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Europe
SUPPLY CHAIN WORLD
Conference and Exposition

What is the Bullwhip Effect caused by?

Study based on the Beer Distribution Game online

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Agenda

Part I What is the Bullwhip Effect?
What are reasons for the Effect?

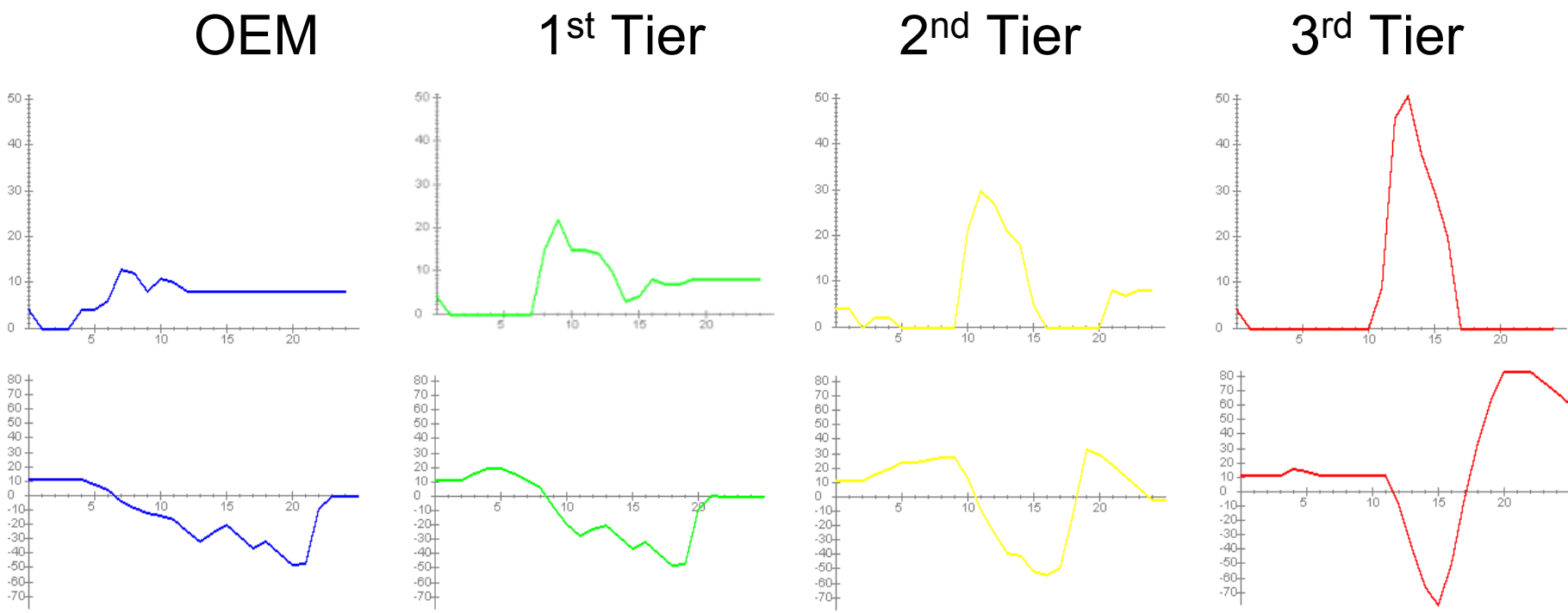
Part II The Beer Distribution Game: Simulating a Supply Chain

Part III What is the Role of Human Behavior in the Bullwhip Effect? (Study based on the Beer Distribution Game online)

Part IV How can Supply Chains cope with the Effect?

