Decision Support Systems 69 (2015) 31–39

Contents lists available at ScienceDirect

Decision Support Systems

journal homepage: www.elsevier.com/locate/dss

Effect of ticket-switching on inventory and shelf-space allocation

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ARTICLE INFO

Article history:
Received 24 February 2014
Received in revised form 14 September 2014
Accepted 30 November 2014
Available online 5 December 2014

Keywords:
Ticket-switching
Inventory information accuracy
Retailer
Shelf-space allocation

ABSTRACT

Ticket-switching incidents *simultaneously* and *directly* affect the actual and store information system inventory of *multiple* products. We model the discrepancy in inventory information stored in the retailer's information system vs. reality and related consequences for the customer and the retail store. We also consider a retail store with constrained shelf-space availability and study how this retailer should optimally allocate shelf-space between these products when ticket-switching is present. We model this by taking into account the customer arrival sequence. For customers who use online store inventory information, our results indicate that in the presence of ticket-switching, an item can be guaranteed to be in-stock at the store for immediate pick-up only for 'cheap' items. The results from this study also have policy implications for retail stores in terms of computing benefit estimates as well as shelf-space allocation.

1. Introduction

Inventory shrinkage, a significant issue in retail stores, arises due to several sources that include employee-theft [10], shoplifting [6], process errors, vendor errors, item misplacement [14], spoilage of perishables [15], breakage during handling, ticket-switching [26], among others. Among these, employee-theft and shoplifting are generally considered to be major contributors that add to about 80% of the overall inventory shrinkage [5].

Several forms of shrinkage and related effects on retailing have been studied by researchers. A common denominator in a majority of shrinkage cases is that each such incident affects only one product. For example, when a camera is stolen from a retail store, the store experiences all related losses due entirely to just this item. While this loss can be significant to the retailer, the effect of this loss is isolated. However, to our knowledge, only one type of shrinkage *simultaneously* and *directly* affects *multiple* items. *Ticket-switching* is the deliberate act of switching the (price) identifier or ticket on an item with the explicit intention of paying less than the item's retailer-set price. Oftentimes, the perpetrator switches the (price) identifier or ticket on an item that sells for a (much) higher price ('expensive' item) with that of an item that sells for a lower price ('cheap' item). For example, a hanging bar code on an expensive item is replaced by one from a cheap item before check-out, with the intended outcome that the customer pays only the cheap item's price to 'purchase' the expensive item. When such an incident occurs, two items are simultaneously affected: the expensive item is gone while the cheap item is left without a price tag or identifier. When this cheap item is the last item in stock of this type or SKU, it is often difficult for the store personnel to reestablish its identity (i.e., generate another identifier, bar code, or price tag for this cheap item) and the item stays in limbo.

To our knowledge, statistics on retailer loss due to ticket-switching is hard to come by simply because of its nature as well as the simultaneous presence of other types of shrinkage. Based on our discussions with major retailers both in the US (e.g., Target, Wal-Mart, and others) and Europe (e.g., Carrefour, Groupe Beaumanoir, Marks & Spencer, Metro, and others), although widespread existence of ticket-switching is acknowledged, none of the retailers we contacted were able to provide specific data on ticket-switching incidents. However, several of these retailers have initiatives in place that involve training store personnel to be aware of ticket-switching (e.g., ensure that shoes and the corresponding shoe boxes indeed match, ensure that scanned item information on the checkout terminal display matches the scanned item, among others). While such initiatives are a good first step, retailers acknowledge that expectations with respect to their implementation are rather low due to (a) the heavy workload already faced by these store personnel, (b) process slow-down when such an initiative is strictly followed, (c) the similarity of the ticket-switched items (e.g., organic vs. conventional apple), (d) the existence of employee complicity, among others.

According to a recent study [8], Electronic Article Surveillance (EAS) was found to be quite effective in reducing shrinkage. The Food Marketing Institute (FMI) estimates that retailers with sales of more than US$3 billion per year experienced lower shrinkage due to better process

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http://dx.doi.org/10.1016/j.dss.2014.11.004
0167-9236/

management and significant investments in loss prevention measures such as video surveillance, EAS/RFID (Radio-Frequency IDentifier)/sensor systems [17], exception reporting, access control and intrusion systems, social media, among others.

Based on a survey of 1187 retailers in 43 countries world-wide, the Global Retail Theft Barometer found that retail shrinkage in 2011 cost the industry an estimated US$119 billion, which is about 1.45% of overall sales. Among different retail categories, apparel, health/beauty and DIY (Do-it-Yourself) experienced the highest shrinkage. While this percentage appears to be rather small, it should be noted that even a 2 to 3% loss of sales can translate to about 25% loss in profit in this industry with tight profit margins [19]. Moreover, in terms of profit, shrinkage reduction from 2% to 1% is tantamount to sales increase of 40% (e.g., [1,4]). Therefore, the importance of shrinkage reduction cannot be overstated.

