Applications and Challenges of Revenue Management in Make-to-Order Steel Manufacturing

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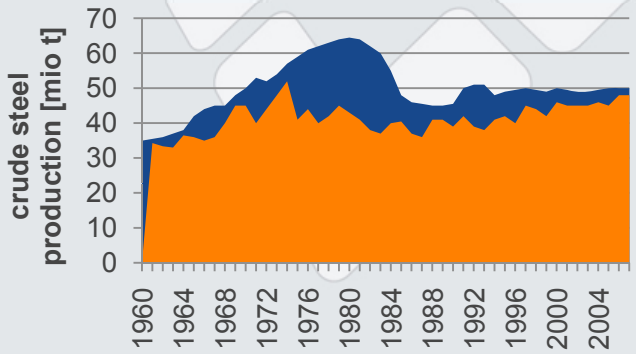
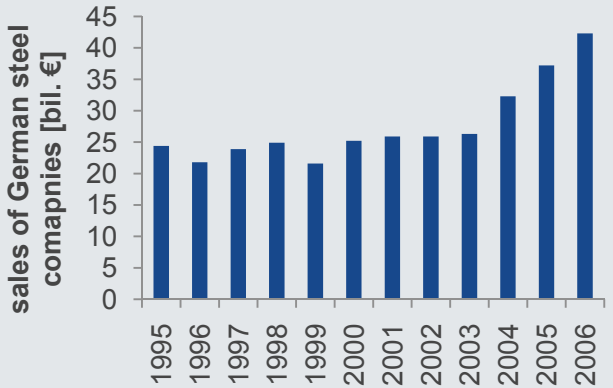
Agenda

1. Order Promising in the Iron and Steel Industry
2. Revenue Management
3. Approaches and Applications
4. Conclusions

Order Promising in Steel Production
Market Environment

- Iron and steel industry has seen significant rise in demand
- Current situation: companies operate near capacity
- Shift towards specialty steel and high performance alloys





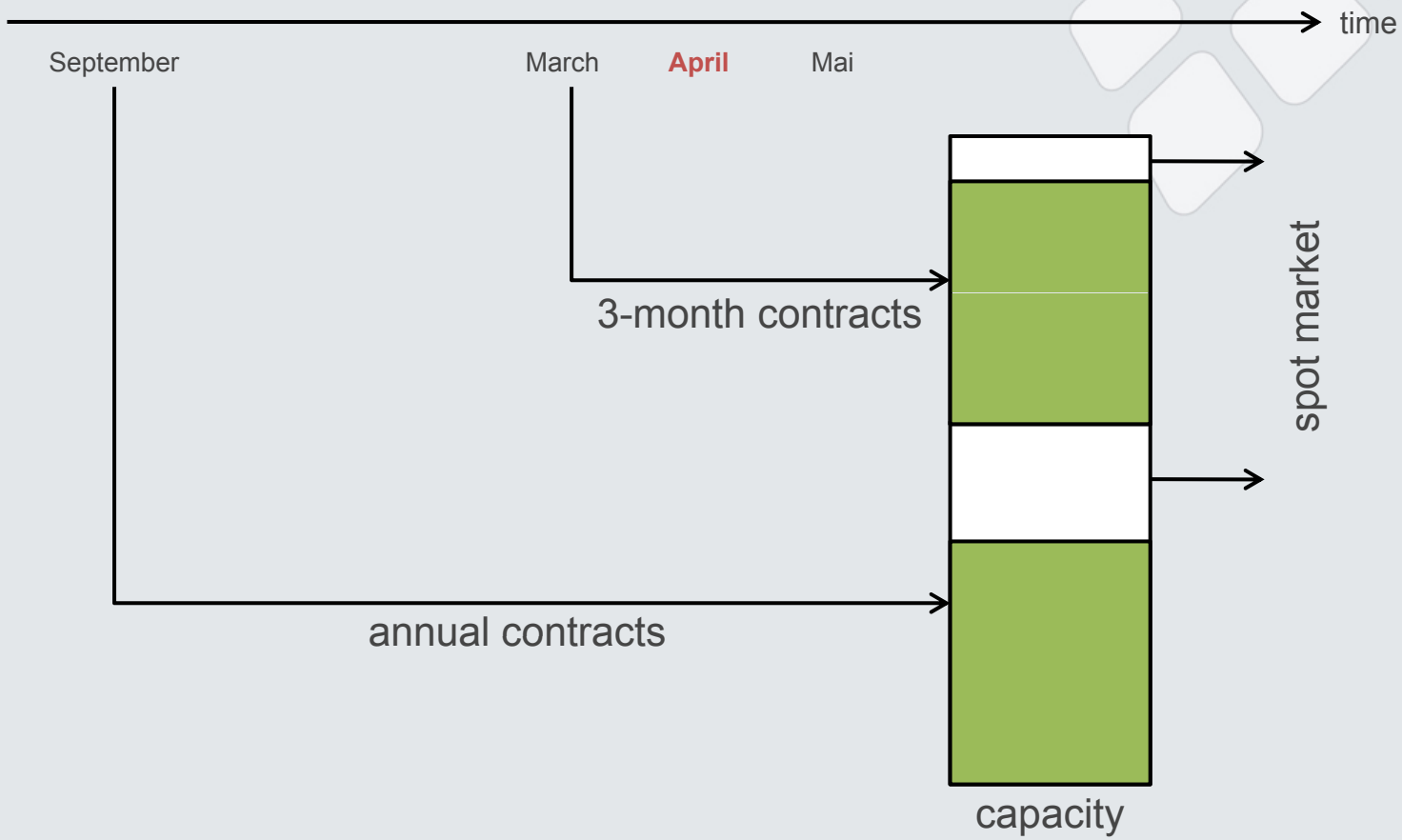
➡ Need for decision support in capacity allocation

Stahlzentrum

Order Promising in Steel Production Industry Structure

traditional steel company	specialty steel company
 	 
▪ traditional steel products ▪ standard production routes (divergent) ▪ mainly direct market and intermediaries ▪ e.g Salzgitter AG, Voestalpine	▪ high performance alloys ▪ variable production routes (cyclic) ▪ mainly project sales ▪ e.g. ThyssenKrupp VDM

