



A new experimental model for profit maximization

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ABSTRACT

The main purpose of this study is to present a comprehensive model in experimental researches, to estimate bias and subjective judgment emphasizing the prominent role of Newsvendor model in inventory and control management that can be generalized for other financial and management areas to modify classic models. In the new approach the real information is the base of measurement and according to it, the new approach considering subjective bias, is complied, then will be comparable to other types of models. The paper also explains the process of work thoroughly.

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1.0 Introduction

One of the main activities of the management is decision making. The decision to identify problems determines the successor to solve problems, choosing from among them and implement the solution selected deals. In the literature of the new management, each of the traditional functions of management such as planning, organizing and controlling are the effect of a decision. The process of decision-making, is a function of the key factors in the decision, the decision maker and most importantly, the complexity of variables that are involved in the decision.

Planning and Control of inventories are the activities of supply chains and logistic systems decision. Thus, in many commercial and industrial companies, Determine the optimal level of inventories regarding demand uncertainty is the most important factor affecting the profitability arises. As yet, several research studies have been done in this area. Within in 1955 for the first time simultaneously examined the theory of pricing and inventory planning in uncertainty. He used to assess the model that later became the model of newsvendor.

Newsvendor model is the classical model of decision- making to determine the optimal level of perishable goods order in uncertainty (Chen & et al., 2013). The classic models are always in front of behavioral models. The classic models are based on absolute rationality, and behavioral models are mainly based on the bounded rationality (March 1994).

Simon (1980) believe that human rational is limited, and this limitation is caused by mental and sense and all discussion about decision should be by knowing the fact. Based on this mental and behavior error, the people open distinct account in their mind over their own financial decisions for evaluating each decision and try to consider to outcome (positive or negative) of every decision by themselves. So, from a whole look, people don't see their

decision set as a coherent whole, and it is possible for them to make decisions don't lead to maximizing their wealth.

Bias means deviation from correct and optimal decision making. Since the time and recognition resources are limited, we can't analyze optimally data which we get from the environment. Therefore, human's mind naturally is used fingertip rules. If these initiative methods are used properly, they can be effective. Else, inevitable misdeed can be happened that are developed by mental accounting (Lurie & Swaminathan, 2009).

Considering to main intellectual process in accounting is based on current classic economy assumptions such as autocratic rationality, interest optimization and other usual methods in the basis of linear methods and however, it is inevitable that managing of resources and properties in companies significantly is based on common assumptions. It should be mentioned that in terms of behavioral attitudes in managing processes and decision of results, some previous researches composed of : Thaler (1985, 1999); Simon (1991); Tversky & Kahneman(1981); Bonner & et al (2014); Chen & et al, (2013) and Chen & Davis (2014) is showed that behavioral attitudes and people's mental misdeed are so important and effective and will influence significantly on the results of calculations and classic measurements and without appraising and estimating of people's mental effects in classical equations, one can't attain to acceptable results.

Considering to subjects mentioned above and since the lack of comprehensive experimental methods in terms of determining importance amount in mental misdeed and personal judgment on management function and decision-making process tend to be far from reality and typical results, however, the main issue of present study is providing a comprehensive experimental methods in order to manage decision by Newsvendor's prominent model and theory called "overlook upon management and controlling inventories".

2.0 Behavioral decision-making

When it is identified the decision makers sense and mental limitation in full analyzing issues and when his/her inability is recognized for full utilization of information and combining and processing and providing, when it can be seen that most of the issues are of problematic and complex nature and at last when we find that prerequisite of data collection is high costs, a question is raised in mind that under these situations how a manager can face to decision-making issue and how the manager can make a decision as a best one (Saadat,1369).

