Universidad del Rosario	**FORMATO DE PRESENTACIÓN DE PROPUESTA DE INVESTIGACIÓN ESCUELA DE ADMINISTRACIÓN***	Junio 2017

PARTE I: INFORMACIÓN GENERAL DEL PROYECTO		
Título del proyecto	*Bargaining service-level agreements: A behavioral investigation*	
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	Unidad académica a la que pertenece	*School of Management and Business*
Descriptores / palabras claves	*Behavioral operations, service-level agreements, bargaining, supply chain contracts, analytical modeling, laboratory experiments.*	
Resumen del proyecto *(máximo 300 palabras)*	*Service-level agreements are performance-based contracts that seek to coordinate the decisions in a supplier-buyer channel to optimize the channel's performance. We aim to understand how bargaining over service level targets and the costs associated with failing to meet such targets or the bonuses for achieving them within a service-level agreement influences the performance of a supplier-buyer channel. On the one hand, analytical approaches on service-level agreements focus on complex inventory systems. If brought to a laboratory experiment, such complexity could introduce confounding factors into the analysis. On the other hand, behavioral approaches on service-level agreements focus on a limited set of service-level agreement structures and do not allow bargaining. Thus, insights derived from such studies are limited. We will derive the full set of service-level agreement structures in a single-period inventory system and test them in a laboratory experiment where human buyers and human suppliers will bargain over the service-level agreement parameters. Results will offer behaviorally-grounded insights about how to design service-level agreements that improve the supplier-buyer channel performance and will provide operations managers with a solid basis for bargaining service-level agreements. This will also lay the foundation for further research that explores service-level agreement bargaining within more complex inventory systems.*	
Duración del proyecto *(en meses)*	*24*	
Fecha esperada de inicio	*July 2021*	
Fecha esperada de finalización	*July 2023*	
Costo general del proyecto	*37,612,382*	

Costo por financiar		
Valor de la contrapartida	*37,612,382*	
Nro. del Comité de Investigación:		*Fecha:*

PARTE II: CONTENIDO DE LA PROPUESTA DE INVESTIGACIÓN

1. Planteamiento del problema y objeto de estudio

It is common in many industries for buyers to use service-level agreements (henceforth SLAs) to set performance targets for their suppliers and specify consequences for failing to meet or achieving such targets. This project aims to study how bargaining over service level targets and the costs associated with failing to meet such targets or the bonuses for achieving them within an SLA influences the performance of a supplier-buyer channel (henceforth SBC).

Within an SLA, the performance of the supplier is evaluated by the buyer in terms of a service level target to be achieved over a given review period. The service level can take the form of either a fraction of periods in which all buyer's demand is filled by the supplier (i.e., in-stock probability or α service level or type I service level) or a fraction of the buyer's demand filled by the supplier in a period (i.e., fill rate or β service level or type II service level). The review period can be either single, where supplier performance is evaluated for every order, or multiple, where supplier performance is evaluated over multiple orders within a long review horizon (e.g., monthly or quarterly). Suppliers pay a penalty or can get a bonus if they fail to meet or achieve the target, respectively, and the penalty or bonus can be either a lump sum or variable (Chen & Thomas, 2018; Liang & Atkins, 2013; Sieke et al., 2012).

Figure 1 shows the structure of an SBC managed with an SLA. For illustrative purposes, the figure focuses on a variable penalty SLA with a fill rate target. The buyer needs to satisfy a stochastic customer demand (D). She buys units from the supplier at a unit wholesale price (w) and sells them to her customers at a unit selling price ($r > w$). The buyer establishes the unit wholesale price and the supplier decides on an order quantity (Q) to satisfy the buyer's customer demand based on this unit wholesale price and her unit production cost (c). Under the SLA, the buyer establishes not only the unit wholesale price but also a fill rate target (β) on her customer demand and a unit penalty cost (p) that is charged to the supplier for every unit short of the fill rate target. The sequence of events is as follows. First, the buyer sets the SLA parameters. Second, the supplier decides on her order quantity. Third, customer demand realizes. Finally, the buyer receives the selling price from customers for every unit sold, pays the supplier the wholesale price for every unit sold, and the supplier pays the buyer the penalty for every unit short of the fill rate target if any.

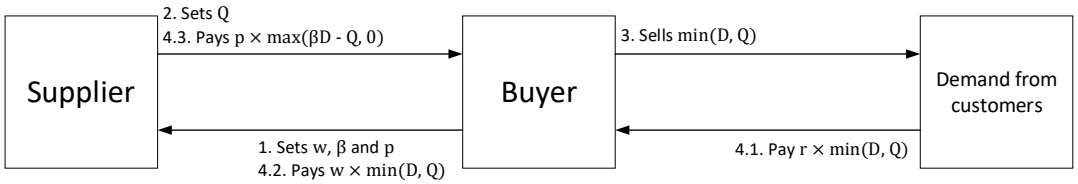

Figure 1. SBC under a variable penalty SLA with a fill rate target.

