Forecasting with Collaboration?
The Gap between Theory and Practice


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Forecasting with Collaboration?
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S&OP is well established & Best Practices exists:

- Use statistics for baseline forecasting
- Limit & constrain expert judgment
- Segment assortment ABC XYZ and focus on important items (in S&OP)
- Measure & track accuracy
- ...
Sales & Operations Planning plus Continuous Replenishment

Manufacturer receives ePOS data of consumer sales from retailer
- Uses ePOS data to improve forecasting & reduce lead time
- Synchronises internal production scheduling & inventory activities with actual sales at retailers
- Retailer still prepares their individual

Sales & Operations Planning
plus Continuous Replenishment
Vendor managed Inventory (& Consignment Selling)

Manufacturer decides on appropriate inventory levels & policies of products
- Manufacturer is responsible for creating & maintaining inventory plan
- Manufacturer creates orders (within previously agreed upon bounds)
- Ownership of inventory remains with downstream (Retail / 3PL) partner
What info sharing & collaboration activities are you currently engaged in?

Motivation and Research Questions

<table>
<thead>
<tr>
<th>Prior Research</th>
<th>Focus</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modelling Studies: Aviv 2001, 2002 Zhao, 2002, Disney 2003 Chen, 2007, Waller 2011</td>
<td>Supply chain benefits * Inventory costs * Service levels * Bullwhip reduction</td>
<td>Often unrealistic assumptions &amp; simplifications Basic demand processes e.g. iid, AR(1) Unrepresentative e.g. seasonality, promos, level shifts <strong>Limited forecasting methods</strong></td>
</tr>
</tbody>
</table>

► So what about the forecasting part?
  - Model selection is important in sharing forecast information (Zhao, 2002)
  - Lack of integration of downstream data into forecasting (Smaros 2007, Lapide 2005)

► Research questions addressed
  1. How are manufacturers collaborating with downstream partners?
  2. How are manufacturers forecasting and using downstream data?
  3. What factors are most important to accuracy?

► Disconnect between theory and practice requires attention (Fildes et al, 2008)
► Empirical evidence sought regarding forecasting practice under collaboration
• **Questionnaire Design**
  - Pilot study in 2011 (to ensure validity)
  - Final version pre-tested with 18 FMCG forecasters
  - Questionnaire implemented online
  - Conducted January 2012-August 2012

• **Survey Sample Design**
  - Specified target group: demand planning & forecasting professionals (in manufacturing)
  - LCF Mailing list, forecasting lists / blogs (ISF, SAS)
  - 100s of LinkedIn Groups
  - 2000+ personalised LinkedIn invites
  - Multiple reminders sent

• **Response**
  - 540 responses
  - 260 incomplete (reminders send, to only speculative interest, unwilling to give email address (although not mandatory), Atrophy (number of repeated questions), unsuitable respondent (industry sector & position)
  - 15 complete responses discarded (Consultants/academics, rushed surveys (10-15 mins), highly inconsistent answers, middle-clicking (same answer for every question in groups)

→ 200 complete surveys from forecasters in Manufacturing
→ 173 classified in comprehensive group of collaboration

→ mostly large manufacturers active in the FMCG / CPG industry
Organisational View

Data View

Functional View

Control (Process) View

Survey Results

85% of companies are engaged in multiple schemes (S&OP plus >>Info >>CPFR >>VMI)

Most companies are engaged in S&OP (unclear how formalised)

Still forecasting in Silos? You are the last one ... ;)

Companies are engaged in multiple organisational schemes
Survey Results
Organisational Setup

Classification by Collaboration Types (200 Manufacturers)

- **CPFR**: 62 responses
- **VMI**: 27 responses
- **S&OP + INFO**: 18 responses
- **S&OP**: 27 responses
- **NA**: 7 responses

Increasing Level of collaborative Advancement → grouped responses: CPFR and S&OP dominate sample responses

27 responses did not clearly fit a scheme & were excluded

Most companies are engaged in multiple collaboration schemes in parallel:
- Should receive substantial amounts of internal + external data!
- Run multiple planning processes in parallel. SUPRISING!
Planners run S&OP, CRP, VMI, CPFR... in parallel!
(different data exchanged, different client contacts, different planning frequencies ...)