The Bullwhip Effect

Orders and Stocks in a Supply Chain



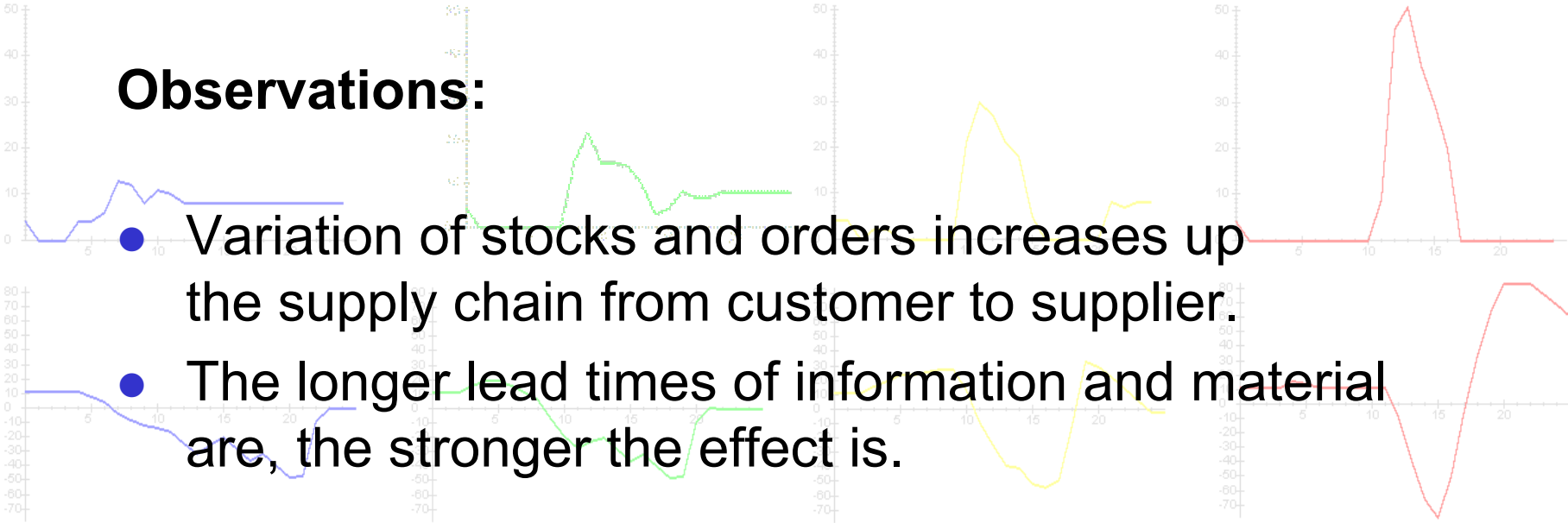
Information (Orders)

Material

The Bullwhip Effect

Orders and Stocks in a Supply Chain

OEM 1st Tier 2nd Tier 3rd Tier



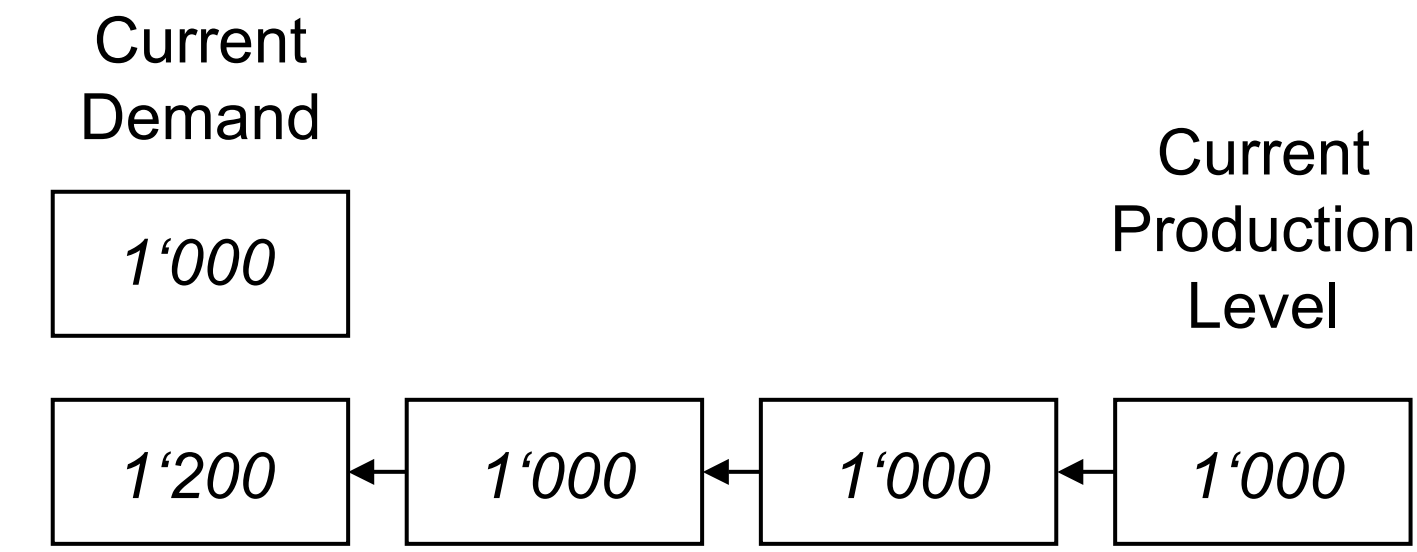
Observations:

