A STUDY ON FUZZY INVENTORY CONTROL SYSTEM UNDER DEMAND UNCERTAINTY

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Introduction

✓ Background

1. Inventory is needed to allow balancing between supply and demand.
2. Careful inventory control is needed to make good economic sense.
3. Considering demand uncertainty is important in inventory control.

Introduction (cont.)

✓ Problem

In an ordinary inventory control system, the demand uncertainty is measured by statistical model of a normal distribution, specified by Mean and Standard Deviation.

Prediction of Mean and Standard Deviation of demand used in an ordinary inventory control system is not always precise.

Many methods have been carried out for the precise prediction of future demand:

- Adaptive forecasting, such as Moving Average, etc.
- Fuzzy system.

Introduction (cont.)

✓ Objective

To investigate the effectiveness of Fuzzy inventory control system for controlling the inventory, especially with the presence of demand uncertainty.

In what condition Fuzzy inventory control system is effective?

When Fuzzy inventory control system is more effective?

Review of Past Studies Related to Fuzzy Application in Inventory Control

Problem Domain:

- Solving demand uncertainty by utilizing demand as Fuzzy variable.
- Showing the effectiveness by comparing the inventory control systems (ordinary, moving average and Fuzzy inventory control system)

Differences between this study and the other past studies:

- Utilizing demand as Fuzzy variable with membership functions.
- Comparing the inventory control systems by dynamic simulation with the possibility that the value of future demand will change.

Data Used for the Dynamic Simulation of Inventory Control

Many data have been collected and the following data have been decided which are appropriate with the needs of the study.

- ✓ Demand Data

  Perpetual demand with normal distribution specified by:

  Mean : 651 units/day

  Sta. Dev. : 200 units/day

- ✓ Lead Time Data

  Constant 2 days.

- ✓ Relevant Costs Data

  Holding Cost : 20% of unit cost per annum.

  Ordering Cost : ¥688 / order (0.47% of unit cost)

  Stockout Cost : 0% ~ 4% of unit cost per unit.

  Unit Cost : ¥150

Model Design for the Dynamic Simulation of Inventory Control

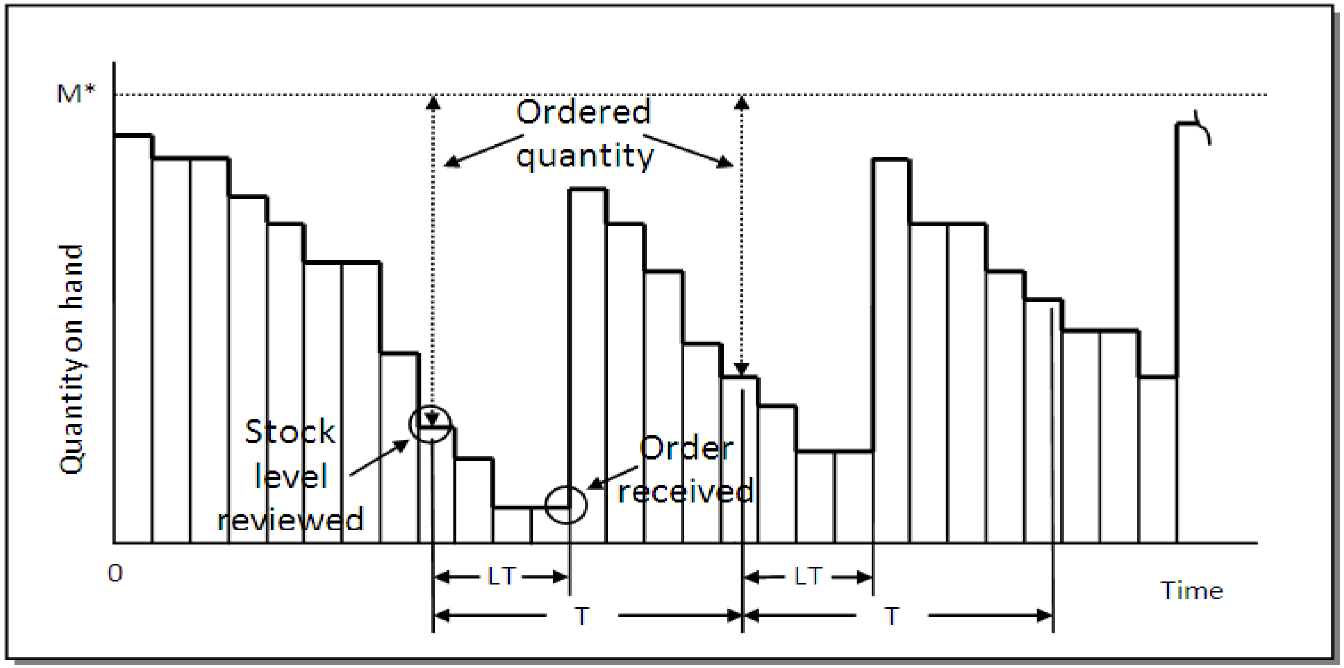
There are three dynamic simulation models, which have been designed in this study:

- ✓ Ordinary Inventory Control System.
- ✓ Moving Average Inventory Control System.
- ✓ Fuzzy Inventory Control System.

Basic method for controlling inventory is periodic review inventory control (base stock policy).

