Models for Inventory Management

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Rutgers Business School – Newark and New Brunswick
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(Tentative)

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Course Objectives: The goal of this course is two fold: (1) help students to build a solid understanding of the models, methodologies and solution approaches in supply chain inventory management; (2) bring students to the research frontier of supply chain inventory management. The course is targeted at graduate (M.S. or Ph.D.) students in the areas of operations management, operations research, industrial engineering and management science. To prepare students to do research and to train students for the job market, this course combines lectures, literature reading and presentations.

Topics covered (tentative)

- Multi-echelon inventory models
- Assemble-to-Order system, allocation rules and component commonality
- Risk aversion and supply chain management
- Revenue management – joint pricing and inventory decisions
- Supply chain dynamics – the bullwip effect
- Supply chain incentive issues and contract – coordination and competition
- Procurement, outsourcing & supply management

Prerequisite: familiarity with linear/non-linear optimization, probability and stochastic processes is essential. It is recommended that students are familiar with basic concepts of stochastic dynamic programming.

Required Text: *Foundations of Inventory Management*. By Paul Zipkin. 2000. McGraw Hill. ISBN 0-256-11379-3

Other Books:

- *Supply Chain Management: Design, Coordination and Operation*. A.G. de Kok and Stephen C. Graves eds., 2003. Handbooks in Operations Research and Management Science (HORMS), Elsevier.

Every student should present a research paper of his/her own, and two other students will serve as referees

Course Policy

Course Requirement: Class grade is based on the following components with the stated weights:

Problem sets	40%
Presentation & Discussant	30%
Term paper	30%

Class Participation: Class participation is necessary. If you cannot attend a class, please notify me *in advance* with a good reason and a solid proof, such as interviews and illness. Absence from the class twice without a good reason could directly result in failure in this course.

Active Learning: To prepare you for a successful career in either academic or industry, this course is planned so that you can get involved in research activities. You will prepare and make presentation, serve as a discussant, search and review literature, and most importantly, identify research problems.

Presentations: depending on enrollment, each student will select several papers (listed below) and present these papers as if you are the author. You can also pick paper of your interest outside of the list, but with my permission. In the presentation, you need to explain the research problem, the motivation, the models, and the solution to the problem. You also need to compare to existing results and point out the contribution. The time limit for a presentation is 1 hour (including Q&A, prepare it as if it is your **job talk**!).

The presentations will be graded based on how well you motivate the research, how clear is the model and results.

Discussants: Besides presenters, each paper will have two discussants. The main task of a discussant is to provide a critique of the papers presented: the significance of the problem, the suitability of the model, the limitations of modeling assumptions and the role that those assumptions play in obtaining results, the significance of the results, and possible extensions. In addition, discussants should look for common themes or key issues that link the papers and enhance our understanding of the topic. Lastly, discussants are expected to raise challenging questions that would guide class discussion.

The discussants will prepare referee reports to the paper presented.

Referee Reports: Papers submitted to refereed journal typically goes through a peer-review process, during which an associated editor (AE) assigns the paper to (at least) two referees. The referees will read the paper and provide suggestions to AE on either accepting or revising or rejecting the paper. A good referee provides constructive suggestions that allow the author to improve the paper. When you serve as a referee, remember one thing: **it is too easy to criticize a paper**; ask yourself two questions: what can I learn from this paper? How can I help the author improve the paper?

Term Paper: The term paper is due on the last day of class. It should be at most 12 typed pages without reference (12pt Times, Times New Roman, 1 inch margins on all sides, double-spaced). You have two options for the term paper:

1. **Research Proposal.** In your proposal you should
a. Identify an open research question: either an interesting real world phenomenon or a gap in the existing literature.
b. Provide a literature review that makes clear the importance of the topic and how relevant papers fail to address the questions or do not provide a satisfactory answer.
c. Outline a suitable model to address the question and sketch the analysis one would want to carry out.