- Variation of stocks and orders increases up the supply chain from customer to supplier.
- The longer lead times of information and material are, the stronger the effect is.

Famous example:
Demand for Pampers disposal diapers, analyzed and published by Procter&Gamble

The Bullwhip Effect

Main Reason for the Effect: It is inherent in the System!



Effect is caused by lead time:

- If customer demand sinks, the supplier needs to empty its pipeline to avoid high capital costs.
- If it raises, pipeline needs to be filled to avoid backlog.

The Bullwhip Effect

Secondary Reasons for the Effect

Planning:

- Changing forecasts lead to changing *safety stocks*. Suppliers not only react on changed demand, they adapt the level of safety stock. Thus variability increases.
- Procurement in *batches* adds variability

Behavior:

- *Variability of prices* (especially: promotions) has an effect on variability of demand.
- Facing *shortage of supply* customers tend to order more than their actual demand. After shortage is over, cancellations occur.

Simchi-Levi, Kaminsky (2000): Designing and Managing the Supply Chain, p. 82

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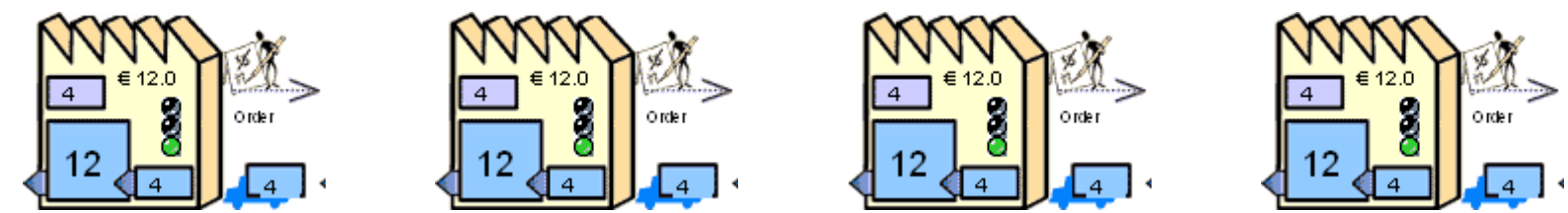
The Beer Distribution Game

Idea: A simple Simulation of a Make-to-Stock Supply Chain

Retailer Wholesaler Distributor Factory

Information (Orders)



Material

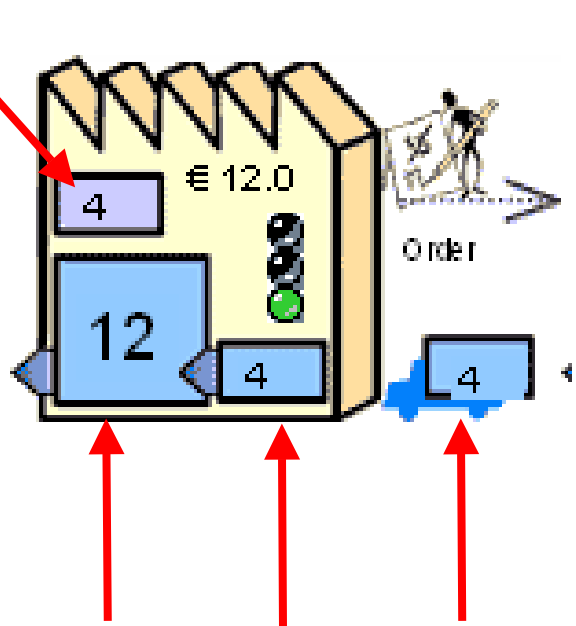
Goal: To miminize cost of capital employed in stock while avoiding out-of-stock situations.

