

TIØ4285 Production and Network Economics

Summary

Spring 2020

Outline

- Short summary of topics
- General information regarding exam preparation
- On choosing projects for 5th year
- (Ruud's and Anne's summary regarding their lectures)

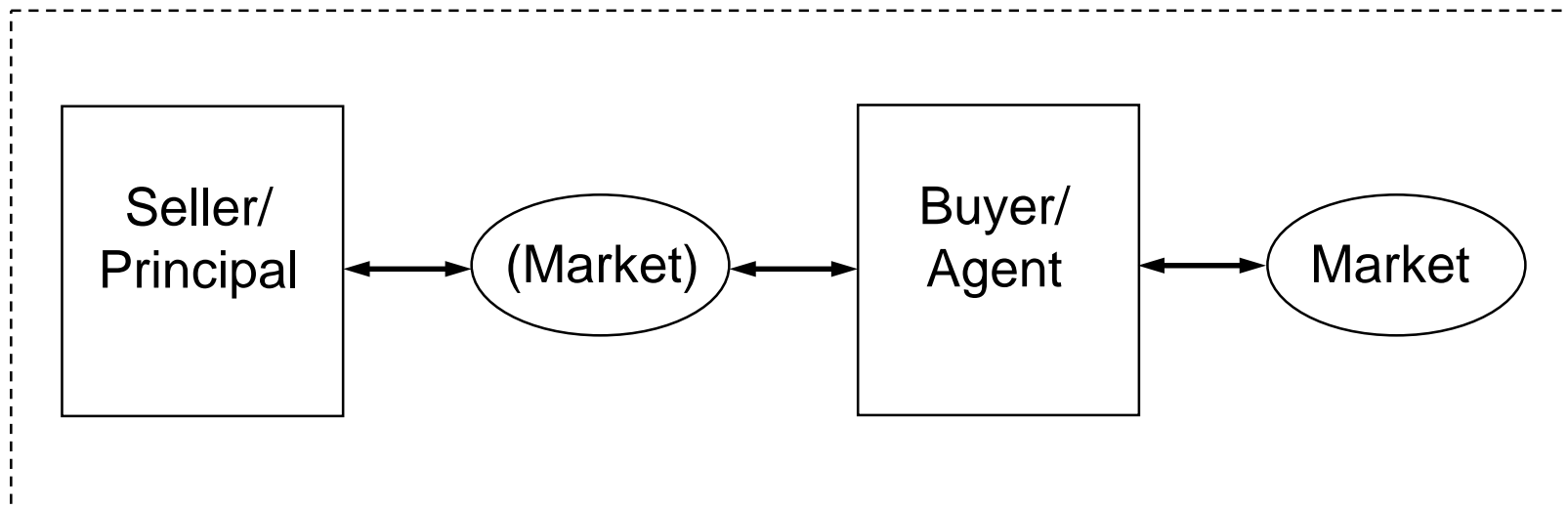
Lectures

Week	Date	Topic	
2	9 January	Planning Problems and Supply Chain Design	PS
3	16 January	Inventory Models and Risk Pooling	PS
4	23 January	Forecasting and Value of Information	PS
5	30 January	Auctions	PS
6	6 February	Equilibrium Modeling I	RE
7	13 February	Equilibrium Modeling II	RE
8	20 February	Equilibrium Modeling III	RE
9	27 February	Pricing and Incentives I	PS
10	5 March	Pricing and Incentives II	PS
11	19 March	Economic Policy Evaluation I	AN
12	26 March	Economic Policy Evaluation II	AN
13	2 April	Asymmetric Information	PS
16	16 April	Summary	PS

Note that these slides only represent parts of the exam-relevant content!

General Setting this Semester

- We have considered problems relevant for
 - Single companies
 - Vertically integrated companies
 - Multiple companies in a supply chain
 - Regulatory bodies



What are typical problems in supply chains?

- Problems depend on planning level
 - Facility location (strategic)
 - Inventory management (tactical/operational)
- How to deal with uncertain or imperfect information?
 - Stochastic programming
 - Newsboy problem
 - Asymmetric information
- How to model market power?
 - Equilibrium modelling (see also Ruud's summary, slides 15-19)
- How do incentives work?
 - Contracts
 - Asymmetric information
 - Economic policy evaluation (see also Anne's summary, slides 20-23)

Hierarchical Planning



Strategic Planning

- Long planning horizons (years to decades)
- Highly aggregated data
- Uncertainty

Tactical Planning

- Medium planning horizon (months to few years)
- Less aggregated data
- Less uncertainty

