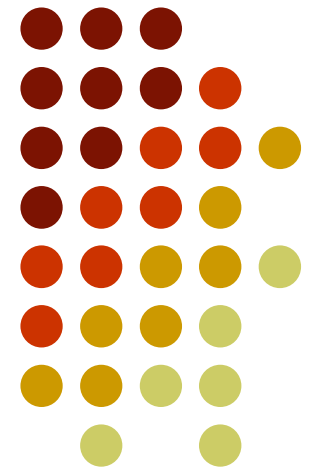


Analyzing Market Interactions in a Multi-agent Supply Chain Environment

William Groves⁺, John Collins⁺, Wolfgang Ketter^{*}, Maria Gini⁺

**⁺Department of Computer Science and Engineering
University of Minnesota**

**^{*}Learning Agents Research Group at Erasmus (LARGE)
Department of Decision and Information Sciences
Rotterdam School of Management, Erasmus University**

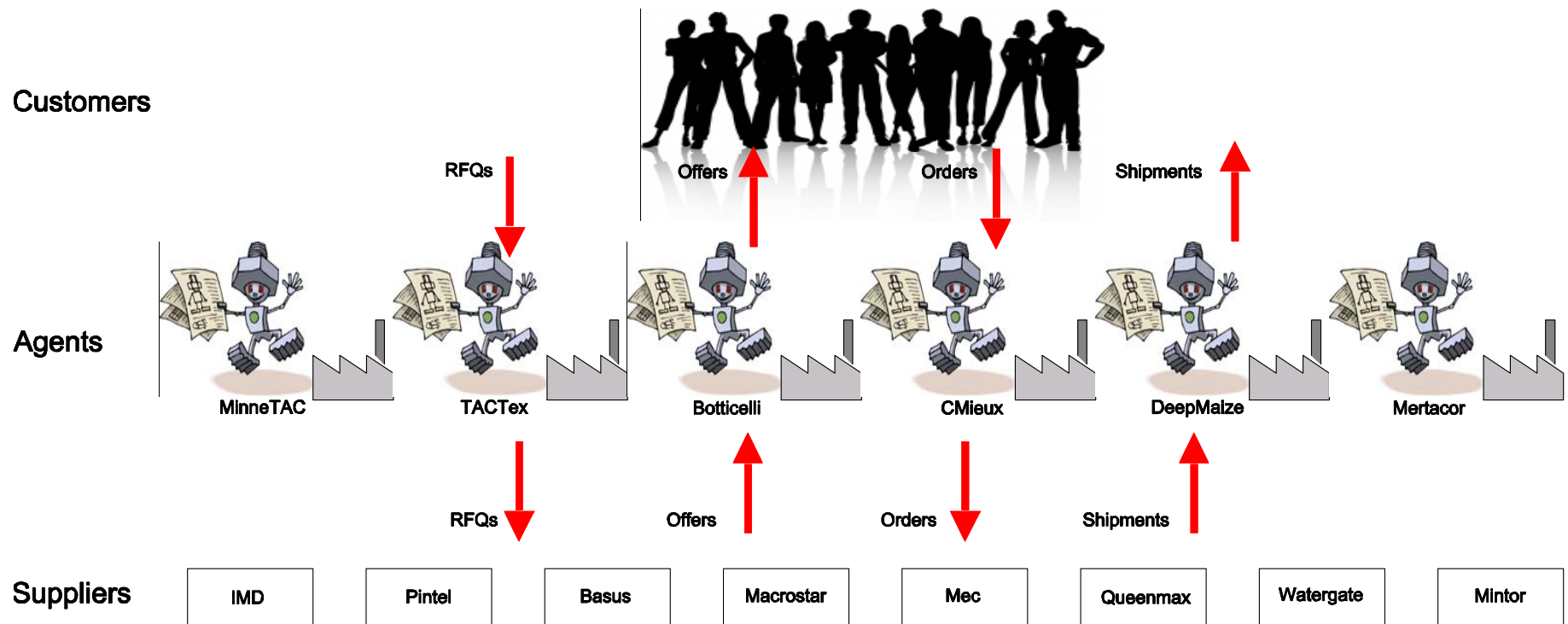


Contributions



- ❑ Description of open source simulation tool used for international trading agent competition in supply-chain management (TAC-SCM)
- ❑ Detailed analysis of the supplier and customer markets in TAC SCM
- ❑ Performance analysis of top agents
- ❑ Analysis of competing procurement strategies