Previous behavioral research using laboratory experiments (henceforth lab experiments) has shown that different combinations of service level targets and expediting costs[1] within an SLA influence the SBC performance in different ways. For example, Bolton et al. (2016) observed that a steep SLA (i.e., low fill rate target and high expediting cost) leads to a higher channel efficiency (i.e., achieves a higher fraction of the channel's optimal expected profit) than a flat SLA (i.e., higher fill rate target and lower expediting cost). More recently, Castañeda et al. (2021) observed that although neither low nor high unit expediting costs (below and above the unit selling price, respectively) lead to optimal ordering decisions, they do improve ordering decisions compared to a cost structure where expediting generates neither profit nor loss, which suggests that the financial consequences of failing to meet a fill rate target should be made salient to influence decision-making.

Bolton et al. (2016) and Castañeda et al. (2021) treat the contract parameters as given and study how the buyer responds to them. Other behavioral research studies how an SBC member sets the contract parameters and the resulting SBC efficiency assuming the other (automated) member optimally responds to those parameters, but no negotiation takes place (i.e., ultimatum bargaining). For example, Davis (2015) experimentally tested an SLA where, first, a human buyer sets the wholesale price and a lump-sum bonus for achieving the service level target and, second, an automated supplier sets an order quantity that maximizes her expected profit given those parameters. His results show that buyers set the wholesale price too low and the bonus too high such that the SBC does not achieve the efficiency predicted by the normative theory.

Under the definition of SLAs provided above, Davis (2015) studies what it would be an SLA with a lump-sum bonus for achieving the service level target, Bolton et al. (2016), an SLA with a variable penalty for failing to meet such target, and Castañeda et al. (2021), two different scenarios: an SLA with a variable penalty for failing to meet such target and a different contract structure where the buyer can make a profit even if she fails to meet such target since she can expedite the shortage units at a low cost. Thus, this project will study a broader set of SLAs, which encompasses Davis (2015), Bolton et al. (2016) and Castañeda et al. (2021) as special cases.

In addition, to the best of our knowledge, no work has behaviorally studied how bargaining over the SLA parameters influences the SBC performance. In practice, the parameters within an SLA can

[1] An expediting cost is the cost that the buyer has to pay to achieve the service level target if the order falls short of such target. If the unit expediting cost is greater than the unit selling price to final customers, it resembles an SLA penalty.

be negotiated (Sieke et al., 2012). Behavioral research with other supply chain contracts shows that supply chain efficiency improves when decision makers can bargain over the contract parameters (i.e., free-form bargaining). For example, Haruvy et al. (2020) studied wholesale price and two-part tariff contracts and experimentally showed that allowing the SBC members to make concessions if offers on the contract parameters are initially rejected (free-form bargaining) improves the SBC efficiency compared to not allowing to make concessions (ultimatum bargaining).

Figure 2 shows how free-form bargaining works. The figure also shows the ultimatum bargaining process to illustrate differences between both bargaining processes.