Herbert Simon (1980) tries to respond this issue by proposing limited rationality concept. He believes that the human rationality is limited, and the limitation is due to mental, and sense limitation and every discussion about decision-making mechanism should be on knowing this reality. Therefore, social and organizational environments in where decision-maker occurs, can be effective in his/her decision process and method (Simon, 1987). In this method, decision-maker after considering some imperfect criteria for solving the problem, as soon as he finds a solution is a satisfaction, he leaves research regarding alternators and problem is ended (Robbins, 2000). March (1978) has extended this idea has proposed the contextual rationality. The model is believed that whenever people want to make a decision, they may be under pressures from the complex environment is affected by many other decisions and decision criteria and also in this situation, limited information and time are available for them. In other words, people as decision maker are in an unclear context, issues aren't clear for them, the relation between different indirect solutions and the whole process is occurred in a political context. Simon believes that choosing and decision making always are conducted on the basis of a limited, approximate and simplified of the real situation. In according to Newel and Simon (1972) reality is depended on what decision maker recognizes reality, say, probably what is recognized as reality by the decision maker, nor is real neither is a whole reality.

Issues and problems to which a decision-maker is faced with an organization, government or international level, often such multiple and abstruse that the manager as a human and with his human limitations doesn't have the ability for encountering and overcoming it and inevitably goes toward simplification. Simplification means that the manager tries to find the appropriate solution rather than the best one. Admitting to find appropriate and sufficient solution (rather than finding the best solution) make decision making easier and more practicable (Simon, 1987). Therefore, it can be concluded decision making like other concepts in management theory, an artificial production or a psychological concept is from the transaction of commitment and action. Decision making is tied to decision maker's psychological traits such that one can't propose and analyze one without another. Personality factors and elements such as temper, intelligence, energy, manager's attitude and insight and emotions all is so effective in his/her decision-making. So, from a Social psychology point of view studying decision-making should be conducted by considering decision-maker in all human traits (Saadat, 1993).

There are much different among people. For example, their experiences aren't identical; risk amount isn't equal for all of them. Security hasn't the same value for all and everyone isn't social like others. The importance of

personal differences among people is that information, what a person make a decision in basis on it, is interpreted, explained and understood according to these differences.

This study has investigated the effects of recognition misdeed and mental accounting on people's decision making, and it is considered an attitude by managers that is caused to lose resources. In other words, the decision about determining the optimum amount of inventory order for a spoilable commodity is evaluated over commercial and productive firms in insecure conditions.

3.0 Decision on determining optimum level order of spoilable commodity in insecure conditions

In the present study, it is investigated that what is the model used by managers for decision making and whether can the models based on mental accounting (prospect theory) provide to managers more comprehensive pattern for decision making or not. Over commercial firms specially one's concern to spoilable commodity, considering to the insecurity that consistently is regarding demand rate, determining of the optimum level is important for maximizing profit. Here, determining optimum level is related to a spoilable commodity. Spoilable commodity refers to commodities are vulnerable, spoilable, evaporable. Products such as nutrients, medicine products, refinery products such as alcohol, gasoline, radioactive etc are contained in the extensive spectrum of products. Another issue has influenced the determination of optimal order rate, is a phenomenon called *inflation* that influence costs over the time and consequently changes economical order policy. The important point in this issue is the inflation's effect on economic order policy for usual commodities and researches are implied that the inflation hasn't significant effect on spoilable commodity (Chen & et al, 2013. Mirzazadeh & et al, 1385)

To investigate the respective results of present study, it is used two models. First refers to the economical classic attitude of Newsvendor's model and second is the researcher's planned model according to the assumptions of prospect theory and mental misdeed adjustment that considering to the time value of money, each of model is compared to another under three pay scenarios, and the results are investigated. The model description and work procedure are followed.

3.1 Newsvendor's model

One of the validated models regarding behavioral election assumption on insecure conditions is Newsvendor's model (Chen & et al, 2013). The model is a mathematic model in managing operation and application economy that is used to determine the optimal level of spoilable commodity, and its primary concept is proposed from newsstand that is encountered to challenge "order and demand" and that is why called Newsvendor's model and newsstand (Vitin, 1955). The model is based on fixed price and possible demand level (with uncertain conditions) for a spoilable product. If commodity's inventory level is considered as q , every higher amount of given level is lost (loss of costumer loss) and every lower of given level will tend to loss of not selling and spoiling of the commodity. Therefore, according to Newsvendor's model, the decision maker should decide that what amount inventory level must be preserved to attain maximum gain and minimum costs? In this model, from an operational view, a decision-maker (manager) selects a product order level that is considered as q and also a manager is aware that he/she faces to a level of product demand (D). So, profit function according to assumptions of Newsvendor's model is followed: $\pi = E [p \min(q, D)] - cq$

