Improving Forecast Quality

Steve Morlidge

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Steve Morlidge

Unilever (1978–2006) roles include:

- Controller, Unilever Foods UK ($1 billion turnover)
- Leader, dynamic performance management change project (part of Unilever's Finance Academy), 2002–2006

Outside Unilever

- Chairman of the BBRT, 2001–2006
- BBRT Associate, 2007 to present
- Founder/director, Satori Partners Ltd., 2006
- Ph.D., Hull University (Management Cybernetics), 2005
- Visiting Fellow, Cranfield University, 2007
- Coauthored book *Future Ready: How to Master Business Forecasting*, 2010
- Editorial Board, *Foresight* magazine, 2010
- Founder, CatchBull (forecasting performance management software), 2011

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Six Key Design Principles

Mastering purpose

Mastering time

Mastering models

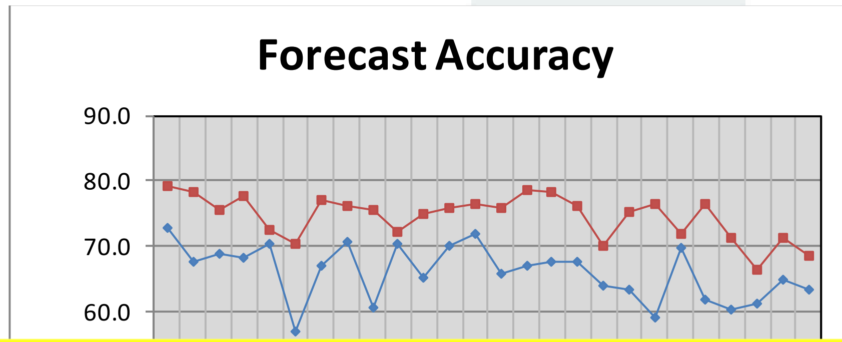
Mastering measurement

Mastering risk

Mastering process

Measuring forecast 'quality'

Period Date	Unit A FA%	Unit B FA%
01 Aug 2010	72.8	79.1
01 Sep 2010	67.7	78.3
01 Oct 2010	69.0	75.5
01 Nov 2010	68.4	77.6
01 Dec 2010	70.5	72.6
01 Jan 2011	57.0	70.4
01 Feb 2011	67.1	77.1
01 Mar 2011	70.6	76.0
01 Apr 2011	60.5	75.5
01 May 2		
01 Jun 2		
01 Jul 2		
01 Aug 2		
01 Sep 2		
01 Oct 2		
01 Nov 2		
01 Dec 2		
01 Jan 2		
01 Feb 2		
01 Mar 2		
01 Apr 2		
01 May 2		
01 Jun 2		
01 Jul 2		
01 Aug 2		
01 Sep 2		



Unanswered questions

- Is this good or bad performance?
- How much of this error is avoidable?
- Is Unit B better at forecasting or is it easier to forecast?
- Is performance declining because it's getting more difficult to forecast?
- What is driving this performance?
- Is your forecasting methodology adding value or destroying it?
- Is the application of judgement improving or degrading performance?
- How much are forecast 'failures' costing?
- What are the implications for stock and customer service?
- Is this better or worse than the norm?
- What is the scope for improvement?
- What do I do now?

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Forecast Quality

- How to measure it
- What we find in practice

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Quality: a practical definition

- Better than ‘not forecasting at all’ (higher bound of forecast error)
- As close to minimum avoidable error (lower bound of error) as possible
- At the decision making level (e.g. supply chain = low level stock replenishment point)
- At affordable cost

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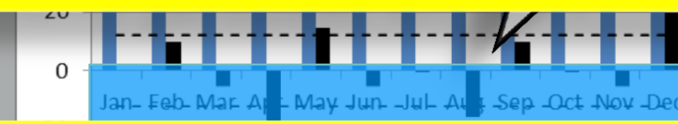
Why forecast? 101 (for the Supply Chain)

Replenishment based on consumption

Replenishment based on forecast

Since replenishment based on consumption is the same as using the prior periods actual as a forecast, the ***upper bound*** *of forecast error should be the naive forecast error…*



…which also allows for forecastability because items with volatile demand are usually more difficult to forecast