Order Promising in Steel Production
Traditional Steel Company

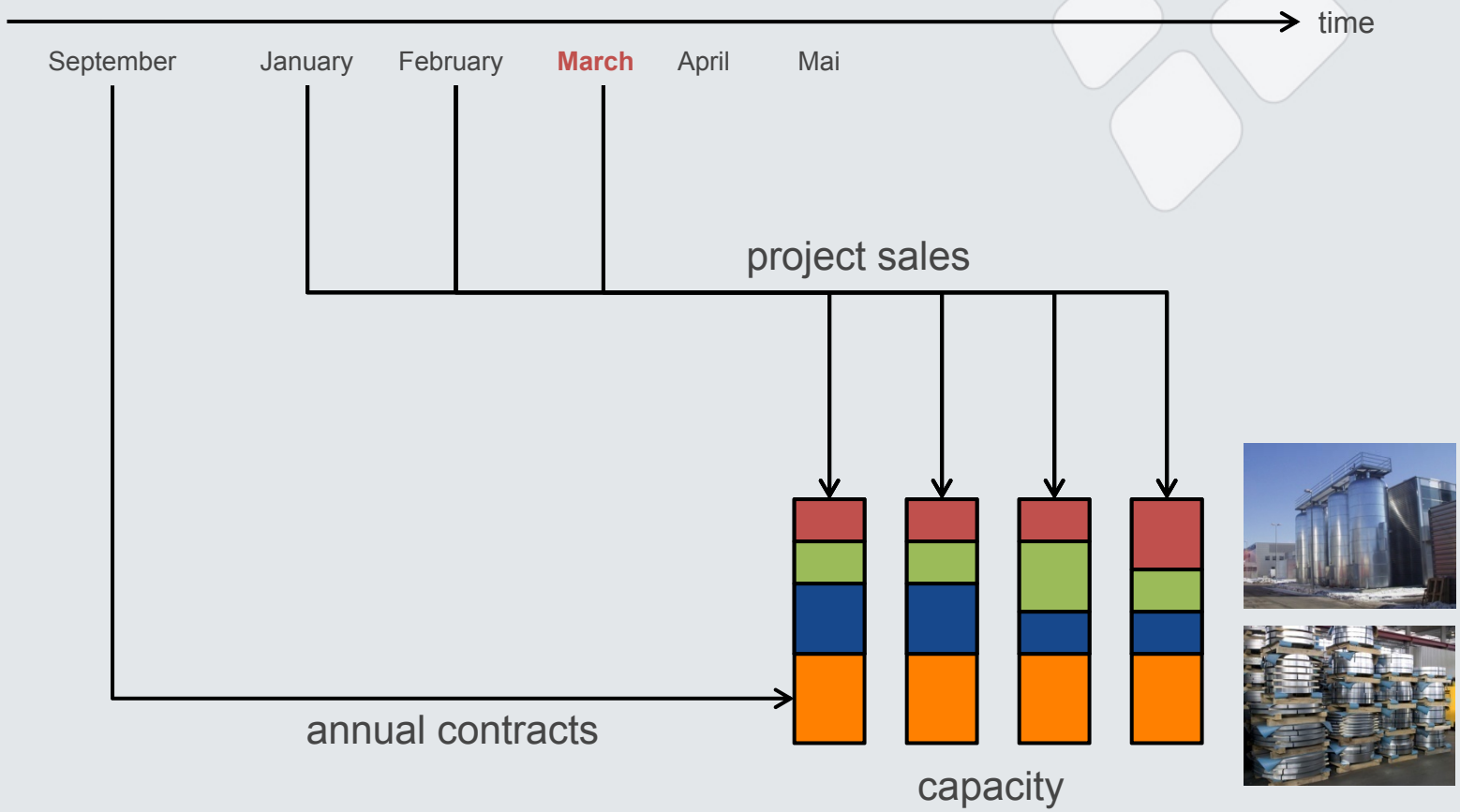


Order Promising in Steel Production
Sales Channels - Traditional Steel Company

traditional steel company

contract sales (direct market)	contract sales (intermediaries)	spot sales
▪ long term - short notice ▪ baseline contracts (1 year) ▪ large quantities ▪ low variety	▪ medium term - short notice ▪ baseline contracts (1/4 year) ▪ varying quantities ▪ medium variety ▪ medium dynamics	▪ ad hoc ▪ varying quantities ▪ high variety ▪ high dynamics
▪ capacity allocation (annual contracts) ▪ tactical decision situation (1 year)		▪ capacity control (fixed production period) ▪ operational decision situation (4-6 weeks)

Order Promising in Steel Production
Specialty Steel Company



Order Promising in Steel Production
Sales Channels - Specialty Steel Company

specialty steel company

contract sales	project sales
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▪ capacity allocation (annual contracts) ▪ tactical decision situation (1 year)	▪ capacity control (variable production period) ▪ operational decision situation (6 weeks to 3 month)

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Revenue Management Fundamentals

revenue management definition

- quantitative methods
- decision support for accepting or rejecting dynamically arriving customer requests which differ in resource requirements and/or revenue
- the aim is to allocate inflexible capacity in a timely bounded period

origin of revenue management

- origin: act of deregulation of passenger airline industry in the USA in the 1970s
- American Airlines reports a revenue contribution by revenue management of 500 Mio. US$, Smith et al. (1992)
- adoptions to further areas of application: air cargo, hotel industry, car rental

Revenue Management Instruments

instruments for capacity control

determination of booking limits	determination of opportunity costs
▸ quantity based methods at the beginning of the booking horizon ▸ based on expected marginal revenue/ contribution margin ▸ only applicable if number of products or product groups is limited	▸ price based methods (e.g. bid-prices) ▸ approximation of opportunity costs incorporating the order's specific capacity utilization ▸ accept order if contribution margin is higher than the opportunity costs
suitable for **tactical** decision support	suitable for **operational** decision support

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Approaches and Applications
Tactical Decision Support