Model Design for the Dynamic Simulation of Inventory Control (cont.)

Periodic Review Inventory Control (Base Stock Policy)



Source: Ballou, R.H (2004)

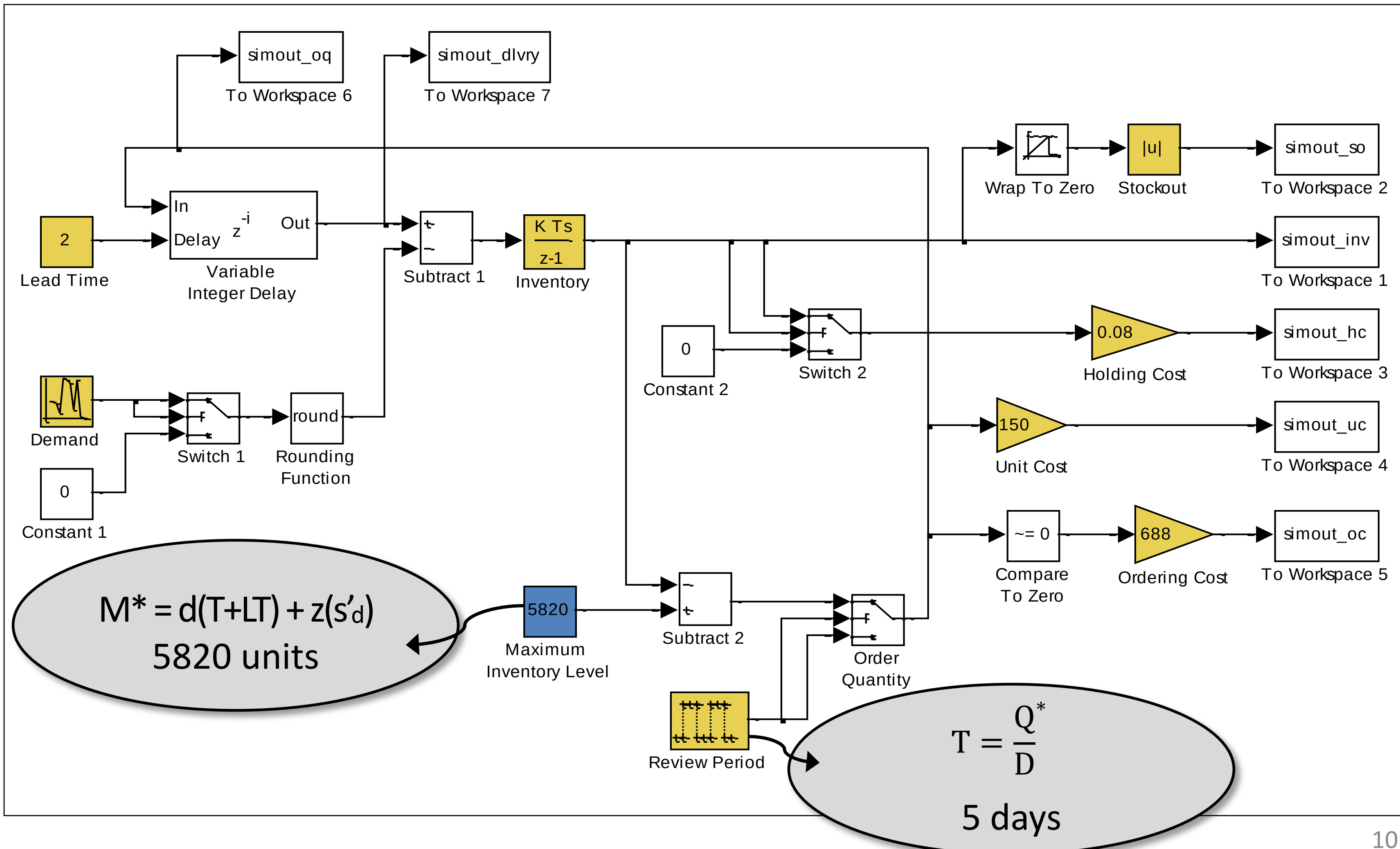
T = Re-orders period

M* = Maximum inventory level

$$Q^* = \sqrt{\frac{2CD}{H}} \qquad T = \frac{Q^*}{D} \qquad M^* = d(T + LT) + z(s'_d)$$