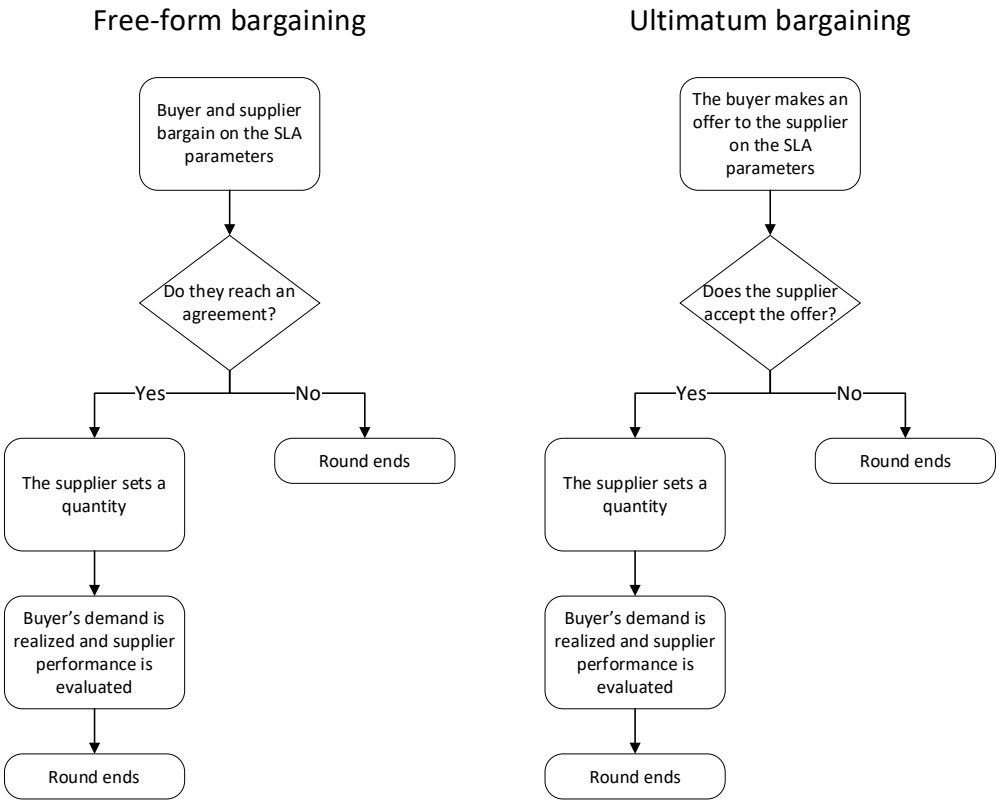

Figure 2. SLA bargaining processes.

By studying how decision makers set the SLA parameters in a broader set of SLAs and allowing free-form bargaining, this project can offer more comprehensive behaviorally-grounded insights about how to design SLAs that improve the SBC efficiency.

2. Justificación

Supply chain contracts can be used to coordinate decision-making within an SBC, that is, to incentivize both the supplier and the buyer to place orders and hold inventories that increase the channel efficiency. They lead the supplier and the buyer to consider the entire channel's profit

margin in decision-making instead of each member's profit margin separately to avoid that both members forgo potential profits (Cachon, 2003; Katok & Wu, 2009). Most supply chain contracts studied in the supply chain literature are cost-sharing contracts (e.g., buyback and revenue-sharing contracts), where both the supplier and the buyer bear a portion of the total supply chain cost (Cachon, 2003). This type of contracts can result in large administrative and transaction costs due to the continuous inventory monitoring needed to implement them (Liang & Atkins, 2013).

Performance-based contracts do not need to continuously monitor inventory to implement them. As the name implies, this type of contracts is structured around the results to be achieved (Liang & Atkins, 2013). SLAs are a common type of performance-based contracts that can serve to motivate suppliers to improve their service beyond what they would provide without penalties or incentives (Chen & Thomas, 2018).

The use of SLAs is common in many industries. For example, food, drink and consumer goods companies often have SLAs with retailers on product availability, product quality and on-time deliveries, and failing to meet the agreed targets can result in penalties that are factored in contract prices (KPMG, 2010). In call center operations, firms often sign SLAs with outsourced call centers to ensure quality in the handling of calls (Milner & Olsen, 2008). Overall, several surveys show that SLAs are widely adopted in both manufacturing and service sectors (Oblicore, 2007; Peerless Research Group, 2013).

Despite its widespread use, there are not many research studies about SLAs. While some analytical (e.g., Liang & Atkins, 2013; Sieke et al., 2012) and behavioral (e.g., Bolton et al., 2016; Castañeda et al., 2021; Davis, 2015) research about SLA design has been done, little is known about whether suppliers and buyers agree on SLA parameters that coordinate the SBC. This project will study how bargaining over service level targets and the costs associated with failing to meet such targets or the bonuses for achieving them influences the SBC performance. The results of the project can offer behaviorally-grounded insights about how to design SLAs that improve the SBC efficiency. This constitutes a new theoretical contribution to the Operations management field. In addition, these results can provide operations managers with a solid foundation for SLA bargaining.

3. Marco teórico y estado del arte

An SLA is a supply chain performance-based contract where the performance of the supplier is evaluated by the buyer in terms of a service level target to be achieved over a given review period (Chen & Thomas, 2018; Liang & Atkins, 2013; Sieke et al., 2012). It seeks to incentivize decision makers to place orders and hold inventories that increase supply chain efficiency without the large administrative and transaction costs common of supply chain cost-sharing contracts (Liang & Atkins, 2013). SLAs have been studied both analytically and behaviorally.

Analytical studies

Analytical studies allow to derive normative properties of particular SLA structures, which can be used to derive recommendations on how to design SLAs (e.g., how to choose the SLA parameters).

To the best of our knowledge, Sieke et al. (2012) was the first study that explicitly investigated the role of SLAs in coordinating the SBC (since this is the first SLA study we will review, we will explain its SLA setting with more detail than the SLA setting of subsequent studies). The authors consider an SBC in which both parties operate under a periodic review inventory system.[2] The buyer specifies a fill rate target and the supplier is expected to achieve this target each period (i.e., the review period is single). If the actual fill rate is below the target, the supplier must pay a penalty to the buyer. The authors analyze both the lump-sum and variable penalty schemes. In the former, the supplier pays the buyer a fixed amount for every period in which the fill rate target is not met (i.e., the penalty cost ignores the size of the inventory shortage). In the latter, the supplier pays the buyer a penalty for every unit short of the fill rate target (i.e., the penalty cost is proportional to the size of the inventory shortage).