traditional steel company

contract sales (direct market)	contract sales (intermediaries)	spot sales
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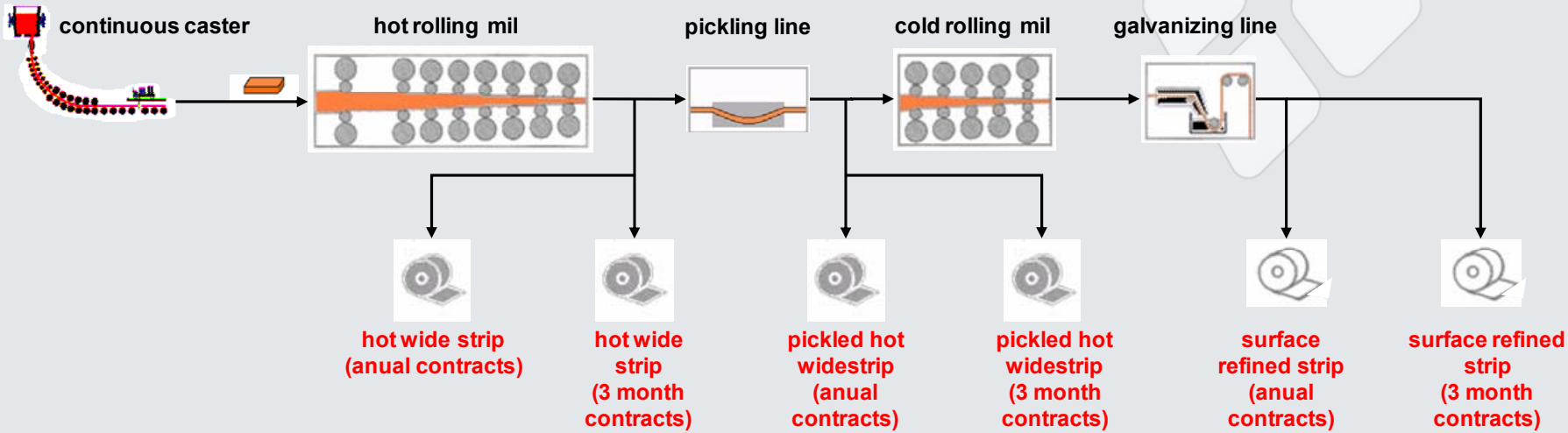
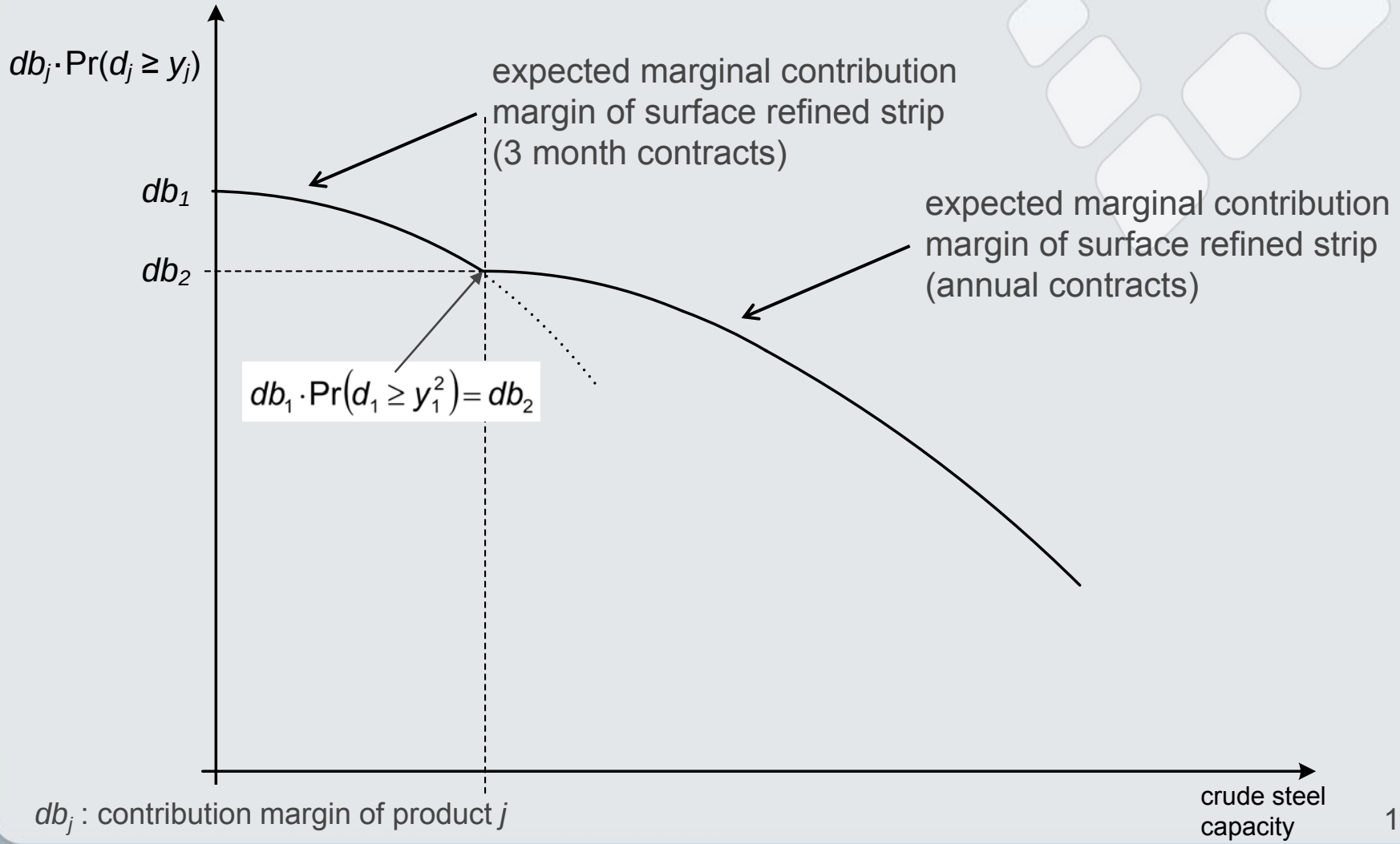
Approaches and Applications
Tactical Decision Support

