General, there’s a battle / between your orders and my songs. / It goes on all the time: / night, day... / I don’t know how long this war will last / but every night one of your orders dies without / being followed... “Song of the Juggler” by Heberto Padilla

Multitasking between operations and marketing activities characterizes much of the job functions in the world of retailing, particularly for store managers. On the employment website Monster.com, when describing the work of store managers, a company rhetorically asks, “Story of our lives?” The answer: “Multitasking and prioritization.” In an influential empirical study, DeHoratius and Raman (2007) find that a store manager’s role entails “two key activities: sales generation and shrinkage control,” and the store manager may be viewed as a “multitasking agent who allocates effort to different activities based on the rewards that accrue from, and the cost of pursuing, each of these activities.” Of the store manager’s two activities, boosting demand and preventing inventory shrinkage—caused by damage, spoilage, and theft—are both critical. According to an estimate by Beck and Peacock (2009) in the book New Loss Prevention: Redefining Shrinkage Management, retailers around the globe suffer a $232 billion annual loss from inventory shrinkage, approximately equal to the GDP of Finland.

Outside of the retail sector, numerous settings involve multitasking between operations and marketing activities. In a global health setting, for example, private agencies are often engaged in delivering and administering vaccines to children residing in some of the hardest-to-reach places in the world. The success of their work depends on not just effective campaigns to raise public awareness of the importance of vaccination (marketing), but also—as highlighted in the 2012 BBC documentary Ewan McGregor: Cold Chain Mission—delicately managing a cold chain system essential for the storage and transportation of vaccines from freezer to freezer (operations).

Drawing from the above motivating scenarios, we study the a firm’s incentive design problem when employing a store manager with two concurrent job functions: marketing and operations. The marketing effort helps boost demand, which is constrained by the inventory level, itself influenced by operational effort. Likewise, an abundant supply influenced by operations effort may be constrained by a weak demand due to poor marketing effort. The outcome of the demand-inventory match (i.e., sales) depends on the “weaker
link.” In settings where a multitasking agent is in charge of both activities, there is a need to design effective incentive contracts to induce the agent to effectively juggle both activities.

The empirical literature (e.g., DeHoratius and Raman 2007) has clearly recognized the importance of the marketing-operations multitasking problem, and practitioners have outlined an incentive design approach to address the problem: provide bonuses for high sales and/or low inventory shrinkages. However, to the best of our best knowledge, such an incentive design problem has not been analytically modeled and solved using a rigorous moral-hazard principal-agent framework until this paper. This is possibly due to the notorious analytical challenges in solving moral-hazard principal-agent problems (see Laffont and Martimort 2009, pp. 200–202 for relevant discussions). In our model, the agent has two types of efforts unobservable to the principal: (1) marketing effort, which increases demand, and (2) operations effort, which reduces inventory shrinkage. Both efforts affect their associated outcomes stochastically so that the principal cannot directly infer the agent’s effort levels by merely observing demand and inventory outcomes. What further cripples the principal’s observability of agent efforts is the phenomenon of demand censoring where any realized demand in excess of the realized inventory level cannot be observed. Demand censoring is a widely observed phenomenon that is well-studied in both the operations management (e.g., Besbes and Muharremoglu 2012; Jain et al. 2014) and the marketing literatures (e.g., Anupindi et al. 1998; Dai and Jerath 2013, 2017). Because of demand censoring, the supply and demand sides affect the firm’s observability differently. Whereas unsold inventory can be observed and used as the basis for compensation, unmet demand cannot be observed. These factors make the incentive design problem challenging to solve. The two types of efforts—operations and marketing—may yield only one observable signal when the realized demand exceeds the realized inventory.

We adopt an “information trigger” approach, originally developed by Ke and Ryan (2018), to overcome a major technical difficulty revealed by the principal-agent theory literature, namely, uncertainty as to the validity of the first-order approach. Information-trigger contracts apply broadly to moral hazard problems with multiple actions and multiple outcomes in the risk-neutral setting. An information-trigger contract is one with two values, where the high value is “triggered” when a certain likelihood ratio reaches a threshold. This threshold reveals the underlying structure of the contract. Different from the general structure set up by Ke and Ryan (2018), our problem involves censored information when demand exceeds supply, which makes the problem more analytically challenging.

We characterize, for the first time in the literature, the structure of the optimal compensation contract for a multi-tasking store manager subject to demand censoring. We prove that the optimal compensation contract consists of three parts: a base salary, a bonus (referred to as “performance bonus”) paid to the store manager if the realized demand is exceeds an inventory-dependent sales threshold, and another bonus (referred to as “stockout bonus”) paid to the store manager if the inventory exceeds a given threshold and
is cleared. Under the optimal contract, the store manager has a potential of receiving two types of bonuses. We find that, surprisingly, the inventory-dependent sales threshold may decrease in the realized inventory level. In other words, as the realized inventory increases, the store manager is eligible for receiving the performance bonus even under a lower realized demand. This goes to the asymmetry of sales and inventory signals. A low inventory reveals not only poor operational effort, but also reduces the principal’s information by crippling the observability of true demand. To our best knowledge, the principal-agent theory literature has not reported on this type of contract structure with three payment levels before. This result highlights how both multitasking and signal observability drive the incentive design. Our approach to analytically tackling signal censoring represents a novel contribution to the moral hazard literature on multi-tasking.

Our work also sheds light onto the important issue of whether marketing and operations activities are complementary or substitutes for each other. We show that the contract should be designed such that both efforts are high enough so they act as complements, but there exist scenarios in which the effort costs become so high and both cannot increase simultaneously, so that they act as substitutes.

References


