THE GOOD NEWS-BAD NEWS EFFECT ON THE DECISION-MAKING PROCESS IN INVENTORY MANAGEMENT IN SUPPLY CHAIN ENVIRONMENTS

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ABSTRACT

We review literature about decision making in supply chains, focusing on cognitive bias for inventory management. We present a model of the effects of one cognitive bias: a tendency to embrace good news while discounting bad news. We conclude with techniques to diminish these effects, and some empirical future directions.

Keywords: cognitive bias; decision-making; inventory management; supply chain

INTRODUCTION

On June 13, 2012, the International Energy Agency noted that Russian crude oils had been shifted from the Druzhba pipeline, which runs to central Europe, into the port city of Ust-Luga, which allowed Russian producers more flexibility in orienting their exports to profitable outlets (Rudnitsky, 2012). One month later, an energy analyst firm noted that the full impact of the opening of the Ust-Luga terminal would not be felt until later in the year (Argus, 2012). In August, a Reuters analyst observed that favorable tax rates on exports of refined oil products, coupled with the increasing sophistication of Russian refineries had enabled the Russian refineries to outbid exporters for Russian crude oil (Campbell, 2012a). This, in combination with a reluctance on the part of European refineries to produce excess fuel for storage, had led to the lowest level of Russian crude oil exports over the Druzhba pipeline since 2009 in spite of increasing overall Russian oil output. He warned, “the continued development of the Russian refining sector will likely further enhance this market power.”

On October 11, a Gaxprom executive made it official: European refiners risked being starved of Russian oil (Reuters, 2012a). Ten days later, the decreased flow from the Druzhba pipeline could not be made up from other crude oil sources, leading two refineries to halt production because they were unable to make up the shortage from other sources (Reuters, 2012b). European diesel fuel customers were hit with a supply disruption (Hovet & Payne, 2012) that led to wholesaler rationing and higher customer prices (Donati, 2012). Subsequent news articles pointed to what by now had become obvious to all: the combination of the opening of the Ust-Luga terminal (Platts, 2012), and the increased sophistication of the Russian refineries (Campbell, 2012b) had turned the table on inland European refineries.

The culprit was “backwardization” or a condition where the futures prices of a commodity are lower than the spot prices. In this condition, the European storage tank owners had an incentive to keep their inventory levels at a minimum, which meant that the smallest supply disruption (in this case the pipeline slowdown) can lead to shortages and large increases in prices. From an operations management perspective, the decision-making process of the storage tank owners is
perfectly rational – they keep their on hand inventory as low as possible in order to avoid selling their product for a lower price in the future. However, their “rational” behavior actually caused the storage tank owners to lose money when they didn’t have stock on hand to deliver when prices are higher.

When criticizing the decision-making of the storage tank owners, it is easy to point to the various warning signs that were available in the news. The more rational thing for them to do would have been to take the predicted changes into account and increase safety stocks, anticipating the supply disruption and being in a position to capitalize on it. However, human decision-making has been shown to be less than rational in most circumstances (Kahneman et al.,1982). In this paper, we explore the effects on supply chains of the tendency of human decision makers, specifically inventory managers, to avoid or discount bad news, which is one of the common ways in which people display their cognitive limitations (Sharota et al., 2012).

**CONCEPTUAL BACKGROUND AND DEVELOPMENT: LITERATURE REVIEW**

**Decision-making in the Supply Chain Literature**

Companies will experience bounded rationality in the decision-making process when balancing business and environment if they are restricted by limited information and information processing ability (March and Simon, 1993). Bounded rationality is “simply the idea that the choices people make are determined not only by some consistent overall goal and the properties of the external world, but also by the knowledge that decision makers do and don't have of the world, their ability or inability to evoke that knowledge when it is relevant, to work out the consequences of their actions, to conjure up possible courses of action, to cope with uncertainty (including uncertainty deriving from the possible responses of other actors), and to adjudicate among their many competing wants”(Simon, 2000, p. 25). It is hard for them to be certain about consequences when the information itself is uncertain and ambiguous and they are not conscious of all the related factors in the decision (Alvesson, 1993). Thus, people who obtain different information may construct different heuristics in the decision-making process (Busenitz and Barney, 1997).

In a supply chain management context, different heuristics may arise from differences in experience, coursework or other seemingly unrelated factors (Hill and Landro, 2012). These different heuristics of individual decision makers in a supply chain results in an even more complex overall process, making it difficult to establish a beneficial configuration for key supply chain factors like production and transport planning, coordination among supply chain nodes, information management, outcome management, and configuration management (Hernández et al, 2011).