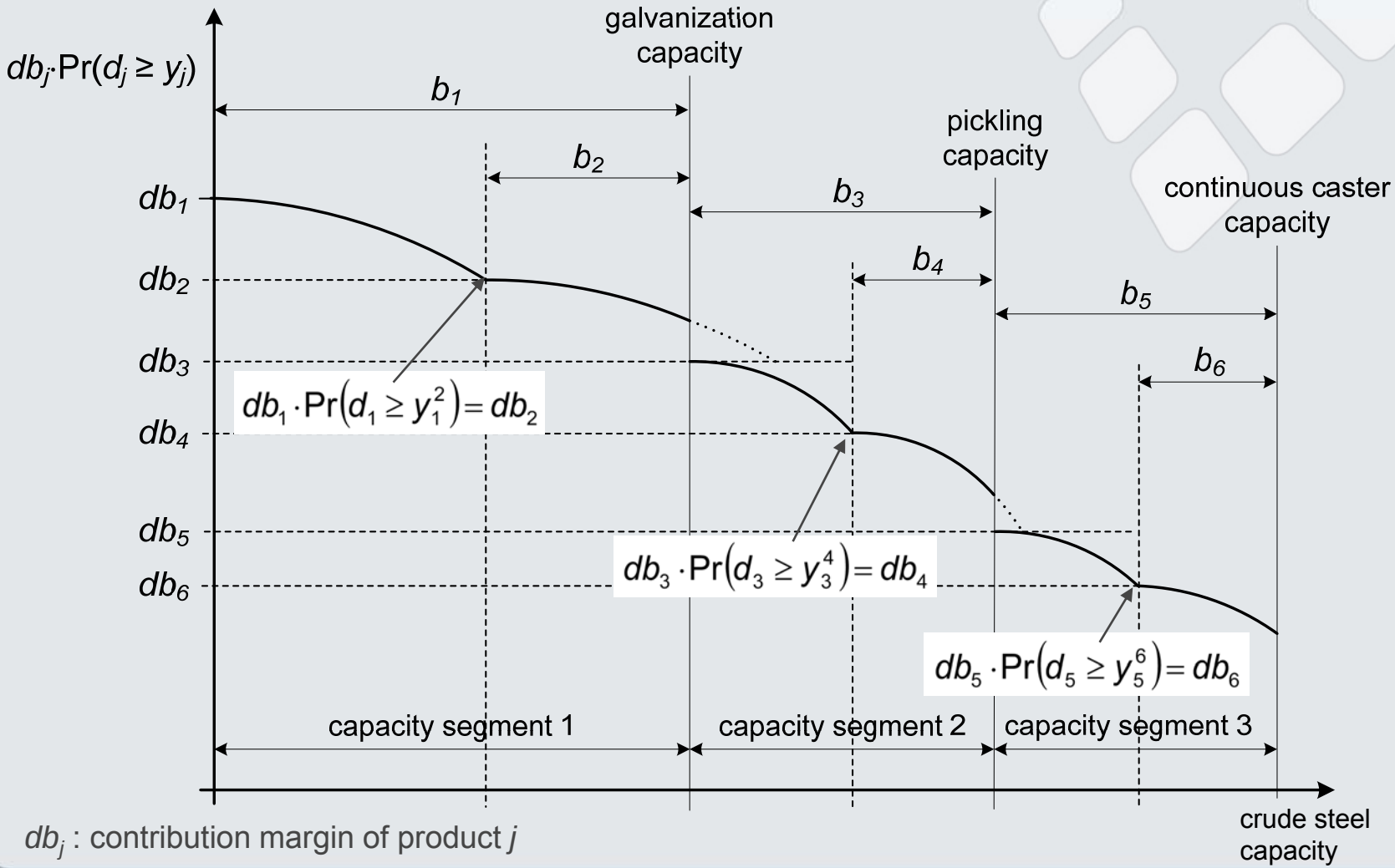


Approaches and Applications
Tactical Decision Support



db_j : contribution margin of product j

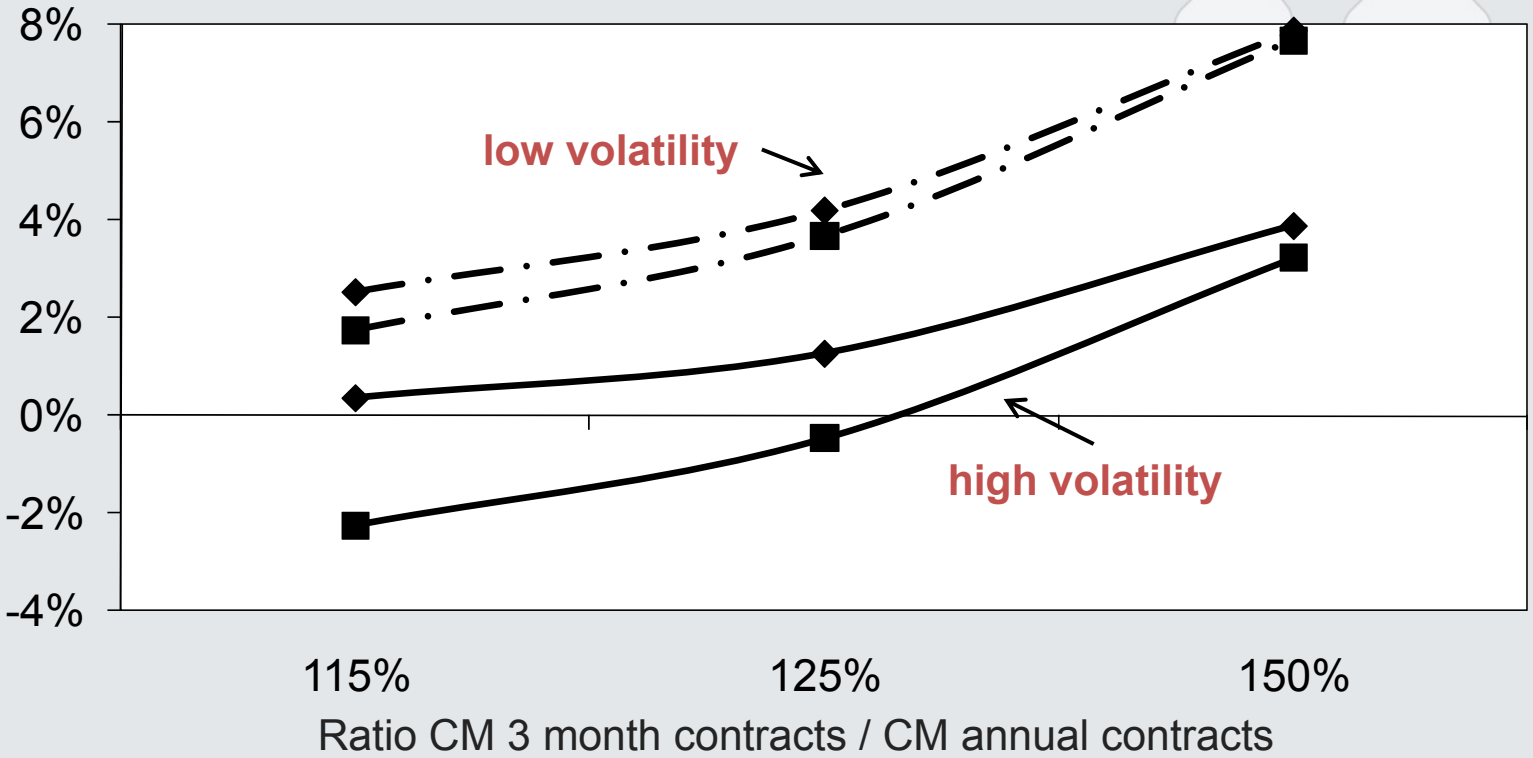
Approaches and Applications
Tactical Decision Support



db_j : contribution margin of product j

Approaches and Applications
Tactical Decision Support

Total contribution margin relative to FCFS (25% excess demand)



Rehkopf (2006)

Conclusions

- Performance improvement for all parameter settings
- Improvements of up to 8% relative to FCFS
- Application requires demand forecasts
- Recommendable, if product variety is low and demand volatility is high

Approaches and Applications
Operational Decision Support

traditional steel company

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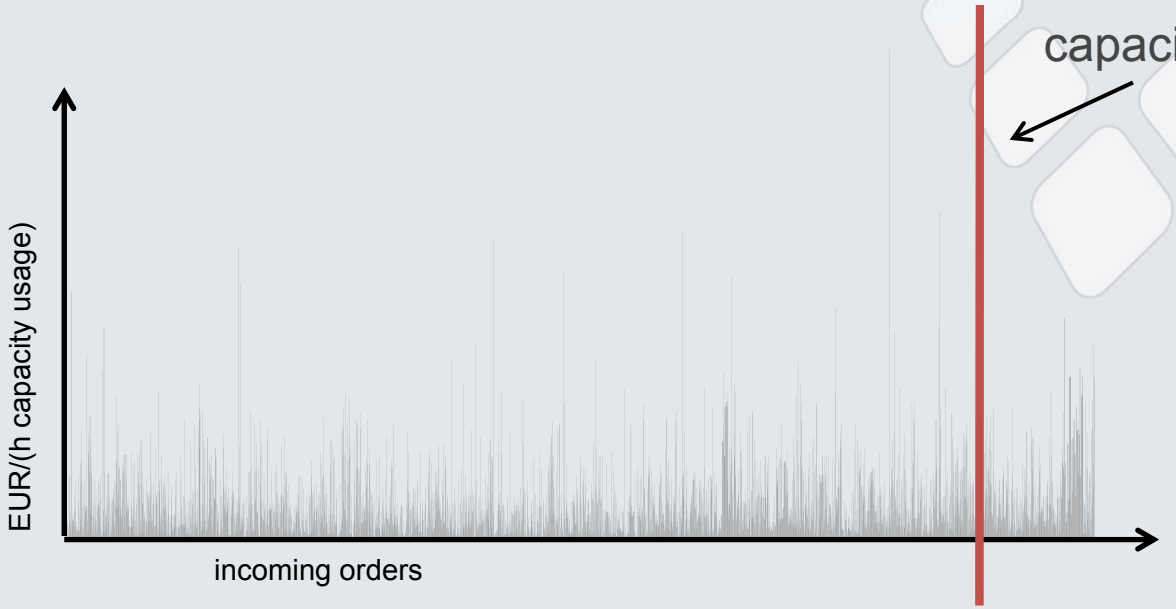
- capacity allocation (annual contracts)
- tactical decision situation (1 year)

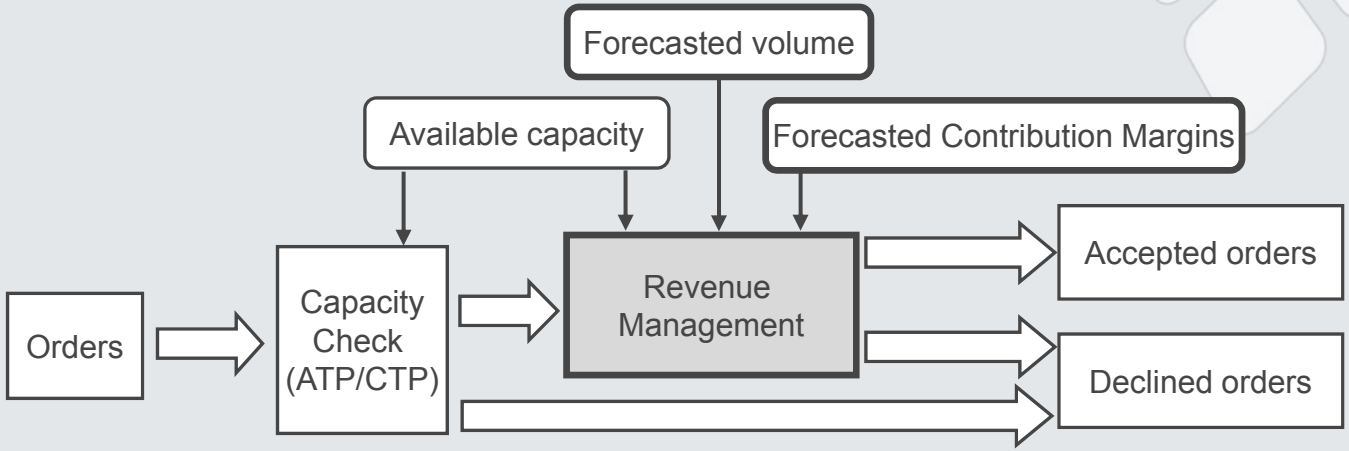
- capacity control (fixed production period)
- operational decision situation (4-6 weeks)