Where, D is a random variable (with a contingency distribution of demand is denoted by F in this study). The price of every product is equal P , purchase value of every unit is equal to C , the available inventory is equal to q and at last, E is equal to mathematical expectancy of given function. By solving given function, optimum level of inventory amount is measured as followed:

$$q = F^{-1} \left(\frac{p - c}{p} \right)$$

Where F^{-1} is denoted the reverse of the mass distribution function. Schweitzer & Cachon (2000) found that the order amount in Newsvendor's model significantly has a propensity towards average. Different factors are influenced on Newsvendor's decisions that composed of initiative decision (Bostian & et al, 2008), the role of learning in feedback of decision results (Bolton & Katok, 2008, and Lurie & Swaminathan, 2009), estimating deviations of demand (¹Feiler & et al, 2012), psychological costs (Ho & et al, 2010), limited rationalism (Su, 2008, Kremer & et al, 2010).

3.2 Prospect theory

Prospect Theory has assumed that everyone's value function possesses positive and negative deviations (profit and loss) from a reference point that is provided in basis on classic concepts. The place of the reference point is

depended on two standard category and decision makers' expects and providing results of information (framework). According to the prospect theory, the slope of value function is in loss realm severe than in profit realm and the value function's form is convex for profits and is concave for losses and it is represented people's jobbery (Roodposhti, 1393). Application concept of the theory is that for example when people are investing they wouldn't pursue maximizing their investment, but they purchase stocks separately and without considering the relation among them. Mental accounting is considered the methods investors assess outcomes. Investors' mental misdeed that is caused to lose their massive look on investment collection is provided in basis on mental accounting that is pursued to make a relation for enjoying of investment profit (product or service) and avoiding to cost for earning product or service. This mental misdeed is caused to people make some decisions are conflicted to maximize wealth.

Another application concept on mental accounting is Framing. Framing theory means that each person mentally forms an equation in his/her mind that at last is determined favorite and person's expected desire. This concept similarly is used on Kane man and Toresky's prospect theory. Many Theoretician on mental accounting is used framing as value function in their analysis (Thaler, 1999). In other words, as seen in diagram 1, people assess their mental results by using the S-shaped value function. The value function is defined for profits and losses and shows that there is discount sensitivity both for profit and loss. But the important point is that according to prospect theory the favorite ratio each person gains per as 1000 Dollars, wouldn't be equal to the favorite ratio for losing 1000 Dollars and because of people's loss-escaped trait, the favorite ratio for a person per as a loss is higher than the same ratio per as a gain.

Now and for providing a new experimental method, two models are compared versus real information. The first model, Newsvendor's model; the model based on classic assumptions that are called expected a profit-maximizing model, and the second one is based on the hypothesis of prospect theory and is called comprehensive research model. Mentioned models are compared, and the results are tested.

3.3 First model: Newsvendor's model (expected profit-maximizing model)

To describe the mentioned model, the function $R_i(q, D)$ is considered as compensating function. Selling number is denoted by q and the developed demand is denoted by D under pay scenario $I \in \{O, S, C\}$. In this way, decision maker considers all sell and purchase paying as integrated and the optimum number of order for maximizing expected profit on every scenario is followed:

$$R_i(q, D) = \begin{cases} -cq + p \min(q, D) & \text{if } i=O \\ (p-c) \min(q, D) - c \max(q-D, 0) & \text{if } i=S \\ (p-c)q - p \max(q-D, 0) & \text{if } i=C \end{cases}$$

The optimum selling number that maximizes the expected profit is followed:
 $q^i = \arg \max_q E_D[R_i(q, D)]$

Where \arg is a maximization function. In this model which is identified as a normalized and classic model. Maximized amount q^i equals Economic Order Quantity (q^*).