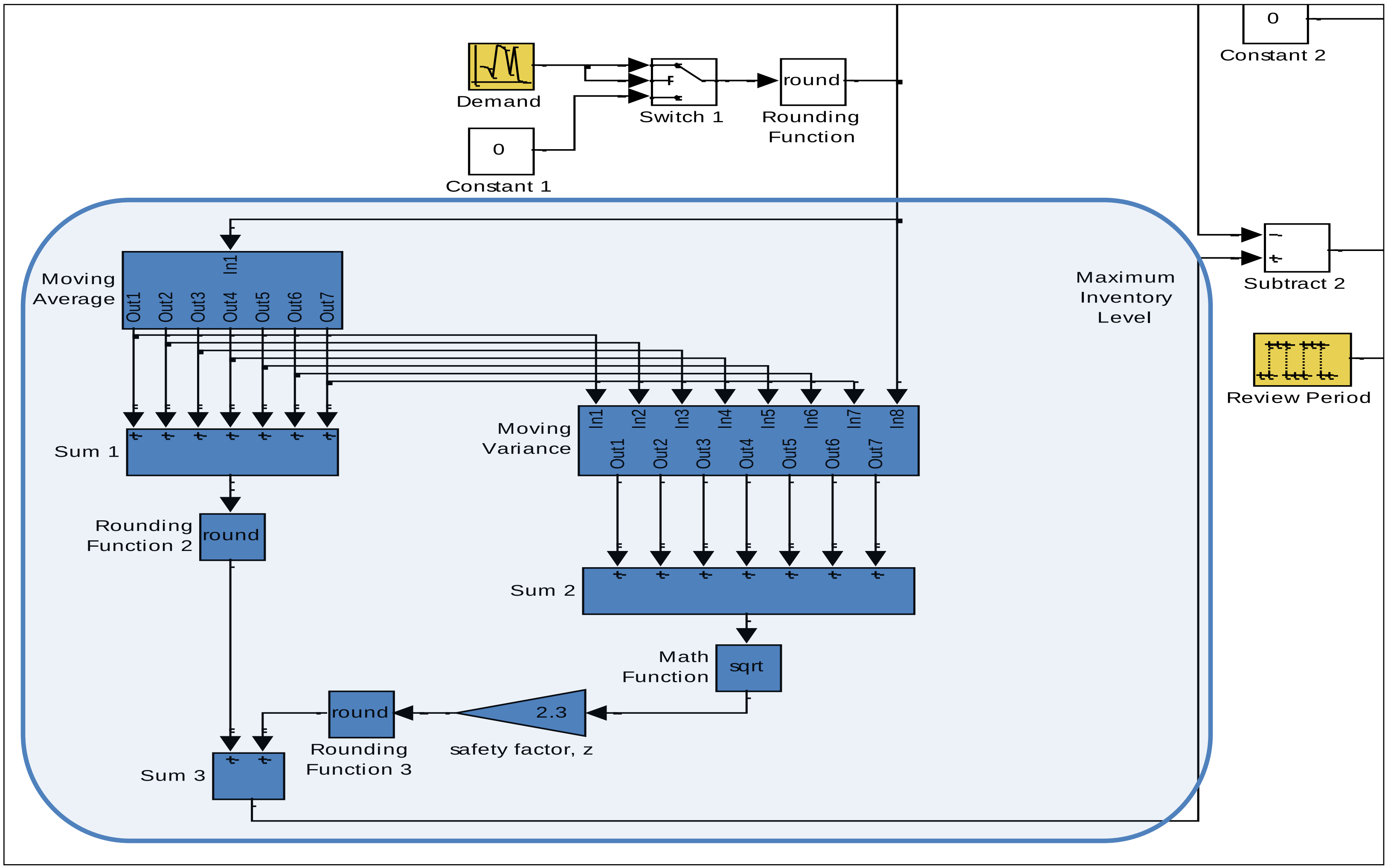
Model Design for the Dynamic Simulation of Inventory Control (cont.)

Dynamic Simulation Model for Ordinary Inventory Control System



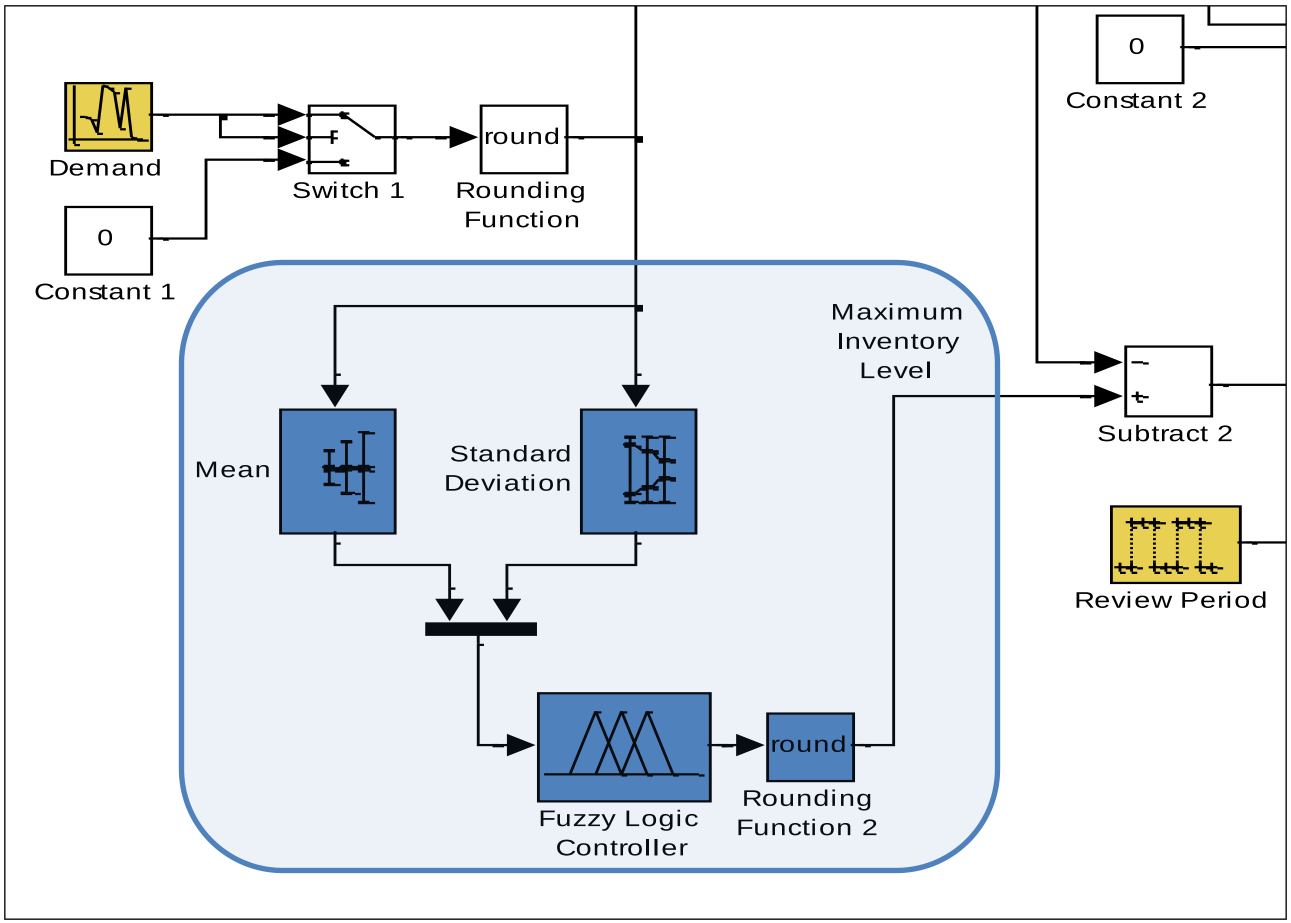
Model Design for the Dynamic Simulation of Inventory Control (cont.)