Think of your document as a proposal you are submitting to a funding agency (e.g., NSF), which relies on a peer-review process to allocate funds. You can expect that your reviewers are familiar with the general research area (Supply Chain Management), but are not experts in your particular subfield. You can also count on the reviewers to be very bright, but extremely busy academic or industry professionals. Your goal is to convince them that your research will address a very important and very timely problem (sections on the problem statement, problem motivation, literature review will serve to accomplish that), and that, if the agency gives you money, you are likely to succeed (sections on the model and the outline of the analysis should help them to make that decision).

The research proposal will be graded based on how convincing it is.

2. **Original Research.** Under this option, you should identify an open research question: either an interesting real world phenomenon or a gap in the existing literature; and attempt to answer it. The objective is to obtain original results that add to the existing knowledge. Similar to the Research Proposal, your report for this alternative should make it clear what research problem you are solving and why this problem is important. But your report should particularly emphasize the results you obtained. You are encouraged to discuss with me on anything you are interested.

For an academician, there is nothing more challenging and rewarding than publish in top journals and make an impact. Therefore, I do not expect that you will have a complete answer to a problem (especially, a difficult problem). Your work will be graded based both on the importance of the problem and the significance of the results.

Homework: Homework problems will be assigned for some well established results.

Weekly Schedule

1. Introduction to Supply Chain Inventory Management (the Literature Tree, Basic Models, Publishable Work, Publish Strategy)

- P. Zipkin 2000, "Introduction" & Chapters 1,2,3.
- E. Porteus 2002, "Two Basic Models" Chapter 1 of *Foundations of Stochastic Inventory Theory*. Stanford Business Books, Stanford, CA.
- De Kok and S. Graves 2003, "Introduction", in HORMS, 1 – 16.

2. Review of Single-Stage Inventory Models – Dynamic and Stochastic Models

- P. Zipkin (2000). Chapters 4, 9 (mention optimality results, focus on performance evaluation/optimization)

3. Stochastic Multi-Echelon (ME) Models: Serial and Distribution Systems

- P. Zipkin (2000). Chapters 6 and 8 (optimal policy in serial system, challenge of finding optimal policy in distribution systems, performance evaluation and optimization in serial and distribution systems)
- D. Simchi-Levi and Y. Zhao 2006. A Comparison of Three Generic Methods for Analyzing Stochastic Multi-Echelon Inventory Systems.

4. Stochastic ME Models: Assembly Systems

- P. Zipkin (2000). Chapters 8 (synchronized base-stock policy for pure assembly systems, policy evaluation and optimization)
- D. Simchi-Levi and Y. Zhao 2006. A Comparison of Three Generic Methods for Analyzing Stochastic Multi-Echelon Inventory Systems.

5. Assemble-to-Order Systems, Allocation Rules & Component Commonality

- Song, J., P. Zipkin (2003). Supply chain operations: Assemble-to-order systems. Chapter 11 in *Handbooks in Operations Research and Management Science*, Vol. 11: Supply Chain Management.
- Song, J., Y. Zhao (2007). Lead-times and the vale of component commonality.
- Lu, Y., Song, J. and Zhao (2007). Dynamic No-Hold-Back Allocation Rules for Assemble-to-Order Systems: Optimality and Comparison.

6. Alternative Approach to ME Models – The Guaranteed Service Models

- Graves, S.C. and S.P.Willems (2000). Optimizing strategic safety stock placement in supply chains. *Manufacturing and Service Operations Management*. 2: 68-83.
- Graves, S.C. and S.P.Willems (2005). Supply chain configuration??? Management Science ???

- Graves, S.C., S.P.Willems (2003). Supply chain design: safety stock placement and supply chain configuration. Chapter 3 in *Handbooks in Operations Research and Management Science*, Vol. 11: Supply Chain Management: Design, Coordination and Operation. North-Holland Publishing Company, Amsterdam, The Netherlands.