TAC SCM Scenario



Market Interactions



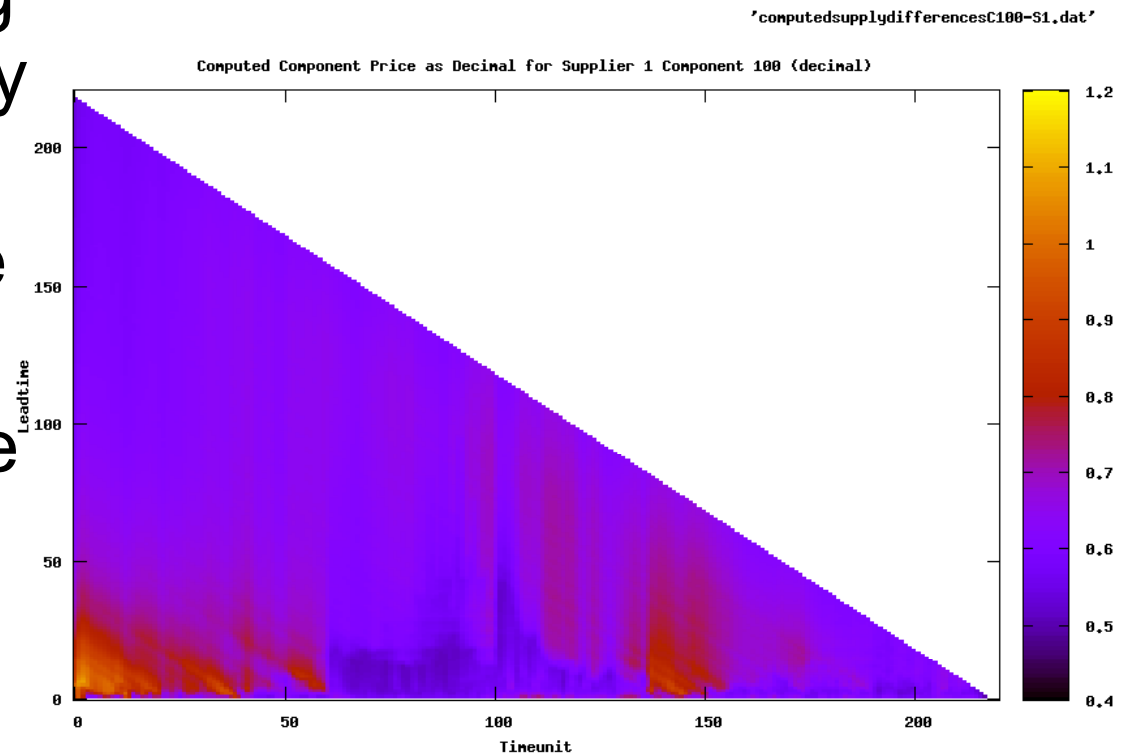
- ❑ Trades and actions of manufacturing agents are motivated by the need to anticipate or fulfill customer requests.
- ❑ Intuitively, price changes in one market can lead to price changes in the other.
 - High customer prices → high component prices

Supply Market Price Structure



Features of Supply Prices

- Prices are always high at the beginning of game (need to buy initial stock)
- Long term prices are generally lower
- Short term prices are highly variable (sometimes lowest, sometimes highest)

