

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



**9th Conference on
New Directions in Management Accounting**

Brussels, Belgium, December 15-17, 2014

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"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



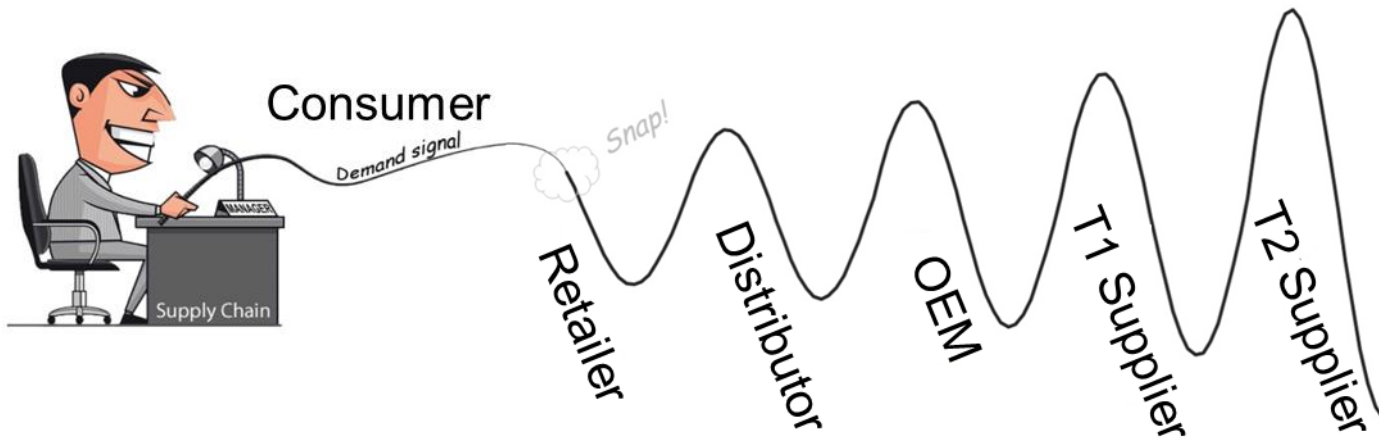
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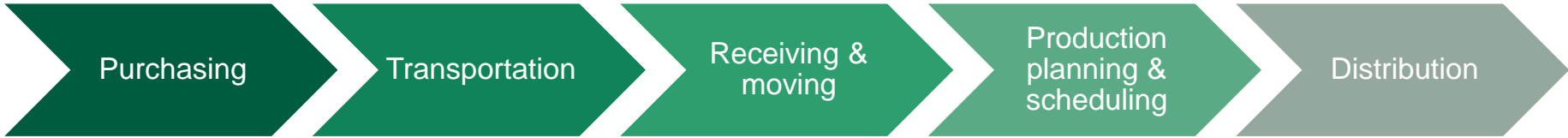
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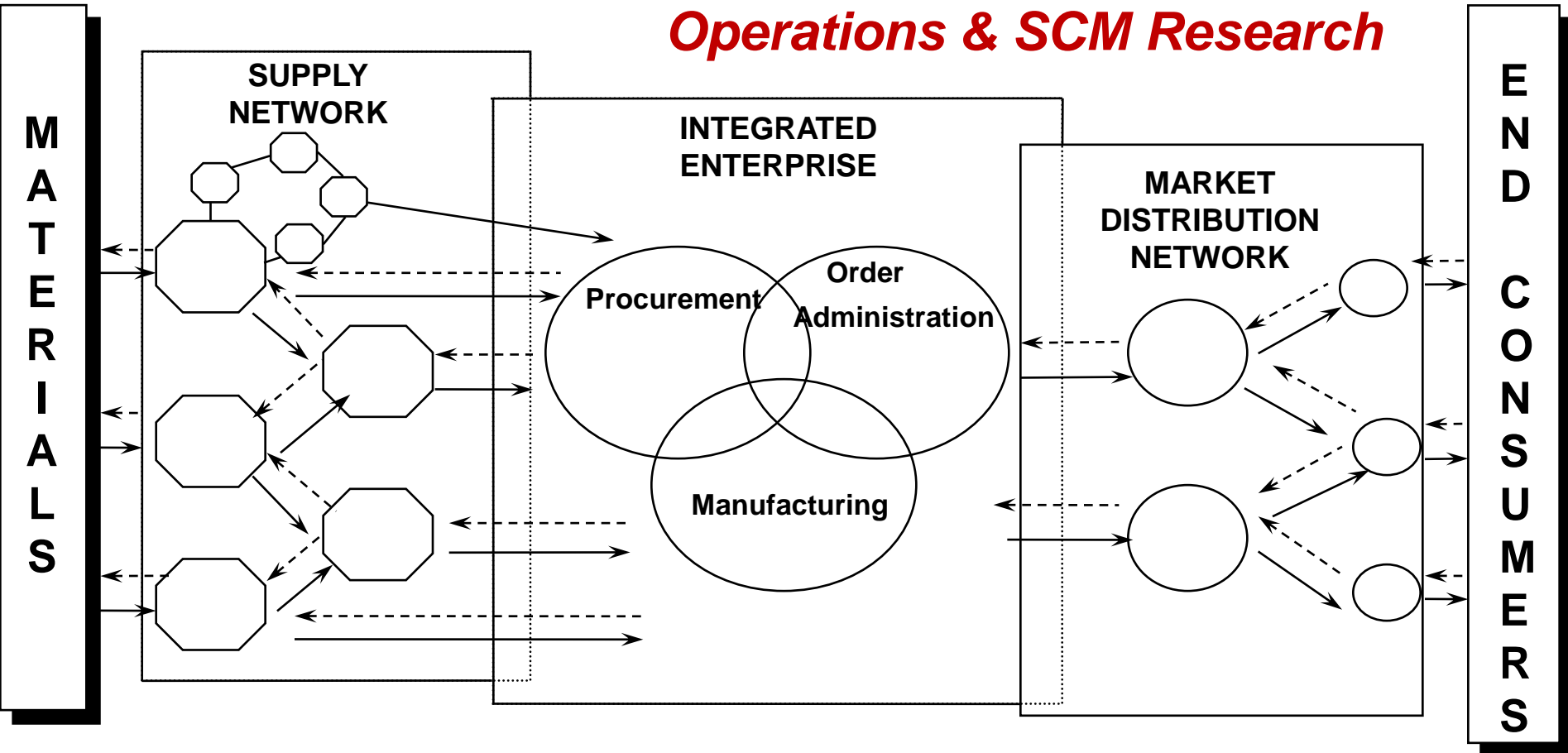
“Bullwhip Effect”