Operational Planning

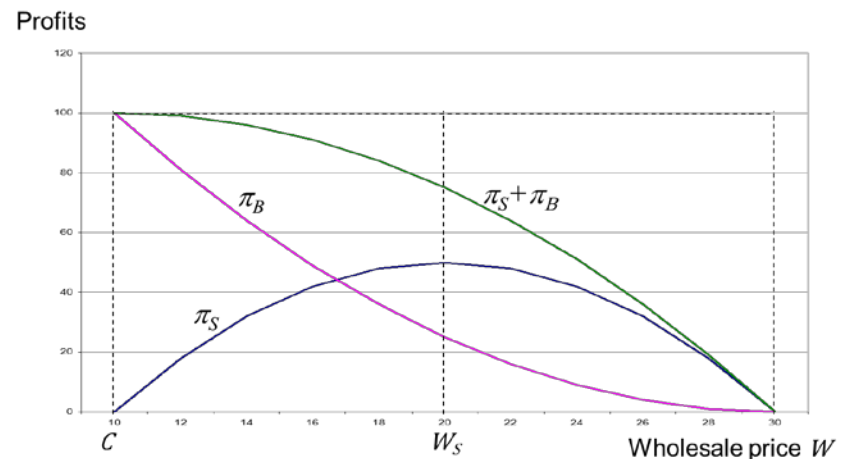
- Short planning horizon (days to few months)
- Disaggregated data
- Even less uncertainty

How to deal with uncertainty?

- Include uncertainty
 - Stochastic programming
- Reduce uncertainty
 - Forecasting
 - The value of information
- Remove uncertainty
 - Auctions
 - Revenue Equivalence Theorem
 - Risk aversion
- Related problems (not uncertain, but imperfect information)
 - Moral Hazard
 - Adverse Selection
 - Risk aversion

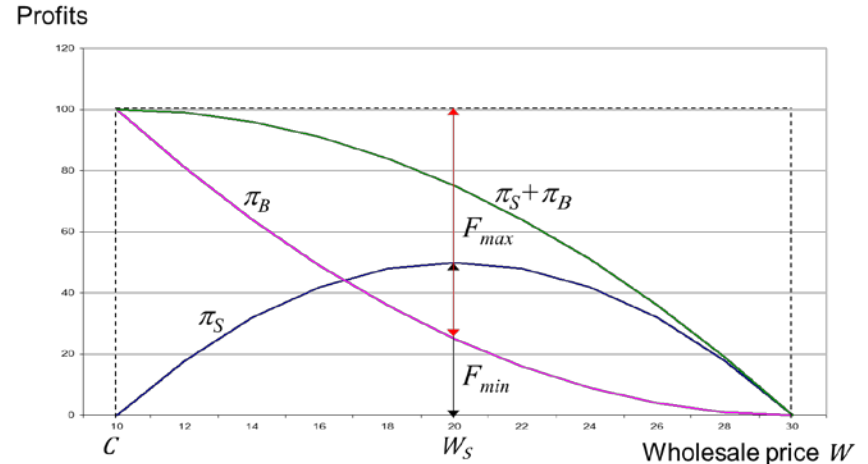
How do companies collaborate?

- Market-based solutions
 - Transfer prices
 - Use prices to determine «correct» decisions
 - What are the «correct» prices?
- What happens if one company exerts market power?
 - Double marginalization



Using contracts

- Deterministic world
 - Simple case
 - Two-part tariff
- Uncertainty and imperfect information
 - More complex situation
 - Deterministic vs. stochastic profits
 - Newsboy problem
 - Principal-agent problems



Limitations of traditional optimization

- Optimization tries to provide decision support to decision makers
 - Underlying assumption of a single decision maker, not really suitable for networks
 - Prices and costs are usually assumed given
 - Strong preference for linear models
 - Normative approach: focus on decisions for the single decision maker
- In reality, we meet a network of actors with different incentives
 - Some of these actors may have market power

What if markets are not competitive?

- Economic approaches to market power are generally covered in Microeconomics
- Equilibrium modeling
 - Optimization approach to modeling market power
 - Imperfectly competitive multi-agent problems wherein not all agents are price-takers
 - Can model market power a là Cournot
 - In this course: focus on combination of equilibrium models and network models

What about incentives?

- Decision makers may act rational on an individual level, but not from a wider (system) perspective
 - Can we change the behaviour of individual decision makers?
 - What is the cost (or benefit) of a change in behaviour?
 - How?
- Using contracts
 - How should I design a contract to achieve higher profits?
 - Efficiency in risk sharing vs. efficiency in production
- Changing the boundary conditions
 - Will a change in the regulatory conditions affect the companies behaviour?
 - How to value common goods (e.g. the environment)?