…so to avoid stock out we need safety stock based on the standard deviation of demand

.. leading to less safety stock as it is based on the (lower) standard deviation of error

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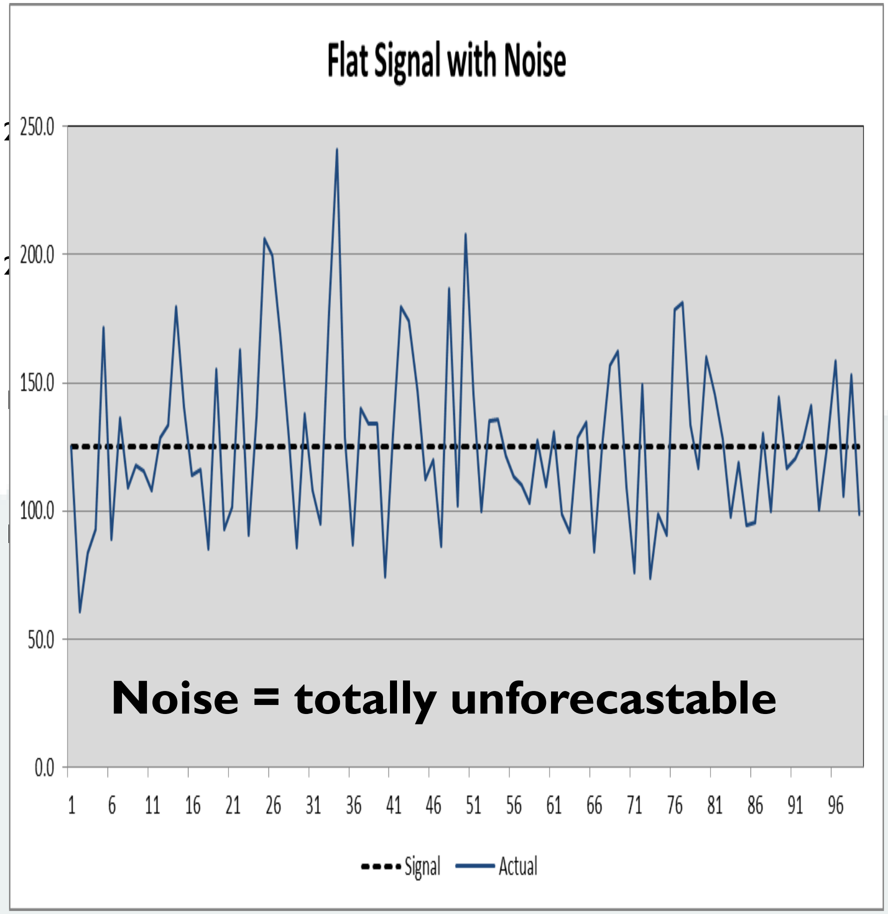
Lower Limit of error



Range of **Naïve Forecast Errors** (including noise)

Range of **Actual (Perfect) Forecast Errors** (excluding noise)

THE ASSUMPTIONS:

- We have the perfect forecasting algorithm.
- The remaining errors are pure noise in the statistical sense that they are "stationary and independently and identically distributed with a mean of zero."
- The change in the signal from period to period is unaffected by the previous period's noise.

THE UNAVOIDABILITY RATIO

Under these assumptions, the ratio of the variance of pure error (that is, error from a perfect forecasting algorithm) to that of the errors from a naïve forecast model will be:

$$\frac{\text{Variance of pure error}}{2\,(\text{Variance of pure error}) + \text{Variance of period-to-period changes in signal} + (\text{Mean change in signal})^2}$$

If there are no systematic changes in the signal (e.g., no trend or cyclical pattern), the second and third terms in the denominator become zero, leaving us with

$$\frac{\text{Variance of noise}}{2\,(\text{Variance of noise})} = 0.5$$

for the best possible performance, and thus the definition of what constitutes unavoidable error.

