Bullwhips, beer, and crystal balls: A proposed new direction for management accounting research

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Karen L. Sedatole
Michigan State University
"The human brain starts working the moment you are born and never stops until you stand up to speak in public."

~ George Jessel

- Things I know (virtually) nothing about
- Things I know a little about
- Things we know a lot about
- Things we should know more about
Things I know (virtually) nothing about

1. Bullwhips
Things I know (virtually) nothing about

1. Bullwhips

2. Beer
Things I know (virtually) nothing about

1. Bullwhips

2. Beer

3. Crystal balls
Things I know a little about

“Bullwhip Effect”
Things I know a little about

**Operations & SCM Research**

- Purchasing
- Transportation
- Receiving & moving
- Production planning & scheduling
- Distribution

**SUPPLY NETWORK**

**INTEGRATED ENTERPRISE**

- Procurement
- Order Administration
- Manufacturing

**MARKET DISTRIBUTION NETWORK**

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Things I know a little about

Operations & SCM Research

• Decision-makers using *cost information* to make tradeoffs
  – Make vs. buy
  – Speed vs. quality
  – Inventory vs. stockouts
  – Ship vs. collocate
  – Customer service vs. customer incentives
Things I know a little about

Operations & SCM Research

• Objective is often to identify previously undiscovered opportunities for optimizing across the value chain (Boudreau 2003)

• Analytic and simulation methods tend to dominate.

• Not much emphasis on the nuances of individual decision-making arising from…
  – Individual incentives
  – Individual cognitive limitations/biases
  – Information quality (or lack thereof)
A curiosity

Information (i.e., costs!) taken as given

Machine operator

Optimize
Things we know a lot about

- Cost information
  - Cost hierarchy
  - Cost system design
- Cognitive limitations & biases in judgments
- Budgeting
  - Who builds budget slack
  - How budget practices affect behavior
- Incentive effects
  - Pay-for-performance
  - Truth-inducing pay schemes
Things I know a little about

“Bullwhip Effect”

Consumer

Supply Chain

Retailer

Distributor

OEM

T1 Supplier

T2 Supplier

Demand signal

Snap!
Things I know a little about

“Bullwhip Effect”
Things I know a little about

• In economics textbooks, supply flows in a smooth and orderly fashion, but in the real world it’s often a panicky mess of misplaced inventory and mistimed forecasts.

Source: James Surowiecki, *The Economist*, 2003

“Bullwhip Effect”
Things I know a little about

- Bullwhips are **costly**
  - For producers… *production instability* results in inventory handling, inventory obsolescence, overtime, materials costs, freight costs, record-keeping costs, quality failure costs (lots of studies)
  - For retailers… 8% *stockout* in a typical store

*“Bullwhip Effect”*

[Diagram showing the bullwhip effect across different levels of the supply chain]
Things I know a little about

Identified causes of the bullwhip effect

• Operational (Lee et al. 1997a/b, 2004)
  1. **Demand-signal processing**: translating current demand information into a forecast of future demand.
  2. **Rationing**: suppliers allocate limited inventory across customers; customers game the system
  3. **Batching orders**
  4. **Varying prices**

Analytic and simulation studies document bullwhip outcomes even with “rational decision-making” algorithms. 

(Croson and Donohue 2002)
Identified causes of the bullwhip effect

Operations researchers turned to the “beer” lab where they could remove the operational causes.

• Behavioral
  – Decision-makers… “fail to account adequately for the supply line” (Sterman 1989) and overreact to backlogs (Oliva & Gonçalves 2007)

Experiments subsequently used to examine the effect on the behavioral bias of (1) reducing lags, (2) sharing inventory/POS information, (3) training.

