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# Forecasts and Order Decisions: Reactions to Demand Variability

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# THE OUTLINE

The newsvendor problem

The literature

Experimental design (conditions, participants)

Results

Discussion & concluding remarks

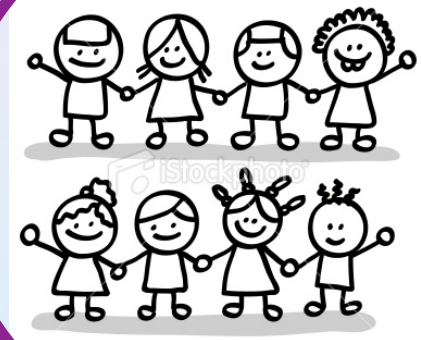
# The Newsvendor Problem



Buy from  $C$  /unit



Sell at  $p$  /unit



Uncertain Demand

Decision:

How many  
to "order"?

Unsold units are scrapped  
Unmet demand is lost

# THE LITERATURE

## REVIEWS ON NEWSVENDOR PROBLEM

- PORTEUS (2000), BENDOLY ET AL. (2006), GINO & PISANO (2008), LOCH & WU (2008), BENDOLY ET AL. (2010)

## BEHAVIOURAL NEWSVENDOR PROBLEM

- SCHWEITZER & CACHON (2000), BENZION ET AL. (2008), BOLTON & KATOK (2008), BENZION ET AL. (2010), GAVIRNENI & ISEN (2010), BOLTON ET AL. (2012), LAU & BEARDEN (2012), FELIER ET AL. (2013), KREMER ET AL. (2013), MORITZ ET AL. (2013), REN & CROSON (2013), VERICOURT ET AL. (2013), LONG & NASIRY (2014), OCKENFELS AND SELTEN (2014), RUDI & DRAKE (2014), KOCABIYIKOĞLU ET AL. (2015), ONKAL ET AL. (2020)

# Behavioural Findings

## Behavioral newsvendor studies:

- Actual vs. normative decision making
  - Normative order quantity :  $\Pr(\text{Demand} \geq x^*) = c/p$
- Orders *deviate* from profit maximizing quantities
- **Pull-to-center** effect (Schweitzer & Cachon 2000)
  - the *tendency* of the decision makers to set their order decisions between **the mean demand** and the **normative order quantity**

# Behavioural Findings

## Behavioral newsvendor studies:

- Explanations for the discrepancy include
  - psychological costs of underage and overage (Ho et al. 2010)
  - demand chasing (Bolton & Katok 2008)
  - random errors (Kremer et al. 2010)
- **Biased perceptions** of the **demand uncertainty** might be another important driver.
  - **Overprecision** (Ren & Croson 2013)
  - Decision makers may be *overprecise* so that they *perceive* the demand variability to be lower than its true value



# Behavioural Findings

## Behavioral newsvendor studies:

- **Overprecision** (Ren & Croson 2013)

- $D_p = \beta D + (1 - \beta)E(D)$

- $D_p$  is the **perceived** demand

- $D$  is the **actual** demand

- $E(D)$  is the **mean** of the **actual** demand



# Behavioural Findings

## Behavioral newsvendor studies:

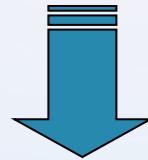
- **Overprecision** (Ren & Croson 2013)
  - $D_p = \beta D + (1 - \beta)E(D)$
  - $(1 - \beta)$  is the **overprecision parameter**
    - If  $(1 - \beta) = 0$ , decision makers are **perfectly unbiased**
    - If  $(1 - \beta) > 0$ , decision makers are **overprecise**, they *perceive* demand to be **less variable (more stable)** than it *actually* is.

# Behavioural Findings

If the decision maker's perception of uncertain demand is *different* from its true form



*Erroneous* judgmental demand forecasts



*Skewed* order decisions which *deviate* from normative quantities

- Understanding how decision makers *react to demand uncertainty* has important ramifications for
  - demand forecasting
  - resultant order decisions

# Research Questions

- How will decision makers' *order decisions* react to changes in demand variability?
- Will *pull-to-centre* effect persist?
- Will the decision makers demonstrate *overprecision*?