The sequence of events in Sieke et al. (2012)'s setting is similar to a Stackelberg game. First, the buyer determines all contract parameters (fill rate target, penalty cost and wholesale price) and offers the contract to the supplier. Then, the supplier accepts the contract if her expected profit per period is above her (exogenous) reservation profit or rejects the contract otherwise. Analytically, the buyer determines the optimal base stock or order-up-to levels of both channel members (hers and the supplier's) that minimize the channel's holding and backordering costs. Then, for a given fill rate target, the buyer determines the penalty cost and wholesale price that incentivize the supplier to choose her optimal base stock level. The fill rate target and the penalty cost are jointly responsible for ensuring that the supplier chooses a base stock level that coordinates the supply chain, while the wholesale price ensures that the supplier earns at least her reservation profit.

Regardless of whether the penalty cost is a lump sum or variable, Sieke et al. (2012) find that the penalty cost is increasing in the fill rate target for low base stock levels and decreasing in the fill rate target for high base stock levels. This illustrates that the dependency between the penalty cost and the fill rate target is affected by the base stock level. Thus, in settings with low base stock levels, increases in the fill rate target must go along with increases in the penalty cost, and in settings with high base stock levels, increases in the fill rate target must go along with reductions in the penalty cost.

Later, Liang and Atkins (2013) studied SLAs also under a periodic review inventory system, but unlike Sieke et al. (2012), they considered a multiple review period. The authors analyze both the penalty and the bonus schemes, both under lump-sum and variable (per unit) costs. In addition, they model the service level target as a target in-stock probability. In their setting, the supplier owns the inventory, for which reason there is only one base stock level that needs to be determined: the supplier's. Given the multiple review period nature of their setting, Liang and Atkins (2013) notice that the supplier, aware of her performance, may prefer to dynamically adjust her base stock level during the review phase, which is undesirable for the channel. The authors investigate the incentive

[2] Under this inventory system, the operations manager wants to maintain a durable item in stock, and when she reviews the stock, she places a replenishment order to bring the stock back to a desired level. The replenishments are done periodically (e.g., weekly, biweekly).

provided by each SLA for avoiding such behavior. They observe that only the variable penalty SLA provides a reasonable incentive for the supplier to behave following the optimal base stock policy.

More recently, Chen and Thomas (2018) studied a supplier operating a periodic review inventory system and serving multiple buyers, each with a homogeneous SLA. Instead of focusing on channel coordination, they analyze how the supplier's inventory allocation rules impact the probability of SLA compliance and the associated non-compliance costs across three dimensions: review period (single and multiple), fill rate target (100% and less than 100%) and penalty scheme (lump sum and variable). The authors find allocation rules that maximize the probability of SLA compliance in all but one setting: single period review + fill rate target less than 100% + variable penalty. Overall, their analysis shows that such rules tend to prioritize allocation to smaller realized demands when meeting such demands prevents a non-compliance charge.

Behavioral studies

Lab experiments allow to control the environment in which decisions are made as well as the rules that govern decision-making behavior so that experimenters can focus on how a particular SLA structure influences decision-making. Katok et al. (2008) considered a periodic review inventory system with a multiple review period, a fill rate target and a lump-sum bonus. They treat the SLA as given to focus on how the buyer decides on her base stock level. Their lab experiment fixes the fill rate target at 95% and manipulates the length of the review period and the size of the bonus. They find that both higher bonuses and longer review periods induce higher base stock levels. Bolton et al. (2016) and Castañeda et al. (2021) considered a single-period inventory system[3] (i.e., single review period), a fill rate target and an expediting cost. They treat the SLA as given to focus on how the buyer decides on her order quantity. Bolton et al. (2016) use a traditional wholesale price contract as a baseline and manipulate the fill rate target and the unit expediting cost, and such cost takes values only above the unit selling price (i.e., variable penalty), while Castañeda et al. (2021) fix the fill rate target at 100% and manipulate the unit expediting cost with values both above (i.e., variable penalty) and below (i.e., profitable secondary supply source) the unit selling price. Bolton et al. (2016) observe that a low fill rate target coupled with a high penalty is the SLA (within their set of three SLAs) that brings orders the closest to the optimal order, while Castañeda et al. (2021) observe that buyers respond better to cost structures that make the financial consequences of failing to meet the fill rate target salient. In these studies, the (automated) supplier's only role is to ship the units ordered by the buyer. Thus, the focus is on how the buyer responds to a given SLA.[4]

The closest study to our approach is Davis (2015). He studied whether an SLA improves SBC efficiency relative to a wholesale price contract. The SLA considers a single-period inventory system (i.e., single review period), a fill rate target and a lump-sum bonus. He fixes the fill rate target at

[3] Under this inventory system, the operations manager makes a one-time ordering decision of a short life cycle item. Replenishments are not possible because the selling season is too short and/or the manufacturing/procurement lead time is too long.