Exam Preparation

- **Note: This information is valid as of today, 16 April 2020. Changes will be published on Blackboard.**
- Written exam: 3 June @ 9am, 4 hours
 - Code A (= open book)
 - Home exam, to be done in Inspera (check your computer for any issues...)
- Q&A: Planned in week 21 (18-20 May)
 - Exact date will be published on Blackboard
 - Questions should be sent by email in advance (more details on Blackboard)
 - Questions after Q&A session have to be posted on the Discussion Board on Blackboard
- Relevant material:
 - Everything mentioned on the reading material list (unless explicitly stated otherwise)
 - This includes lecture slides (incl. other material used in lectures) and assignments

Project & Master

- Mixer at Kjelhuset on 5 May is not going to happen. No information yet whether or not this will be replaced by a digital meeting.
- If you plan to define your own project and master, contact your choice of supervisor soon. Don't wait until the end of the deadline.
- Feel free to contact me regarding topics that I intend to supervise next year (I can't answer for my colleagues' topics).
 - You can send questions by email (peter.schuetz@ntnu.no)
 - We might agree on a short Skype-meeting where I will answer your questions.
 - I expect my colleagues to be available by email as well, but haven't asked them...

Ruud's Summary of Equilibrium Modelling

Students should (be able to):

- Explain why and when equilibrium models and network models are useful
- Formulate and solve analytically small-scale network and equilibrium problems
- Interpret and have an intuition for equations and results

Focus on model formulation & interpretation, not algorithms

You will not need to implement in software any models during the exam.



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Equilibrium Modeling

- Imperfectly competitive multi-agent problems wherein not all agents are price-takers
- Equilibrium problems can model market power a la Cournot
- Implemented as sets of Karush-Kuhn Tucker (KKT) or *complementarity* conditions
- Convex minimization & linear constraints: KKT points are solutions
- Procedure:
 - Formulate agent problems as minimization with restrictions in the order: Sources-Sinks (\geq or $=$) 0
 - Add market clearing conditions (MCCs) for exchange of commodities or services between different agent types, in the order: Sources-Sinks = 0
 - Assign dual variables to all restrictions
 - Derive all First Order Conditions (FOCs) wherein duals of restrictions are additionally multiplied by '-1'
 - Add Market Clearing Conditions
 - For price-taking agents, after deriving the FOCs replace the exogenous price by the inverse demand curve.





Network modeling - modeling of transportation in networks

- Networks are part of very many real-world problems and subject of research in many fields (not just O.R. and economics)
- Minimal cost (network) flow problem generalizes very many types of problems
- Elements: Supply, demand, transshipment
- Restrictions: Capacity limits, Demand levels (or functions), Mass balance constraints
- Characteristics: Capacities, costs, losses
- Assignment problems (including Facility location, set coverage): integer decisions
- Formulate optimization problems, interpret and explain solutions including dual variables, do limited what-if analysis





Markets with transport networks

- Combines equilibrium modeling and network modeling (as long as all decisions are continuous)
- More complicated to set up the agent problems and it takes more time to derive the FOCs, but the derivation steps are the same.
- Formulate agents' optimization problems, derive complementarity conditions, understand logic of complementarity conditions; derive and interpret solutions, explain prices, explain dual variable values,....



Anne's Summary of Economic Policy Evaluation

Why these two lectures?

- Evaluate (infrastructure) projects allowing policy makers to take informed decisions
- Marginal projects (of public interest) usually do not consider external effects
- Based on economic theory (some of which has been subject in this course) economic policy analysis aims to put numbers on benefits and costs of investments, policy decisions, changes in laws etc
- We have encountered two approaches: cost benefit analysis (L10) & policy evaluation (L11)

Key concepts Lecture 10

- Financial analysis (NPV and IRR) vs. social appraisal of projects (cost benefit analysis;
- Systematic approach to estimate short and long term consequences
- In particular important for infrastructure projects taking into account external effects (put monetary values to these)
- Four types of CBA; main critique: choice of discount rate
- Valueing the environment (WTP vs. WTA)
- Stated preferences vs. revealed preferences methods

Key concepts Lecture 11

- Goal is to identify and measure causal effects
- Concept of the «counterfactual»
- Treatment effect:
 - Comparison of different outcomes
 - Independent of action actually taken
- Causal inference in the OLS framework
- Internal and external validity
- Method (there are many more out there!)
 - Experiments and Quasi-Experiments
 - Difference-in-Difference
- Problem set and the paper