweighting the expert's judgment (underweighting the system forecast)
- Compensating for large errors previously

Optimism

- Occurs when Final > Actual
  - Whether adjustments are positive or negative
- Does optimism improve/ damage FVA?

Method

- Calculate bias and FVA by info for each ‘company’
  - Summarize using medians (to avoid size effects)

Conclusions

- Robust over data sets, companies
- Optimism damaging for upward adjustments
  - For negative adjustments beneficial: more attention SFC

	Adjust	Optimistic	Bias	FVA
Overall	Down	No	0.951	0.962
		Yes	0.886	0.884
	Up	No	0.831	0.945
		Yes	0.888	0.995

Over-adjustment

- Occurs when
  - Positive adjustment: Final >Actual
  - Negative adjustment: Actual >Final
- Percentage of overadjustments

	info	
Overadjust	-1	1
All: No	43.77	33.59
Yes	56.23	66.41

Results mirror optimism:

- FVA (and bias) worsens for positive overadjustments (optimistic)
- Worsens also for negative info (conservative forecast)

Over-adjusting up or down leads to 'damage'

What we should know about FVA

What we have learnt:

- Characteristic biases leading to poor or –'ve FVA
  - ✓ Size, direction, optimism of adjustments
- For 'many' companies expert adjustment has more potential than improved statistical methods

But:

- We need to identify the sku-level characteristics & processes that deliver FVA (Baker, Foresight, forthcoming)
- Levers to guide and restrict adjustments- what are they?
  - ✓ Forecasting software to support FVA (Mike Gilliland, SAS)
- Crucially

  ? How can recommendations such as downweight adjustment be implemented?

Take Aways- How do we manage FVA?

- Focus only on the A-class important products
- And only those products where there is plenty of room for improvement (Z-class)
  - ✓ Products where the statistical forecast error is large
- Monitor FVA
  - ✓ By category/ sku, by region, by demand planner
    - – But beware, motivational issues
    - – Some region, SKUs, customers are harder to forecast
- Store event data to link to error

Companies are already managing the first three of these?
Machine learning won't eliminate the need for FVA analysis

Lots of further analysis – added data sets

Identification of where FVA is achievable

See forthcoming articles in *Foresight: Baker with comments by Gilliland and Fildes*

Thank you for your attention!

Q&A?!

Robert Fildes (r.fildes@Lancaster.ac.uk)

Marketing Analytics & Forecasting

Lancaster University Management School