Costs: 0,50 € per product on stock per round
1,00 € per product, that could not be delivered

The Beer Distribution Game

How much to order from your supplier?

Order received from customer



Products ... on stock ... in transport

... being received

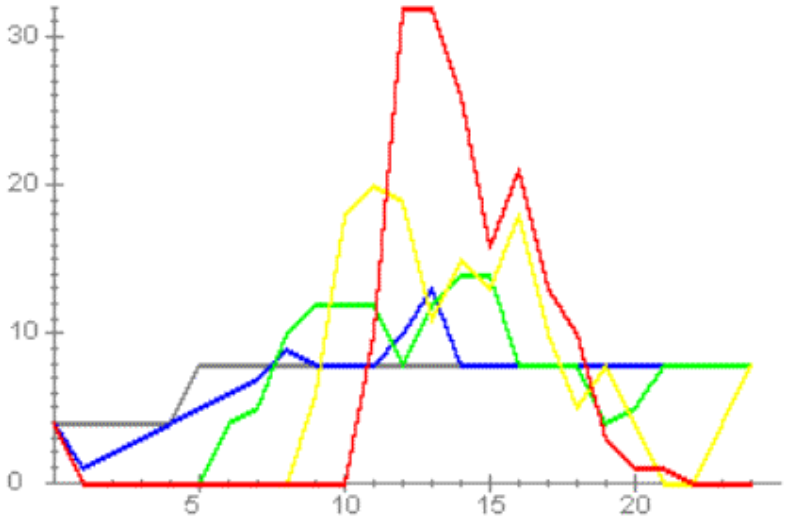
Taking into account
- outstanding orders
- products in transfer
- and on stock

How many products does my company need to meet future demand?

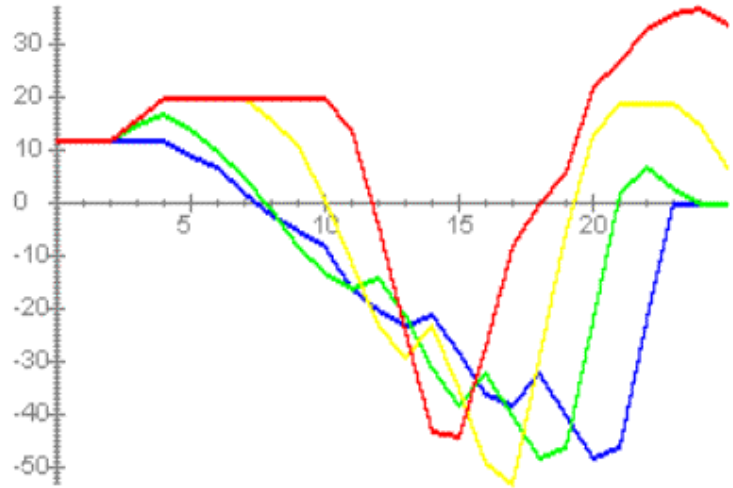
The Beer Distribution Game

Results are surprising…

Orders



Stocks



Retailer
Distributor
Customer
Wholesaler
Factory

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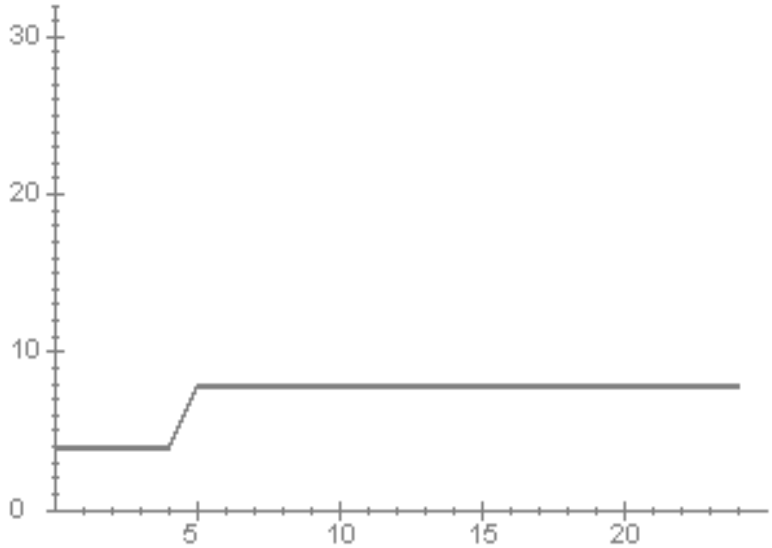
The Role of Human Behavior

Is there a Best Solution to the Simulation?