# EXPERIMENTAL DESIGN

## INSTRUCTIONS



- price = 120
  - cost = 30 (*high profit margin setting*)
  - cost = 90 (*low profit margin setting*)
  - demand distribution:  $D \sim \text{Uniform}$
- (Schweitzer and Cachon 2000)

- pilot round + 40 experimental rounds (4 levels of demand conditions - each treatment lasted 10 rounds)
- Study not time restricted
- Information message displayed on the screen when the cost/demand parameter changed



# EXPERIMENTAL DESIGN

## Between-subject

- **High profit margin setting** ( $p = 120$ ,  $c = 30$ )  
number of participants = 26
- **Low profit margin setting** ( $p = 120$ ,  $c = 90$ )  
number of participants = 29

## Within-subject

Demand condition	Demand Mean	Demand Variance
Uniform(30,50)	40	33.33
Uniform(20,60)	40	133.33
Uniform(10,70)	40	300.00
Uniform(0,80)	40	533.33



# EXPERIMENTAL DESIGN

The screenshot shows a web browser window titled 'RDSS'. The main content area has a light blue background. At the top, a white box contains the text 'Round 1' in bold black font. Below this, another white box states: 'Demand for this product is distributed uniformly between 0 and 80.' In the center, there is a table with three columns: 'Your order', 'Price', and 'Cost of ordering'. The 'Your order' column contains an empty white input box. The 'Price' column contains the value '120' in bold black font. The 'Cost of ordering' column contains the value '30' in bold black font. Below the table, a white box on the left contains the text: 'Please enter your decision and click \'proceed\''. To the right of this box is a blue button with the word 'Proceed' in white text.

Your order	Price	Cost of ordering
<input type="text"/>	120	30

Please enter your decision and click 'proceed'

**Proceed**

Sample screenshot from high-margin condition  
(**before** order decision)

# EXPERIMENTAL DESIGN

RDSS

## Round 1

Demand for this product is distributed uniformly between 0 and 80.

Your order	Price	Cost of ordering	Demand	Total revenue	Total cost	Profit
40	120	30	74	4800	1200	3600