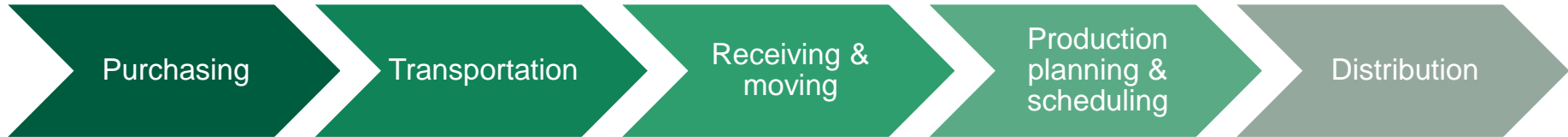
Things I know a little about



Operations & SCM Research



Things I know a little about

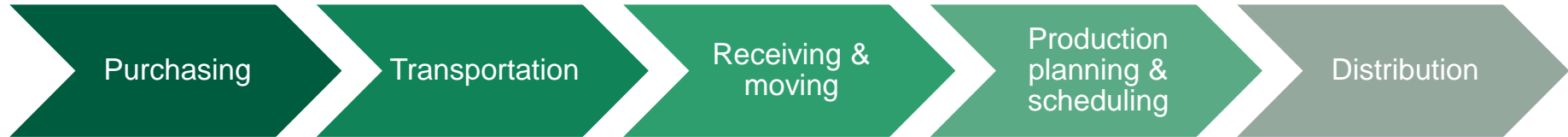


Operations & SCM Research

- 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

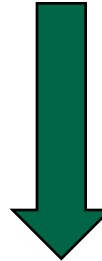


Operations & SCM Research

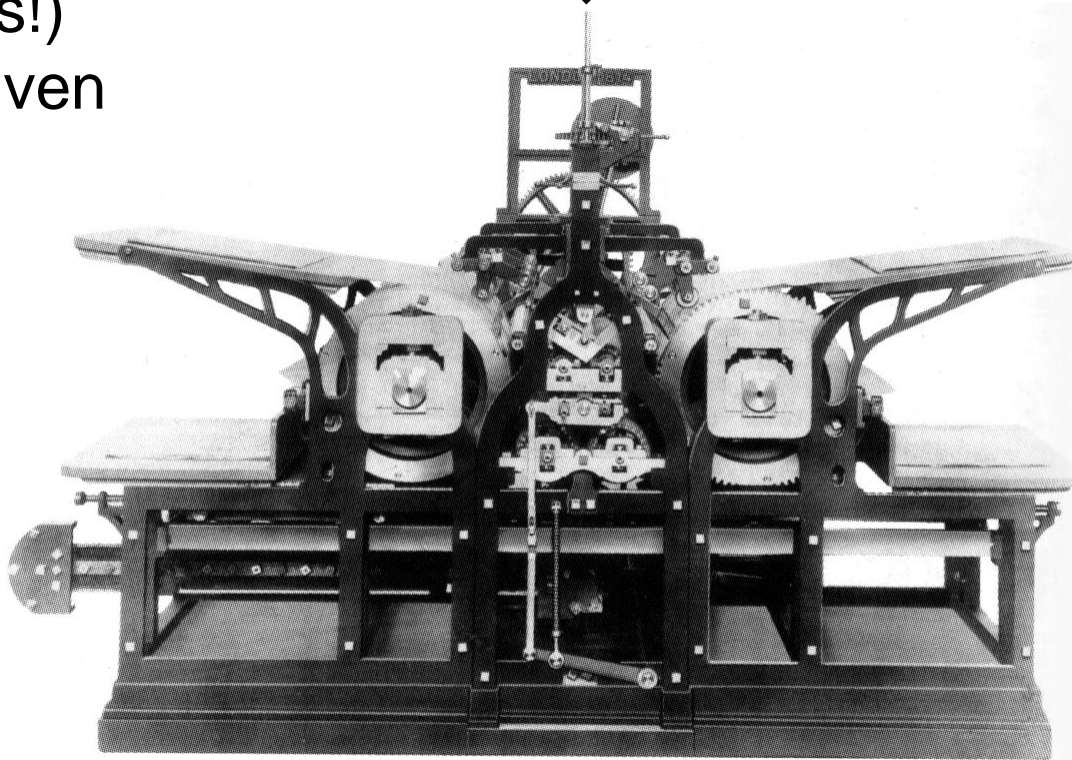
- Objective is often to **identify previously undiscovered opportunities for optimizing across the value chain** (Boudreau 2003)
- **Analytic** and **simulation** methods tend to dominate.
- Not much emphasis on the nuances of individual decision-making arising from...
 - Individual incentives
 - Individual cognitive limitations/biases
 - Information quality (or lack thereof)

A curiosity

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



Machine
operator



Optimize

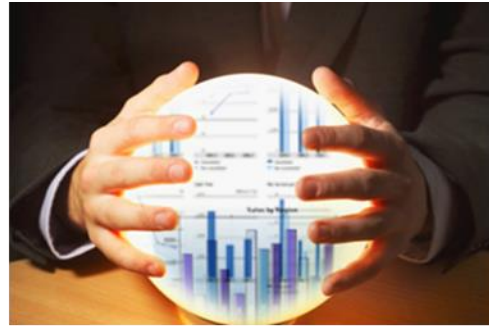
Things we know a lot about

- 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



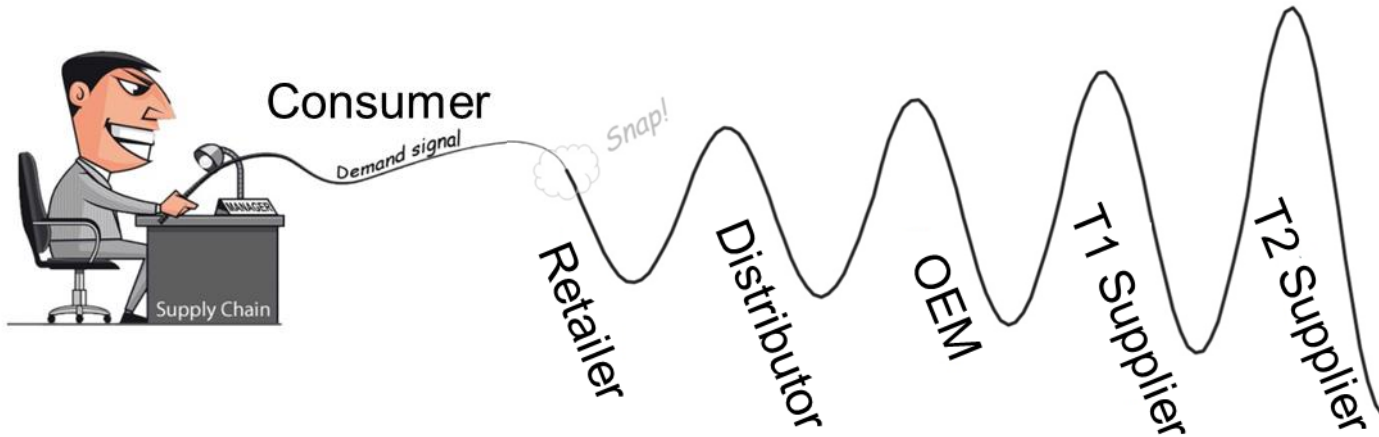
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“Bullwhip Effect”