Dynamic Simulation Model for Moving Average Inventory Control System



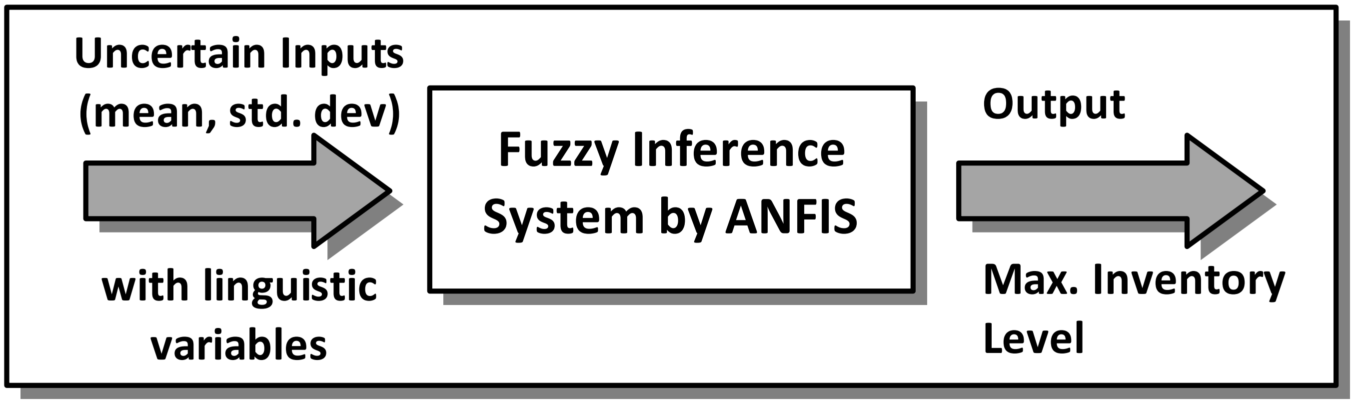
Model Design for the Dynamic Simulation of Inventory Control (cont.)

Dynamic Simulation Model for Fuzzy Inventory Control System



Model Design for the Dynamic Simulation of Inventory Control (cont.)

Process inside the Fuzzy Logic Controller Block



Fuzzy Inference System includes membership functions, rules, and output parameters.

ANFIS will construct a Fuzzy inference system with some parameters are tuned (adjusted).