[4] In other words, the buyer and final customers of these studies would be the supplier and buyers under the SLA structure considered in this project, respectively, while the (automated) supplier would be a second-tier supplier.

100% and automates the supplier so that she maximizes her expected profit given the wholesale price and the bonus offered by the human buyer, that is, his study focuses on whether an SLA can coordinate the SBC under an ultimatum bargaining protocol. He finds that that buyers set the wholesale price too low and the bonus too high such that the SBC does not achieve the efficiency predicted by the normative theory.

Discussion

On the one hand, the analytical studies on SLAs tend to focus on complex inventory systems (e.g., periodic review inventory systems). If brought to a lab experiment, such complexity could introduce confounding factors into the analysis, which can make more difficult to derive clean behaviorally-grounded recommendations for SLA design. Thus, a simpler inventory system (e.g., single-period inventory system) is preferred. In this regard, this project will take Davis (2015) as a starting point and will complement his SLA structure (single-period inventory system, fill rate target and lump-sum bonus) by analytically deriving the remaining SLA structures: variable bonus and both lump-sum and variable penalty.

On the other hand, the experimental studies on SLAs tend to treat the SLA as given or assume an ultimatum bargaining protocol. Thus, their behaviorally-grounded insights on the role of SLAs in coordinating the SBC are limited. In this regard, this project will use a free-form bargaining protocol where a human buyer and a human supplier will bargain over the SLA parameters.

Thus, this project will test whether an SLA can coordinate the SBC under free-form bargaining and considering a broader set of SLA structures. By studying how a human buyer and a human supplier set the SLA parameters in a broader set of SLA structures, this project can offer more comprehensive behaviorally-grounded insights about how to design SLAs that improve the SBC efficiency.

4. Objetivos

General objective

To determine how bargaining over the wholesale price, the service level target and either the penalty for failing to meet the service level target or the bonus for achieving such target within an SLA affects the SBC efficiency.

Specific objectives

- To identify the different types of models proposed to describe the SLAs commonly studied in the literature.
- To interpret the results of the different types of models proposed to describe the SLAs commonly studied in the literature.
- To derive an analytical model of an SLA for a single-period inventory system under a fill rate target and lump-sum bonus, variable bonus, lump-sum penalty and variable penalty.
- To design a lab experiment where a human buyer and a human supplier bargain over SLA parameters under different SLA structures.

- To compare the experiment's results among different SLA structures and against the analytical model.

5. Metodología propuesta

5.1. Tipo de estudio y alcance de la investigación

The main research methodology of this project is lab experiments. They allow to study causal relationships in a controlled decision-making environment (Friedman & Sunder, 1994). A lab experiment has three key elements: an environment, an institution and subjects' behavior. The environment is a simulation of a decision-making situation. Our environment will be an SBC where the channel members will bargain over an SLA's parameters. The institution refers to the rules or procedures that govern subjects' behavior in the simulated environment. It is defined by the experiment's instructions given to subjects. Our institution will define the activities that subjects will be asked to perform during the SLA bargaining process. Subjects' behavior refers to subjects' observed decisions, which are interpreted as function of the environment and the institution (Smith, 1994). Our study will capture the SLA parameters bargained by the SBC members and the ordering decisions made by the supplier.

The relative advantage of lab experiments over other research methodologies is the control that the experimenter can exert over the environment and the institution, which allows establishing cause-and-effect relationships in a cleaner way (Katok, 2010; Siemsen, 2011). Lab experiments manipulate one or more components from the environment and the institution to observe subjects' behavior under such manipulations. The configurations that result from such manipulations are usually called treatments. Control ensures that the observed behavior is the result of the implemented treatments. This control is achieved through two mechanisms: induced value theory and random assignment of subjects to treatments.