**Four Phases of Effective Decision-making Process**

Simon (1960, p. 1) proposed that “decision-making comprises three principal phases: finding occasions for making a decision; finding possible courses of action; and choosing among courses of action”. These three processes are summarized as follows. The Intelligence phase consists of searching the environment for conditions calling for a decision to be made, and is largely based on the military definition of intelligence. The so-called Design phase consists of inventing,
developing, and analyzing possible courses of action. Simon’s third phase, Choice, encompasses the processes that support selecting a particular course of action from the available courses of action. Generally speaking, each phase is itself a complex decision-making process; the Design phase, for example, may call for new intelligence activities; problems at any given level generate subproblems that, in turn, have their intelligence, design, and choice phases, and so on (Simon, 1960).

In addition to describing these three phases of decision making, Simon (1997) also states that the evaluation of decisions is also important. Thus, we will consider Evaluation to be a fourth phase. In this phase, decisions are evaluated to determine whether they are correct. Furthermore, we suggest that Evaluation acts as a recursive step, which can in turn impact later decision making processes. This Evaluation phase may consist of three steps which include determining the completeness of implementation, evaluating the effectiveness of implemented solution and modifying the solutions when necessary (Bednarz, 2011).

**Decision-making Process in Inventory Management**

One of the most important decision-making processes in a supply chain surrounds the activity of inventory management. Inventory management refers to the processes in a firm that are used to maintain stocks of finished products, work in process, and raw materials (Krishna et al., 2009). Inventory control plays a critical role in the demand-supply relationship: a well managed inventory provides a good opportunity for customer satisfaction and smoothes the production planning processes, all of which are critical to the entire supply chain (Lee and Liu, 2010). If done properly, inventory management can increase revenue for a firm by avoiding missed sales, while at the same time decreasing costs by reducing the need for expedited shipping or overtime production runs (Krishna et al., 2009).

Broadly speaking, inventory management is a process that relies on human estimations. Even when supported by technologies such as a hand held computer, a manager will generally walk the aisles of their accumulated inventory and choose how much to order based on how much inventory is on the shelf and how much they expect to consume in the coming days or weeks. Therefore, the process relies heavily on the perceptions and understanding of the inventory manager and, when demand and/or supply estimates are incorrect, can lead to over- or under-ordering, and resulting over- or under-stocking (Moole and Korrapati, 2004).

Inventory management decision making can also be view from the perspective of the four phase decision making process. In Intelligence phase, an inventory manager is expected to analyze large amounts of data, including historical sales data (Moole and Korrapati, 2004). Using this historical data, the inventory manager will estimate the trend of customer demand and use this information as they make a decision in the following phases. In Design phase, the inventory manager may use some forecast methods like decision support system to help making a decision. The large data sets of historical sales are generally too large to be processed without the aid of computer-based information systems (Moole and Korrapati, 2004). The use of a decision support system can mitigate cognitive biases and potentially eliminate such phenomena as the bullwhip effect because a system can store and analyze the historical data. This enables the manager to make a more scientific estimation of the trend of demand and thereby give more rational suggestions about the ordering. Demand can be dependent on a variety of factors like category,
price, promotion, competition, historic sales, new products, and even weather (Moole and Korrapati, 2004). Even in the most primitive analysis of historical data (e.g. forecast based on average for previous week) is generally better than a pure guess (Moole and Korrapati, 2004). In Choice phase, the inventory manager should determine, at best, minimum and maximum inventory levels that are to be kept to achieve a desired level of performance (Ramaekers, 2009). Holding too much inventory results in costs of storage, opportunity costs for missed sales of other items or capital costs, and/or excess storage management costs (Dubey, 1991). Not holding enough inventory can lead to problems with customers (whether internal or external). In this final phase, the inventory manager makes their decision about ordering in order to meet the customer demand. In Evaluation phase, the inventory manager will evaluate whether the ordering decision is right or wrong. In the optimal case, the decision maker will compare the desired outcome of their performance measure with the actual outcome that was achieved; however, even decision evaluation is subject to human limitations on decision making, meaning supply chain decision.