“Not very promising”
“Human factors influencing the behavior in supply chains are largely unexplored.”
Things I know a little about

• Conclusions of the SCM literature:
  – “Whip happens” and it is a bad thing
  – Uncertainty in demand is underlying culprit
  – 4 operational causes
  – To mitigate the bullwhip, don’t do those four things
  – Even without 4 operational causes, “whip happens” (behavioral anomaly…but not sure exactly what)
#3 Batch orders

One of the conclusions out of this research is that the bullwhip effect can be mitigated by devising “strategies that lead to smaller batches, frequent resupply” (Lee et al. 1997)

Didn’t I learn in accounting that this is costly, too??
Things we should know more about

- How good is the cost information firms use to make these tradeoffs? How could the cost information be improved?
- Would improved cost information (i.e., ABC) lead to different conclusions about optimal strategies?
  - Develop a new method for evaluating operational efficiency using ABC concepts
- Is there any relation between the bullwhip phenomenon and observed “sticky” costs?
Things we should know more about

• If cognitive factors are at least partially to blame for observed bullwhips, what are the specific cognitive processes at play?

• Would/could better/different cost information mitigate cognitive limitations and biases?

• To what extent do incentives drive the behavior? How might incentives be restructured to mitigate the behavior?
  – Intra-firm
  – Inter-firm
# Things we should know more about

<table>
<thead>
<tr>
<th></th>
<th>Bullwhip effect in the supply chain (inter-firm)</th>
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</table>
| **Analytic models**  | 4 operational causes and their corresponding solutions  
                       Inter-org contracting solutions |
| **Simulations**      | 4 operational causes and their corresponding solutions  
                       Cost system design to provide information to mitigate the bullwhip and/or its detrimental effects |
| **Experiments**      | Identify cognitive limitations & biases  
                       Mitigate through  
                       (i) Better/different information  
                       (ii) Incentives (including contracting)  
                       (iii) Trust-building |
| **Archival/Field/    | Magnitude of the problem and its consequences  
                       Survey/ Case Study research |  
                       Incentive-related causes  
                       Role of trust  
                       Cost system design  
                       Cost behavior  
                       Impact of information quality  
                       Inter-org control practices |
Things we know a lot about

Generating more useful cost information

Behavior of individual decision-makers
Things I know a little about

Purchasing  Transportation  Receiving & moving  Production planning & scheduling  Distribution

Operations & SCM Research

SUPPLY NETWORK

INTEGRATED ENTERPRISE

Procurement  Order Administration

Logistics  Manufacturing

MARKET DISTRIBUTION NETWORK

END CONSUMERS

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Things I know a little about

Operations & SCM Research

Supply Network

Integrated Enterprise

Market Distribution Network

Procurement

Order Administration

Logistics

Manufacturing

Materials

Marketing demand forecasts

Production planning

End Consumers
"Sales & Operations Planning (S&OP) Process"

... the process used to balance demand requirements and supply capabilities of the firm...

Bowersox et al. (2010)
Sales forecasts are a primary coordination mechanism.

Traditional functional approach to planning reflects differences in information and incentives and often leads to suboptimal decisions.
Things we know A LOT about

The determinants and consequences of budget-based (BB) control practices are among the most widely studied topics in management accounting research.

(Covaleski et al. 2003)

- BB Goal + PFP $\rightarrow$ motivation/performance
- BB Goal difficulty $\rightarrow$ motivation
- BB Goal $\rightarrow$ commitment $\rightarrow$ performance
- PFP, Ratchet, risk preferences, information asymmetry, control style, honesty $\rightarrow$ Budget slack
- Budget slack $\rightarrow$ performance
- Budget participation $\rightarrow$ motivation/performance
- Budget participation $\rightarrow$ budget slack
Perhaps not surprising that practitioners…

- **Regard** planning uses as more important than control uses (Sivabalan et al. 2009),
- **Argue that** forecasts are supplanting the budget as the primary planning and coordination tool, especially in highly uncertain environments (Bittlestone 2000; CIMA 2009; Vadasz and Lorain 2010; Hagel 2014; Sivabalan et al. 2009; Ekholm and Wallin 2011), and
- **View** shortcomings in both budgets and forecasts as planning and coordination tools.