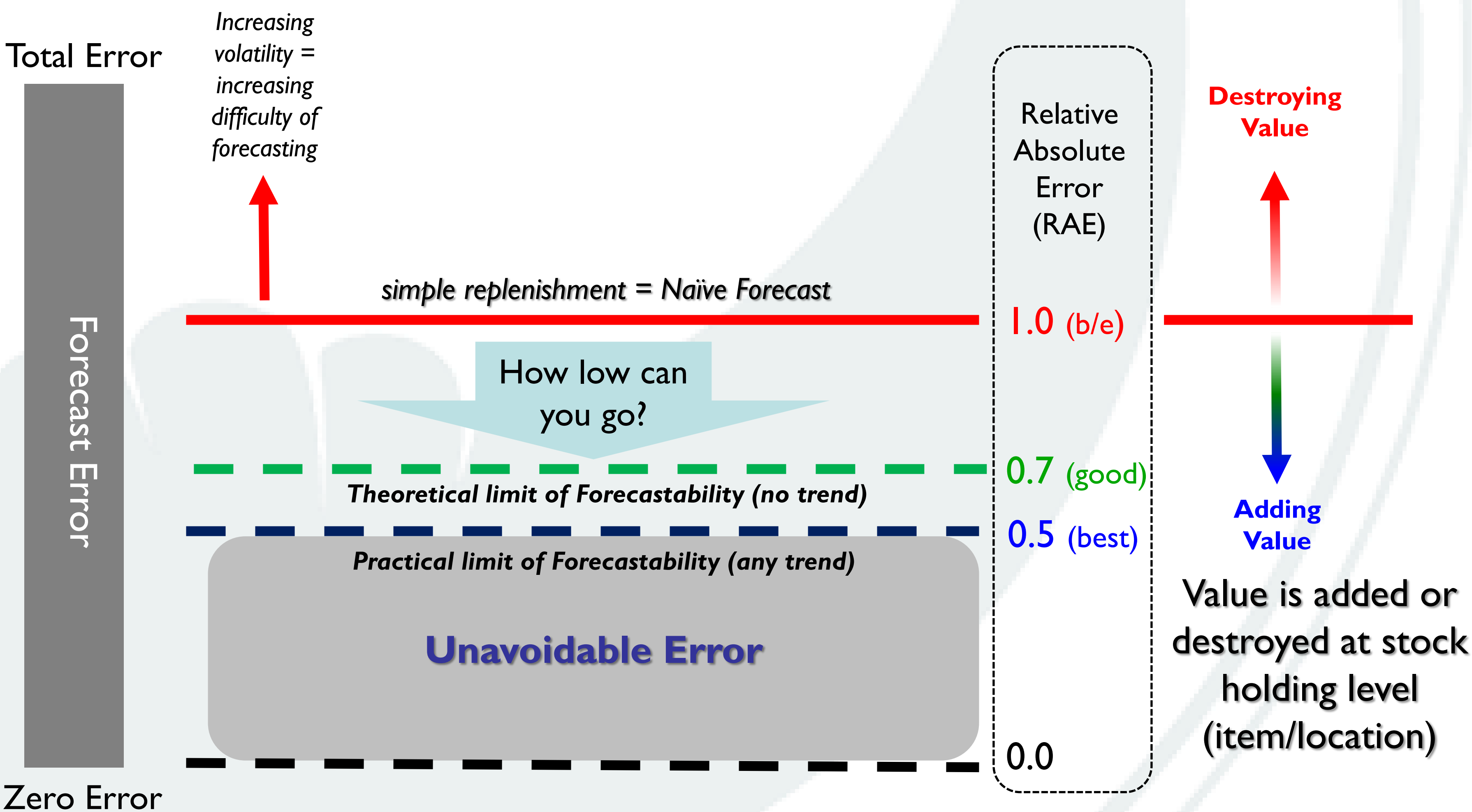
Goodwin: Foresight Summer 2013

Flat Signal
Min RAE = √0.5 =0.71

Changing Signal
Min RAE = < 0.71

*The **lower bound** of forecast error is **<u>also</u>** related to the naïve forecast…expressed as **Relative Absolute Error (RAE)***