Things I know a little about



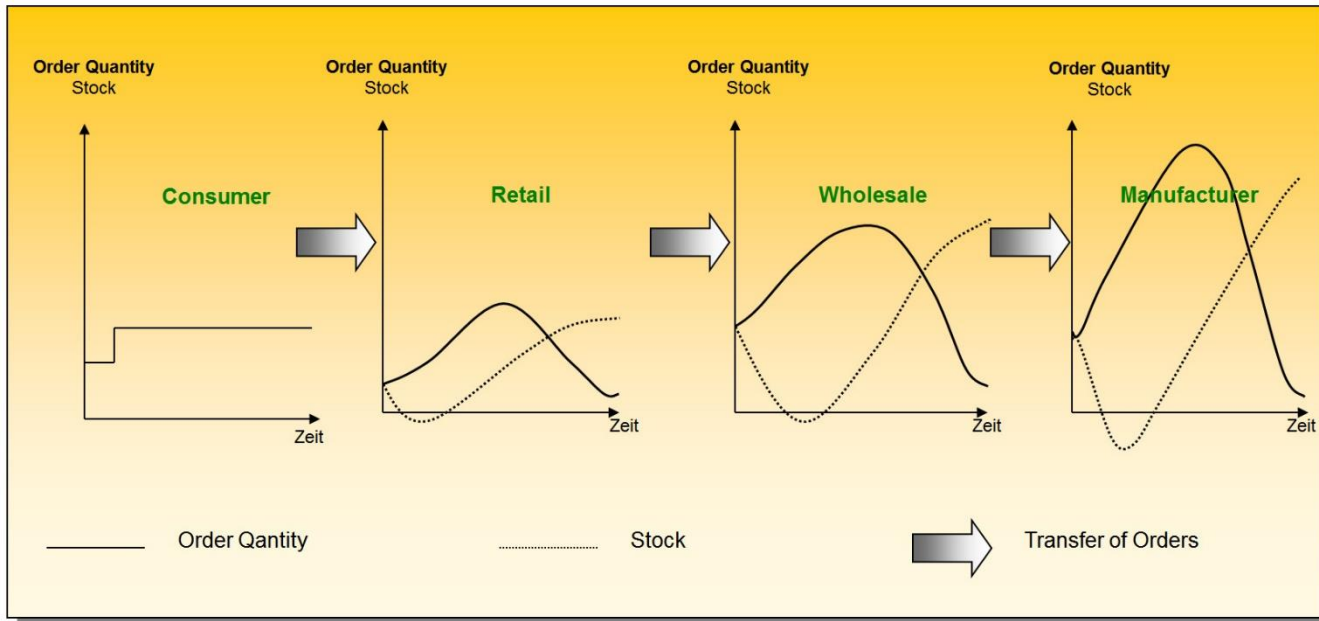
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“Bullwhip Effect”

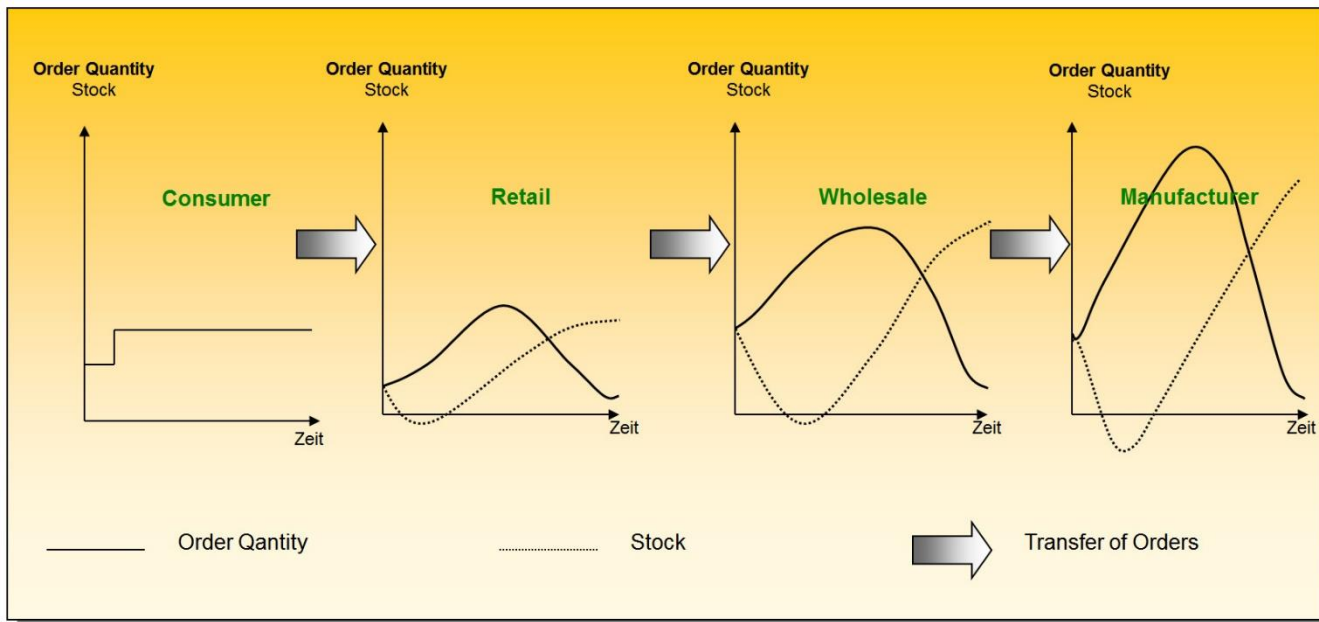


Things I know a little about

- 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

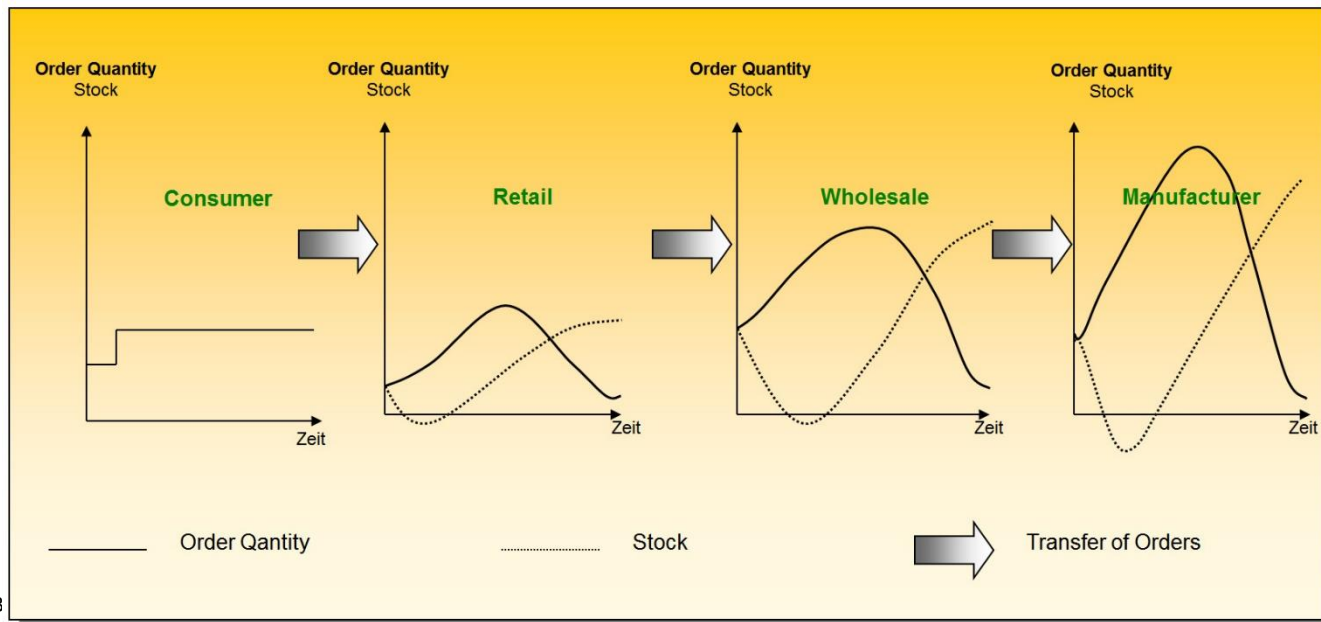
“Bullwhip Effect”



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”



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** } encourage forward buying.