... requires good Multitasking!
(It can be done, with standardised data & supporting IT systems)

Survey Results
Data Exchange

Q3: To what extent are the following types of data available?

<table>
<thead>
<tr>
<th>Availability</th>
<th>INT</th>
<th>EXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Rarely</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Sometimes</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Often</td>
<td>☞</td>
<td>☞</td>
</tr>
<tr>
<td>Always</td>
<td>☞</td>
<td>☞</td>
</tr>
</tbody>
</table>

Classification: ☐ CPFDR ☐ VMI ☐ SOP+INFO ☐ SOP ☐ SILOS ☞ SAMPLE MEAN

- Never for silos ....
- Less for silos ....
- External info shows different availability by CPFR >> VMI ...
- Internal data widely available (across schemes, effect of S&OP)

→ On average, more internal data is available than external (despite IS&C)
→ (as expected) IS&C schemes have more external data available
Survey Results
Data Exchange

Q4: Which information is available internally for forecasters? (i.e. provided from within your organisation and not directly from the customer) 

Company internal data sources!

Survey Results
Data Exchange

Q5: Which data is provided directly to you by customers who share information?

Company external data sources!

Forecasting with Collaboration?
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Myriad of information is available!

Internal info more available than external info

Choice of 6 transactional data sources is always available

Up to 18 (5 internal + 13 external) data sources sometimes available

Amount of information = Information overload!

How do I chase the missing data?
What else do I expect will likely happen?
What will rather not happen?

Why do I have to spend my time on this?
I should be out there making forecasts!
Maybe next month ....
What data do you share?

Survey Results

Q7: By which means do your customers share this data (Never-Always)?

- Email
- Telephone
- Face-to-face
- Systems Access
- Struct. Messaging/EDI
- Collaborative Platform

Data is exchanged by unstructured means (eMail ...)

Structured Data is mostly for CPFR & VMI (but still rare for a standard)
Survey Results
Data Exchange

Q8: Do you agree or disagree with the following statements?

- Information-sharing is consistent (similar) from customer to customer
- Our customers share the same types of data (e.g. EDI, forecasts, stock, promo)
- Our customers share data at the same level of aggregation (account/warehouse/store)
- Our customers share data in the same time buckets (days/weeks/months)
- The method of data exchange is the same for all customers

Consistency Score

Data is not exchanged in a standardised or consistent form

Data arrives in heterogeneous formats ...

... how to harmonise & integrate into systems?
Repetitive data collection & transformation
→ (productive) Value Added activity?

... rather a time killer!
Survey Results
Data Exchange

Q16: Do you use these types of software in forecasting?

Spreadsheets are most widely & regularly used

Q17: How often do you use these types of software in forecasting (Never - Always)?

Q18: How satisfied are you with your forecasting software?

Few individuals are really happy ;}
What systems do you use?

Survey Results
Algorithm Usage

Q11: What percentage of your final forecasts consist of the following approaches?

- 25% pure expert Judgment

Q12: What percentage of statistical forecasts are made with these methods?

- Only 10% of methods are capable to integrate causal drivers in forecasting (Promos, DC stock …)
- 43% use simplest methods only for level time series (28% MA + 15% Naive)

→ 25% of all judgment + 76% of stats (57%)
→ 82% of forecasts are made with simple Methods
What algorithms do you use?

Survey Results

Data Usage

NONE of the data is not used purely statistically!

→ Use of judgment on myriad of data sources?
Survey Results

**Q31: How important are different types of internal data to your forecast accuracy?**

Most data is considered important, but used only judgmentally.