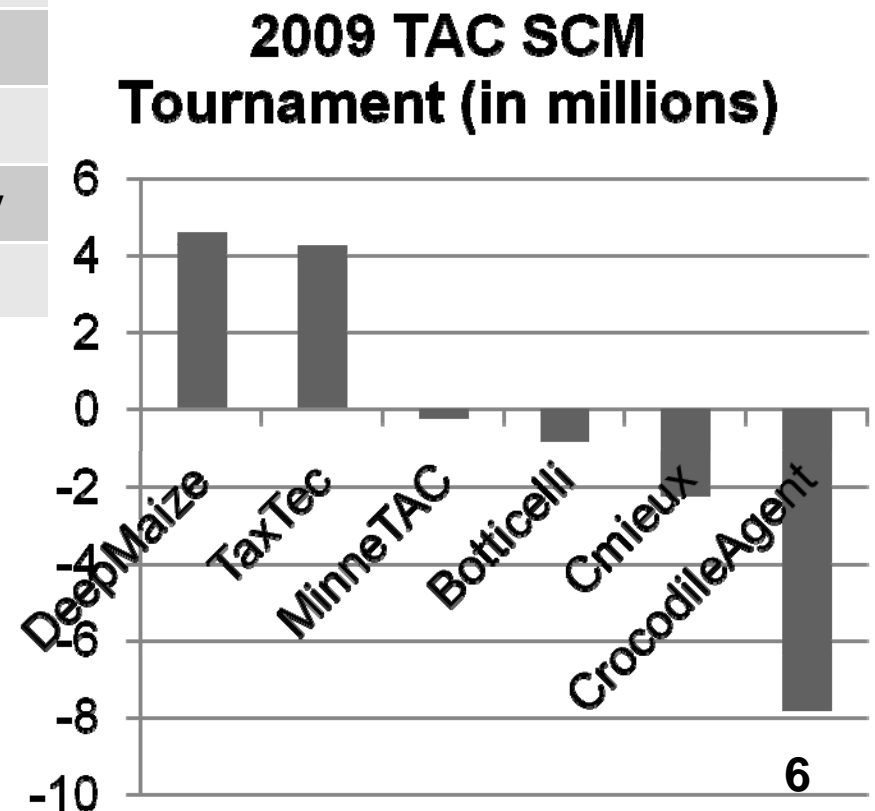


TAC SCM 2009 Results

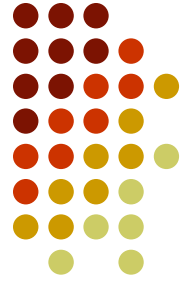


Agent	Institution
DeepMaize	University of Michigan
TacTex	University of Texas at Austin
MinneTAC	University of Minnesota
Botticelli	Brown University
CMieux	Carnegie-Mellon University
CrocodileAgent	University of Zagreb

Top 2 agents in 2009 were virtually tied, but used very different approaches!



TAC SCM 2009 Results



Aggregate performance measures for two top agent in 2009 final round

	Profit	Revenues	Material Cost	Interest Cost	Storage Cost	Unit Price normalized	Unit Cost normalized	Factory Utilization
DeepMaize	4.606	83.22	75.78	0.263	1.158	0.778	0.71	0.662
TacTex	4.270	110.9	103.2	0.538	2.411	0.788	0.72	0.880
Ratio	--	0.75	0.735	0.472	0.486	0.988	0.986	0.751
P-value	0.547	0	0	0	0	0	0	0

DeepMaize:

- Low cost strategy
- Minimum inventory

TacTex

- High volume
- Strategic inventory

Analysis of Agents and Markets



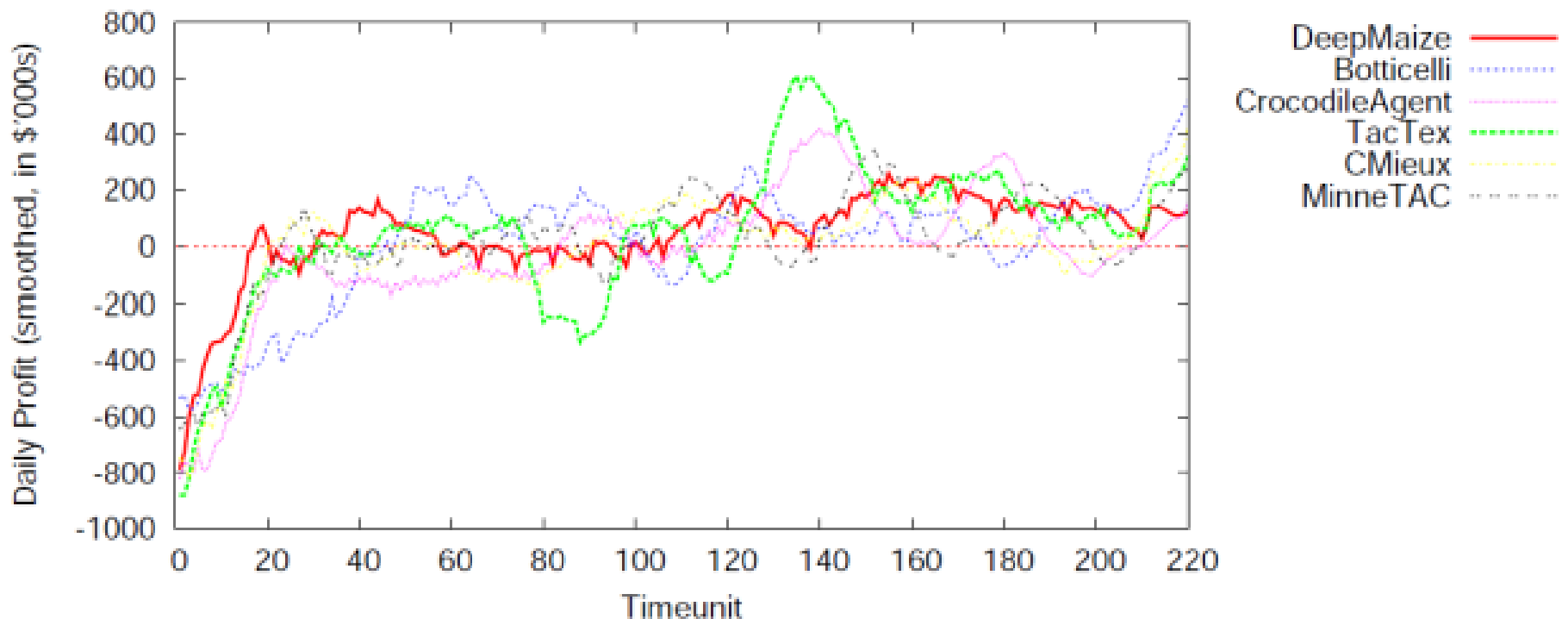
- ❑ Individual Agent Performance Measures
 - Daily profit and loss
- ❑ Market-specific Measures
 - Supplier Market
 - Leadtime of Component Request
 - Component Price vs. Leadtime
 - Opportunistic Procurement
 - Supply and Demand
 - Customer Market
 - Supply and Demand

