Protocolo de investigación
Escuela de Administración
Universidad del Rosario

1. Información General

Nombre del Proyecto	*Decision-Making Biases in Operations: An Investigation of the Alignment between Decision Makers' Preferences and Operational Goals*	
Línea de Investigación	*Liderazgo y Comportamiento Organizacional*	
Programa de investigación	*--*	
Descriptores / palabras claves[1]	*Behavioral Operations, Decision-Making Biases, Experimental Economics, Inventory Management, Priming, Supply Chain Management*	
Investigador principal (nombre completo y apellidos)	*Jaime Andrés Castañeda Acevedo*	
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Co-investigadores	*Sebastián Villa*	
Duración	*2 years*	
Fecha esperada de Inicio y terminación	*May 2016 – May 2018*	
Clasificación del área científica o disciplinar	*Supply Chain Management*	
Costo general del proyecto		
Tiempo de dedicación semanal (agregando todo el recurso humano)	*06*	
Comité de investigación:	*May 25 / 2016*	

2. Resumen Ejecutivo de la propuesta

This research project aims to understand how decision makers' preferences for particular operational goals (e.g., optimize profit, optimize service level, meet a profit target, etc.) and their degree of alignment with given operational metrics (i.e., goals) affects performance in a traditional supply chain management area: inventory management (e.g., Newsvendor problem, Beer Game). Notwithstanding the identification of decision-making biases in this fundamental area, we still lack a clear understanding of the underlying causes of these biases. This project posits decision makers' preferences for particular operational goals and their degree of alignment with given operational metrics is an important determining factor of ordering behavior, determining how aligned/competing goals affect operational performance. We will use Experimental Economics to run behavioral experiments in inventory management. We will use also priming techniques from psychology to activate mindsets in participants aligned with given operational goals. Depending on the cell of the proposed factorial design,

[1] Identifique palabras claves que definen el proyecto y que permitan ubicarlo en sistemas de información

participants will be asked to choose order quantities with the aim of optimizing a given operational metric while holding a mindset associated with a given operational goal. This project expects to deliver a robust explanation of biased ordering behavior by exploring a hypothesized underlying cause, laying the foundations for further research that develops effective de-biasing strategies. Results could help operations managers prioritize decision-making improvements based on their mission and values and how much they are aligned with the nature of the products or services they offer.

3. Descripción de la propuesta

   a. Necesidad identificada (600 palabras máximo)

   This project posits decision makers' preferences for particular operational goals and their degree of alignment with given operational metrics is an important determining factor of ordering behavior.

   Some experimental evidence points to this direction. For example, Moritz (2010) observed that service level preferences could explain why order quantities are pulled away from the expected profit-maximizing order quantity for low profitability Newsvendor items, while Gonçalves and Castañeda (2013) observed that salient service level preferences could push order quantities toward the expected profit-maximizing order quantity for high profitability Newsvendor items. My postdoctoral research also points to related explanations. For example, participants in our Newsstand problem experiment tended to allocate some of their budget to low profitability items even though allocating nothing to them was a better strategy, suggesting service level preferences play a role. Also, some artisanal manufacturers in Castañeda *et al.* (2016) tended to choose order quantities that were below expected demand even though all contracts were high service level contracts, suggesting profit preferences play a role this time.

   Figure 1 illustrates how some misalignments work. Assume a setting where the metric subject to optimization is profit and the optimal order quantity is below expected demand, i.e., low profitability operation (left-hand side of Figure 1). If the decision maker has a preference for meeting customer demand —service level preference—, she would rather choose order quantities above this optimal order quantity: if she chooses the optimal order quantity, she risks no meeting much demand since expected demand is high, which is inconsistent with her preferences.

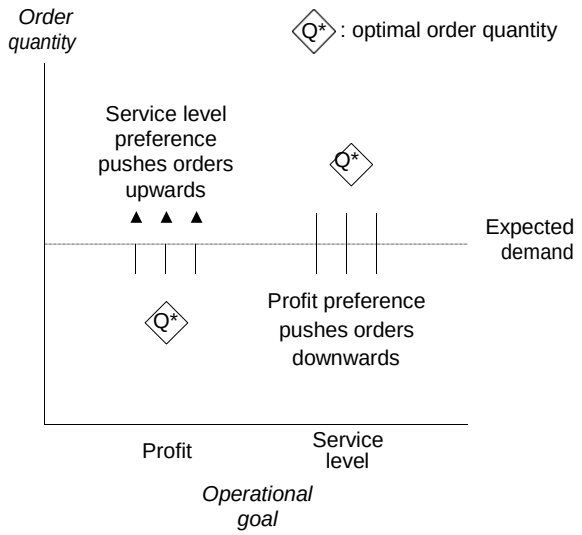

Figure 1. Misalignments between decision makers' preferences and operational goals.