Induced value theory

The induced value theory prescribes the use of an incentive to 'induce' a certain behavior in subjects to reduce the effect of their characteristics or particular motivations on their decisions (Friedman & Sunder, 1994; Morton & Williams, 2010; Smith, 1976). This theory is based on four precepts: monotonicity, saliency, dominance and privacy (Smith, 1976, 1982). An incentive is *monotonic* if subjects always prefer more than less amount of the incentive, *salient* if changes in the incentive amount are due to subjects' behavior, and *dominant* if changes in subjects' utility are the result of changes in the incentive amount. Generally, awarding subjects financial incentives that depend on their performance and that are greater than their opportunity costs satisfy these first three precepts (Hey, 1996). Finally, an incentive is *private* if subjects are only given information related to their own incentive. Having information about other subjects' incentives could affect behavior, reducing the incentive's *dominance*.

Hence, we will incentive subjects by awarding them monetary incentives contingent on their performance in the lab experiment. Their performance will be evaluated according to the achieved SBC efficiency. In subsection 5.2, we explain how we estimate the amount of the incentives.

Random assignment

When a researcher runs a lab experiment, she is interested in the effect of the treatments on subjects' behavior (Katok, 2010; Morton & Williams, 2010). Randomizing the assignment of subjects to treatments ensures that the effect of subjects' variables that can confound the effect of treatments is randomized across treatments, thus minimizing their influence (Katok, 2010; Morton & Williams, 2010; Siemsen, 2011).

Hence, we will randomly assign subjects to treatments. Recall that we seek to derive an SLA for a single-period inventory system under a fill rate target and lump-sum bonus, variable bonus, lump-sum penalty and variable penalty. Thus, we would have four treatments, as shown in Table 1.

Table 1. Single-period fill rate target SLA structures.

		Price form	
		Lump-sum price	*Variable price*
Incentive scheme	*Penalty scheme*	Lump-sum penalty for failing to meet the fill rate target	Penalty for every unit short of the fill rate target
	Bonus scheme	Lump-sum bonus for achieving the fill rate target	Bonus for every unit of the fill rate target filled

To clearly disentangle the effect of free-form bargaining on the SBC efficiency, we require a baseline study with ultimatum bargaining. Thus, we would consider a *2x2x2* full-factorial design, that is, three factors each with two levels: bargaining protocol (ultimatum vs. free-form), incentive scheme (penalty vs. bonus) and price form (lump-sum price vs. variable price), resulting in eight treatments.

It is important to note that as our understanding of SLAs improves, the experimental design could change. For example, in a single-period fill rate target SLA structure with a variable bonus, such bonus is a premium for every unit of the fill rate target filled that is paid on top of the wholesale price, for which reason it could lose applicability and we would discard two treatments.

5.2. Población/muestra/participantes

The subject pool for our lab experiment will be third to fifth year undergraduate students from management related programs (e.g., business administration, supply chain management, industrial engineering). Undergraduate students are well suited to induced valuation given their low opportunity cost and steep learning curves (Hey, 1996; Morton & Williams, 2010). Given the initial number of treatments (eight) and that we would consider a between-subjects design, the lab experiment would be run with approx. 240 subjects assuming that approx. 30 subjects per treatment constitute a fairly representative sample size (e.g., Becker-Peth et al., 2013; Ho et al., 2010; Lee & Siemsen, 2017).

Given the expected number of subjects that will participate in the lab experiment, the amount of the incentives is estimated assuming a COP 10,000 show-up fee per subject, which increases the effectiveness of the recruitment (Morton & Williams, 2010), and a rate of COP 50,000 per subject

per hour, which is usually greater than the opportunity cost of undergraduate students and, hence, enough to motivate subjects to take the lab experiment seriously (Katok, 2011). Based on previous experience (e.g., Castañeda et al., 2021; Castañeda & Gonçalves, 2018), we assume that a subject will take one hour on average to complete the lab experiment. Thus, the expected amount of the incentives is estimated as follows:

Number of treatments (T) = 8
Number of subjects per treatment (S) = 30
Show-up fee per subject (F) = 10,000
Average hours per subject (H) = 1
Reward per subject per hour (R) = 50,000

Expected amount of the incentives = (T × S × F) + (T × S × H × R)
Expected amount of the incentives = 2,400,000 + 12,000,000
Expected amount of the incentives = 14,400,000

The estimated amount of the incentives is rounded up to COP 16,000,000 to account for potential outliers.

5.3. Mecanismos para la recolección de la información

The experiment will be programmed and run with special purpose software for lab experiments such as z-Tree (Fischbacher, 2007) or oTree (Chen et al., 2016). These platforms automatically keep record of all variables, including subjects' decisions, either locally or in the cloud.

5.4. Procedimiento para el procesamiento de los datos y para el trabajo de campo

Subjects will be recruited by an open call from the same population of undergraduate students. The call will provide information on how to sign up in the lab experiment. Subjects will sign up using SignUp, a web platform where they will indicate the session they wish to join and provide contact information. The number of sessions will be determined based on the total number of subjects required and the size of the computer lab chosen to run the experiment. We will seek to run the lab experiment in one computerized room from the University's North Branch.

