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# Supply network coordination – a very brief introduction

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Péter Egri

Fraunhofer Project Center for Production Management and Informatics, MTA SZTAKI

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# Outline

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Introduction

Vendor Managed Inventory with multiple buyers – an example problem

Further possibilities

# Outline

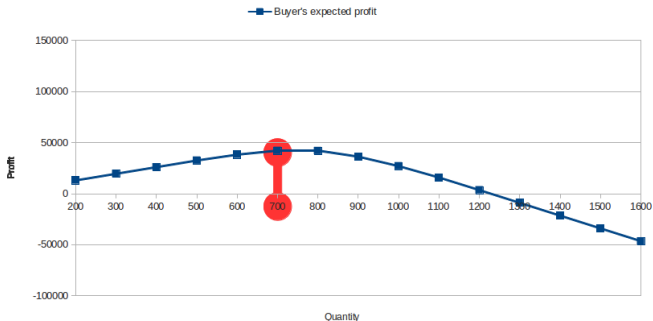
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## Introduction

Vendor Managed Inventory with multiple buyers – an example problem

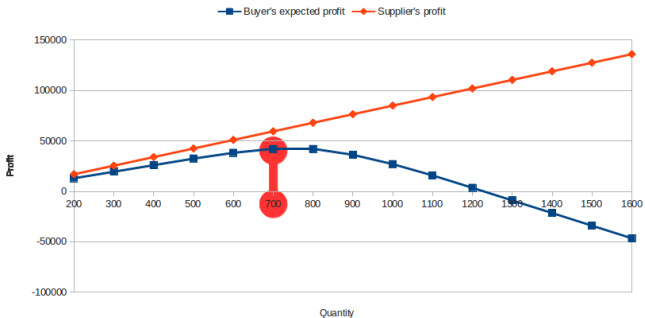
Further possibilities

# Illustrative example



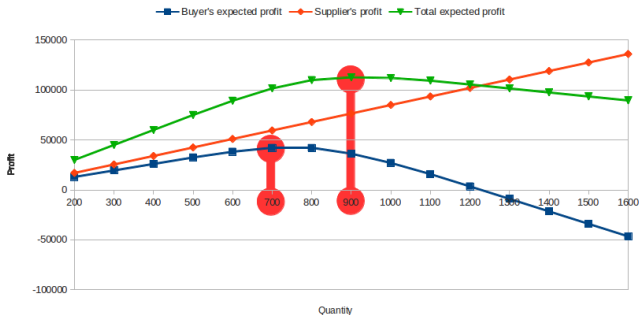
- Buyer: purchase-to-forecast
- Buying too much products results in obsolete inventory or additional inventory costs
- Buying too few products results in shortage and smaller profits

# Illustrative example



- Supplier: make-to-order
- Risk is only at the buyer's side

# Illustrative example



**Uncoordinated  
Chain optimal**

**Buyer (€)**

42 080

36 270 ▼ (-5 810)

**Supplier (€)**

59 500

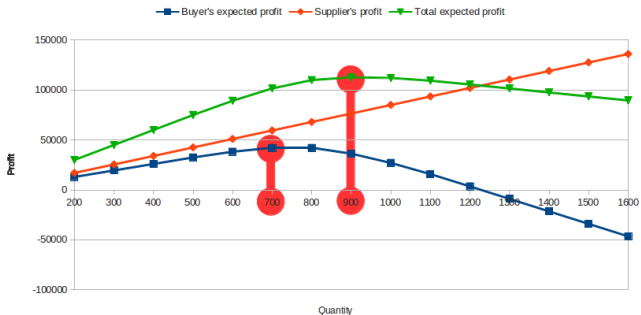
76 500 ▲ (+17 000)

**Total (€)**

101 580

112 770 ▲ (+11 190)

# Illustrative example



	Buyer (€)	Supplier (€)	Total (€)
<b>Uncoordinated</b>	42 080	59 500	101 580
<b>Chain optimal</b>	36 270 ▼ (-5 810)	76 500 ▲ (+17 000)	112 770 ▲ (+11 190)
<b>Sharing the surplus</b>	47 675 ▲ (+5 595)	65 095 ▲ (+5 595)	112 770 ▲ (+11 190)

# Summary

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- Properties of the coordination problems
  - Not completely antagonistic goals (non-zero sum game)
  - The standard solution (equilibrium) is not Pareto-optimal  
Corollary: possibility of improvement
  - Proposed solution: contracts (e.g., buyback, revenue sharing, etc.)