Daily Profit and Loss of Agents



When do individual agents make their profits?

- All lose money initially
- After breaking even, some make consistent profits, others have varying daily performance



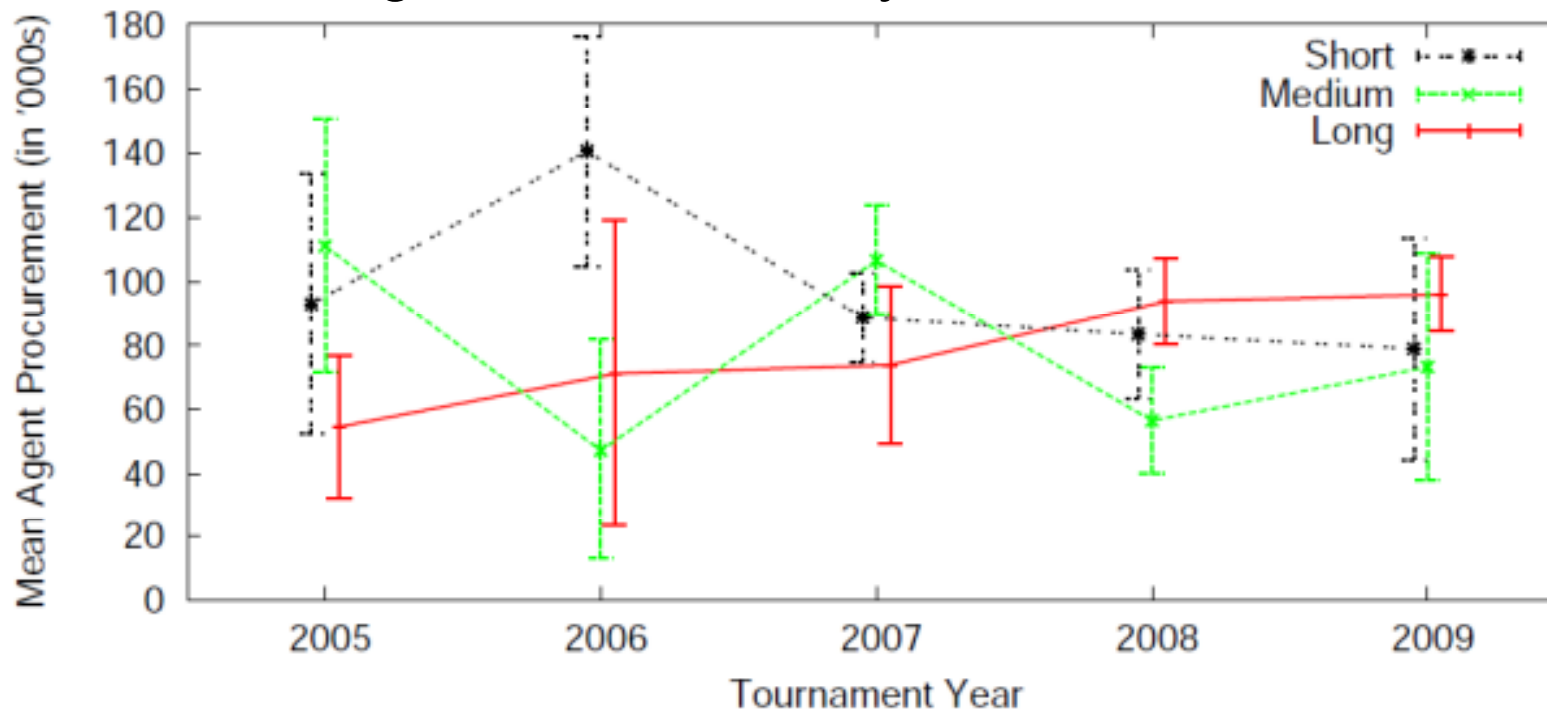
Leadtime of Component Requests



What leadtimes do agents use in their requests?