**New Tools?**
Naive Method(s)

“[Image of two people] It can drive a 6-D nail thru a 2 X 4 at 200 yards”

New Tools!
Brown (1956) & Box & Jenkins (1970) predicted that the trend would continue "for at least ten years".

Moore (1965) noted that the number of components in integrated circuits (IC) has doubled every year from its invention in 1958 until 1965.

Breiman (1996) and his collaborators, including Freund & Schapire (1997), have been influential in the development of machine learning algorithms.

Breiman (2001) and his colleagues have also contributed to the field.

Rumelhart & McClelland (1986) introduced the backpropagation algorithm, which is a key component of many modern neural networks.

Breiman, Guyon, and Vapnik (1992) have also made significant contributions to the field.

Breiman (2001) has been influential in the development of support vector machines.

Does your vehicle fleet look like this?

BMW Isetta (1956-1962)

Austin Healey 3000 (1959)
Does your hardware look like this?

Working with IBM type 704 electronic data processing machine used for making computations for aeronautical research. 21 March 1957. NASA

Do your employees look like this?
Then why do your algorithms look like this?

\[ L_t = \alpha \cdot \frac{Y_t}{S_{t-s}} + (1 - \alpha) \cdot (L_{t-1} + T_{t-1}) \]
\[ T_t = \beta \cdot (L_t + L_{t-1}) + (1 - \beta) \cdot T_{t-1} \]
\[ S_t = \gamma \cdot \frac{Y_t}{L_t} + (1 - \gamma) \cdot S_{t-s} \]
\[ F_{t+h} = (L_t + T_t \cdot h) \cdot S_{t-2+h} \]
... talking about TECHNOLOGY!

Ask yourself …

Can you afford to ignore 60 years of progress?
ARE you asking yourself?  
(... just checking!)

Review your algorithm’s maturity!
Upgrade to 1970s technology … ?

ARIMAX
Multiple Regression

Survey Results
Accuracy

Table 2: Reported MAPE (%) summary

<table>
<thead>
<tr>
<th>Aggregation</th>
<th>1m</th>
<th>2m</th>
<th>3m</th>
<th>12m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Category</td>
<td>33.10</td>
<td>32.81</td>
<td>35.57</td>
<td>38.57</td>
</tr>
<tr>
<td>2 Item</td>
<td>46.21</td>
<td>36.56</td>
<td>40.74</td>
<td>44.81</td>
</tr>
<tr>
<td>3 Customer</td>
<td>38.11</td>
<td>39.11</td>
<td>41.92</td>
<td>43.35</td>
</tr>
</tbody>
</table>

Classification: CPFRI VMI SOP+INFO SOP SILOS SAMPLE MEAN
**Survey Results**

**Accuracy**

Q83: How satisfied are you with forecast accuracy?

Accuracy Satisfaction

- Not at all
- Slightly
- Moderately
- Highly
- Completely

Level of Satisfaction

Classifications: CPFR, VMI, SOP+INFO, SOP, SILOS, SAMPLE MEAN

→ ...

**Survey Results**

**How to improve?**

Q84: Which of the forms of CIS have been important in improving forecast accuracy?

Importance to Accuracy

Classifications: CPFR, VMI, SOP+INFO, SOP, SILOS, SAMPLE MEAN

→ ...
Survey Results
How to improve?

Q27: Which of these factors would most help you to improve accuracy? (select only the relevant answers in order of importance)

Take aways

- Companies are engaging in multiple Info Sharing & Collaboration schemes simultaneously
  → does this Multitasking add value?
- Demand Planners are overloaded with Data
  → which data sources add value & Information?
- Demand planners receive unstructured Data
  → tedious data processing jobs kill valuable time
- Lack of systems support
  → Excel is great for data gathering, not forecasting!
- Companies ignore newer algorithm that can help!
  → algorithms exist to integrate data automatically
- Review your Collaborative practices
  → try new approaches to forecasting & using info!

... making Collaboration work!
... Discussion?

Questions?

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