Approaches and Applications
Operational Decision Support



In case of excess demand, order selection is required

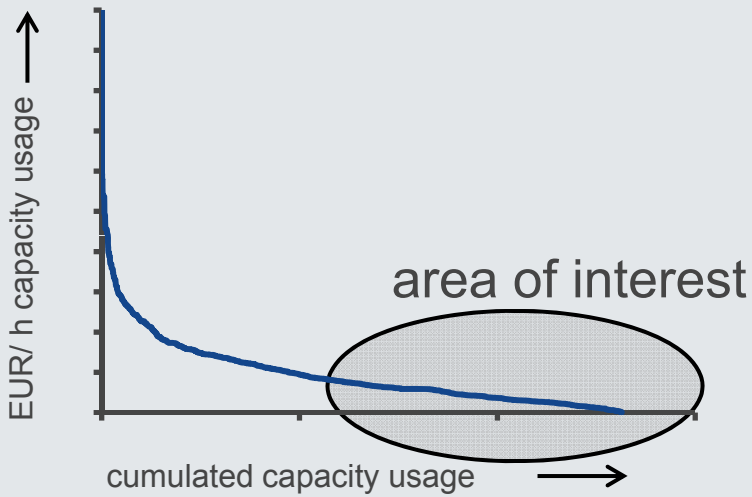
Approaches and Applications
Operational Decision Support

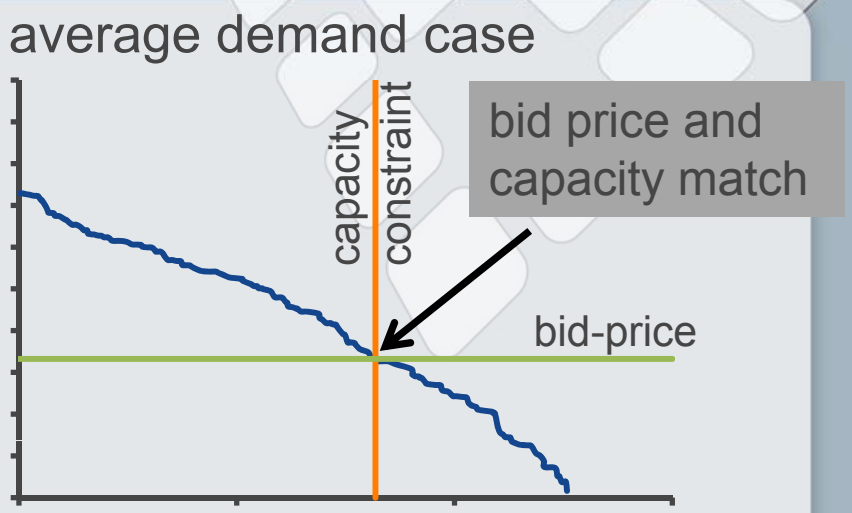


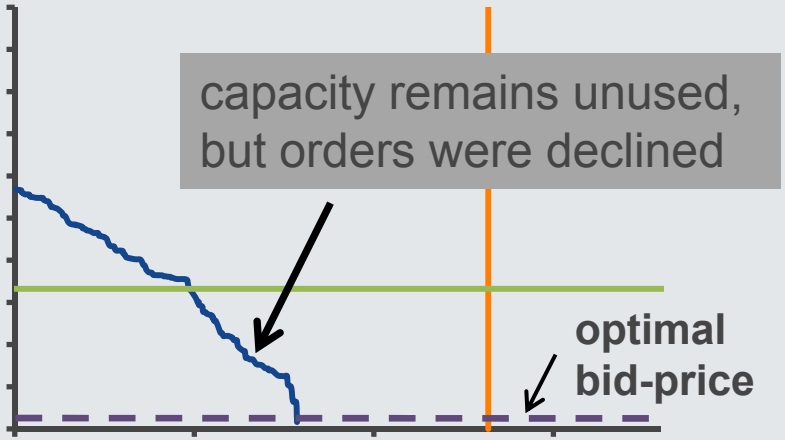
➡ Revenue Management provides decision support for order selection

Spengler et al. (2007)

Approaches and Applications
Operational Decision Support







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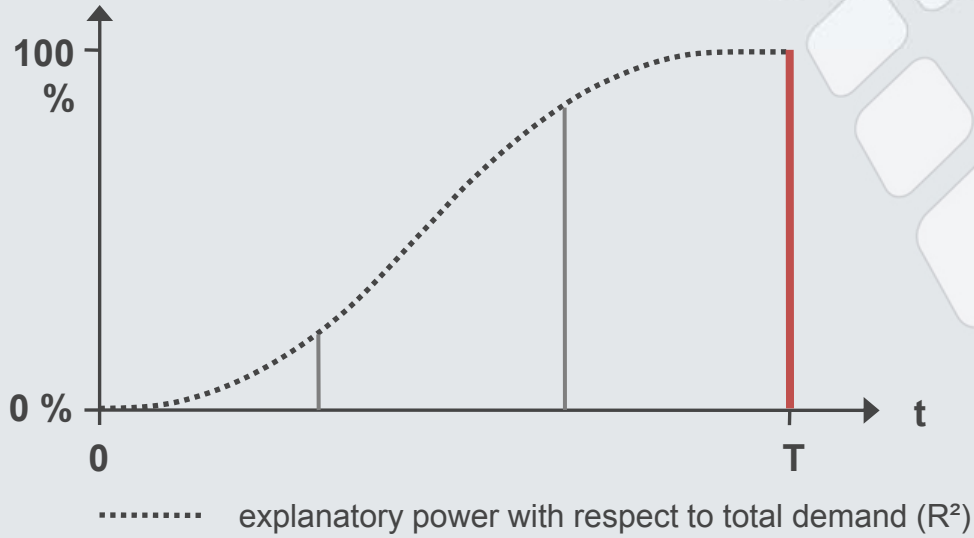
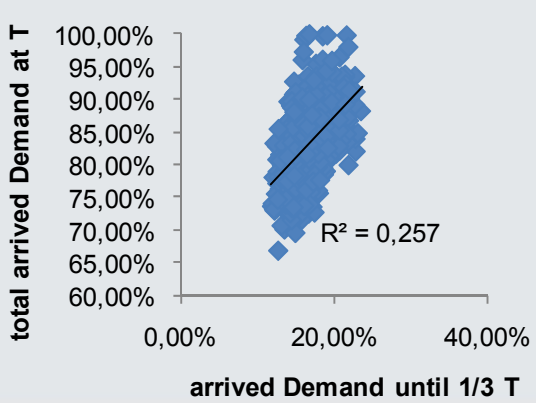
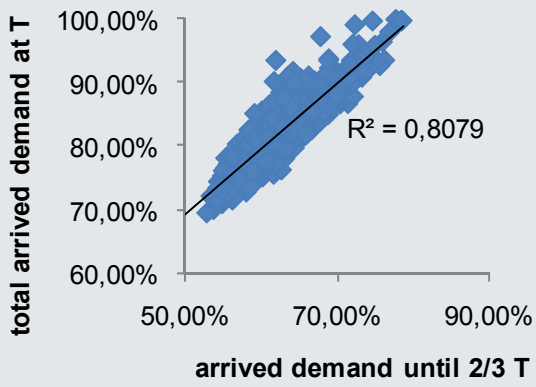
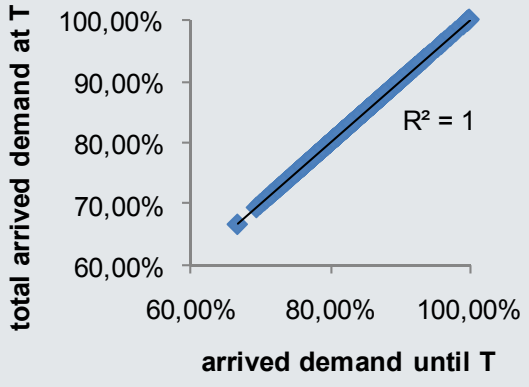
Operational Decision Support