(Croson and Donohue 2002)

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

Things I know a little about

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” (Sternan 1989) and overreact to backlogs (Oliva & Gonçalves 2007)



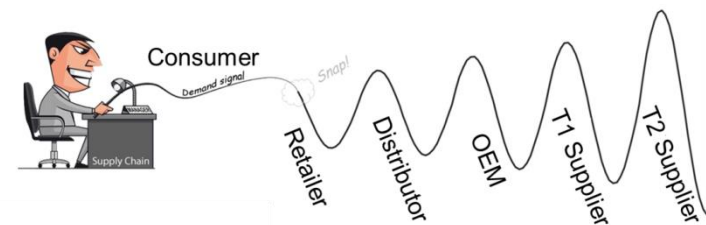
Experiments subsequently used to examine the effect on the behavioral bias of (1) reducing lags, (2) sharing inventory/POS information, (3) training.

“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?
 - Example: Cherchye, De Rock, Dierynck, Roodhooft, Sabbe (2013) Opening the “Black Box” of Efficiency Measurement: Input Allocation in Multioutput Settings. *Operations Research* 61(5):1148-1165.
 - 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

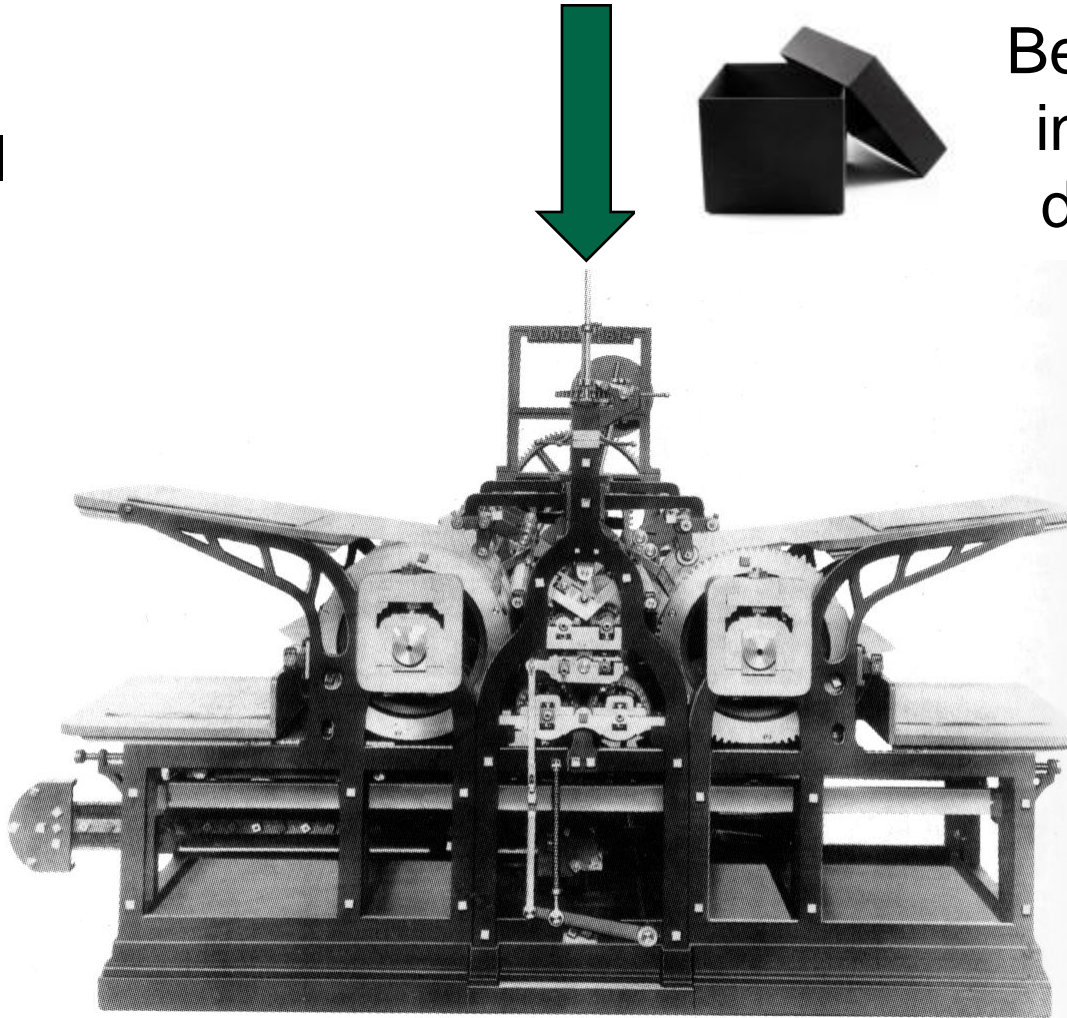


Things we should know more about

	Bullwhip effect in the supply chain (inter-firm)
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/ Survey/ Case Study research	Magnitude of the problem and its consequences 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