New thinking: new measures



The evidence: research 2013

9 samples from 8 businesses – 330,000 data points

	Median RAE	Wtd Av RAE	Median MAPE	Forecast Accuracy
Sample 1	0.94	0.89	56%	49%
Sample 2	1.15	1.04	34%	77%
Sample 3	0.97	0.81	89%	34%
Sample 4	1.00	*1.53*	56%	35%
Sample 5	0.99	1.14	56%	45%
Sample 7	1.06	*1.89*	42%	8%
Sample 7	0.94	0.99	10%	35%
Sample 8	1.05	0.87	105%	53%
Sample 9	1.10	0.99	110%	51%
Mean	**1.02**	**1.13**	**62%**	**43%**
Excl Outliers		***0.96***		

Traditional measures unhelpful

Very little value added

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Research 2013

9 samples from 8 businesses – 330,000 data points

	Median RAE	Wtd RAE	[illegible]	[illegible]
Sample 1	0.94	[illegible]	[illegible]	[illegible]
Sample 2	1.15	1.04	34%	77%
Sample 3	0.97	0.81	89%	34%
Sample 4	1.00	*1.53*	56%	35%
Sample 5	0.99	1.14	56%	45%
Sample 7	1.06	*1.89*	[illegible]	[illegible]
Sample 7	0.94	0.99	[illegible]	[illegible]
Sample 8	1.05	0.87	105%	[illegible]
Sample 9	1.10	0.99	110%	51%
Mean	**1.02**	**1.13**	**62%**	**43%**
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Distribution of RAE

<0.5	0.5-0.7	0.7-1.0	>1.0
0%	6%	52%	42%
[illegible]	5%	33%	62%
8%	12%	33%	47%
13%	11%	27%	49%
1%	9%	42%	48%
7%	10%	27%	56%
4%	11%	44%	40%
6%	2%	35%	57%
2%	3%	31%	64%
5%	**8%**	**36%**	**52%**

What "**good**" looks like

Few forecasts can beat RAE of 0.5…natural limit?

Most forecasts are destroying value

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Forecast Quality

…Putting the research to use

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Key Concepts

- Identify and cost **avoidable** error:

  ….to provide an objective business assessment of quality and its value

- Separate **two types** of error:

  ….target bias and variation to improve forecast quality

- Translate into **F**orecast **V**alue **A**dded:

  ….the one metric/benchmark for **all** users

- Continuously **track performance** at all levels:

  ….to stimulate speedy corrective action

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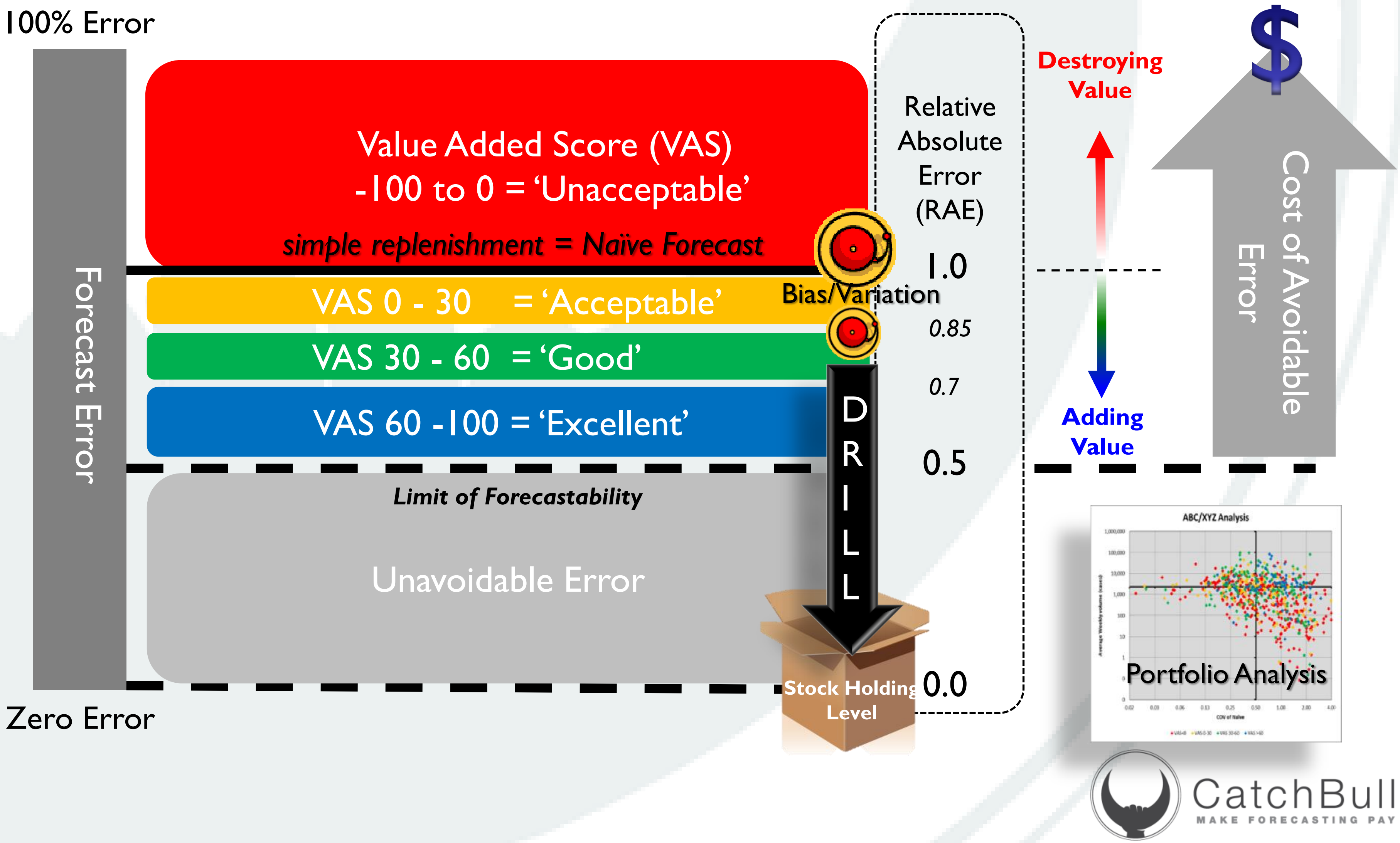
Key Concepts:
Forecast Value Added



