Inventory Management

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Rutgers Business School – Newark and New Brunswick
Fall 2012

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Lecture: Wednesdays, 1-3:50pm, at 1 WP 528
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Course Description: Inventory management is the cornerstone of supply chain management. The goal of this course is three-fold: (1) identify problems and key trade-offs in inventory management, (2) introduce the main stream literature that model, solve and understand these problems, (3) bring students to the frontier of this active research area. 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, case studies, literature reading and presentations.

Topics covered (tentative)

- Economic lot sizing models – lot scheduling, multi-echelon lot sizing models
- Related materials on stochastic processes and Markov Decision Process
- Single echelon inventory models
- Multi-echelon stochastic inventory models
- Supply chain incentive issues and contract – coordination and competition
- Special topics – research frontiers

Prerequisite: It is recommended that students are familiar with the basic concepts of linear/non-linear optimization, probability and statistics.

Related Courses: Supply Chain Modeling & Algorithms, Supply Chain – Marketing Interfaces, Stochastic Models in Supply Chains.

Required Text Books:

- *Inventory Control*, 2nd edition. By Sven Axsater. 2006. Springer. ISBN-10: 0387332502

Recommended Books:

- *Modeling and Analysis of Stochastic Systems*. By Vidyadhar G. Kulkarni. 1995. Chapman & Hall.
- *Foundations of Stochastic Inventory Theory*. By E. Porteus 2002. Stanford Business Books, Stanford, CA.

Course Policy

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

Homework	25%
Mid-term	20%
Final	20%
Presentation (Research)	15%
Presentation (Case)	15%
Referee/Discussant	5%

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.

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 presentations, serve as a discussant, search and review literature.

Presentations (Research): depending on enrollment, each student will select several research papers (listed below) and present these papers as if you were the author. You can also pick paper of your interest outside of the list (it could be your own research paper), 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 a discussant. 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, discussant should look for common themes or key issues that link the papers and enhance our understanding of the topic. Lastly, discussant is expected to raise challenging questions that would guide class discussion.

The discussants will prepare a referee report to the paper presented.

Referee Report: 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(s) to improve the paper?

Presentations (Cases): depending on enrollment, students will form into teams of at most two students to analyze the cases. Each team will be assigned one case in the first class. Please analyze the case, make recommendations and providing quantitative support as if it was a consulting project. Prior to your presentation date, please submit a PPT file (for the presentation) and an Excel file (for the calculation). The grade will be based on your analysis and presentation (1 hour). Make sure discussing with me before you start analyzing the case.

List of cases:

- The Chocolate Factory – Economic Order Quantity vs. Economic Production Cycle. Rutgers Business School case, 2010 (by Vijay Hanagandi, Stephen Johanson and Yao Zhao)
- TLJ Pharmacy – Ordering Strategies. Rutgers Business School case, 2011 (by Yao Zhao)
- VASTA Wireless – Multi-Echelon Inventory Management. Rutgers Business School case, 2011 (by Yao Zhao)
- Valentine's Roses – Supply Strategies. Rutgers Business School case, 2011 (by Yao Zhao)

Weekly Schedule (Tentative)

1. Introduction (9/5)

Content: Course Policy. Course Overview. Basic Models & Literature Tree.

Readings:

- S. Axsater 2006, Chapters 1 & 3
- E. Porteus 2002, "Two Basic Models" Chapter 1 of *Foundations of Stochastic Inventory Theory*. Stanford Business Books, Stanford, CA.

2. Deterministic Models – Economic Lot Scheduling Problems (9/12)

Content: EOQ Models.

Readings:

- S. Axsater 2006, Chapter 4 (4.1-4.4).

3. Deterministic Models – Multi-Echelon Lot Sizing Problems (9/19)

Content: Joint Replenishment, Economic Lot Scheduling Problem, Multi-Echelon Lot Sizing Models

Readings:

- S. Axsater 2006, Chapter 7 (7.2-7.3) and Chapter 9 (9.1-9.2).
- Elmaghraby S. E. 1978, "The Economic Lot Scheduling Problem (ELSP): Review and Extensions". *Management Science,* **24**, 587–598

4. Discrete-Time-Markov-Chain (9/26)

Content: Discrete-Time Markov Chains with Finite Space State. Inventory Applications.