*Planning and coordination issue of concern to managers…*
Things I know a little about

• Production instability

“intensity of revisions or changes to the production schedule over time.”

(Pujawan and Smart 2012)

– Also known as production “nervousness”

– A primary cause is forecast inaccuracy (Jeunet 2006; Kerkkänen et al. 2009; Pujawan and Smart 2012)
Things I know a little about

• Production instability
  – Costs
    • inventory handling, inventory obsolescence, labor overtime, materials costs, freight costs, record-keeping costs, quality failure costs, and lost sales (Pujawan and Smart 2012)
  – Solutions (operations research)
    • Schedule freezing
    • Safety Stock
    • Postponement
Things we should know more about

• What role does accounting information play in planning and coordination?

• How might our expertise in budgeting be used to provide more (and more useful) insights into the use of forecasts in the S&OP process?

• In particular, how might we inform, or be informed by, issues related to production instability?
  – Are there informational solutions to the problem?
  – Are their incentive-based solutions?
The folly of forecasting: The effects of sales forecast accuracy and bias on inventory and production decisions under aggregated and disaggregated forecasting regimes

Alexander Brüggen
Maastricht University

Isabella Grabner
Maastricht University

Karen Sedatole
Michigan State University

What role do budget-based incentives and accounting information play in the causes and solutions to production instability??
Example: Bruggen, Grabner, Sedatole (2014)

- Large agriculture chemical company
- Very challenging demand forecasting environment
  - Low forecast accuracy \(\Rightarrow\) low production stability
- Sales/marketing incentives:
  - Budget-based incentives create *ex ante* incentives to build sales budget slack \(\Rightarrow\) negative budget bias
  - *Ex post* incentives to build inventory slack \(\Rightarrow\) positive forecast bias

*Pattern of 3m sales forecast bias.*
• Production manager must (?) rely on the sales forecast

"Prisoner’s Dilemma"

<table>
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<tr>
<th>Supplier</th>
<th>Buyer forecasts truthfully and supplier trusts the forecast.</th>
<th>Buyer inflates forecast; supplier trusts the inflated forecast (supplier incurs cost of inventory and cancellation).</th>
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• Production manager must(?) rely on the sales forecast

**Example: Bruggen, Grabner, Sedatole (2014)**

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**“Prisoner’s Dilemma”**

Example: Bruggen, Grabner, Sedatole (2014)

- Production manager must(?) rely on the sales forecast
- “Quasi natural experiment”
  - Disaggregation of sales forecast into more certain and less certain components… “contingency system”
  - Objective: increase production stability and reduce inventory
These proposed relations have strong theoretical (i.e., via analytic and simulation methods) underpinnings in the operations/SCM literature, but little in the way of empirical support.
These proposed relations have strong theoretical (i.e., via analytic and simulation methods) underpinnings in the operations/SCM literature, but little in the way of empirical support.
**Example: Bruggen, Grabner, Sedatole (2014)**

- Prior to the sales forecast disaggregation:
  - Relations predicted by the SCM literature largely do not hold. **Why??**
• After the sales forecast disaggregation:
  – Sales forecast accuracy improves
  – Inventory increases, BUT with a shift toward WIP (postponement = “wait until forecast is firm”)
  – Predicted relations largely restored
  – + Forecast bias increases
## Things we should know more about

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*How might our budgeting research inform?*
In conclusion

- Our colleagues in operations and supply chain management deal with many bloody interesting problems.
- They are very good at operational and mechanical solutions aimed at finding previously undiscovered optimization opportunities.
- They are not so good at considering the more contextual variables that undoubtedly play a big role.
- Contextual variables have great promise in reconciling deviations of observed practice from optimal practice.
- We could make a huge contribution to this literature by shifting the focus to
  - Information quality (i.e., cost information), and
  - The incentives, cognitive limitations, and biases of individual decision-makers.

Avoid the “absurdity” of suggesting their pursuit of optimal solutions doesn’t matter.
There are many opportunities and we are well-equipped to play in this “sandbox.”

Thank you!