Procurement Leadtime Categories:

- Short: leadtime < 10 days, after day 10
- Medium: leadtime > 10 days, after day 10
- Long: within first 5 days, all lead times



Top 3 Agents

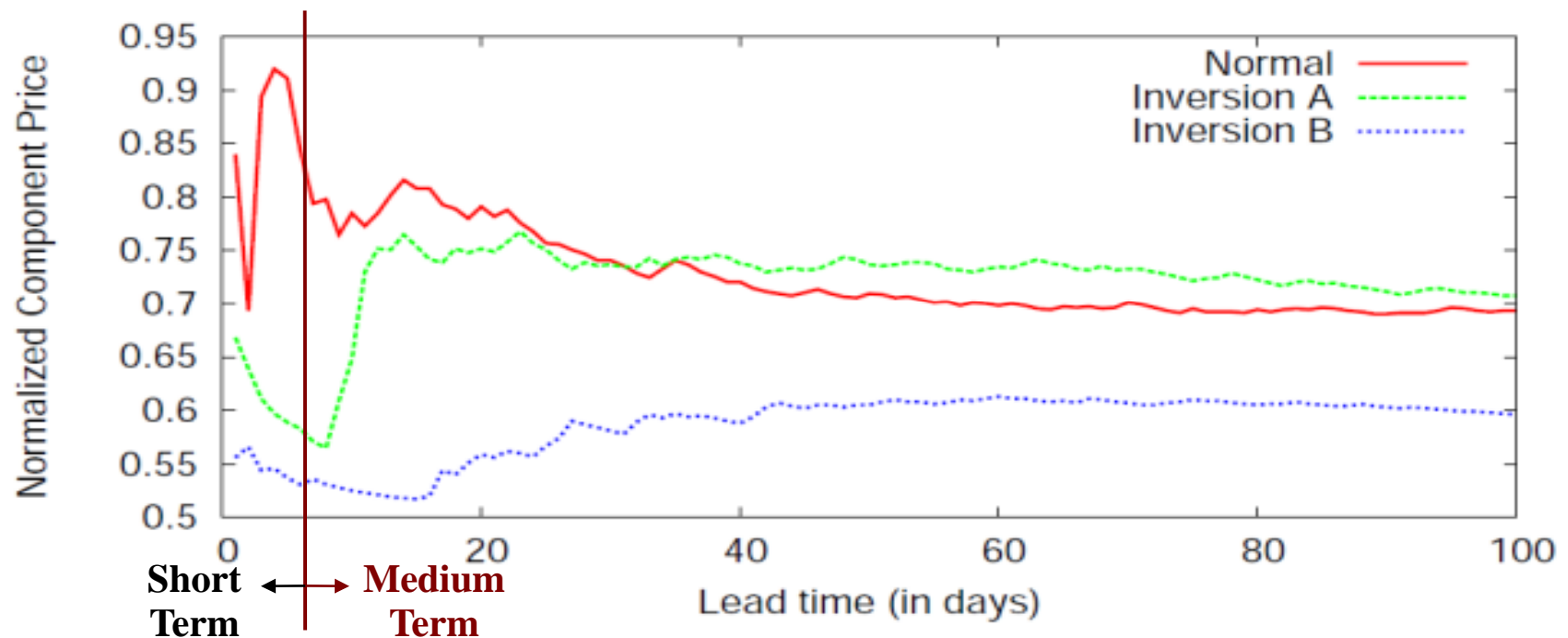
Component Price vs. Leadtime



How do agents select leadtime?