Readings:

- V. G. Kulkarni 1995, Chapter 2 (2.1-2.3), Chapter 3 (3.1, 3.2, 3.3, 3.5)

5. Poisson Process (10/3)

Content: Exponential random variables, Poisson process

Readings:

- V. G. Kulkarni 1995, Chapter 5 (5.1, 5.2, 5.4)

6. Continuous-Time Markov Chain (10/10)

Content: Continuous-Time Markov Chains. Applications in Inventory Management

Readings:

- V. G. Kulkarni 1995, Chapter 6 (6.1, 6.2, 6.3, 6.6), Chapter 7 (7.3).

7. Markov Decision Process (10/17)

Content: Markov Decision Process. Optimal Inventory Policies.

Readings:

- E. Porteus 2002, Chapters 3-4 of *Foundations of Stochastic Inventory Theory*. Stanford Business Books, Stanford, CA.
- S. Axsater (2006). Chapter 10 (10.1).
- Clark and Scarf (1960). Optimal Policies for a Multi-Echelon Inventory Problem. *Management Science*, **6**, 475-490.

8. Midterm, Single-Echelon Inventory Systems (10/24)

Content: Midterm. Single-Echelon Inventory System Policy Evaluation

Readings:

- S. Axsater (2006). Chapter 5 (5.3-5.5, 5.7).

9. Multi-Echelon Inventory Systems: Policy Evaluation & Optimization (10/31)

Content: Inventory System Evaluation and Optimization.

Readings:

- S. Axsater (2006). Chapter 5, Chapter 10 (10.2-10.4, 10.6)
- D. Simchi-Levi and Y. Zhao (2007). Three Generic Methods for Evaluating Stochastic Multi-Echelon Inventory Systems.

10. Bullwhip Effect & Game Theory Primer (11/7)

Content: Beer Game. Information, Gaming and the Bullwhip Effect. Supply Chain Contract Theory.

Readings:

- Lee, H. L., V. Padmanabhan and S. Whang (1997). Information Distortion in a Supply Chain: The Bullwhip Effect. *Management Science* **43**, 546-558. (Myung Song [90], Phat [90])
- S. Axsater (2006). Chapter 10 (10.6)

11. Supply Chain Coordination and Competition (11/14)

- Case presentation 1
- Dada, M., K.N. Srikanth. 1987. Pricing Polices for Quantity Discounts. *Management Science*, 33 (10): 1247-1252. (Kwon, Jilian)

- Cachon, G. 2004. The allocation of inventory risk in a supply chain: push, pull and advance-purchase discount contracts. *Management Science* **50**, 222-238. (Jilian, Wei)

12. <u>Supply Chain Competition & Information (11/28)</u>

- Case presentation 2
- Lippman, S. A and K. McCardle (1997). The Competitive Newsboy. *Operations Research*, **45**. 54-65. (Frank Alston, Jian)
- Cachon, G., M. A. Lariviere. 2001. Contracting to Assure Supply: How to share Demand Forecasts in a Supply Chain. *Management Science*, 47 (5): 629-646. (Phat, Frank)

13. <u>Special Topics 1 (12/5)</u>

- Case presentation 3
- Guajardo, J.A., M. Cohen, S. Kim, S. Netessine 2012. "Impact of Performance-Based Contracting on Product Reliability: An Empirical Analysis." *Management Science*, 58 (5): 961-979. (Jian, Andy)
- Powell, W.B., H. Topaloglu 2005. Approximate Dynamic Programming for Large-Scale Resource Allocation Problems. Chapter X in Tutorials of Operations Research. (Andy, Myles)

14. <u>Special Topics 2 (12/12)</u>

- Case presentation 4
- Chen, H., F. Murray, O. Wu 2007. "U.S. Retail and Wholesale Inventory Performance from 1981 to 2004." *Manufacturing & Service Operations Management*, **9**, 430-456. (Wei, Song)
- Huh, W.T., R. Levi, P. Rusmevichientong, J.B. Orlin (2012). "Adaptive Data-Driven Inventory Control Policies Based on Kaplan-Meier Estimator." To appear in *Operations Research* (Myles, Kwon)

15. <u>Final</u>