The call will inform subjects that they will be awarded a show-up fee and a variable payment contingent on their performance in the lab experiment, both in cash. Upon arrival to the lab, subjects will be given an informed consent and the instructions describing the SBC, the SLA and the decisions they have to make. They will be allowed to ask clarifying questions. Finally, subjects will run the lab experiment using the chosen special purpose software.

The data will be characterized through summary statistics including averages, standard deviations and box-plots, among others, that will show general trends in the data. These data will provide the inputs for the statistical hypothesis tests and econometric analyses. By comparing different performance metrics (e.g., suppliers' ordering decisions, SBC efficiency) among treatments,

statistical hypothesis tests (e.g., *t*-tests) will allow to determine whether the different SLA structures influence such performance metrics.

We will complement the statistical hypothesis tests with econometric analyses, which can increase the robustness of the data analysis. For illustrative purposes, Eq. (1) shows an econometric model to analyze the effect of the treatment and control variables on suppliers' ordering decisions:

$$Q_{i,t} = \beta_0 + \beta_1 X_{i,t} + \beta_2 Y_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where i is an index for subjects and t for rounds, $Q_{i,t}$ is the dependent variable, that is, supplier i's ordering decision in round t, $\beta_1 X_{i,t}$ represents the treatment variables and their coefficients, $\beta_2 Y_{i,t}$ represents the control variables and their coefficients, and $\varepsilon_{i,t}$.is the error term. The treatment variables may include, for example, an indicator variable for the type of bargaining protocol and another indicator variable for the incentive scheme. Control variables may include, for example, demographic information collected at the end of a session (e.g., gender, program). β_1 and its significance level will indicate whether a given treatment variable significantly influences suppliers' ordering decisions after controlling for the effect of other treatment and control variables.

5.5. Relación entre la pregunta de investigación y los objetivos, la metodología propuesta/prevista, los resultados esperados y los tiempos de ejecución. Lo anterior, de acuerdo con el siguiente esquema:

Pregunta	Objetivo	Metodología	Resultado esperado
What are the SLAs commonly studied in the literature?	To identify the different types of models proposed to describe the SLAs commonly studied in the literature	Literature review	Set of SLA models
What are the normative properties of the SLAs commonly studied in the literature?	To interpret the results of the different types of models proposed to describe the SLAs commonly studied in the literature	Literature review	Characterization of the normative properties of SLA models
What are the normative properties of a single-period fill rate target SLA?	To derive an analytical model of an SLA for a single-period inventory system under a fill rate target and lump-sum bonus, variable bonus, lump-sum penalty and variable penalty	- Literature review - Analytical modeling	- Analytical model of a single-period fill rate target SLA - Characterization of the normative properties of a single-period fill rate target SLA

What experimental design allows to disentangle the effect of different SLA structures on the SBC efficiency?	To design a lab experiment where a human buyer and a human supplier bargain over SLA parameters under different SLA structures	Experimental economics	Source files (e.g., informed consent, experiment's instructions, special purpose software file) to run the experiment
How does bargaining over the SLA parameters affect the SBC efficiency?	To compare the experimental results among different SLA structures and against the analytical model	- Statistical hypothesis tests - Econometric analysis	Recommendations for SLA design

6. Productos de nuevo conocimiento científico o tecnológico esperados

1. Conference presentation 1: initial results of the project.
2. Conference presentation 2: additional results of the project.
3. Working paper 1: analytical paper describing the normative properties of a single-period fill rate target SLA.
4. Working paper 2: experimental paper describing the effects of bargaining over the SLA parameters on the SBC efficiency.

Given the publication dynamics of the major journals that publish research on behavioral operations, we cannot commit to have published papers within the two-year duration of the project.

7. Productos de formación esperados

1. Engage one *Joven Investigador*: this is contingent on the availability of financial resources (e.g., Small Grants financing).
2. Engage one *Asistente Graduado*: the Supply Chain Management research line is currently working with one *Asistente Graduado*. We expect to engage this person in some of the project's activities since this could be beneficial for her training (e.g., design of the lab experiment, data analysis).

8. Estrategia de divulgación de resultados y de apropiación de los conocimientos generados

We expect to present the project's results in institutional research seminars, both internal and external. In addition, some academic journals offer the possibility of making accepted papers more accessible by giving their authors the opportunity of writing short articles without any technical jargon or analysis. To the extent that such option is available, we intend to use it to communicate the results to a non-academic audience.

9. Impactos esperados

1. At an academic level, this project expects to deliver behaviorally-grounded recommendations for the design of SLAs that increase the SBC efficiency. This could also lay the foundation for further research that explores SLA bargaining within more complex inventory systems.
2. At a practice-oriented level, this project expects to provide operations managers with a solid foundation for SLA bargaining.