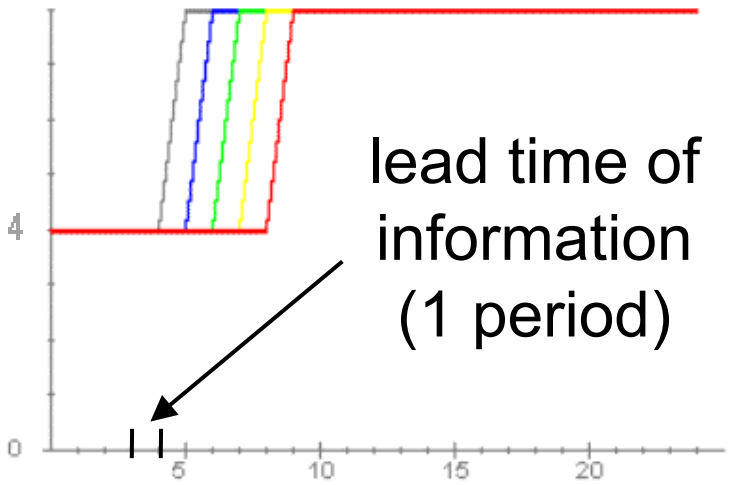


If you could centrally plan supply chain operations (those of all four partners) *how would you react* on this customer behavior?

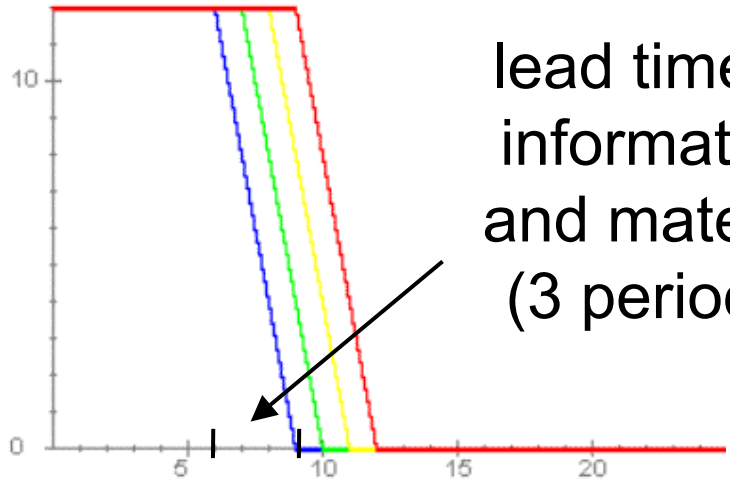
The Role of Human Behavior

The Best Strategy does not even require central planning!

Orders



Stock



If each partner would target at a constant level of stock by *simply passing on his customers' order* to his supplier ...

... initial stock levels would cover the higher usage during the lead time of information and material.