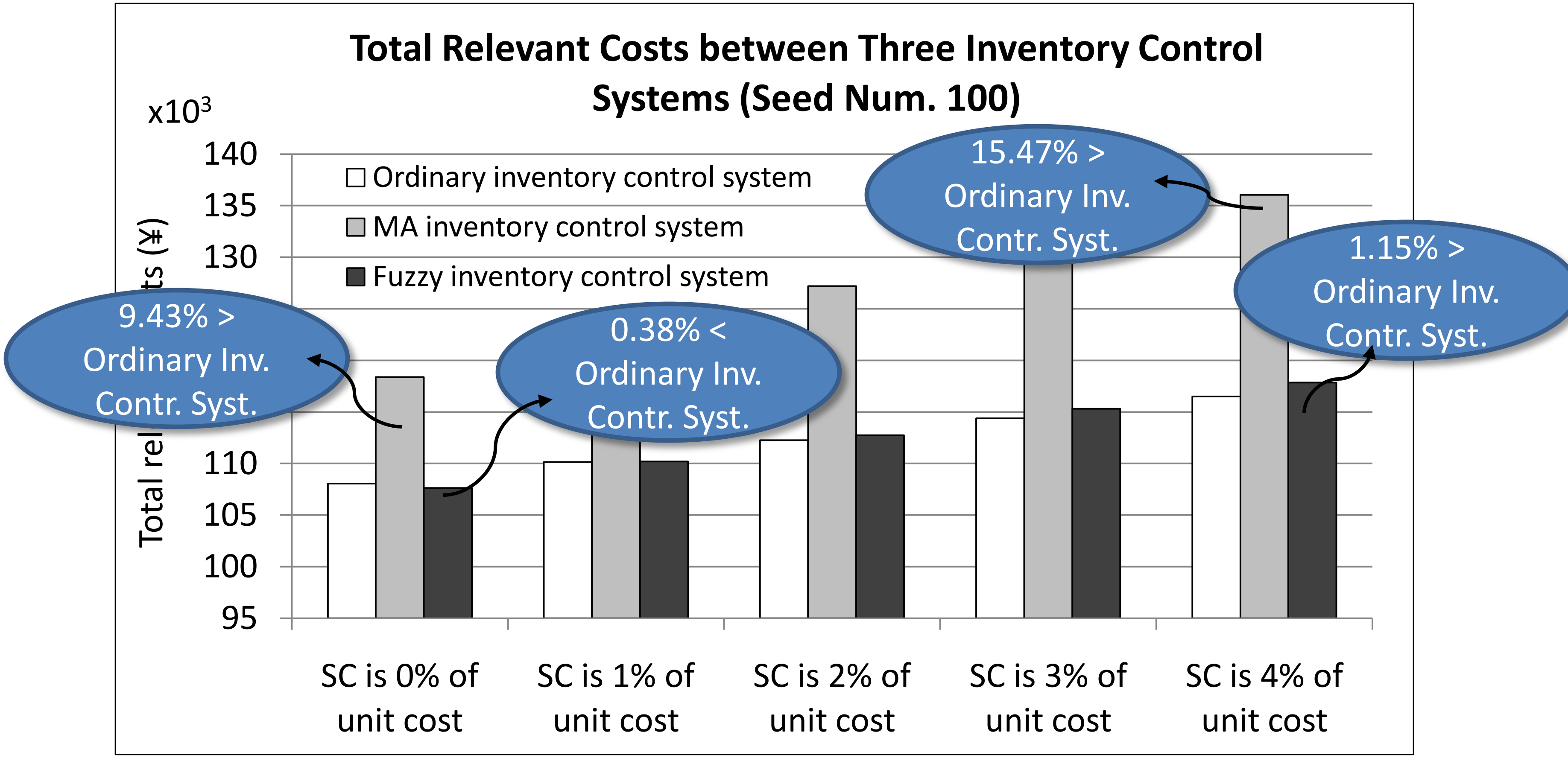
Result of the Simulations

Simulation Conditions

	Demand mean	Demand standard deviation
Condition 1 (There is no change with the future demand or the future demand is same as the expected demand)	Expected demand mean	Expected demand standard deviation
Condition 2-A (Future demand mean is uncertain, demand standard deviation is fixed)	Vary from -50% to +50% of expected demand mean (step is 10%)	Expected demand standard deviation (fixed)
Condition 2-B (Future demand mean is fixed, demand standard deviation is uncertain)	Expected demand mean (fixed)	Vary from -50% to +50% of expected demand standard deviation (step is 10%)

Result of the Simulations (cont.)

Simulation Results with Condition 1
(there is no change with the future demand)



Result of the Simulations (cont.)

Simulation Results with Condition 1
(there is no change with the future demand)