- Agents must select lead times carefully
- Short term prices can be very volatile
- 3 sample price curves shown below

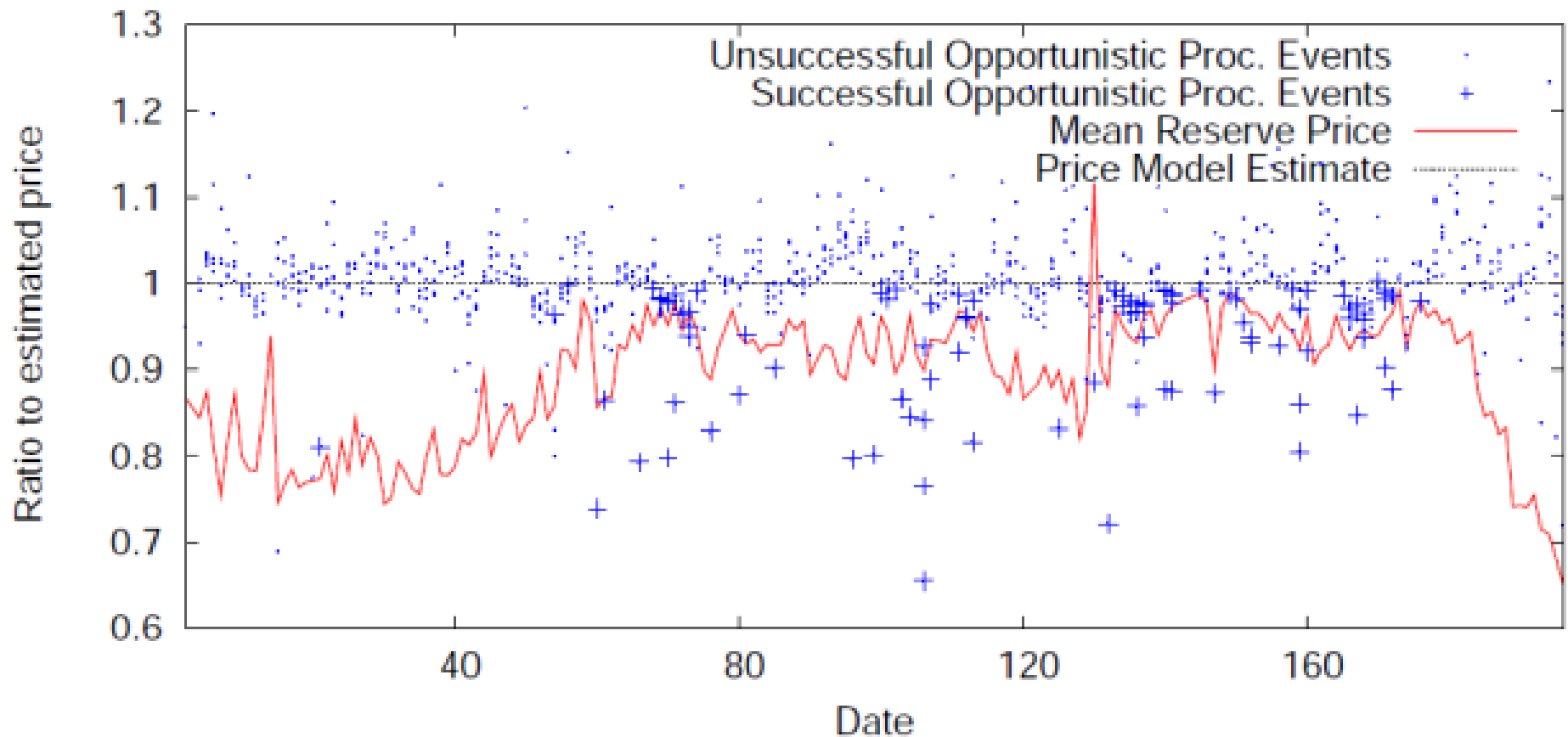
Observed Price vs. Lead time Curves



Opportunistic Procurement



MinneTAC: taking advantage of natural price variability

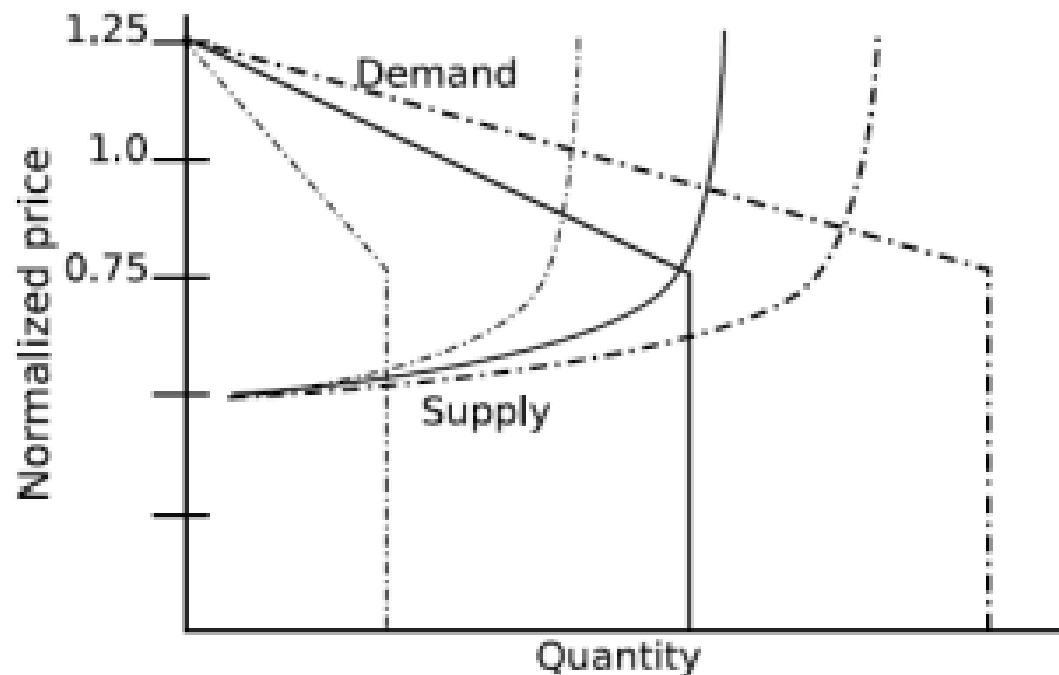