3.4 Comprehensive research model: The adjusted model by mental misdeed (comprehensive model)

Taller (1985) has suggested on his researches that for a consumer pay and gain ratio isn't considered as a distinct frame, but the paying is connected to consuming from a mental view and also consuming is connected to paying (Perlect and Levinshtin, 1998). But an important point is that intensity of the connection isn't identical and differs depending on occurrence sequence of each subject. In this interpretation, people use typical mental accounting that is known as "prospective accounting". In other words, if paying is done at the start of treatment by prospecting gain to future, the intensity of the connection between pay and gain will be stronger and vice versa. If consuming is conducted at the beginning and a person has the commitment to pay for future, then the intensity of connection will be weaker. Therefore, as the model's name shows it follows a prospective viewpoint and looks towards enjoying at future and according to a hypothesis on the model, people don't include enjoying at the past in own decision making. There are same conditions in Newsvendor's model, and decision maker faces to input and output stream of cash that each one has special sequence and is identified according to develop demand. In the present study, there are three factors for pay and gain (each ordered unit, each demanded unit, each remainder unit). It is assumed that people mentally consider financial events separately. For a decision maker, paying on order time is considered connectedly to paying on demand time. So, according to this model, for all three scenarios, it is used the prospective accounting. On paying scenario O, weight factor β ($0 < \beta < 1$) is considered for paying on order time.

And on paying scenario C, weight factor α ($0 < \alpha < 1$) is considered for order time. For paying scenario S, no weight factor is considered. Compensate function is followed:

$$R^i(q, D) = \begin{cases} -\beta cq + p \min(q, D) & \text{if } i=O \\ (p-c) \min(q, D) - c \max(q-D, 0) & \text{if } i=S \\ \alpha(p-c)q - p \max(q-D, 0) & \text{if } i=C \end{cases}$$

The optimal order number that maximizes the expected profit is followed:

$$q^i = \arg \max_q E[R^i(q, D)]$$

4.0 New experimental method

The type of research is based on the purpose of experimental research. The experimental study more than other study's technique is based on positivism. The study characteristics are: the variables of the model are handled, other variables are remained stable and controlled and at last it is observed the independent variable's effect on the dependent variable. For this purpose, experimental groups are testing such a way that a proper number of educating a student (general universities) are selected for test and will be tested. Then research scenarios will be available to individuals with complete instruction and the mental, and real results are recorded directly by the researcher without any changes. Then, imperfect data is removed, and others are collected, and categorized to analyze. It should be mentioned that the given experiment has been held consistently during two stages called primary test and ultimate test, each person will be tested independently. On primary test, some random number (as random demand number) are available each (it is recommended that the given number exceed of 30 numbers per as each person) and according to random demand on that stage, the individual should declare his/her order number at same stage and in this way the results of each stage are recorded by researcher and the same process is repeated consistently and similarly. So, each person in basis on each pay scenario declares a q per as a D that from resultant of a person's comment set on every scenario, the mental account is defined for every person and according to it, factors α and β respective to comprehensive research model are estimated individually and separately and by multi variable regression test and then the comprehensive study model is extracted that we provide the comprehensive research model as inclusive model.

Then all people over statistical community whom we conducted learning the process on them and are experienced the order process again will be tested at the same time and procedure (ultimate test). The real results for every person is assessed by mutual variance analysis and it is compared to comprehensive study model (inclusive model) and Newsvendor's model, and two characteristics are considered. In the first place, which model has the connection characteristic to decision making and the second one which model has the highest score regarding profit ratio. To assess the inclusive model from the connection view on decision making comparing to classic model, one can do as followed:

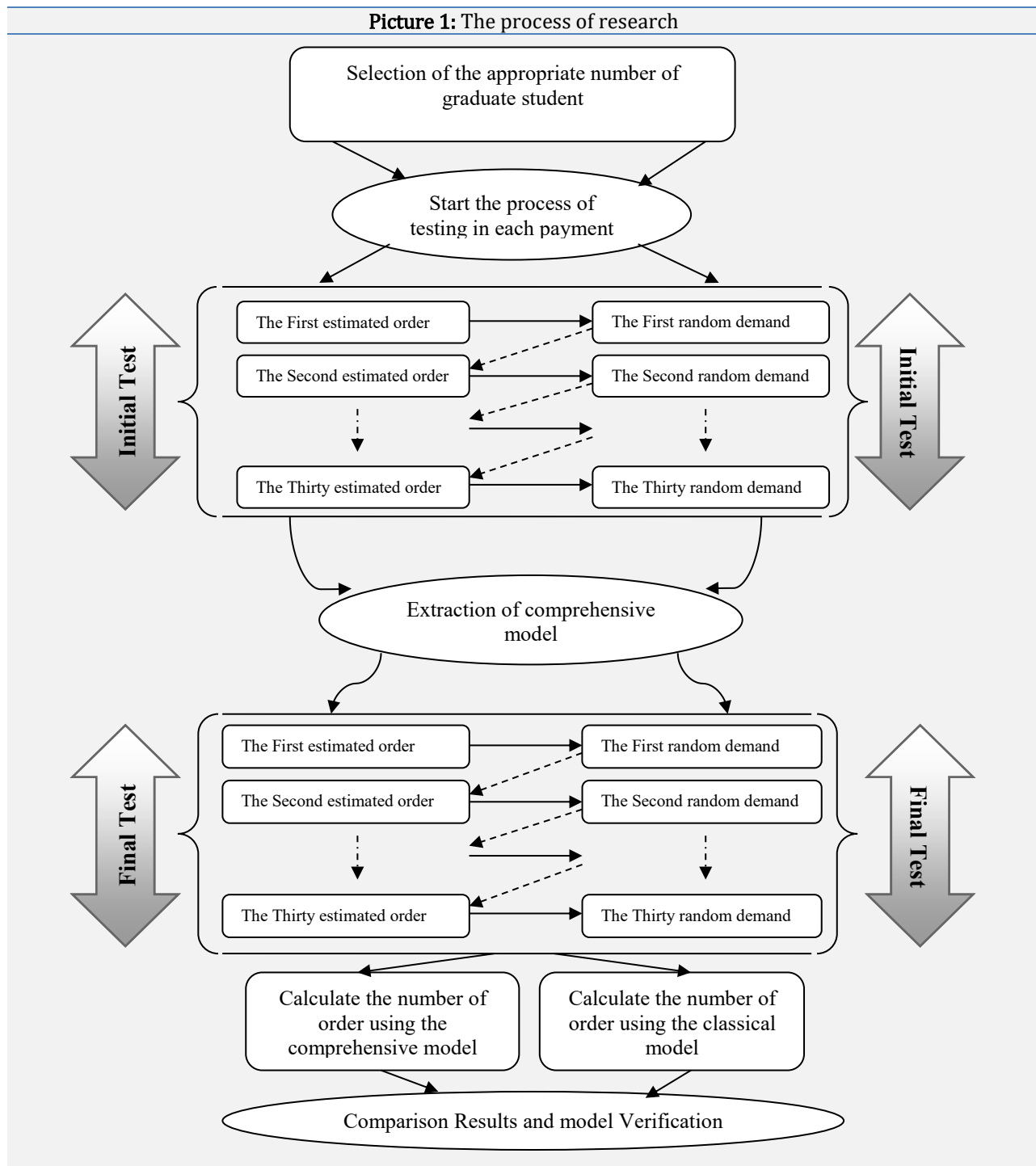
$$\sum |q_{(\text{Inclusive Model})} - q_i| \leq \sum |q_{(\text{Maximizing Model})} - q_i|$$

Where the inclusive model's connection characteristic is assessed versus classic model. In other words, the difference of order number according to Newsvendor's model $q_{(\text{Maximizing Model})}$ is considered by the real difference number q_i and the lower difference is closer to the results of real order number and when the inclusive model's lower difference is verified it can be concluded that the inclusive model from people's real action view point on decision making is closer to reality and it (inclusive model) posses more respective characteristic for decision-making.