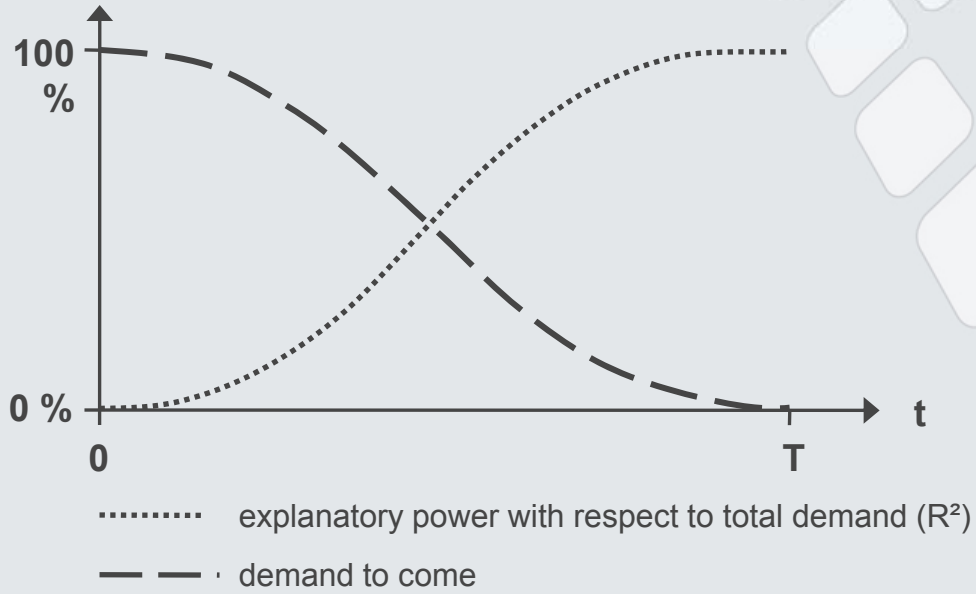






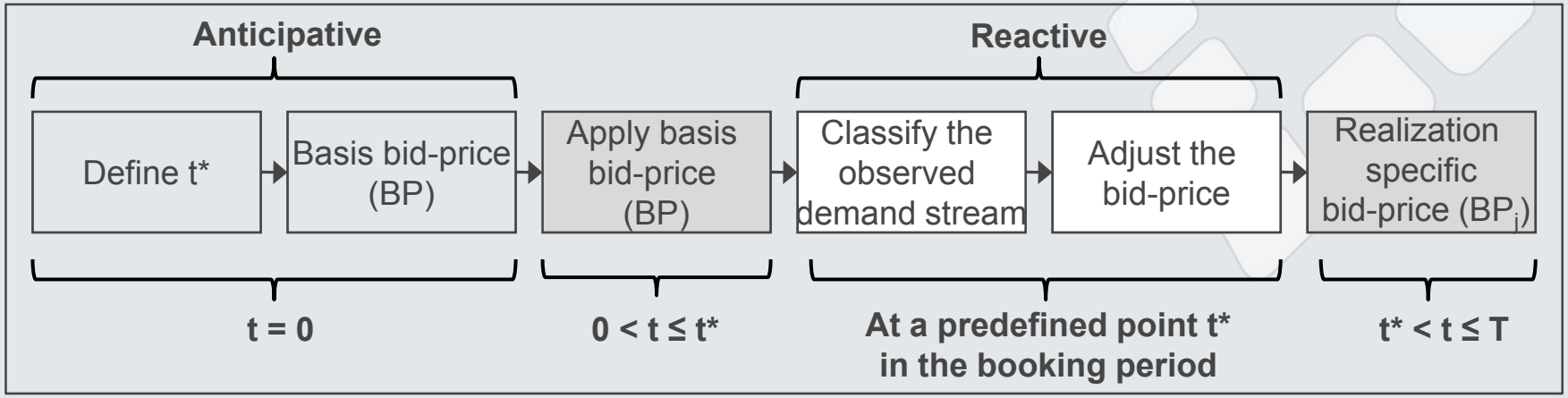


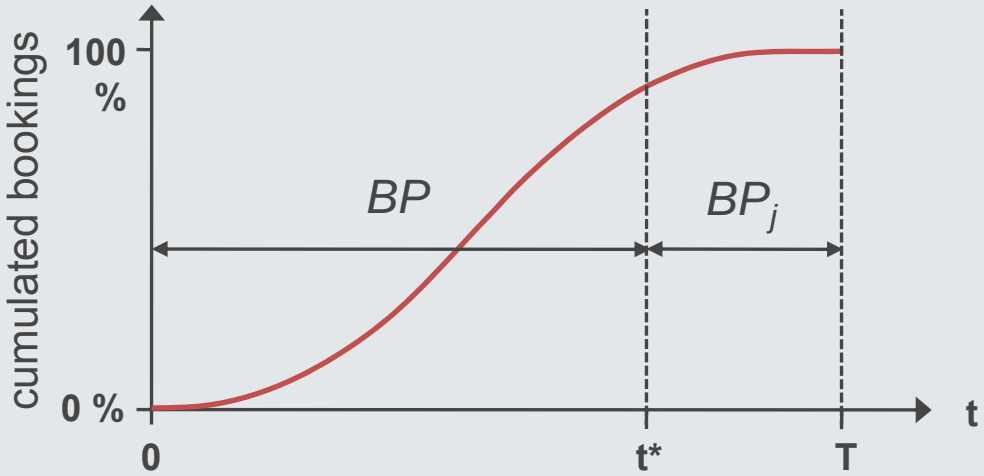
Approaches and Applications
Operational Decision Support



➡ Trade-off between explanatory power and effectiveness

Approaches and Applications
Operational Decision Support





Approaches and Applications
Operational Decision Support

	low volatility		high volatility	
	10% excess demand	25% excess demand	10% excess demand	25% excess demand
FCFS	100.0%	100.0%	100.0%	100.0%
Randomized Linear Programming (RLP)	106.6%	118.9%	106.0%	118.8%
Dynamic Bid Price (Ex-Post)	**108.5%**	**120.8%**	**108.4%**	**121.0%**
Ex-Post Optimum	108.9%	121.2%	108.8%	121.4%

➡ The potential of dynamic bid price approach is higher than static randomized linear programming (RLP) bid-prices

Conclusions

- Dynamic bid prices can capture untapped revenue potential
- Unlike resolving, bid price are only adjusted after sufficient demand information is available
- Option to change the bid price is explicitly considered
- Particularly suitable for spot market sales
- Future work: application to multi resource settings