Please press 'continue' to see the summary table

**Continue**

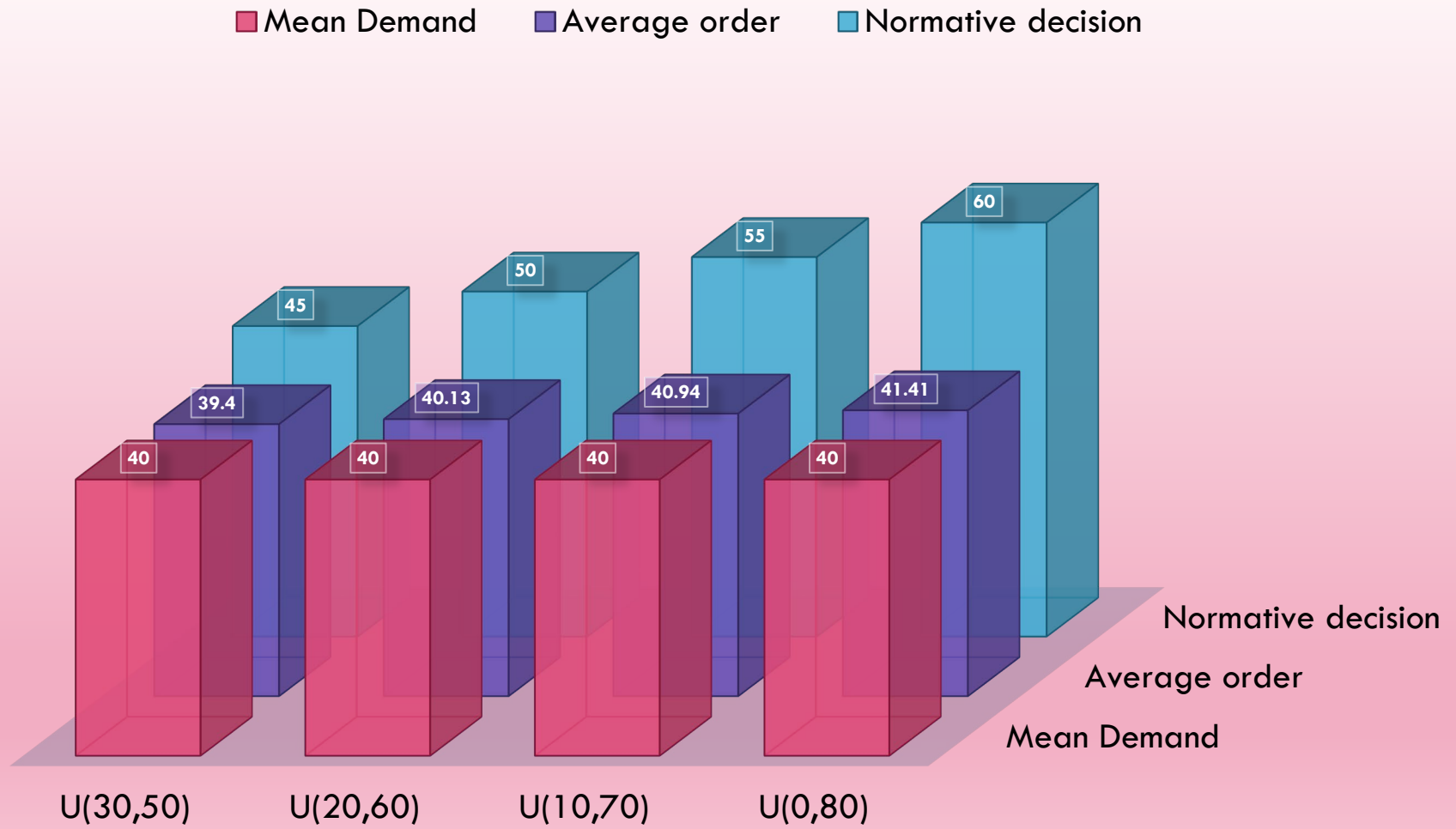
Sample screenshot from high-margin condition  
(**after** order decision)