For assessing the second characteristic, say assessing inclusive model regarding profitability at comparing of classic model, we can do as followed:

$$\sum |q_{(\text{Inclusive Model})} - D_i| \leq \sum |q_{(\text{Maximizing Model})} - D_i|$$

Where it is assessed the inclusive model's profitability characteristic in the ratio of the classic model. In other words, the order number difference according inclusive model ($q_{(\text{Inclusive Model})}$) is assessed by the real demand D_i at comparing the order number difference based on Newsvendor's model and the lower difference ratio denoted to be closer to real demand number and if the inclusive model's lower difference verified it could be concluded that the inclusive model is caused to more profitability than classic model. Therefore, the main purpose, maximizing accounting profit is realized by using inclusive model. Schematic diagram to conduct the study process is represented as followed on picture (1):

Picture 1: The process of research

5.0 Conclusion

The main purpose of the present study is providing a new experimental approach regarding managing and controlling inventory and optimum level order. In this research, it is used the Newsvendor's classic model to determine the optimal level order for spoilable commodities on uncertain conditions and since the human rational is limited and this limitation is from human's mental and sense limitation, all discussion about decision-making mechanism should be by knowing this reality. However, the comprehensive research model is provided by knowing the mental misdeeds to compare by classic model from the connection and profitability.

For conducting this research, some educating students (general universities) are selected for testing. The given experiment is held consistently during two stages. On the primary test, some random purposeful numbers will be available on three pay scenarios and according to random demand on given level, the person declares his/her order amount. From the resultants of a person's comment set in each scenario, every person's mental account is defined and according to it, the inclusive model's factor is estimated by multi-variable regression test and then

the comprehensive study model is extracted at the next stage, the ultimate test is conducted for statistical community's individuals who have participated in primary learning process and real results are investigated by mutual variance analysis. Then, by using real results, the efficiency of comprehensively extracted model as "inclusive model" and also Newsvendor's model regarding connection and profitability are compared, and the supreme model is introduced that is explained completely in future literature.