Approaches and Applications
Operational Decision Support

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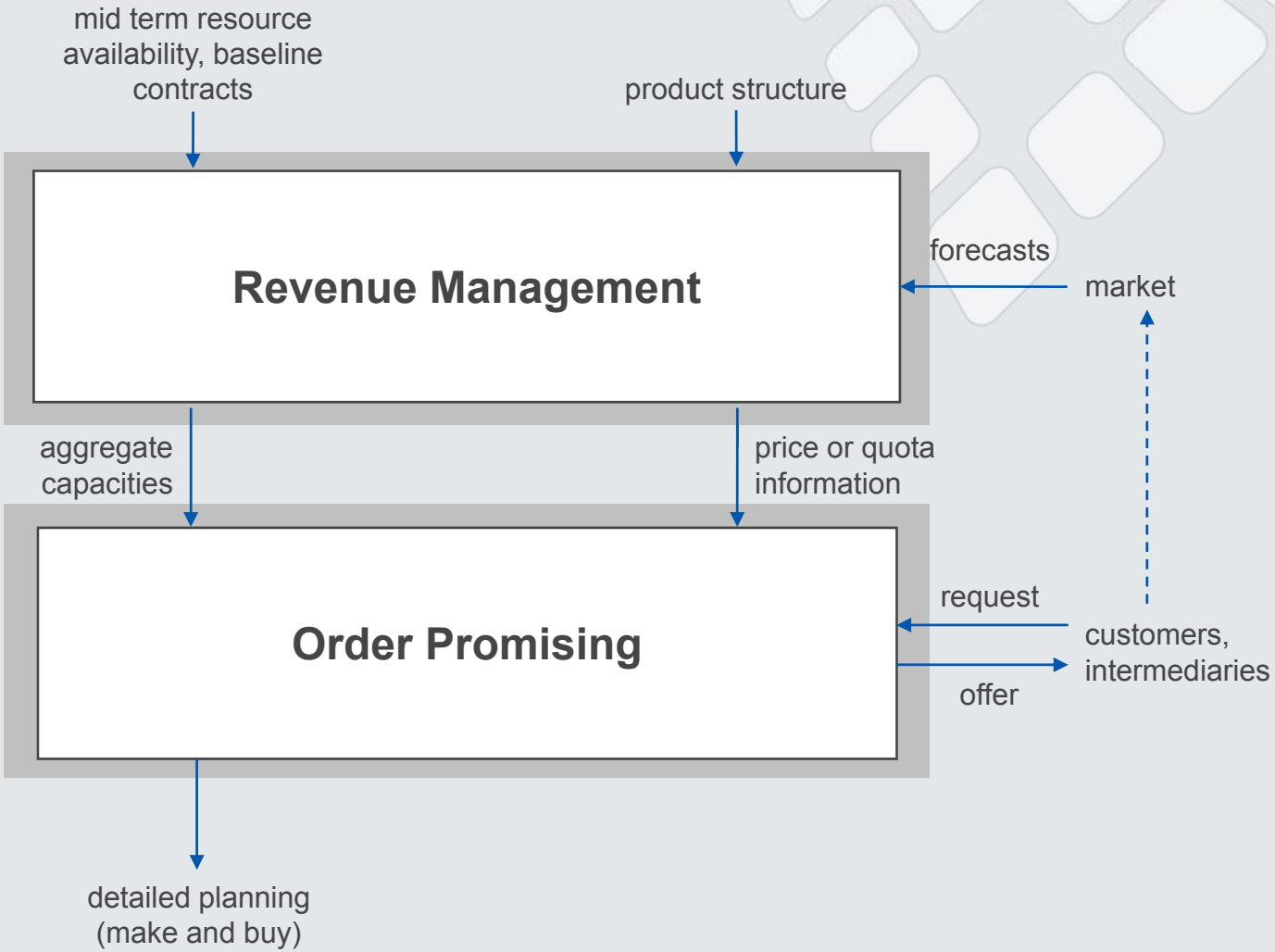

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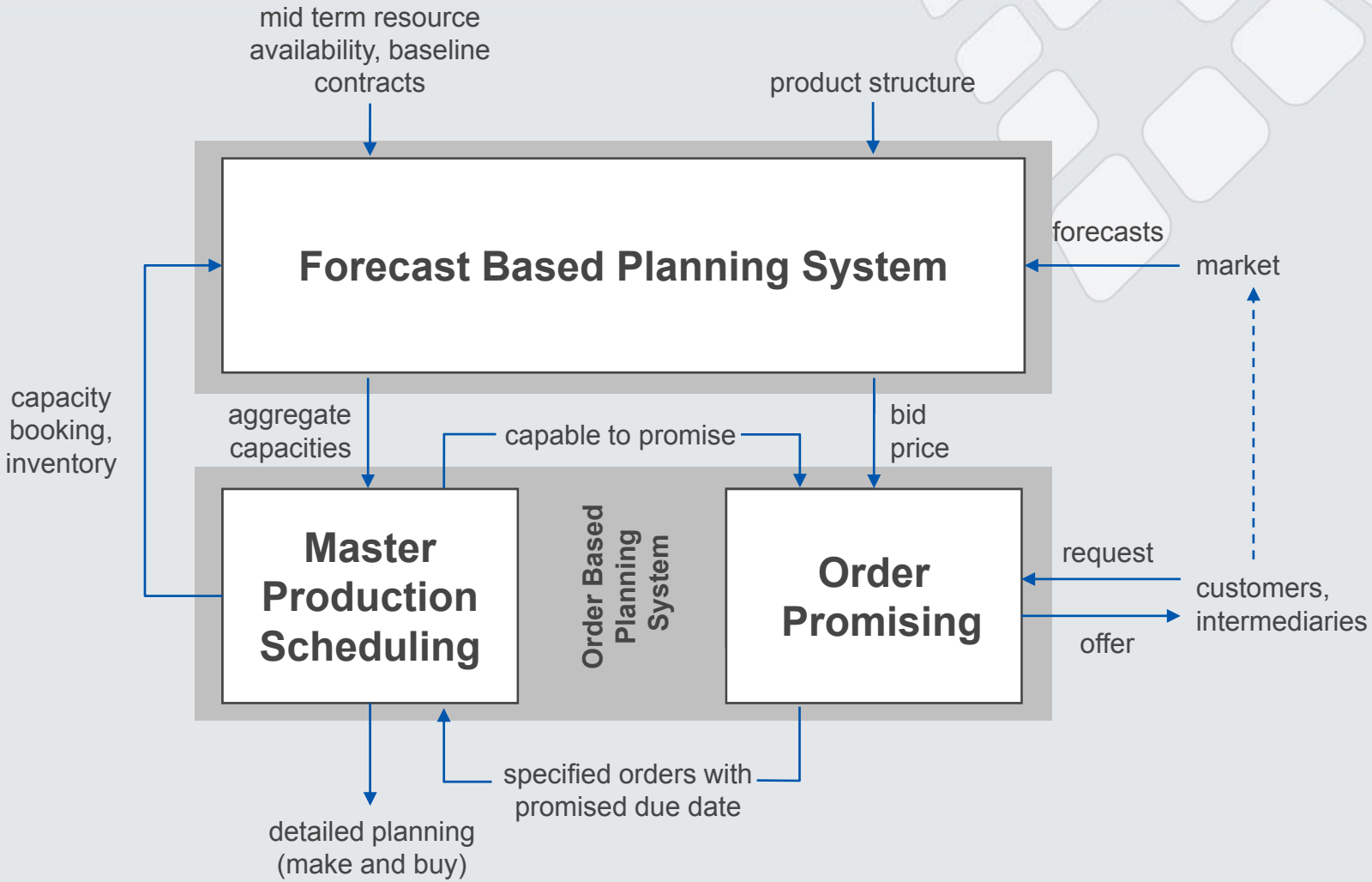