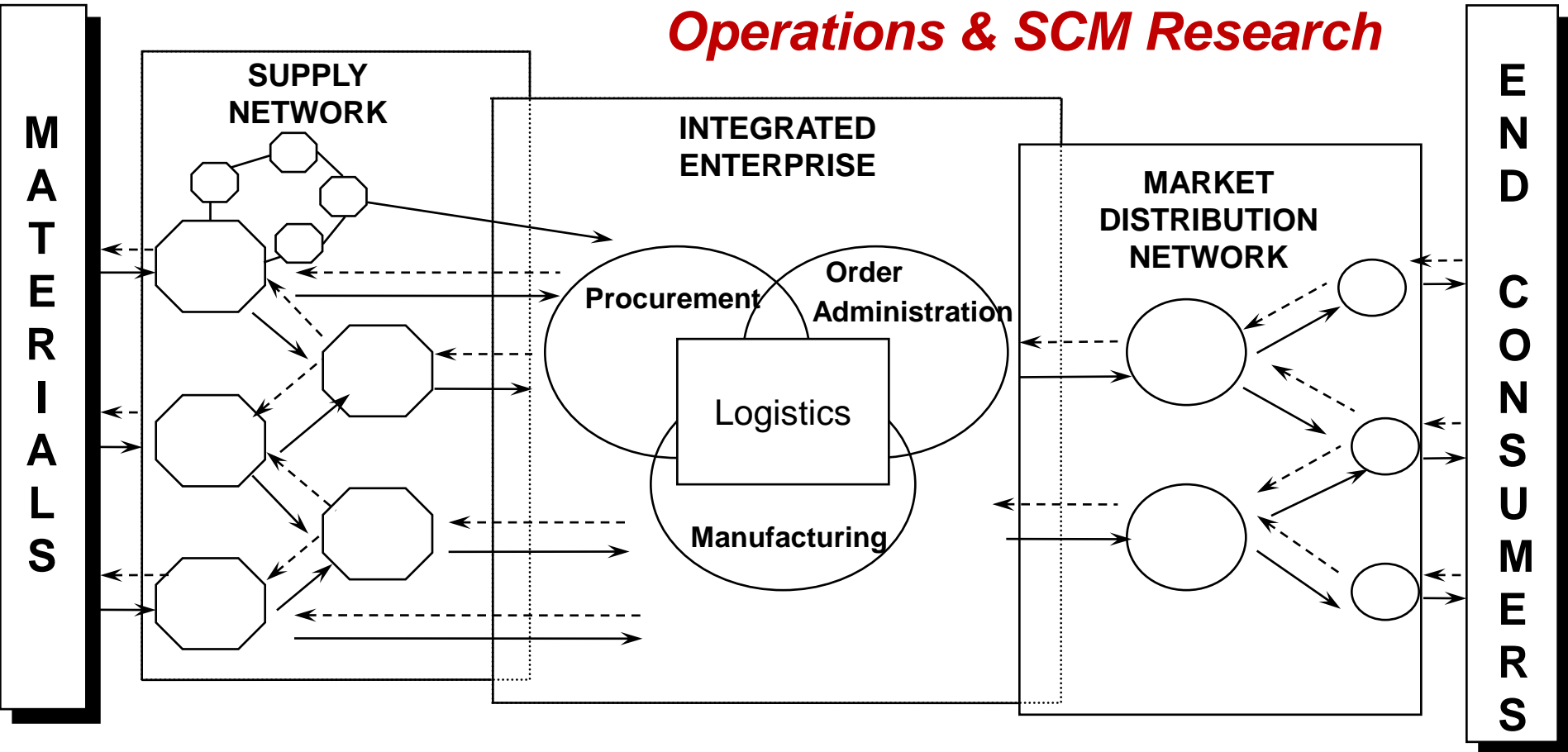
Behavior of
individual
decision-
makers



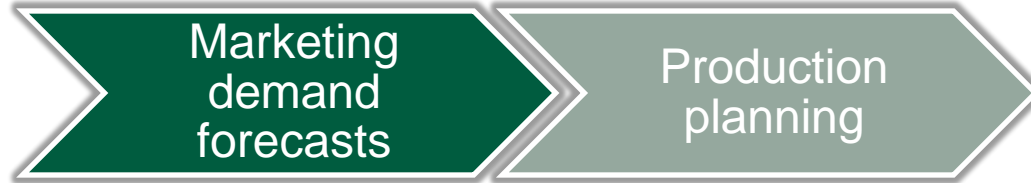
Things I know a little about



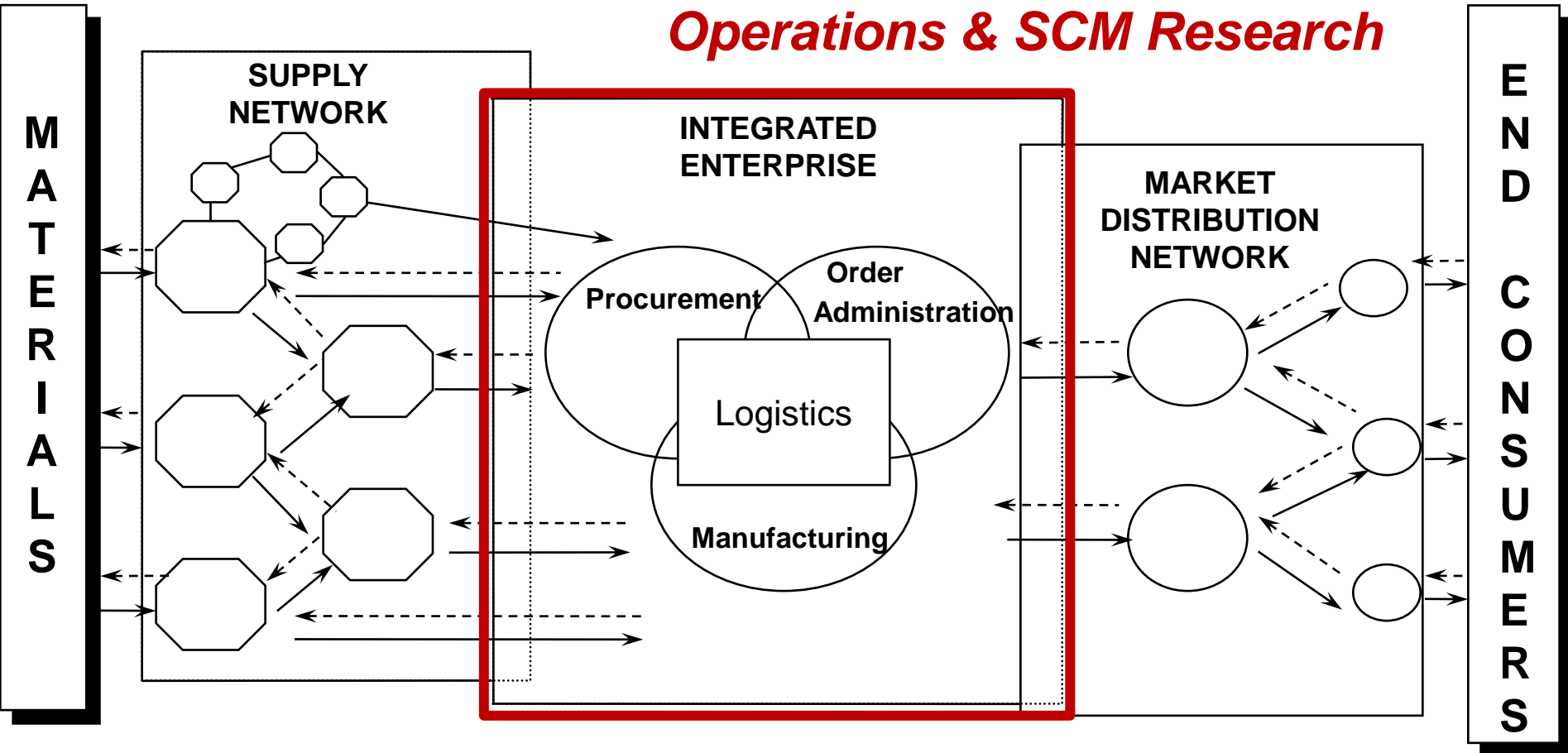
Operations & SCM Research



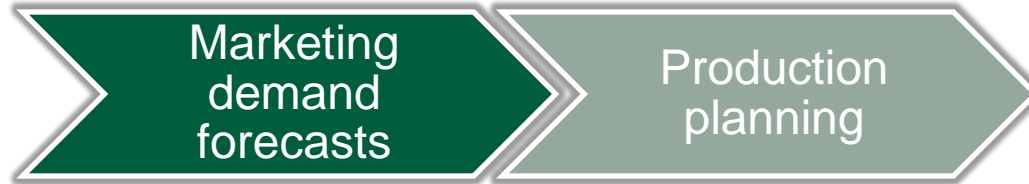
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Operations & SCM Research