	Ordinary	Moving Average	Fuzzy
Service Level (%)	99.41	98.77	99.29

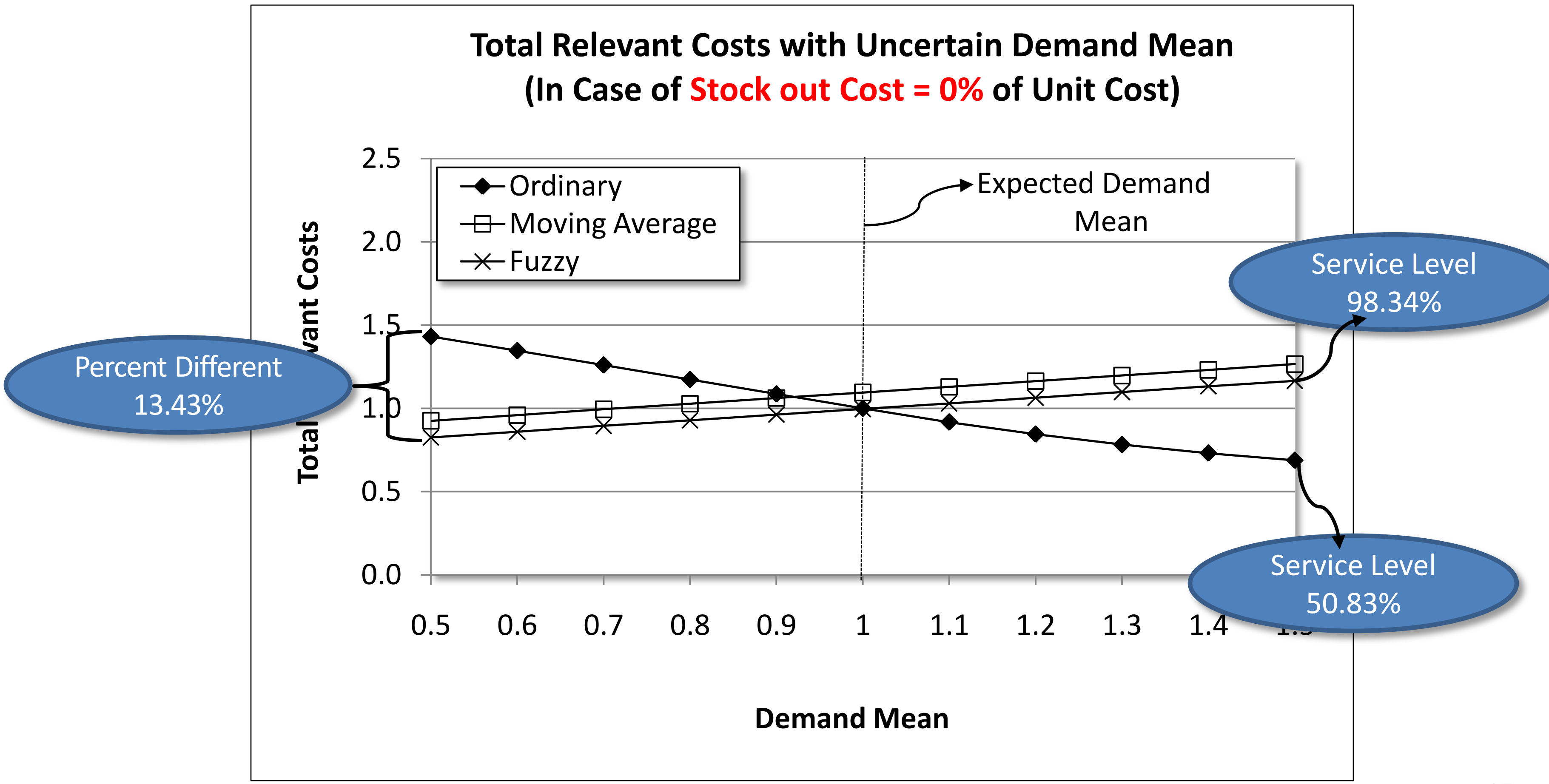
Conclusion of Simulation Results with Condition 1

When the stockout cost is not considered, Fuzzy inventory control system is more effective.

When the stockout cost is considered, ordinary inventory control system is more effective.

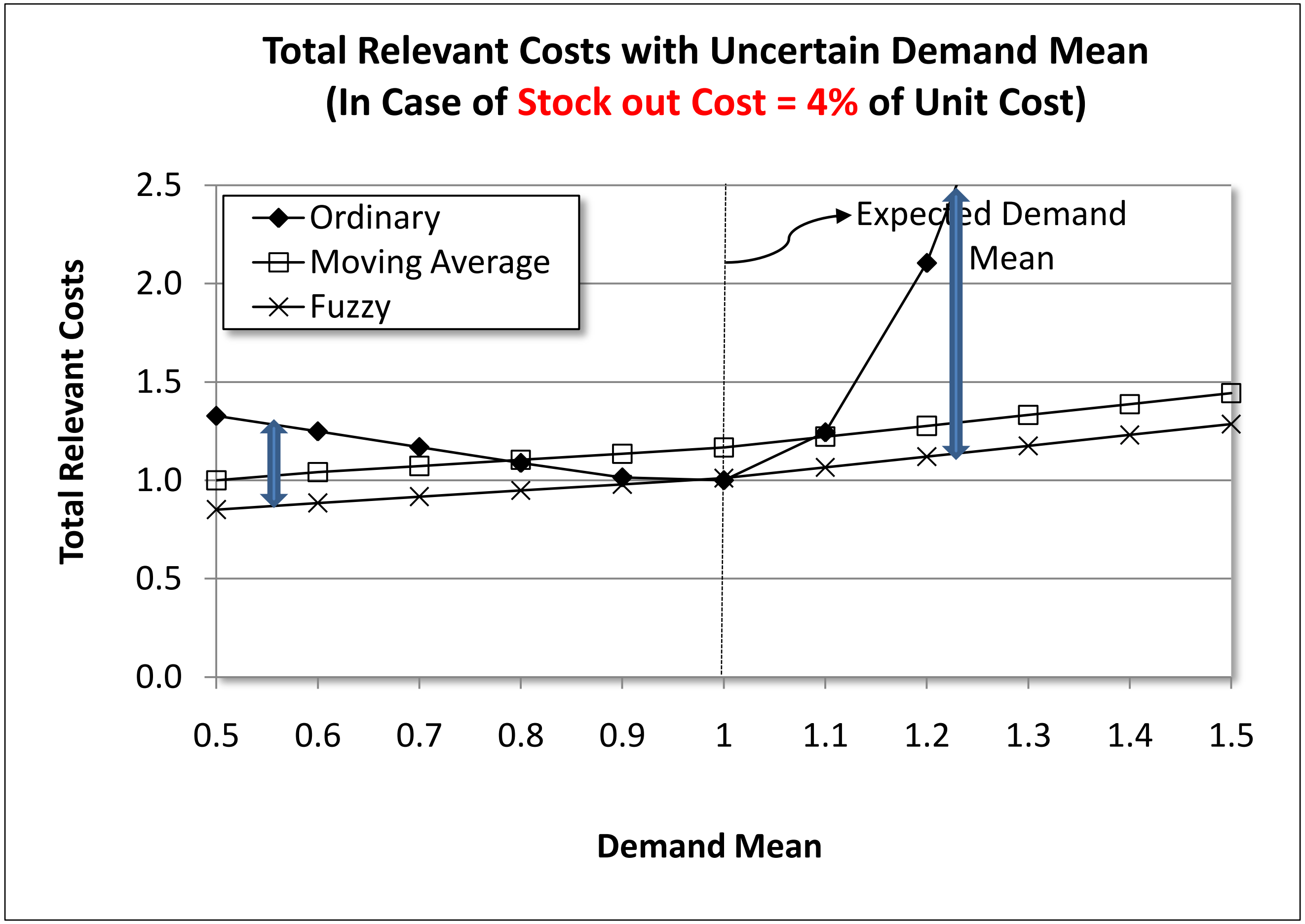
Result of the Simulations (cont.)