On the other hand, assume a setting where the metric subject to optimization is service level and the optimal order quantity is above expected demand, i.e., high profitability operation (right-hand side of Figure 1). If the decision maker has a preference for meeting costs —profit preference—, she would rather choose order quantities below this optimal order quantity: if she chooses the optimal order quantity, she risks incurring high costs since expected demand is low, which is inconsistent with her preferences.

b. Objetivo (100 palabras máximo)

Determine how aligned/competing operational preferences in inventory management affect operational performance, laying foundations to increase our understanding of ordering behaviors and improve corresponding performance.

c. Fundamentación teórica (1200 palabras máximo)

Literature studying operational decisions from a behavioral perspective has focused mainly on two well-known settings: The Newsvendor problem (one-echelon supply chain system) and the Beer Game (four-echelon serial supply chain system). Within each, the literature has identified decision-making biases that drive operational performance away fromoptimum.

In the Newsvendor problem, research has identified two systematic decision-making patterns. First, an average decision maker tends to choose order quantities that fall between the expected demand and the optimal order quantity. This behavioral regularity is also known as anchoring —to the expected demand— and insufficient adjustment —toward the optimal order quantity— (Schweitzer and Cachon, 2000) or pull-to-center effect —pulling order quantities toward the expected demand— (Bostian *et al.*, 2008). These two expressions have underlying assumptions about the behavioral mechanisms at play. Some scholars prefer the more neutral term level bias (Rudi and Drake, 2014). And second, an average decision maker tends to choose order quantities that are positively correlated with the prior demand realization (e.g., Bolton and Katok, 2008; Schweitzer and Cachon, 2000). This behavioral

regularity is also known as demand chasing (Schweitzer and Cachon, 2000). Together, they contribute to suboptimal performance (Rudi and Drake, 2014).

On the other hand, work with the Beer Game has identified also two systematic decision-making patterns. First, average decision makers tend to not fully account for the orders they will soon receive from their upstream teammates when they choose their current order quantities. This behavioral regularity is also known as the underweighting of orders in transit (Sterman, 1989). And second, this underweighting of orders in transit tends to be stronger in the upstream echelons (e.g., Steckel *et al.*, 2004; Sterman, 1989). Together, they sink the entire supply chain into the bullwhip effect —oscillations in stock positions that are amplified as one moves up the supply chain (Lee *et al.*, 1997).

Several strategies that aim to reduce the extent of underperformance have been tested. Within the Newsvendor problem, scholars have tested providing extended learning opportunities (Benzion *et al.*, 2010; Bolton and Katok, 2008; Bolton *et al.*, 2012), training (Bolton *et al.*, 2012), improved outcome feedback (Bolton and Katok, 2008; Bostian *et al.*, 2008; Feng *et al.*, 2011; Lurie and Swaminathan, 2009) and sharpened payoff differentials (Bolton and Katok, 2008; Bostian *et al.*, 2008), among others. On the other hand, Beer Game research has tested providing training (Wu and Katok, 2006), point-of-sales data sharing (Croson and Donohue, 2003; Steckel *et al.*, 2004), inventory level data sharing (Croson and Donohue, 2005, 2006) and coordination risk control mechanisms (Croson *et al.*, 2014), among others.

Although a number of these strategies have been proven useful to some extent, we still lack a clear understanding of what causes these biased ordering behaviors (Katok, 2010; Ren and Croson, 2013). Understanding the causes of these biases is a critical step to developing effective de-biasing strategies (Kremer *et al.*, 2010; Ren and Croson, 2013). A number of scholars have proposed and tested cognitive reflection (Moritz *et al.*, 2013; Narayanan and Moritz, 2015), overconfidence (Ren and Croson, 2013), random errors (Kremer *et al.*, 2010; Su, 2008) and reference dependence (Ho *et al.*, 2010; Tong, 2012), among others.

Most of these causes are rooted in psychological explanations; however, not all of them provide robust explanations. For example, Ho *et al.* (2010)'s estimates are consistent with the reference dependence explanation; however, they cannot explain the typical asymmetry observed in level bias in which underperformance tends to be stronger in low profitability operations (e.g., Bolton and Katok, 2008; Bostian *et al.*, 2008; Kremer *et al.*, 2010; Lurie and Swaminathan, 2009; Moritz, 2010; Schweitzer and Cachon, 2000). Kremer *et al.* (2010) observed that providing an operations context to the ordering task does make a difference, showing no support for the random errors explanation. While the underweighting of orders in transit is linked to an individual's level of cognitive reflection (Narayanan and Moritz, 2015), level bias in low profitability operations is not (Moritz *et al.*, 2013).

Here, we draw on results observed in previous behavioral operations research (see section 3.a. above) and propose an alternative explanation that, at first sight, is consistent both with those results and with results of more traditional behavioral experiments in inventory management (e.g., Bolton and Katok, 2008; Moritz *et al.*, 2013; Schweitzer and Cachon, 2000). The

behavioral experiment proposed below will put to the test the rationale behind this alternative explanation.

d. Metodología (600 palabras máximo)

The main research methodology of this project is behavioral experiments. They are controlled tests of decision making. According to Experimental Economics, the key components of every experiment are: environment, institution and behavior (Smith, 1976, 1982). The environment is a set of initial circumstances that cannot be altered by the participants or the institutions within which they interact (e.g., economic parameters, available information, etc.) Our environment will be a Newsvendor problem.[2] The institution refers to the rules or procedures that govern behavior in the experiment. This institution is defined by the experimental instructions given to participants. Our institution will define the activities that participants will be asked to perform during both the priming and the decision making sections of the experiment. The behavior refers to the observed decisions of participants, which are interpreted as function of the environment and the institution (Smith, 1994). Our study will capture participants' ordering decisions.