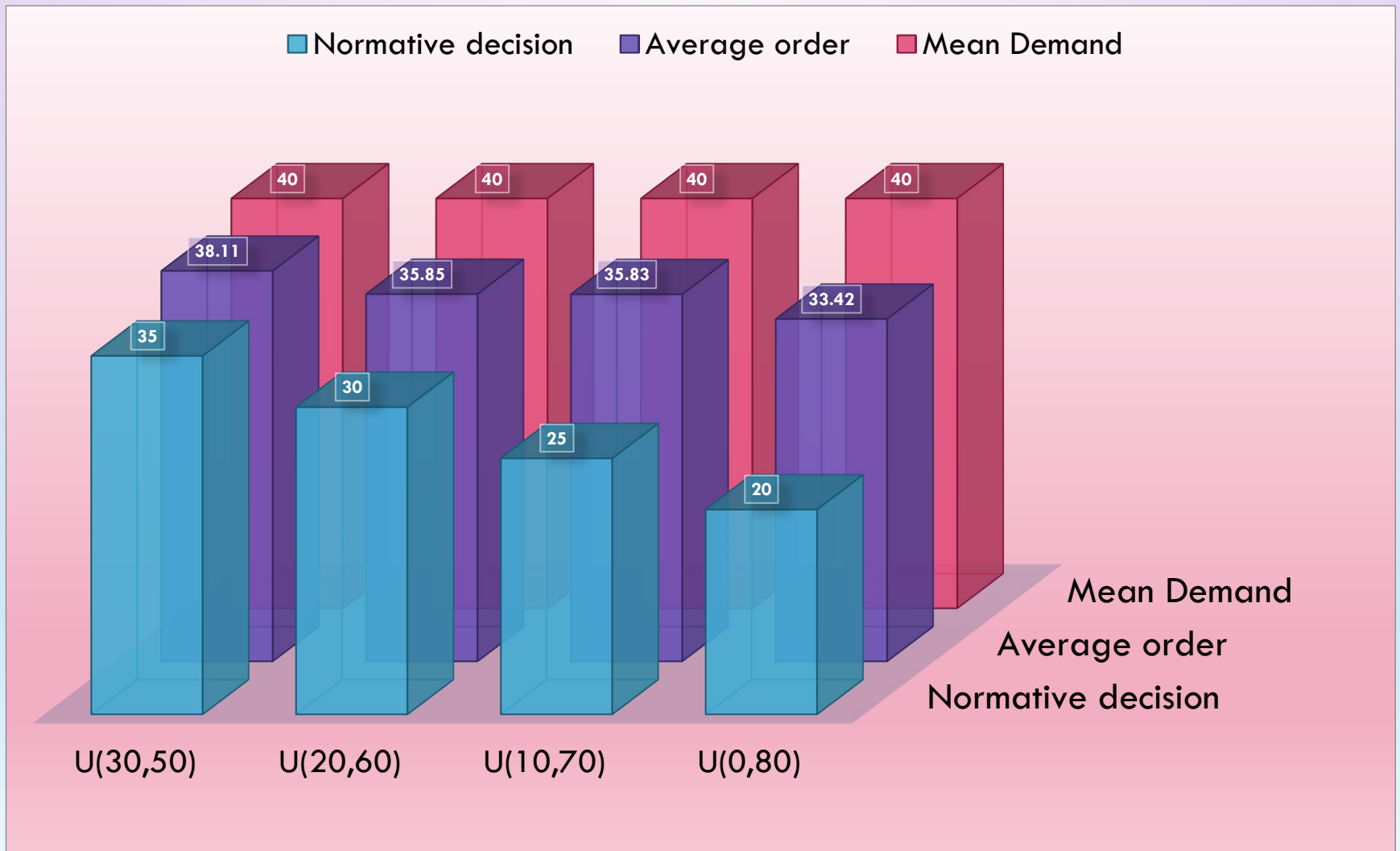
# RESULTS

Demand condition	High-margin setting		Low-margin setting	
	Average order decision	Normative decision	Average order decision	Normative decision
Uniform(30,50)	39.40	45	38.11	35
Uniform(20,60)	40.13	50	35.85	30
Uniform(10,70)	40.94	55	35.83	25
Uniform(0,80)	41.41	60	33.42	20