7. Risk Aversion and Supply Chain Management

- Eeckhoudt L., C. Gollier and H. Schlesinger (1995). The risk-averse (and Prudent) Newsboy, *Management Science*, 41(5), 786 – 794.
- Chen, F. and A. Federgruen (2000). Mean-variance analysis of basic inventory models.
- Xin Chen, Melvyn Sim, David Simchi-Levi, and Peng Sun (2007). Risk Aversion in Inventory Management. To appear in *Operations Research*.
- Choi, S., A. Ruszczyski, Y. Zhao (2007). The Multi-Product Risk-Averse Newsvendor with Law-Invariant Coherent Measures of Risk.
- Sziego G. (2002). "Measures of Risk", Journal of Banking and Finance, 26, 1253-1272.
- Dentcheva, D., A. Ruszczyski (2006). Portfolio optimization with stochastic dominance constraints. *Journal of Banking and Finance*, **30**, 433-451.

8. Revenue Management – Joint Pricing and Inventory Decisions

- Gallego, G., G. van Ryzin. 1994. Optimal dynamic pricing of inventories with stochastic demand over finite horizons. *Management Science* 40(8) 999-1020.
- Zhao, W., Y.S. Zheng. 2000. Optimal dynamic pricing for perishable assets with nonhomogeneous demand. *Management Science* 46(3) 375-388.
- X. Xu, W.J. Hopp. 2007. A Monopolistic and Oligopolistic Stochastic Flow Revenue Management Model. To appear in *Operations Research*.

9. Supply Chain Dynamics – the Bullwhip Effect

- Lee, H. L., V. Padmanabhan and S. Whang (1997). Information Distortion in a Supply Chain: The Bullwhip Effect. *Management Science*, 43, 4, 546-558.
- Cachon, G., T. Randall, G. Schmidt (2007). In Search of the Bullwhip Effect. *Manufacturing & Service Operations Management*. **9**(4). 457-479.

10. Supply Chain Contracts and Coordination I

- Pasternack B. A., 1985, "Optimal Pricing and Return Policies for Perishable Commodities", *Marketing Science*, 4(2): 166–176.
- Lariviere, M. A. and E. L. Porteus, 2001, Selling to the Newsvendor: an Analysis of Price-Only Contracts. M&SOM, 3(4): 293 – 305.
- Cachon, G. P. and M. A. Lariviere, 2005, "Supply Chain Coordination with Revenue-Sharing Contracts: Strengths and Limitations" *Management Science*, 51(1) 30-44.

11. Supply Chain Contracts and Coordination II

- Cachon G., 2003, "Supply Chain Coordination with Contracts", Chapter 6 in HORMS, 229 - 340.

12. Supply Chain Incentive Issues: Competition

- Lippman, S. A and K. McCardle, "The Competitive Newsboy," *Operations Research*, Jan/Feb 1997.
- Cachon, G. and P. Zipkin. 1999. Competitive and cooperative inventory policies in a two stage supply chain. *Management Science*. **45** (7) 936-953.
- Cachon, G. 2001. Stock wars: inventory competition in a two echelon supply chain. *Operations Research*. **49**(5). 658-674.

13. Decentralized Supply Chains: Information Asymmetry

- Cachon, G., M. Lariviere, 2001, Contracting to Assure Supply: How to Share Demand Forecasts in a Supply Chain. *Management Science*, 47(5): 629-646.
- Ozer, O. and W. Wei, 2006, Strategic Commitments for an Optimal Capacity Decision Under Asymmetric Forecast Information. *Management Science*, 52(8): 1239-1258.
- Corbett C. J., D. Zhou, C. S. Tang, 2004, Designing Supply Contracts: Contract Type and Information Asymmetry, *Management Science*, 50(4): 550-559.

14. Procurement, Outsourcing and Supply Management

- Cachon, G. P., P. Harker, 2002 "Competition and outsourcing with scale economies," *Management Science*, 48 (10): 1314-1333.
- Federgruen, A., N. Yang, 2005. Optimal Supply diversification Under General Supply Risks. To appear in *Operations Research*
- Cachon, G. P., F. Zhang (2007). Obtaining Fast Service in a Queueing System via Performance-Based Allocation of Demand. *Management Science*, **53** (3): 408-420

15. Term Project Presentations