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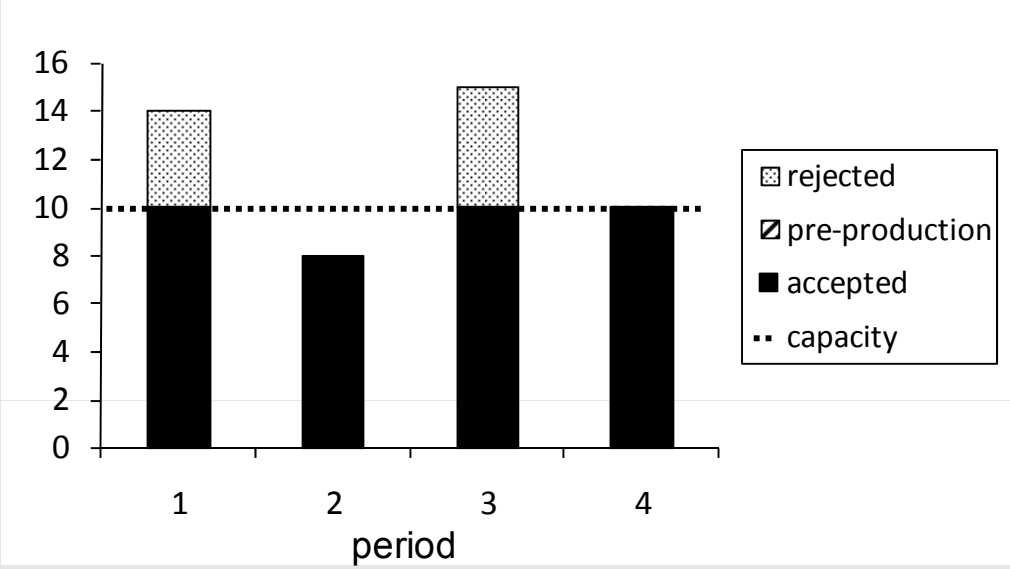

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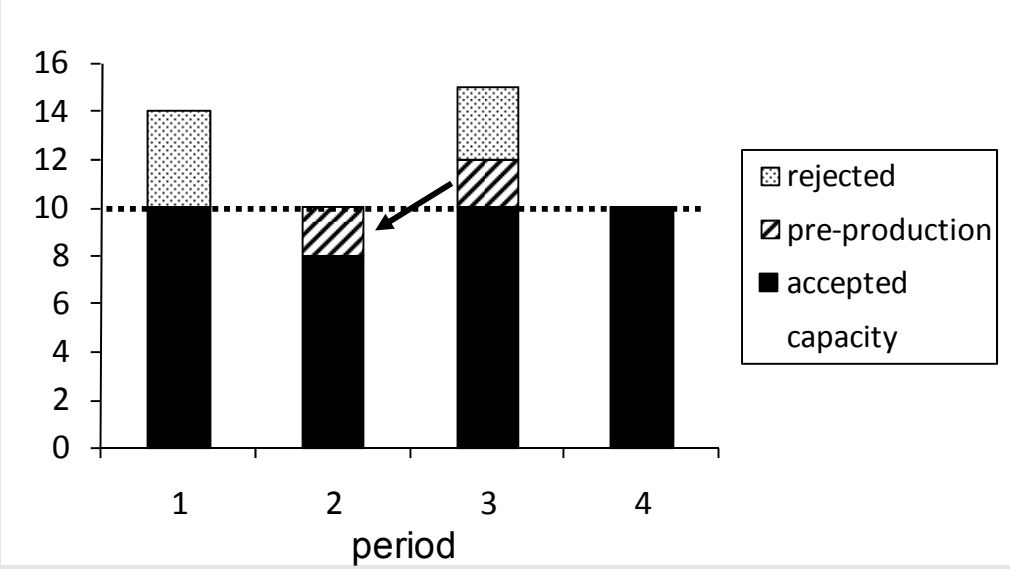
Spengler et al. (2008)

Approaches and Applications
Operational Decision Support



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Approaches and Applications
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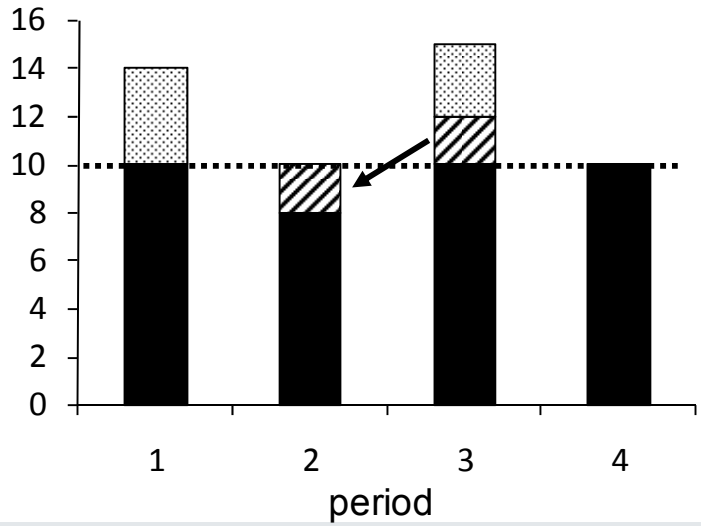

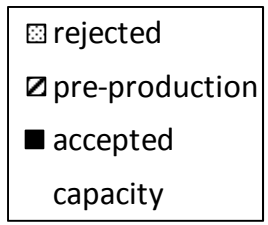

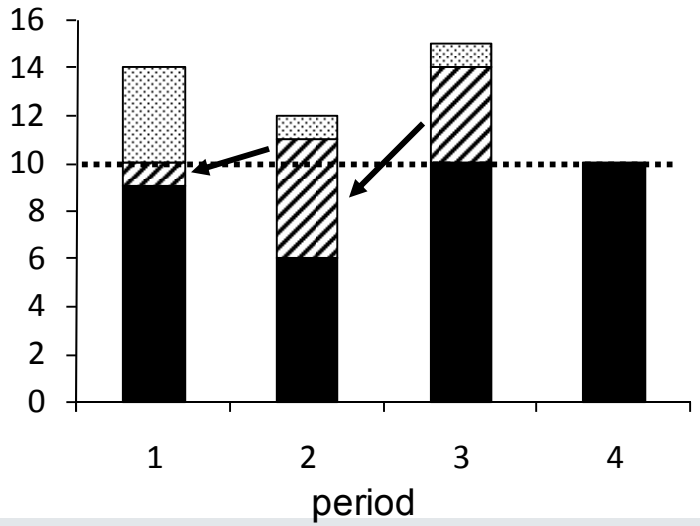

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➡ Sequentially computed bid-prices are systematically to low

Spengler et al. (2008)

Conclusions

- Current revenue management applications in MTO focus on single period settings
- Revenue potential can be increased by incorporating storage capabilities
- More work necessary on modeling approaches - in particular on dynamic aspects and integration with MPS

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Conclusions

- Market situation in the iron and steel industry requires for capacity allocation
- Revenue management can be used to support allocation decisions
  - Tactical allocation: quantity based methods
  - Operational allocation: price based methods (static/dynamic and single period/multi period)
- Current research:
  - Extension of dynamic approaches to multi-resource settings
  - Implementation of multi-period revenue management

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