Improving Forecast Quality

In practice

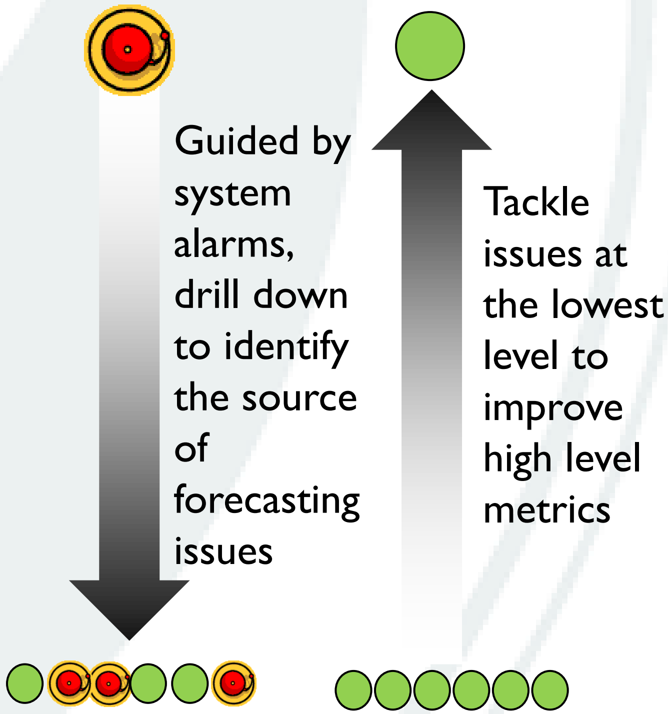
1. Issue management: eliminating bias

Traditional Metrics focus on high level performance…

	Product
Level 0	All Products (1)
Level 1	Brands (70)
Level 2	Minor Brands (150)
Level 3	Products (1500)