Simulation Results with Condition 2-A
(demand mean is uncertain, demand std. dev is fixed)



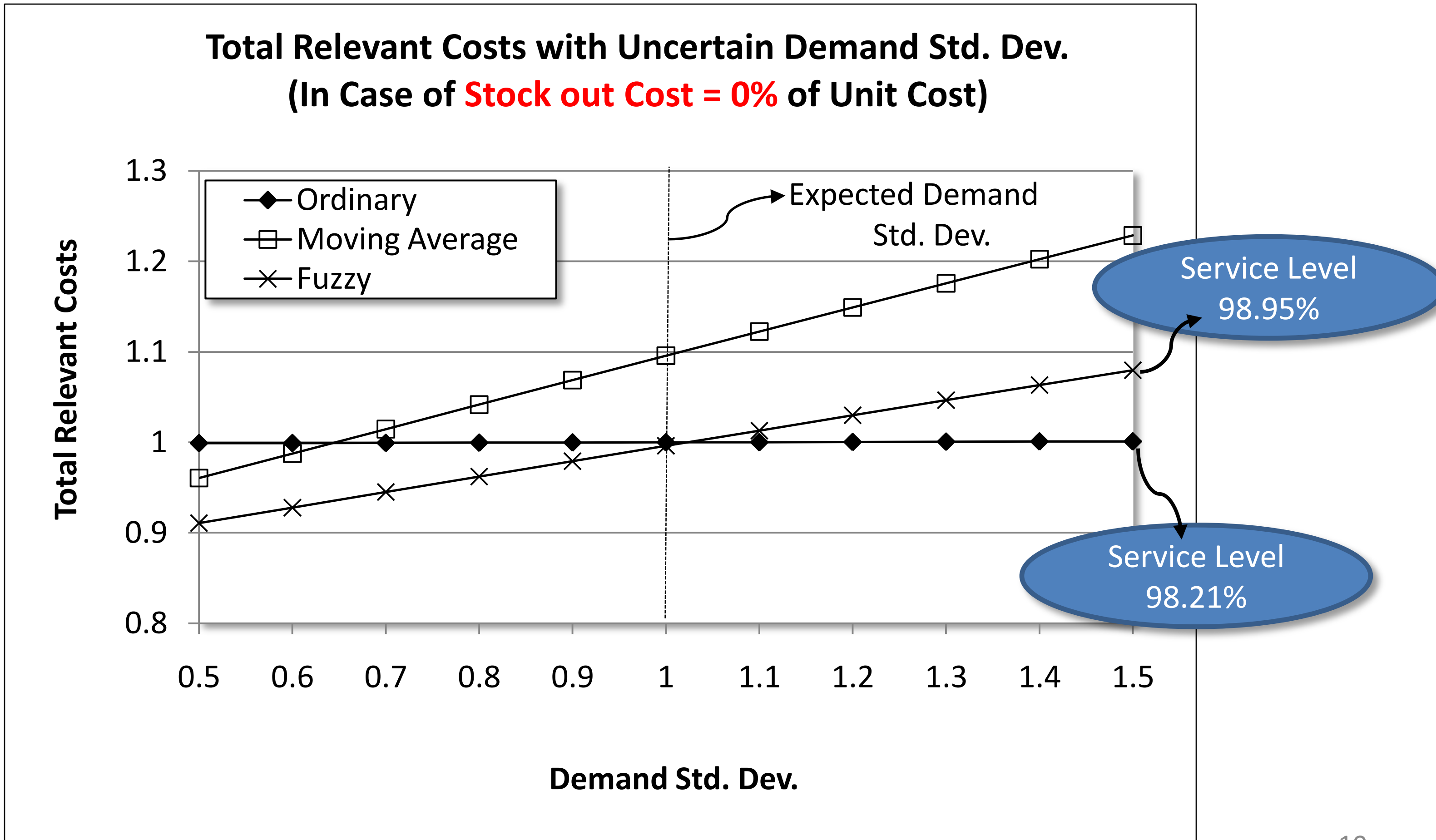
Result of the Simulations (cont.)