**Cognitive Bias in the Supply Chain Literature**

In supply chain literature, there have been increasing calls to recognize the limitations of human decision makers. People are a crucial component of operating systems from manufacturing and services to supply chains and R&D (Gino and Pisano, 2008). The sustained significance of human behavior in operation management implies that people have a significant impact on how operating system work, perform, and respond to management interventions. Most formal supply chain models assume that people can distinguish signal from noise, that they will only react to relevant information and not consider irrelevant information, that their preferences are consistent, and “their decision-making process incorporates all relevant alternatives and variables and is unhampered by cognitive biases or emotions” (Gino and Pisano, 2008, p.4).

However, it is in fact impossible for human decision makers to behave rationally. Supply chain complexity is a function of the interrelationships among elements in the supply chain, while supply chain decision making complexity is a function of human cognition and decision making processes (Manuj & Sahin, 2011). Thus, “real world supply chains are messy,” consisting of numerous, different employees with various levels of experience and diverse cultural backgrounds; inevitably, there are hidden actions and information (Amaral & Tsay, 2009, p. 632). In such an environment, supply chain managers must navigate with tactics better interpreted by bounded rationality and behavioral biases than by economic optimization.

For example, “systematic decision biases, such as the disregard of alternatives or the acceptance of a ‘satisficing’ rather than an optimal solution caused by cognitive heuristics can lead to unwarranted outcomes in the supplier selection context” (Kaufmann, Carter & Buhrmann, 2012, p. 413). Such cognitive biases are seen even more profoundly in an inventory management context – one of the causes of the bullwhip effect is the cognitive bias that causes people to underestimate the inventory in supply chains (Croson & Donohue, 2002). Furthermore, suboptimal decision making in a supply chain is specifically linked to person-level issues; recent work has identified specific cognitive deficits that may affect the replenishment management (Tokar, 2010).
Because that the decision-making process in inventory management is easily affected by
cognitive biases (Carter et al., 2007; Sprague and Callarman, 2010), there exist almost
unavoidable deviations from the standard assumptions of the “rational economic actor” and thus
it is necessary to identify and develop debiasing strategies in supply chain management
(Kaufmann et al., 2009).

When it comes to reducing/minimizing the effect of cognitive bias on supply chains, two
effective methods stand out. One is to replace humans with computers when making decisions in
supply chain because information technology such as demand forecasting is not affected by such
bias and thus can considerably diminish the bullwhip effect (Zhang, 2004). Furthermore,
feedback on the historical performance of forecasting technology could reduce the impact of
cognitive biases that might impact the choice of which forecasting technology to use (Lee &
Gao, 2005). The second approach to reducing biases is to educate or train people in supply chain,
raising employee awareness (Smith-Daniels, 2007). Such training could be a broadening of what
is now taught as part of business ethics, to include what is known about how human minds work
and expose decision makers to the unconscious mechanisms that underlie decision making, and
include exposure to exercises and interventions that can further root out these biases (Banaji et
al., 2003).

A CONCEPTUAL MODEL AND PROPOSITIONS

Theoretical Foundation

Generally speaking, humans tend to discount bad news, but embrace good news when forming
their beliefs (Sharota et al, 2012). In a supply chain context, inventory managers would likewise
be prone to embrace good news when making decisions. Because there is a tendency to restrain
or change bad news, while at the same time overstating and diffusing good news, the reliability
of the communication networks the managers depend on to make decisions is adversely affected
(Larson & King, 1997). Researchers have studied the effect of good news in the background of
decision evaluation; for example, people are prone to alter their judgment about their own beauty
when they obtain some good information which implies that they are more charming than others
(Eil & Rao, 2011).

In a modern supply chain environment, inventory managers occupy a vital position in
manufacturing and retail industries, and are expected to develop systems that can minimize
inventory costs, improve the flow of inventory and meet customer demand in a timely fashion
(Beheshti, 2010). Thus, we expect them to tend to accept good news about their supply chain
while restraining or changing bad news.

Theoretical Development

Although the tendency of people to discount bad news but embrace good news is thought to be
due to human brain function (Sharota et al., 2012), there are practical reasons that good news is
more likely than bad news to even reach decision makers. We define good news as news that
supports the mission, ambitions and survival needs of the organization while bad news is defined
as news that discloses a gap between goals and actual performance, expresses doubts and
disagreement to a given course of action or proposal and negative feedback (Larson & King,
1997). We present our theoretical model of the effect on inventory management decision makers of embracing good news while discounting bad news in Figure 1 below.