A potential experimental design could consider three factors: decision makers' preferences, operational metrics and location of optimal order quantity, with the following levels in each factor:

* Three levels in decision makers' preferences:
  - No manipulation of preference (control group)
  - Preference for profit
  - Preference for service level

* Two levels in operational metric:
  - Optimize profit or meet a profit target
  - Optimize service level or meet a service level target

* Two levels in location of the optimal order quantity:
  - Below expected demand (i.e., low profitability operation)
  - Above expected demand (i.e., high profitability operation)

That is, we could consider a *3x2x2* full factorial between-subjects design (i.e., 12 treatments).

It is important to note that as our understanding of the research problem increases, the experimental design could change. For example, one could theoretically control for pull-to-center effect by choosing parameters so that the optimal order quantity was equal to the expected demand. In addition, one could run a pre-experimental test to check whether

[2] Beer Game experiments are more complex than Newsvendor problem experiments because of the considerable number of participants involved in the former, which is at least four times the number of participants in the latter. Hence, the development of a Beer Game experiment is contingent on the quality of the results observed in the Newsvendor problem experiment and would be a follow-up project. Alternatively, a more simplified two-echelon system (e.g., one retailer and one supplier) could be considered instead of the complex Beer Game setup (e.g., Villa *et al.*, 2015).

participants have a natural tendency for a given preference and decide treatment assignment based on those tendencies.

The relative advantage of experiments is control. When running an experiment, one should be able to state that, as between a number of treatments, individual characteristics either do or do not differ in a specified way. Such control is achieved by using two mechanisms: induced valuation and randomization. Induce valuation refers to the use of a reward structure to induce prescribed monetary value on the actions of participants, making individual interests irrelevant (Smith, 1976, 1982). Randomization refers to the random assignment of participants to treatments from a set of participants recruited from the same subject pool to avoid any systematic composition of participants in the treatments (Katok, 2010). Individual interests are thus made irrelevant and are randomized such that they do not correlate with the treatments, avoiding or sidestepping the problem of confounding (Siemsen, 2011). Hence, participants will be randomly assigned to treatments and rewarded monetarily contingent on their performance in the experiment.

The manipulation of decision makers' preferences will be done through priming techniques. Priming techniques are diverse. Some examples include roles (e.g., Anderson and Berdahl, 2002), physical cues (e.g., Chen *et al.*, 2001), conceptual/semantic priming (e.g., Smith and Trope, 2006) and mindset/episodic priming (e.g., Van Loo and Rydell, 2013). Although all of these techniques vary on multiple dimensions, they serve the same purpose in studying the consequences of the activated mindset. That is, the mindset is possessed or activated in one context, and then its effects are explored in contexts unrelated to the source or activation of the mindset (Smith and Galinsky, 2010).

The experiment will be programmed and run with the software z-Tree (Fischbacher, 2007). It will be run with approx. 240 to 360 participants assuming 20 to 30 subjects per treatment constitute a fairly representative sample size (e.g., Becker-Peth *et al.*, 2013; Ho *et al.*, 2010). Undergraduates and professionals are usually prone to the same operational biases (Bolton *et al.*, 2012; Croson and Donohue, 2006). Hence, participants will be drawn from a subject pool of undergraduates. They are also better suited to induced valuation given their low opportunity cost and steep learning curves (Hey, 1996; Morton and Williams, 2010).

e. Resultados esperados (100 palabras máximo)

This project expects to deliver an unexplored explanation of typical ordering behaviors in inventory management. By doing so, not only a better understanding of biased ordering behaviors will be provided, but also the inputs for further research that aims to develop effective de-biasing strategies.

Producto	***Fecha de entrega***	***Titulo***
Conference presentation	Behavioral Operations Conference Second quarter 2017	To be defined
Conference presentation	POMS Conference Second quarter 2018	To be defined
Submitted paper	Fourth quarter 2018	To be defined

4. Justificación de la propuesta con relación al proyecto del profesor y a la línea al cual se inscribe (300 palabras máximo)

This project builds on results from my doctoral dissertation and my postdoctoral research (see section 3.a. above). It is a natural extension of my work and is in line with my research interest on behavioral aspects of operational decision making. The project relates to the research line Leadership and Organizational Behavior by exploring decision making behavior within one core area of most organizations: supply chain management. Although it explores decision making of individuals, the decisions under consideration are also managerial decisions that can affect the performance of the organization as a whole.

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6. Firma del Director de Línea

7. Firma del Director de Investigaciones

Nota: el protocolo de investigación no debe exceder las 15.000 palabras, aproximadamente 30 páginas.