…but cost and customer service are driven by the quality of low level forecasts

Continuous Improvement



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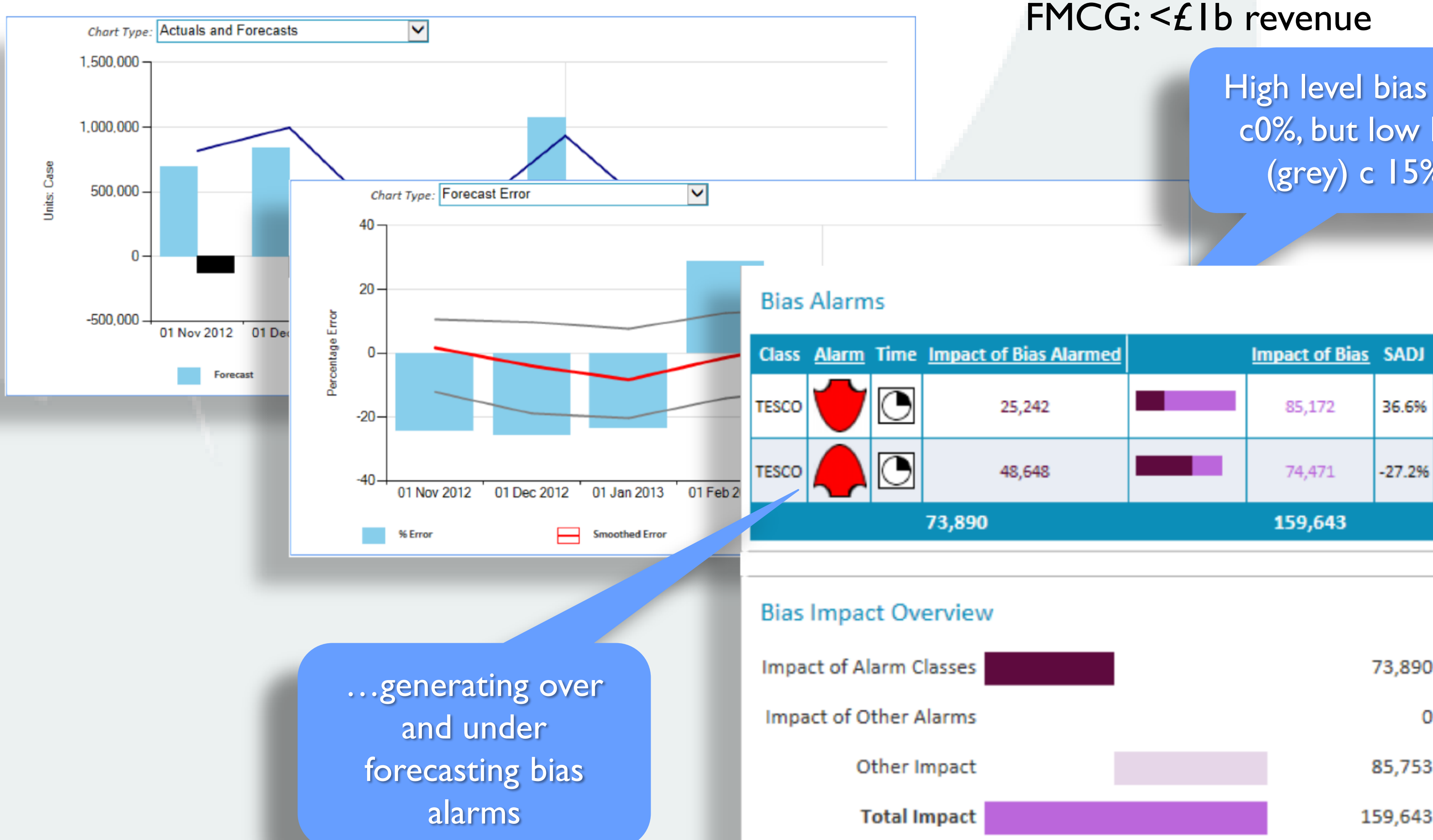
Issue Management Example

FMCG: <£1b revenue

High level bias (red) c0%, but low level (grey) c 15%...