![Diagram](image)

**Figure 1: Theoretical model of the effect on inventory management decision makers of embracing good news while discounting bad news**

*Proposition 1: If inventory managers only accept good news and discount bad news in the intelligence phase of the decision-making process, they will accept more good news about their suppliers and customers than bad news*

In the intelligence phase of decision-making, the inventory managers must be able to identify the problem and be able to state in clearly and concisely, or they will be unable to maintain a focus on the decision making process and its purpose (Bednarz, 2011). However, if the inventory managers only accept good news and discount bad news, they will not gain a better and comprehensive understanding of the existing problems and not be able to identify the problems reasonably and accurately. In particular, inventory managers will embrace more good news about their suppliers and customers than bad news. This can mean missing important information about the health of a supplier that might result in a supply interruption (Arntzen and Bruce, 2009), and an inventory shortfall.

The same tendency can apply to the customer side of the supply chain as well. For example, a customer might be reticent to discuss their plans to cut costs, which might mean the loss of a purchase order (Arntzen and Bruce, 2009). Furthermore, if customers start canceling orders and/or delaying payments, an inventory manager might tend to either ignore this bad news or not pass it along – a company in this situation that continues to order from and pay suppliers in full and on time will soon feel the “profit squeeze” (Arntzen and Bruce, 2009, p. 12).
People are not only prone to accept more good news than bad news from others, they are also likely to report more good news to their suppliers and customers. Manufacturers will report a good operating condition of their business to suppliers in order to make a good impression so that suppliers will choose them as partners. Organizations will also publicize and propagandize the merits of their product to their customers by advertisements and promotions in order to gain more brand loyalty.

*Proposition 2: If inventory managers only accept good news and discount bad news in the design phase of the decision-making process, they will fail to plan for the unfavorable information in inventory management*  

In the design phase of decision-making, it is important to develop, evaluate, and select alternatives and solutions to solve the identified problem over the entire range of acceptable options outlined in the intelligence phase (Bednarz, 2011). If inventory managers only accept good news and discount bad news, they will only select favorable information to develop, evaluate and select alternatives. The natural tendency for people to desire favorable information and defend in the face of unfavorable information always results in information distortion (Larson & King, 1997).

In an inventory management context, the decision to order a lot versus a little hinges to a large degree on the signals one receives from down and upstream sources. Sudden spikes in orders from customers can distort demand information (Moon and Dong-Jin, 2005), and lags in delivery or back orders can distort supply line projections. The information distortion will have a serious impact on selecting alternatives to solve problems. These alternatives might be useful and appropriate to solve some superficial or external problems considering the favorable information, but fail to plan for latent or internal problems that the unfavorable information can trigger. For example, if inventory managers only accept good news or good information, they are very likely to “fail to plan for the unfavorable information such as the devastating hurricane, the shocking terrorist attack and the collapse of an important supplier in the wake of political upheaval or accounting fraud” (Bosman, 2006, p. 4). Besides, the alternatives chosen in design phase will have a direct impact on the choice phase in the decision-making process. If the alternatives are not comprehensive and objective, the choice of alternatives are meaningless and thus the inventory managers can not arrive at the right decision about the optimal inventory level in the inventory management.

*Proposition 3: If inventory managers only accept good news and discount bad news in the choice phase of the decision-making process, they will not be able to make the correct decision in inventory management*  

In the choice phase of decision-making, one should choose the best alternatives and make a decision carefully and prudentially. If inventory managers only embrace good news but ignore bad news, it is impossible for them to choose suitable choices and make a right decision. Psychological research has shown that the cognitive errors people make in the decision-making process include being too risk averse and overstating small probabilities (Kahneman et al., 1982).
Human judgments fall prey to a number of systematic biases and distortions (Stracca, 2004). Kudryavtsev and Cohen (2011) considered two well-documented behavioral biases, namely, the hindsight bias and the anchoring bias. The hindsight bias occurs when people overestimate how predictable an outcome was when looking at their decision in light of the actual outcome. Anchoring bias refers to “people’s tendency to make estimates about the likelihood of uncertain events or to predict or recall certain values or outcomes by considering an initial value and adjusting it upwards or downwards to yield a final estimate” (Kudryavtsev and Cohen, 2011, p. 16). Hindsight bias affects “one’s perceptions of how much other people are responsible for the outcomes of their decisions – the bias makes these consequences appear more foreseeable than they probably were” (Kudryavtsev and Cohen, 2011, p. 20). When inventory managers embrace good news while discounting bad news, they are more likely to fall prey to these biases.

**Proposition 4:** If inventory managers only accept good news and discount bad news in the evaluation phase of the decision-making process, they will fail to alter poor decision making practices.