PARTE III: INTEGRIDAD CIENTÍFICA

10. Consideraciones éticas

Para ayudar a determinar si el proyecto de investigación requiere el análisis ético por parte del Comité de Ética en Investigación de la Universidad del Rosario, puede guiarse con la información que se incorpora a continuación, así como con la infografía presente en el siguiente link.

Para someter el proyecto de investigación al Comité de Ética, el profesor deberá descargar y diligenciar los siguientes documentos:

- Descripción de consideraciones éticas
- Carta de sometimiento
- Documento de Consentimiento Informado

11. Valoración de impactos negativos

N/A.

PARTE IV: CRONOGRAMA Y PRESUPUESTO

12. Cronograma

Número	Actividad	Desde	Hasta	Tiempo (en meses)
1	Literature review	July 2021	September 2021	3
2	Analytical modeling	September 2021	July 2022	11
3	Analysis of model's results	November 2021	July 2022	9
4	Paper 1 writing	November 2021	July 2023	21
5	Progress report	July 2022	July 2022	1
6	Design of experiment	August 2022	October 2022	3
7	Execution of experiment	November 2022	November 2022	1

8	Data analysis	December 2022	July 2023	8
9	Paper 2 writing	December 2022	July 2023	8
10	Progress report	July 2023	July 2023	1
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

13. Presupuesto

RUBROS		FUENTE			TOTAL
		Fondo concursable	CONTRAPARTIDA		
			Facultad	Otros[1]	
Personal[2]	Jóvenes investigadores	$ -	$ -	$ -	$ -
	Asistentes de investigación	$ -	$ -	$ -	$ -
	Asistentes graduados	$ -	$1,392,478	$ -	$1,392,478
	Otros (IP)	$ -	$36,219,904	$ -	$36,219,904
Equipos nuevos		$ -	$ -	$ -	$ -
Software		$ -	$ -	$ -	$ -
Servicios técnicos		$ -	$ -	$ -	$ -
Viajes y viáticos		$ -	$ -	$ -	$ -
Costos por estancias cortas de investigación		$ -	$ -	$ -	$ -
Materiales y suministros		$ -	$ -	$ -	$ -
Salidas de campo		$ -	$ -	$ -	$ -
Material bibliográfico		$ -	$ -	$ -	$ -
Arrendamiento de equipos		$ -	$ -	$ -	$ -

Trámite de licencias ambientales	$ -	$ -	$ -	$ -
Talleres[3]	$ -	$ -	$ -	$ -
Publicaciones y patentes[4]	$ -	$ -	$ -	$ -
Imprevistos (3% del total)	$ -	$ -	$ -	$ -
OTROS (especifique)	$ -	$ -	$ -	$ -
TOTAL	**$ -**	**$37,612,382**	**$ -**	**$37,612,382**

[1]Por favor, especifique la(s) fuente(s) de la(s) que proveerá la contrapartida, en caso de que el proyecto vaya a presentarse a otras convocatorias o que exista una contrapartida por parte de otras instituciones participantes en el proyecto.
[2]Incluir la contratación de jóvenes investigadores, asistentes graduados, estudiantes de doctorado y otros actores que participarán en el proyecto.
[3]Incluir los costos asociados a talleres y eventos de socialización.
[4]Incluir los costos asociados a traducción y edición de textos para publicación, así como los costos de sometimiento de artículos, cuando corresponda.

Si la propuesta ha sido presentada o va a presentarse a otras fuentes de financiación, por favor, especifique las fuentes, los montos solicitados y los cambios en el alcance del proyecto, si es favorecido por mayores recursos.

PARTE V: COMPOSICIÓN DEL EQUIPO DE INVESTIGACIÓN

14. Descripción de los investigadores

Nombre	Institución de afiliación	Unidad académica de afiliación	Correo electrónico	Tiempo de dedicación
Jaime Andrés Castañeda	Universidad del Rosario	School of Management and Business	jaime.castaneda@urosario.edu.co	8 hours/week
Sebastián Villa	Indiana University	Kelley School of Business	svillab@iu.edu	3 hours/week
Gloria Urrea	University of Colorado Boulder	Leeds School of Business	gloria.urrea@colorado.edu	3 hours/week
Joven Investigador, to be defined	Universidad del Rosario	School of Management and Business	To be defined	40 hours/week
Sara Cossio (*Asistente Graduada*)	Universidad del Rosario	School of Management and Business	sara.cossio@urosario.edu.co	3 hours/week

Jaime A. Castañeda A.

Jaime Andrés Castañeda
C.C. 8.031.123

NOMBRE DEL DIRECTOR DE LÍNEA
C.C.

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