...generating over and under forecasting bias alarms

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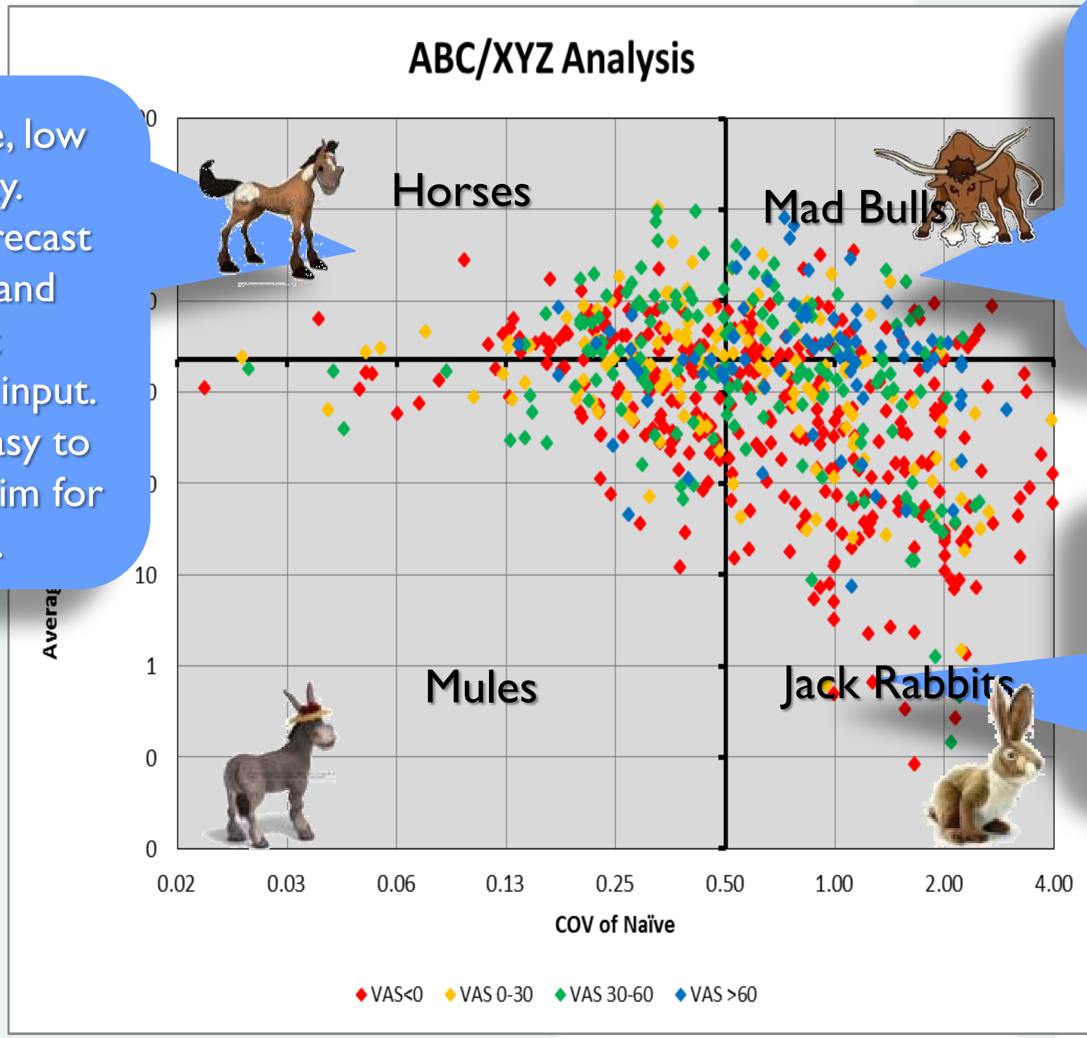
2. Improving Methods:

where to use judgement



High volume, low variability. Optimise forecast algorithm and restrict judgemental input. Should be easy to beat naive. Aim for green…

High volume, high variability. Forecasting involves judgement. Difficult but possible to excel. Aim for blue

Low volume, high variability. Use simplest/cheapest methods – aim for amber or low red