Simulation Results with Condition 2-A
(demand mean is uncertain, demand std. dev is fixed)



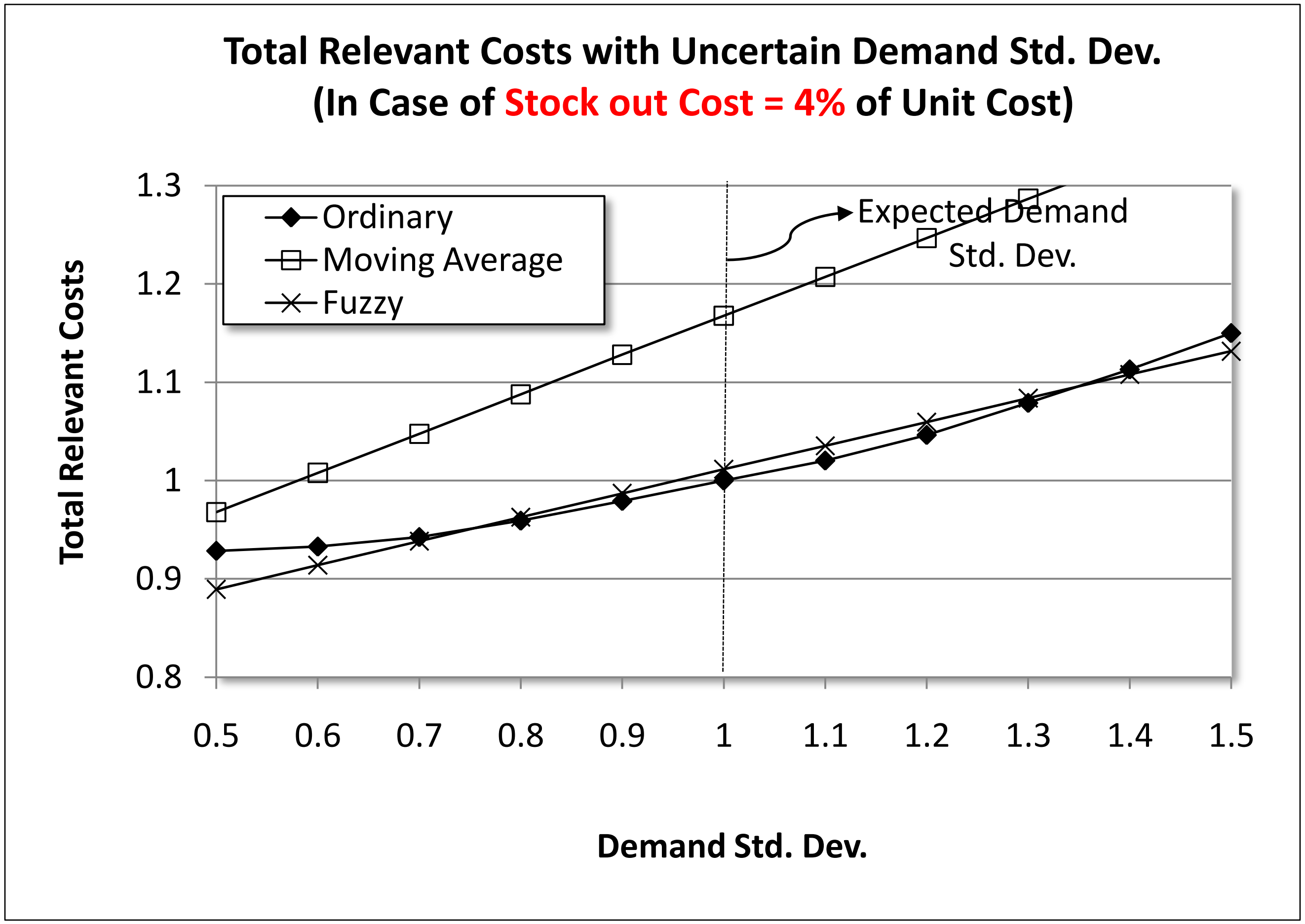
Result of the Simulations (cont.)

Simulation Results with Condition 2-B
(demand mean is fixed, demand std. dev is uncertain)



Result of the Simulations (cont.)

Simulation Results with Condition 2-B
(demand mean is fixed, demand std. dev is uncertain)



Conclusion

- When there is no change with the future demand:

  Fuzzy inventory control system is more effective (stock out cost is not considered)

  Ordinary inventory control system is more effective (stock out cost is considered)

- When the future demand mean is uncertain:

  Fuzzy inventory control system is more effective.

- When the future demand standard deviation is uncertain:

  Stockout cost is not considered:

  Fuzzy inventory control system is effective only when the future demand sta. dev. lower than the expected demand sta. dev.

  Stockout cost is considered:

  Both ordinary and Fuzzy inventory control system is effective.

Future Research Direction

- ✓ The other uncertainties such as supply uncertainty, lead time uncertainty and costs uncertainty can be present in inventory control.
- ✓ Comparing the result of this study with the result of the other studies with different Fuzzy system.
- ✓ Concerning the multi echelons/stages within the supply chain is also interesting for the future research.

Thank You
For Your Attention