References

- Abad, P. L., (2003). Optimal pricing and lot-sizing under Conditions of perishability, finite production, and partial back ordering and lost the sale. *European Journal of Operational Research*, 144, 677–685.
- Bendoly E, Donohue K, Schultz K (2006) Behavioral operations management: Assessing recent findings and revisiting old assumptions. *J. Oper. Management* 24(6):737–752.
- Bhargava, J. N.; *Economics of Information Management*; Jaipur: Arihant Publishing House, 1993, Pp.62-5.
- Bolton GE, Katok E (2008) Learning by doing in the newsvendor problem: A laboratory investigation of the role of experience and feedback. *Manufacturing Service Oper. Management* 10(3):519–538.
- Bolton GE, Ockenfels A, Thonemann U (2010) Better decisions? Why experience managers aren't always right. *Internat. Commerce Rev.* 9(1):49–57.
- Bonner. S E, Clor-proell. S M, & Koonce L. (2014) Mental accounting and disaggregation based on the sign and relative magnitude of income statement items, *The Accounting Review*, Vol 89, No. 6, pp 2087-2114.
- Bostian AA, Holt CA, Smith AM (2008) Newsvendor "pull-to center" effect: Adaptive learning in a laboratory experiment. *Manufacturing Service Oper. Management* 10(4):590–608.
- Chen L, Kok G, & Tong J D. (2013) The effect of payment schemes on inventory decisions: The role of mental accounting, *Management Science*, Vol 59, No. 2, pp. 436-451.
- Croson R, Donohue K (2006) Behavioral causes of the bullwhip effect and the observed value of inventory information. *Management Sci.* 52(3):323–336.
- Drucker, Peter; "How the effective executive does it?"; *Fortune*; 1987, Feb. Pp. 142-145.
- Feiler DC, Tong JD, Larrick RP (2012) Biased judgment in censored environments. *Management Sci.*, ePub ahead of print December 19, <http://dx.doi.org/10.1287/mnsc.1120.1612>.
- Gourville J. & Soman D., Payment Depreciation: The Behavioral Effects of Temporally Separating Payments from Consume Piton, *Journal of Consumer Research* 25, 1998, pp.160-174
- Heath C. & Soll J., Mental Budgeting and Consumer Decisions, *Journal of Consumer Research* 23, 1996, pp. 40-52
- Ho T-H, Lim N, Cui TT (2010) Reference dependence in multilocation newsvendor models: A structural analysis. *Management Sci.* 56(11):1891–1910.
- Kahneman D, Tversky A (1979) Prospect theory: An analysis of decision under risk. *Econometrica* 47(2):263–291.
- Kremer M, Minner S, Van Wassenhove LN (2010) Do random errors explain newsvendor behavior? *Manufacturing Service Oper. Management* 12(4):673–681.
- Lim, S. S., Do Investors Integrate Losses and Segregate Gains? Mental Accounting and Investor Trading Decisions, *Journal of Business*, Vol. 79, 2006, no. 5
- Lurie NH, Swaminathan JM (2009) Is timely information always better? The effect of feedback frequency on decision making. *Organ. Behav. Human Decision Processes* 108(2):315–329.
- March, J; "Bounded Rationality, Ambiguity, and the Engineering of Choice", in *Bell Journal of Economics*, Vol. 9, 1978, Pp. 587-608.
- Newell, A., & Simon A.H.; *Human Problem Solving*; New Jersey: Prentice-Hall, 1972, Pp.34-5.
- Prelect D.& Lowenshtain G., The Red And The Black: Mental Accounting of Sowings & Debt, *Marketing Science* 17,1998, pp.4-28
- Read, D., Loewenstein, G. and Rabin, M. (1999). 'Choice bracketing', *Journal of Risk and Uncertainty*, 19:1-3; 171-197
- Robbins, S. P., (2000) *Managing Today*; New Jersey: Prentice Hall, P. 69.
- Schelling T. C., (1984) Self Command in Practice, in *Policy & in a Theory of Rational Choice*, *American Economic Review*, 74, pp.1-11
- Schweitzer ME, Cachon GP (2000) Decision bias in the newsvendor problem with a known demand distribution: Experimental evidence. *Management Sci.* 46(3):404–420.
- Shafir E, Thaler RH (2006) Invest now, drink later, spend never: On the mental accounting of delayed consumption. *J. Econom. Psych.* 27(5):694–712.
- Simon, H., (1991). "Bounded Rationality and Organizational Learning". *Organization Science* 2 (1): 125–134.
- Simon, H. A.; "Making Management Decisions: The role of Intuition and Emotion"; *Academy of Management Executive*; No. 1, (Feb. 1987), Pp. 57-64.
- Simon, Herbert H. (1980) "Cognitive Science: The newest science of the artificial"; *Cognitive Science*, 4: 33-46.

- Su X (2008) Bounded rationality in newsvendor models. *Manufacturing Service Oper. Management* 10(4):566–589.
- Thaler RH (1985) Mental accounting and consumer choice. *Marketing Sci.* 4(3):199–214.
- Thaler RH (1999) Mental accounting matters. *J. Behav. Decision Making* 12(3):183–206.
- Thaler, R. H. and Johnson, E. J. 'Gambling with the house money and trying to break even: the effects of prior outcomes on risky choice', *Management Science*, 36(6) (1990), 643-660.
- Thaler, R., (1990) Anomalies: Saving, Fungibility, and Mental Accounts, *The Journal of Economic Perspectives*, Vol.4, No.1, Winter.
- Thaler, R. H., (1999). Mental Accounting Matters. *Journal of Behavioral Decision Making*, 12(3), 183–206.
- Tversky D, Kahneman D., (1981) The framing of decisions and the psychology of choice. *Science* 211(4481):453–458.
- Whitin, T. M., (1955). Inventory control and price theory. *Management Science*, 2:61-68.
- Woodman, R. W.; J. e. Sawyer, & R. W. Griffin; "Toward a Theory of Organizational Creativity"; *Academy of Management Review*; April 1993, Pp. 293-321.