# Summary

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## ■ Properties of the coordination problems

- Not completely antagonistic goals (non-zero sum game)
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Corollary: possibility of improvement
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## ■ Further complications in reality

- Private information (costs, forecasts, etc.)  
Corollary: information elicitation mechanism design is needed
- More complex production planning problems

# Outline

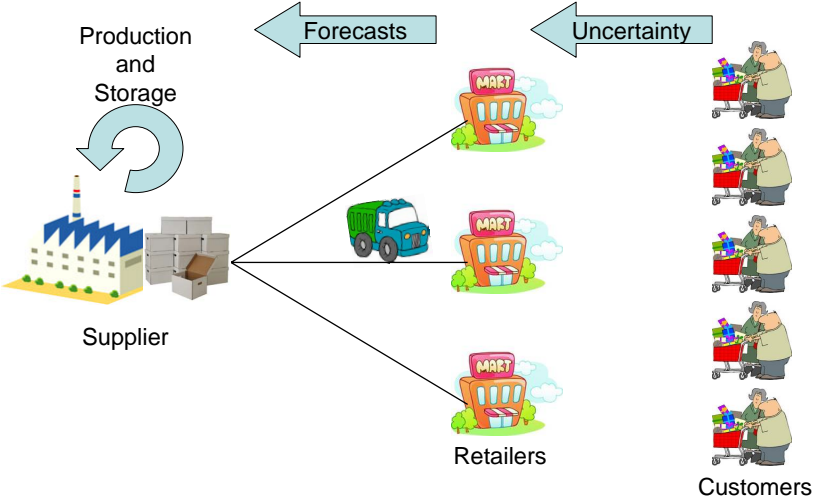
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# Procurement with Vendor Managed Inventory



# Assumptions

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- We focus here on the procurement of a specific product
- Several buyers (e.g., retailers)
- Buyers create demand forecasts
- More precise forecast is achievable at a higher cost (e.g., market survey)
- Products can be bought on the *forward market* (based on the forecast)
- If demand exceeds purchased quantity, the remaining can be bought on the *prompt market* at a higher price

# Solutions

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- “Individual”: buyers buy independently on the markets minimising their own costs
- “Idealistic”: buyers cooperate in order to minimise the total cost, even if this is worse than the individual solution for some of them
- Mechanism design problem: how can the minimal total cost of the “idealistic” solution be achieved considering selfish buyers of the “individual” solution?

# The proposed mechanism

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- The *mechanism* is an independent entity (e.g., a common distribution center, a supplier)
  - Collects forecasts from the buyers
  - Aggregates forecasts
  - Purchases on the forward market
  - Balances demand and supply on the prompt market
  - Provides the required products to the buyers
  - Collects payments from the buyers
  
- Payment
  - Payment for the required products: based on the realised demand
  - Payment for the risk handling *service*: based on the difference of the realised and the expected demand, scaling with the uncertainty of the forecast

# Mechanism properties

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- **Incentive compatibility:** The selfish buyers create the optimally precise forecasts and report them truthfully to the mechanism in order to minimise their payments.
- **Efficiency:** The mechanism minimises the expected ordering cost (achieving the “ideal” solution).
- **Individual rationality:** The buyers pay less (or equal) than their cost is in the “individual” solution.
- **Budget balance:** The mechanism does not require external sources for financing deficit or surplus on the long term, i.e., the payments of the buyers and the purchasing costs level off on the long term.

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## Further variants and research possibilities

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- Allowed lost sales (e.g., Egri and Váncza, 2013 [2])
- Rolling horizon planning (e.g., Váncza et al., 2008 [3])
- Simple automated negotiation protocol (e.g., Egri et al., 2011 [1])
- Multi-product planning with capacity constraints
- Robustness analysis
- Uncertainty of the forecasting cost function
- Realised demands are private knowledge of the buyers
- Etc.

# Bibliography

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-  P. Egri, A. Döring, T. Timm, J. Váncza: Collaborative Planning with Benefit Balancing in Dynamic Supply Loops. *CIRP Journal of Manufacturing Science and Technology*, 4(3), pp. 226–233, 2011.
-  Egri P., Váncza J.: A Distributed Coordination Mechanism for Supply Networks with Asymmetric Information. *European Journal of Operational Research*, 226(3), pp. 452–460, 2013.
-  Váncza J., Egri P., Monostori L.: A Coordination Mechanism for Rolling Horizon Planning in Supply Networks. *Annals of the CIRP – Manufacturing Technology*, 57(1), pp. 455–458, 2008.