unexpected usage		lead time		stock necessary
4	x	3	=	12

BWI ETH ZÜRICH Prof. Dr. P. Schönsleben Prof. M. Baertschi

The Role of Human Behavior

Human vs. Computer Performance

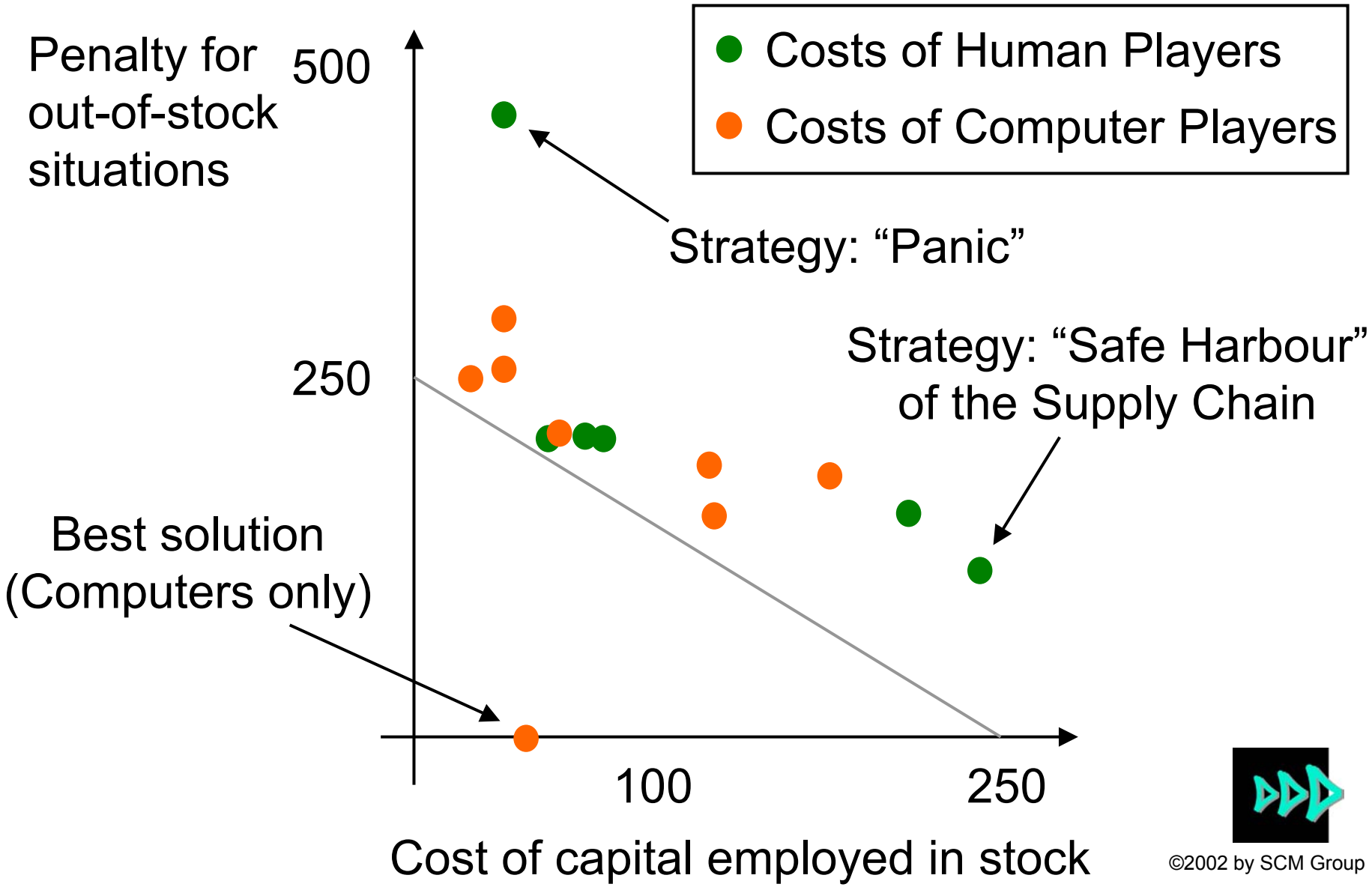
This *best solution*, which was achieved by a „group“ of computer players, only has costs of 228 €. Those are costs of capital employed in stock.

Groups with humans in average have costs of about 500-600 €. Generally speaking, the more human players are in a group, the higher costs are.

Maximum costs „achieved“ by a group of four humans: 1526 €

The Role of Human Behavior

Humans tend to an extreme behavior.



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How to cope with the Bullwhip Effect

Measures

Planning

- Reduce lead time of information
  (orders, demand and capacity forecast, point-of-sale data for the whole supply chain)
- Reduce lead time of material
  (Just-in-Time, Postponement)

Behavior

- Decrease variability of prices
- Cooperation with suppliers on issues of demand and capacity (supply chain management).

Acknowledgements

MIT, Systems Dynamics Group
- created the Beer Distribution Game in the early 60s

Christoph Duijts
- contributed a lot of good ideas for the Beer Distribution Game online and
- implemented it in the course of his diploma thesis

You are invited
to get known to the Bullwhip Effect:

http://www.beergame.lim.ethz.ch

Thanks for your attention!