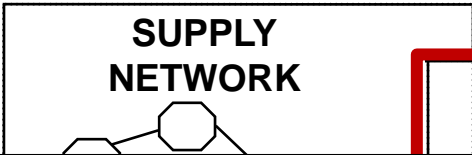
Things I know a little about



Operations & SCM Research

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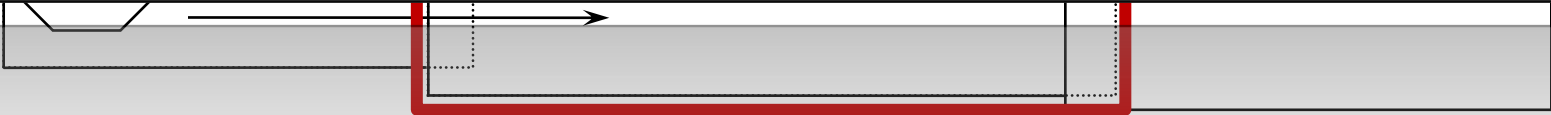
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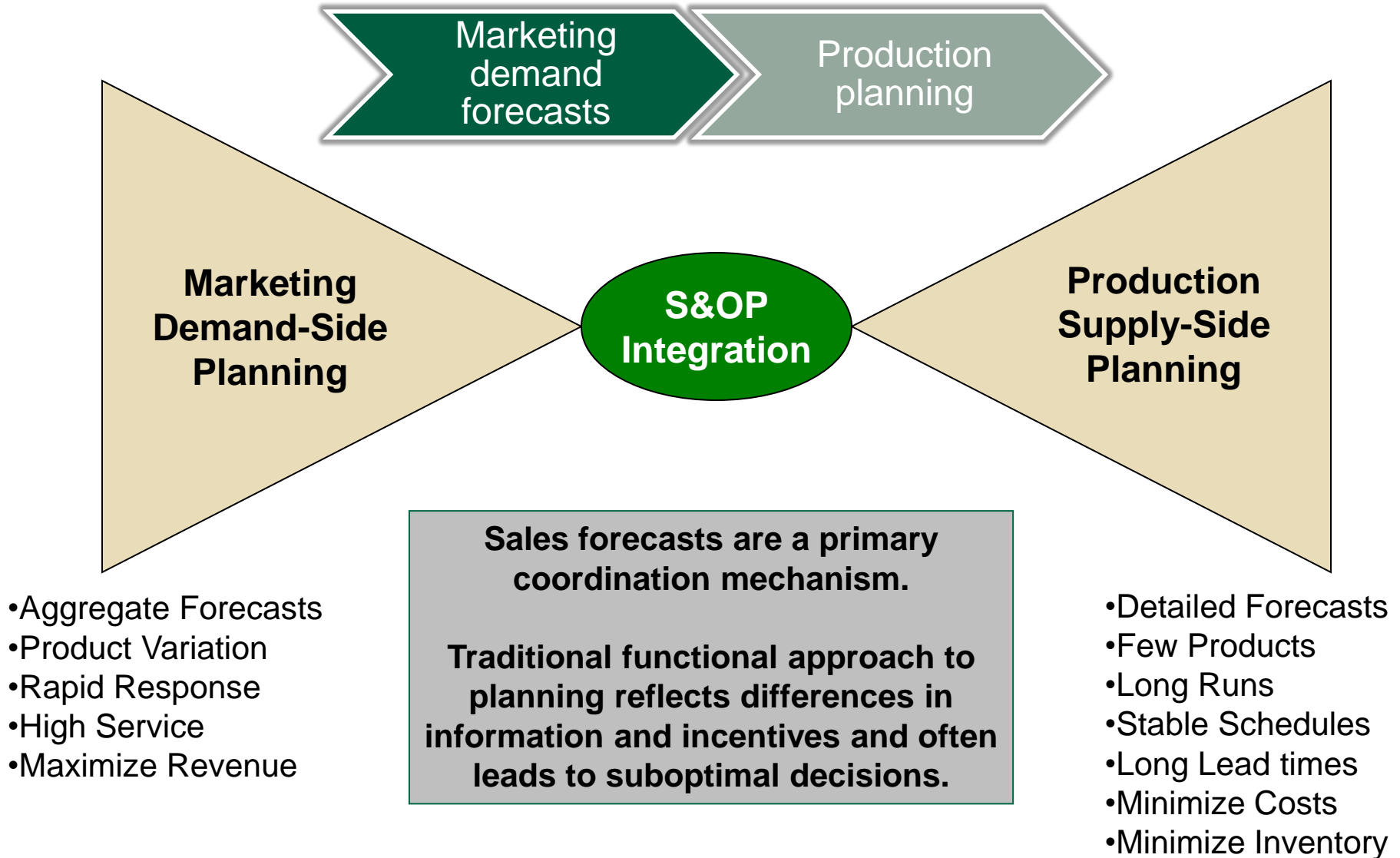
“Sales & Operations Planning (S&OP) Process”

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

Bowersox et al. (2010)



Things I know a little about



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 → motivation/performance
- BB Goal difficulty → motivation
- BB Goal → commitment → performance
- PFP, Ratchet, risk preferences, information asymmetry, control style, honesty → Budget slack
- Budget slack → performance
- Budget participation → motivation/performance
- Budget participation → budget slack

Things I know a little about

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?



Example of a study of S&OP processes

The folly of forecasting: The effects of sales forecast accuracy and bias on inventory and production decisions under aggregated and disaggregated forecasting regimes

Alexander Brüggem

Maastricht University

Isabella Grabner

Maastricht University

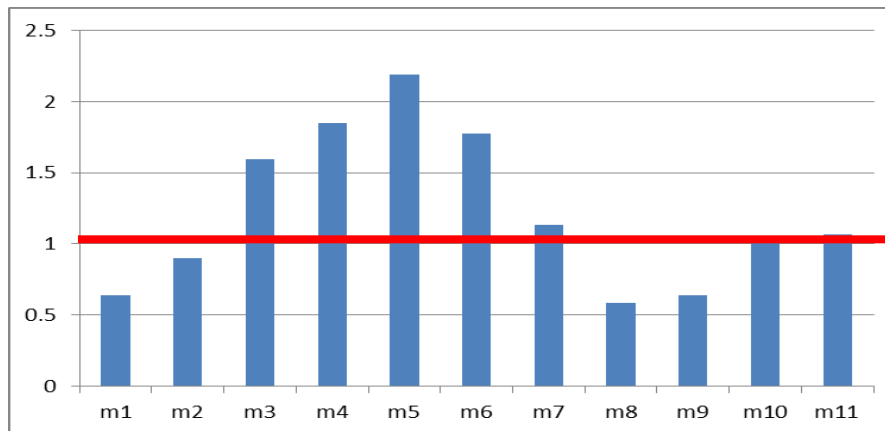
Karen Sedatole

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 → low production stability
- Sales/marketing incentives:
 - Budget-based incentives create *ex ante* incentives to build sales budget slack → **negative budget bias**
 - *Ex post* incentives to build inventory slack → **positive forecast bias**



Pattern of 3m sales forecast bias.

Example: Bruggen, Grabner, Sedatole (2014)

- Production manager must(?) rely on the sales forecast

“Prisoner’s Dilemma”

		Supplier	
		<i>Cooperate (trust forecast)</i>	<i>Do Not Cooperate (ignore forecast)</i>
Buyer	<i>Cooperate (forecast truthfully)</i>	Buyer forecasts truthfully and supplier trusts the forecast.	Buyer forecasts truthfully, but supplier waits until a firm purchase order is submitted (buyer incurs cost of delay).
	<i>Do Not Cooperate (inflate forecast)</i>	Buyer inflates forecast; supplier trusts the inflated forecast (supplier incurs cost of inventory and cancellation).	Buyer inflates forecast, supplier discounts forecasts and waits until firm purchase order is submitted.

Source: Christian Terwiesch, Z. Justin Ren, Teck H. Ho, Morris A. Cohen, (2005) An Empirical Analysis of Forecast Sharing in the Semiconductor Equipment Supply Chain. *Management Science* 51(2):208-220.