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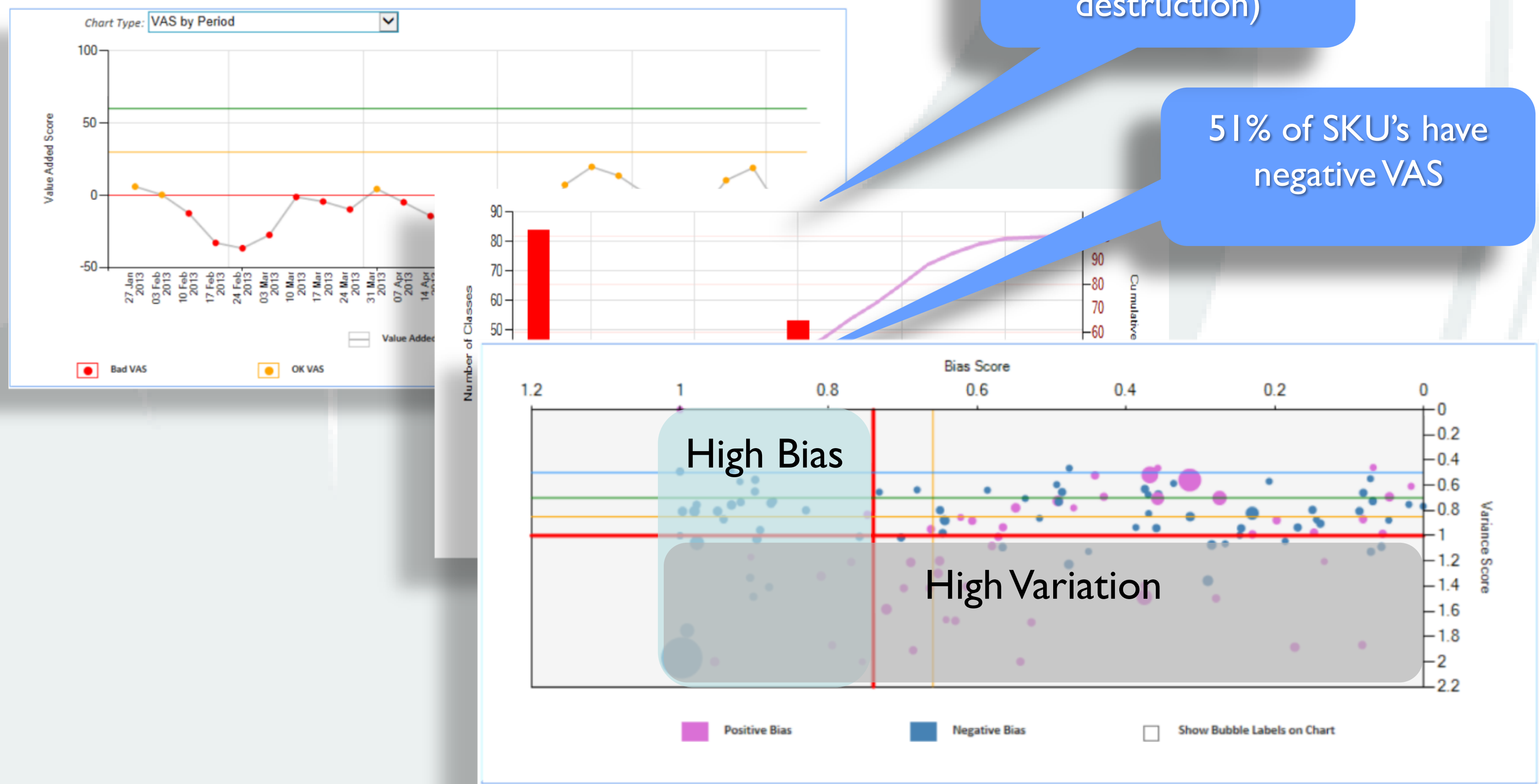
2. Improvement Example

FMCG: >£1b revenue

Value Added Score mostly red (value destruction)

51% of SKU's have negative VAS



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What is this worth?

Ready Reckoner	Cost of Sales	Per €1b revenue*
Total Cost of Error	4%-8%	€20-40m
Forecast Value Added	0%-2%	€0-10m
Avoidable Error	2%-4%	€10-20m

* *Assuming 50% Gross Margin*

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Key points

1. Measurement is key
2. Need to account for forecastability
3. Measures should be actionable
4. Improvement is from a)tuning and b)choosing models
5. Forecasts add value by beating the naïve forecast
6. The first step is to stop destroying value: 'easy'
7. Differentiate between bias and variation: the impact of interventions and of model choice
8. Drill from high to low level to tune forecasts
9. Differentiate to help choose modelling approach

In summary

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Contact details

Thank you

steve.morlidge@catchbull.com

www.catchbull.com

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