Customer Market: Supply/Demand

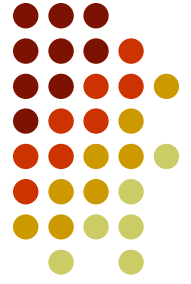


Qualitative representation of supply and demand in the customer market

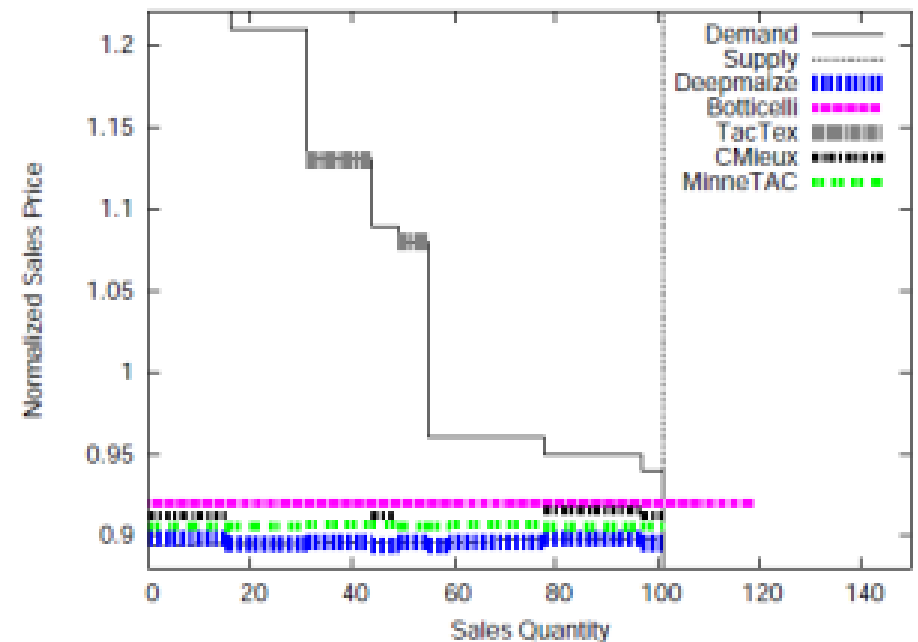
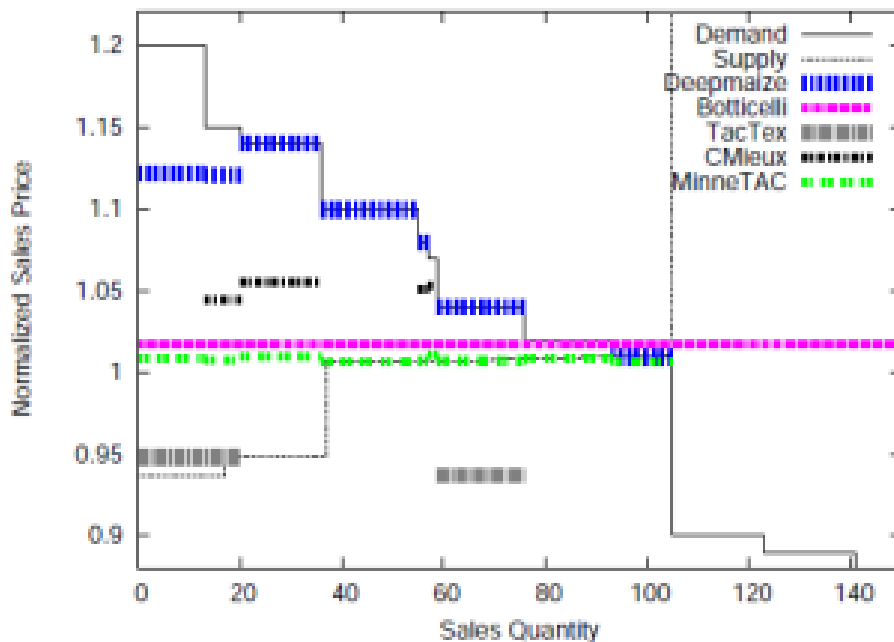
- Manufacturing agents provide “supply”
- Customer agents provide “demand”