Example: Bruggen, Grabner, Sedatole (2014)

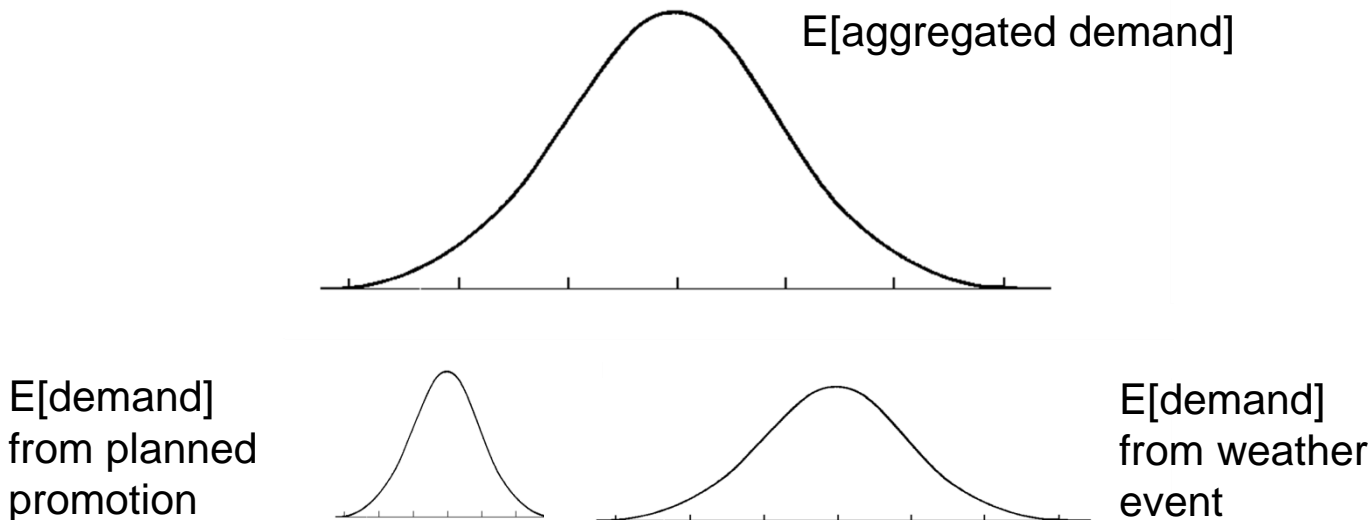
- Production manager must(?) rely on the sales forecast

		PRODUCTION	
		<i>Cooperate (trust forecast)</i>	<i>Do Not Cooperate (ignore forecast)</i>
SALES	<i>Cooperate (forecast truthfully)</i>	SALES forecasts truthfully and PROD trusts the forecast.	SALES forecasts truthfully, but PROD waits until a firm purchase order is submitted SALES incurs cost of delay).
	<i>Do Not Cooperate (inflate forecast)</i>	SALES inflates forecast; PROD trusts the inflated forecast (PROD incurs cost of inventory and cancellation).	SALES inflates forecast, PROD discounts forecasts and waits until firm purchase order is submitted.

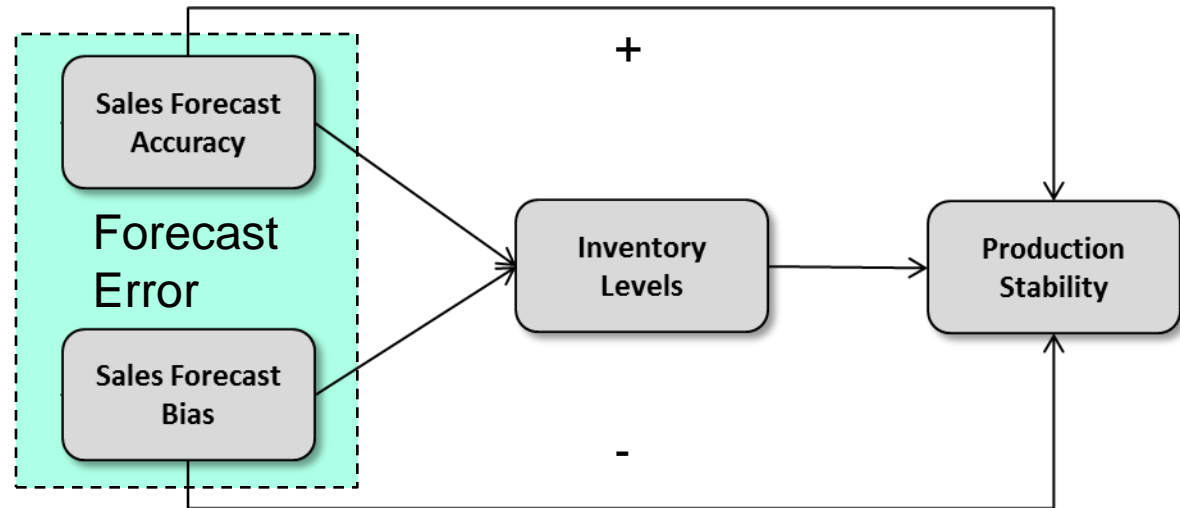
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Example: Bruggen, Grabner, Sedatole (2014)

- 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

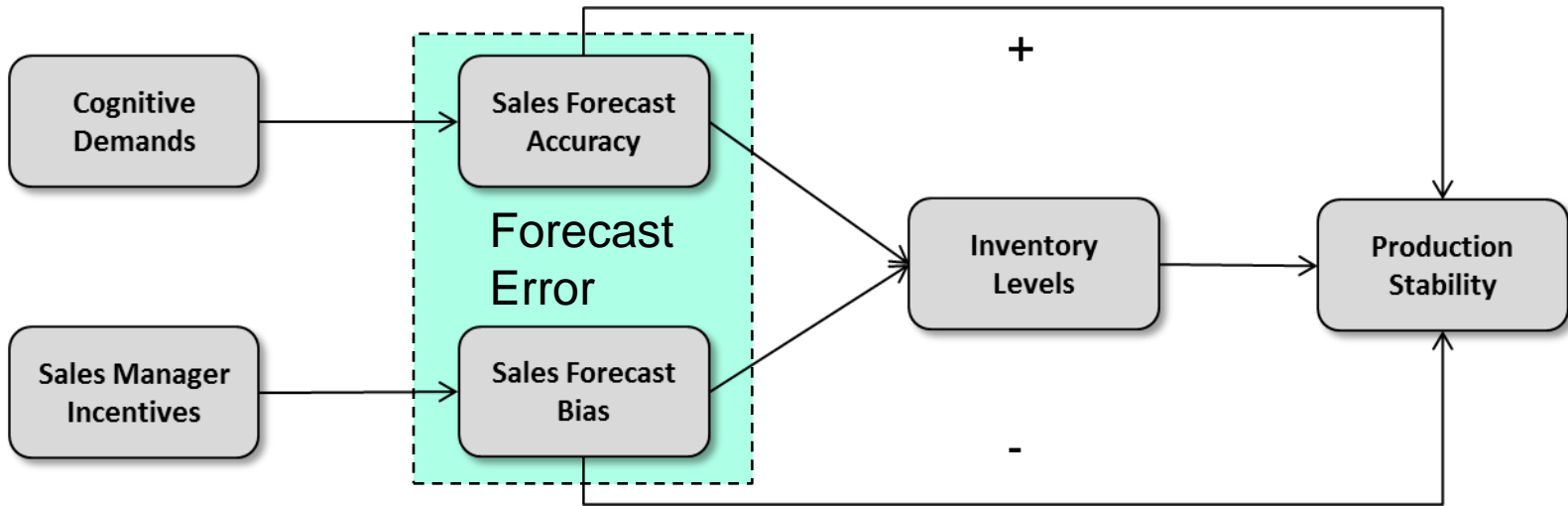


Example: Bruggen, Grabner, Sedatole (2014)