# RESULTS : HIGH-MARGIN



# RESULTS : LOW-MARGIN



# RESULTS : OVERPRECISION

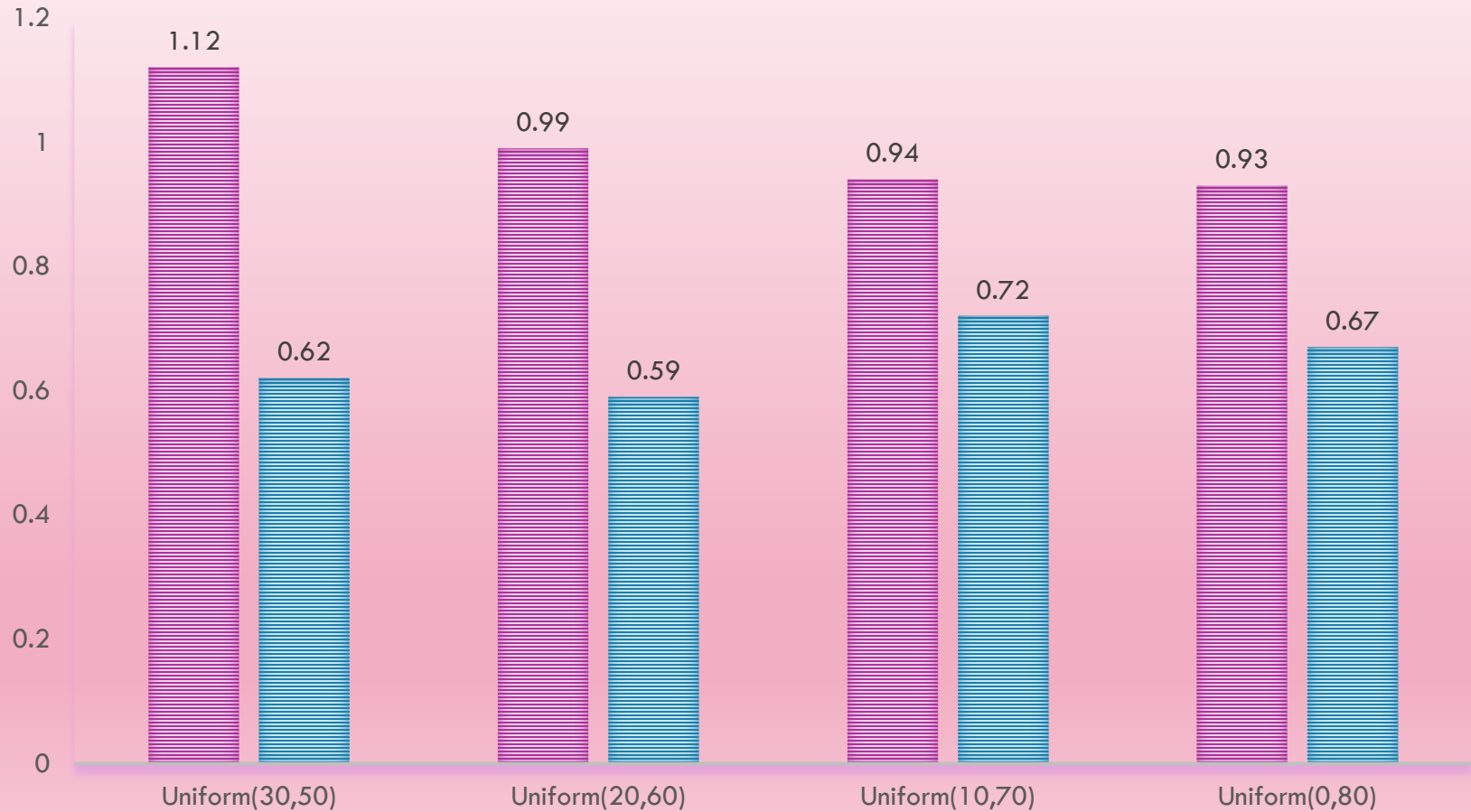
- The overprecision parameters ( $1 - \beta$ ) were uniformly **positive**.
- The participants *perceived* demand to be **less variable (more stable)** than it *actually* is

Demand condition	Overprecision Parameters ( $1 - \beta$ )	
	High-margin setting	Low-margin setting
Uniform(30,50)	1.12	0.62
Uniform(20,60)	0.99	0.59
Uniform(10,70)	0.94	0.72
Uniform(0,80)	0.93	0.67

# RESULTS : OVERPRECISION

## OVERPRECISION PARAMETERS

■ High-margin setting   ■ Low-margin setting



# Discussion & Concluding Remarks

- A behavioural study of newsvendor decision making under different demand patterns
- The *actual order decisions* differ profoundly from *normative* profit maximizing quantities
  - *Pull-to-centre effect* persists almost irrevocably
- Decision makers' *order decisions* react to changes in demand variability

# Discussion & Concluding Remarks

- Their average orders are *further away* from the *normative order quantities* as variability increases
- Decision makers seem to perceive demand to be *less variable* than it actually is for both *high-margin* and *low-margin* settings
- These findings are in line with Ren and Croson (2013) that decision makers are **overprecise** in perceiving demand uncertainty



# Future Research

- We need to better understand the process that starts with *perceiving the demand* and ends up with the order decision. Specifically,
  - How do demand perceptions affect the forecasts?
  - How do demand forecasts influence the order decisions?