In the evaluation phase, one should measure the degree to which desired outcomes were achieved and try to modify the processes for obtaining those results if the desired outcomes were not achieved. If inventory managers only embrace good news and ignore bad news, they will not be able to evaluate our decisions or solutions rationally and fairly and thus they will fail to alter poor decision making practices. When inappropriate decision making processes are adopted, it will result in a compromised efficiency in the inventory management.

**DISCUSSION**

Thus, we should consider some methods to eliminate or minimize the effect of cognitive bias on decision-making in inventory management. As mentioned above, one proposed method is to replace humans with computers. Tools or technologies that mitigate the effect of cognitive bias on decision-making will improve the efficiency of inventory management. For example, in food inventory management, the existing approach only depends on human decision makers, however, the increase in errors due to human cognitive bias in decision-making makes food quality control become a difficult task (Lao et al., 2011). Thus, it is very important to employ a decision support system to enhance the inventory management. The bullwhip effect and cognitive bias hinder people’s judgments on the forecasts of demand, and thus affect the efficiency of inventory management. In order to eliminate this effect, Electronic Data Interchange (EDI) can diminish traditional information processing problems such as human error during data reentering and it contains a built-in content-related error check and integrates other information flows in the logistic process (Udo, 1993). In addition to information technology, we can also use some cooperative strategies like VMI (Vendor Managed Inventory) to share information and reduce the cognitive bias. For example, if the manufacturer and retailer can retrieve the customer demand information in synchronized manner by using EDI, a VMI strategy can be adopted to improve the performance of inventory management because the manufacturers can make the inventory replenishment decisions depending on the customer demand process directly without considering the retailer’s ordering information (Yu et al., 2001). Although cognitive bias might still affect the efficiency of the whole supply chain, some parts of a supply chain could employ systems that mitigate or eliminate these effects.
CONCLUSION AND FUTURE DIRECTIONS

Conclusions

In this paper, we have established a conceptual model for investigating the effect of cognitive bias on the decision-making process in inventory management in the supply chain environment. Using a theoretical paradigm based on the observation that human decision makers tend to embrace good news while discounting bad news, we propose the following. 1) If inventory managers only accept good news and discount bad news in the intelligence phase of the decision-making process, they will accept more good news about their suppliers and customers than bad news; 2) If inventory managers only accept good news and discount bad news in the design phase of the decision-making process, they will fail to plan for the unfavorable information in inventory management; 3) If inventory managers only accept good news and discount bad news in the choice phase of the decision-making process, they will not be able to make the correct decision in inventory management; 4) If inventory managers only accept good news and discount bad news in the evaluation phase of the decision-making process, they will fail to alter poor decision making practices. In order to diminish this effect of cognitive bias, two effective methods stand out. One is to replace humans with computers when making decisions in inventory management; the other is to educate or train people to raise their awareness to minimize the effects of cognitive bias in their decision-making process.

The main purpose of this study is to fill the gap between people’s cognitive bias and the decision-making process in inventory management. Previous studies have largely ignored cognitive bias in supply chain management. For example, most formal supply chain models assume that “people can distinguish signal from noise, that they react to relevant information and discard irrelevant information, that their preferences are consistent, and that their decision-making process incorporates all relevant alternatives and variables and is unhampered by cognitive biases or emotions” (Gino and Pisano, 2008, p. 4). However, it is in fact impossible for human inventory managers to behave rationally. Real-world supply chains are composed of different employees with various levels of experience and diverse cultural backgrounds, thus there are inevitably hidden actions and information (Amaral & Tsay, 2009). This paper focuses on cognitive bias in the decision-making process of inventory management.

Future Directions

Although this study provides a theoretical analysis and evidence that people’s cognitive bias would have a negative impact on the decision-making process of inventory management, it suggests several future research directions. This conceptual model should be subjected to empirical tests. In future research, a beer game-style experiment could be designed to test the propositions mentioned above. In the intelligence phase, participants will gather the information about their current inventory and shipment arriving for the week. In the design phase, participants estimate the trend of the current inventory and the shipment arrivals. In the choice phase, participants make decisions about the amount of order form distributor for next week according to the good news and bad news suggested in the design phase. In the evaluation phase, participants evaluate whether we make a good decision or bad decision according to the trend of current inventory for this week. Experimental interventions can be designed that would affect
each phase of decision making, and be designed in a way that tests the extent to which humans tend to highlight good news and ignore bad news.

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