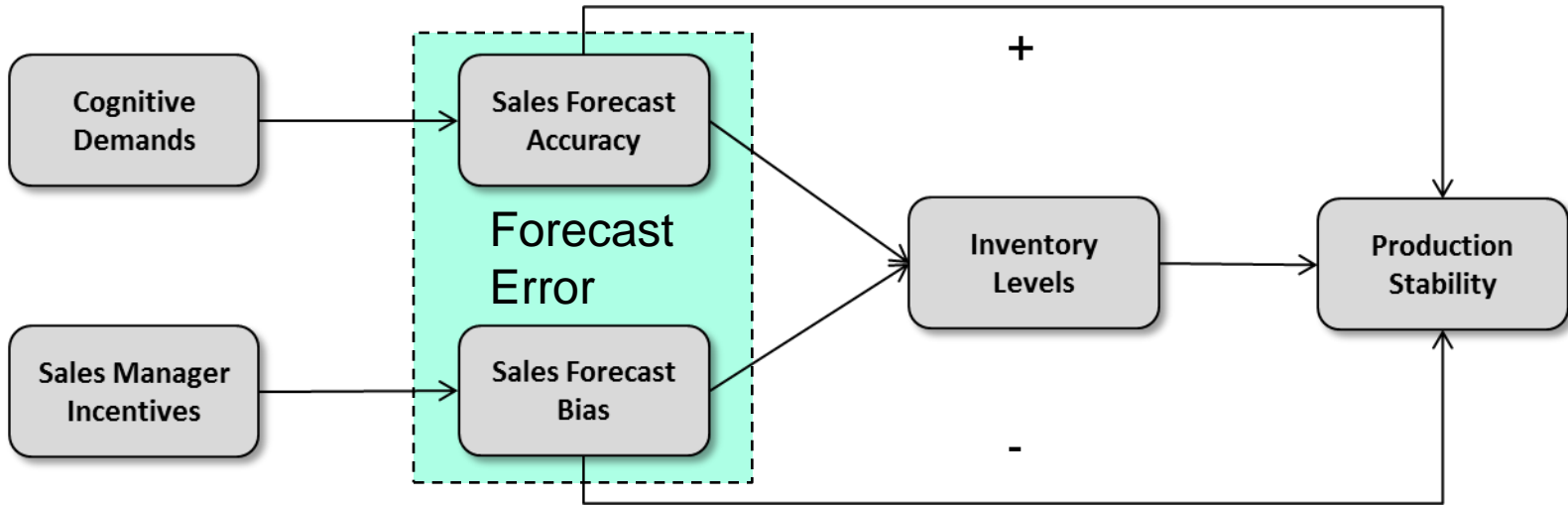
These proposed relations have strong theoretical (i.e., via analytic and simulation methods) underpinnings in the operations/SCM literature, but little in the way of empirical support.

Example: Bruggen, Grabner, Sedatole (2014)



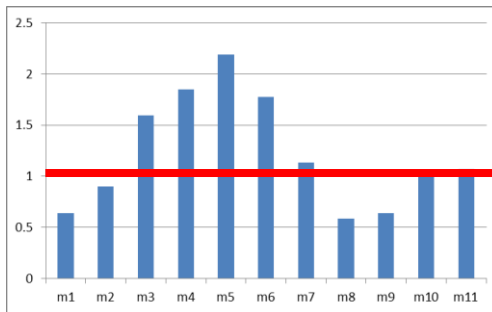
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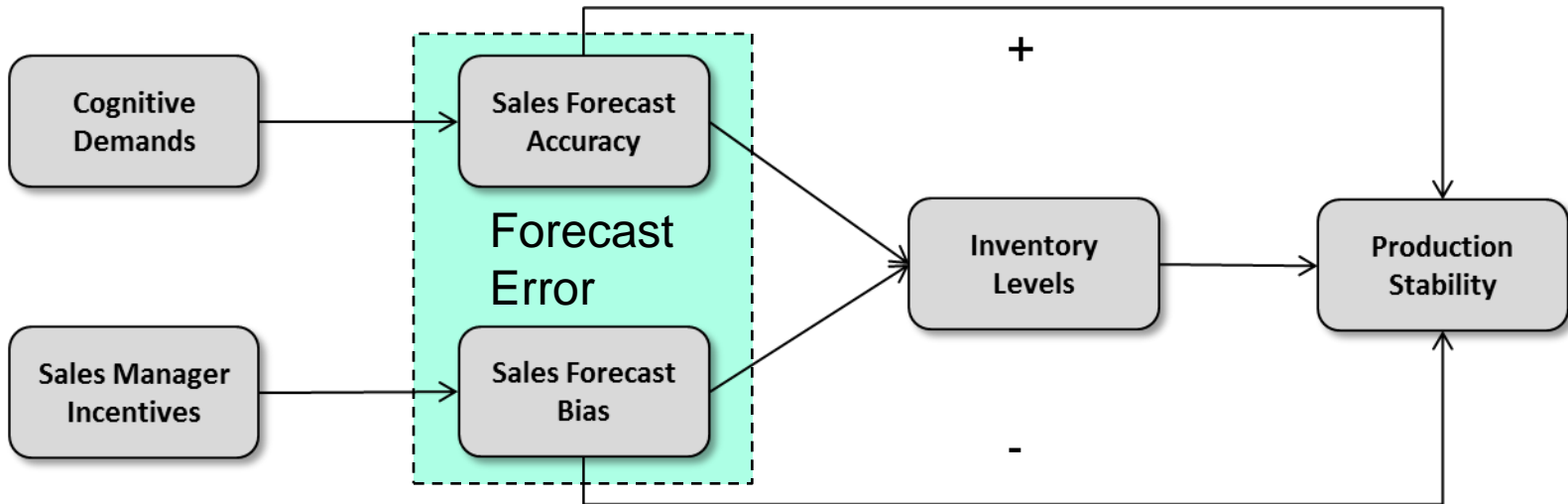
- Prior to the sales forecast disaggregation:
 - Relations predicted by the SCM literature largely do not hold.

Why??



		Supplier	
		Cooperate (trust forecast)	Do Not Cooperate (ignore forecast)
Buyer	Cooperate (forecast truthfully)	Buyer forecasts truthfully and supplier trusts the forecast.	Buyer forecasts truthfully, but supplier waits until a firm purchase order is submitted (buyer incurs cost of delay).
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Example: Bruggen, Grabner, Sedatole (2014)



- 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

	Forecasting processes within the firm	
Analytic models	<p>Improved quantitative forecasting techniques</p> <p>Effects of forecast inaccuracy on production stability</p> <p>Operational solutions (e.g., postponement)</p> <p>Budget slack and truth-inducing pay</p>	
Simulations	<p>Improved quantitative forecasting techniques</p> <p>Effects of forecast inaccuracy on production stability</p> <p>Operational solutions (e.g., postponement)</p> <p>Cost system design to provide information to mitigate the detrimental effects of inaccurate forecasts</p>	
Experiments	<p>Identify cognitive limitations & biases in forecasting</p> <p>Mitigate through</p> <ul style="list-style-type: none"> (i) Better/different information (ii) Incentives (iii) Trust-building 	<p><i>How might our budgeting research inform?</i></p>
Archival/Field/ Survey/ Case Study research	<p>Magnitude of the problem and its consequences</p> <p>Incentive-related causes</p> <p>Role of trust</p> <p>Cost system design to mitigate the detrimental effects of inaccurate forecasts</p> <p>Impact of information quality</p>	

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!