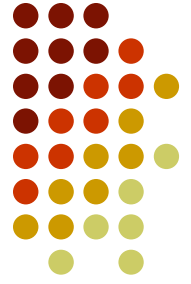
Customer Market: Supply/Demand



- Agents can limit demand on bids by either
 - not bidding or
 - raising their offer price (see left figure)
- Many agents bid the same price for a given product type on a given day.



Applications to Real Markets and Future Work



□ Prediction

- Stock/Commodities Markets
 - Electricity Markets
- Economic Regimes

□ Unique Market Mechanisms

- Dutch Flower Auction

Literature



For more information on TAC SCM see

Trading Agent Competition in Supply Chain Management
website

<http://tac.cs.umn.edu>

Question Time



Contact Information

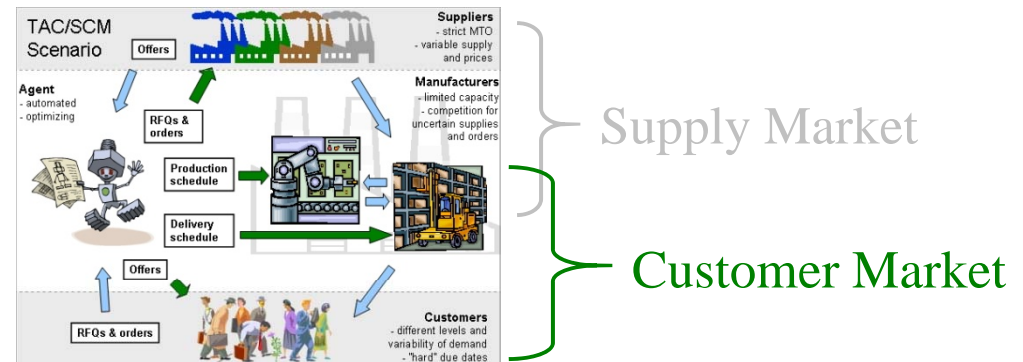


- ❑ Presenter: Wolf Ketter
www.ketter.ws
wketter@rsm.nl
- ❑ Primary Author: William Groves
groves@cs.umn.edu

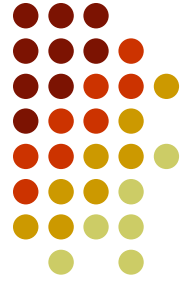


Customer Market Detail

- Customers represent demand from all consumers who wish to buy computers. All demand in simulation comes from there.
- Customers make specific requests (RFQs) for computers with:
 - Specific model (CPU speed, memory size, hard drive size, ...), quantity, maximum delivery date (between 3-12 days leadtime), reserve price
- Requests sent to all manufacturing agents
- Manufacturing agent that responds with the lowest price is the winner of the contract



Supply Market Detail



- Manufacturers need parts to fulfill their contracts to deliver computers. The parts to build these computers are procured in this market.
- A manufacturer sends a request (RFQ) to an individual supply agent specifying:
 - part number
 - quantity
 - delivery date
 - reserve price (maximum per unit price agent will accept)
- The supply agent responds with an offer stating an available quantity, price, and delivery date. If the manufacturer accepts the offer it sends an order.