A ticket-switching event could easily be misinterpreted and counted as a combination of other types of shrinkage. It is also difficult to determine which items comprise a ticket-switched pair from aggregate shrinkage data. Given that theft is a large part of shrinkage, it is reasonable to assume that ticket-switching is significant even if it's a small fraction of the overall theft statistic. Moreover, based on our knowledge of publicly-available ticket-switching incidents and the fact that several of these required only the use of cheap and readily available devices (e.g., bar code printers), we can reasonably assume that such incidents are not uncommon.

Given the existence of ticket-switching in retail store environments and their peculiar dynamic with respect to the inventory level of multiple items, there is a surprising lack of research literature that consider this phenomenon. We attempt to address this gap in extant published literature. We consider ticket-switching from a shelf-space allocation perspective and associated dynamics of information generated by the store inventory information system as well as the actual state of affairs. Specifically, we consider the existence of two products — one 'cheap' and the other 'expensive' — and the switching of the expensive product's ticket with that from the cheap product. We then consider the effect of ticket-switching on shelf-space allocation (e.g., [9]) and possible inflation/deflation of information due to its invisibility to the store's inventory information system until its synchronization with actual store inventory. To our knowledge, this is the first paper to consider store inventory dynamics and shelf-space allocation in the presence of ticket-switching behavior. For the remainder of the paper, we use 'information system' to refer to the store's inventory information system.

We study a few facets of the dynamics of ticket-switching incidents that are novel to existing literature. Based on these, the contributions of this paper are three-fold: (a) we model the benefits to the retailer and suggest associated policy implications when ticket-switching behavior is present, (b) we model shelf-space allocation in the presence of ticket-switching behavior and suggest related policy implications and (c) we suggest implications for the customer when ticket-switching behavior is known to exist.

Our results have practical and policy implications for both customers as well as retail stores when ticket-switching is present. For customers who use the store's online inventory checker to ensure that an item is in stock for in-store pick-up, the in-store-stock guarantee can be provided only for the 'cheap' items. The store inventory manager must allocate more space to the 'expensive' items, especially those with more unit revenue and stock-out cost. When computing revenue estimates based on information from the store information system, care should be taken to consider deflation in the estimated results.

The remainder of the paper is organized as follows: We briefly discuss ticket-switching and some recent ticket-switching incidents that gained wide-spread media-attention in Section 2. In Section 3, we model disparities in information from the information system and actual inventory in the presence and absence of ticket-switching incidents. We model shelf-space allocation when ticket-switching is present in Section 4. We conclude the paper in Section 5 with a brief discussion on findings and possible extensions to this study.

2. Ticket-switching

Although there is no publicly-available statistic or historical data on ticket-switching incidents, ticket-switching cannot occur in the absence of price tag or identifier/ticket. Moreover, ticket-switching requires the simultaneous existence of a 'cheap' and an 'expensive' item at a retail store. It is, therefore, reasonable to assume that the origin of ticket-switching incidents dates back only as far in time as the introduction of item-level price tags [25] or some form of item-level identifier/ticket in retail environments. In principle, while it is possible to ticket-switch items with the same price, we are not aware of any such reported incidents. Nevertheless, our developed model implicitly includes this case.

As the number of items sold at a single retailing environment grew, it most likely became relatively difficult to deter and/or prevent ticket-switching behavior. Retailers' introduction and use of item-level price stickers presumably facilitated ticket-switching behavior. About four decades ago, the introduction of automatic identification technology such as bar code, which enables relatively efficient inventory-taking and check-out, facilitated successful 'purchase' of ticket-switched items. This is readily accomplished since the check-out person may not necessarily be vigilant to match each purchased item with information associated with the scanned bar code and the item's price.

Among different price-/item- identification technologies, price stickers are the easiest to switch since they generally don't have any information about the associated item. On the other hand, bar codes have relevant information (e.g., the item's identity) stored in database(s) that are readily accessible by check-out personnel. At this point in time, bar codes are the most commonly used technology for check-out information in retail settings. Price stickers are not that uncommon while RFID (Radio-Frequency IDentification) tags are slowly being introduced [24], albeit primarily for inventory management purposes at present.

Although not presumed to be uncommon, ticket-switching behavior is rarely caught by retailers who bear all related losses. While the primary effect of ticket-switching is the capital loss associated with the difference in price of the cheap and expensive items, the retailer suffers additional consequences. These consequences depend on the frequency at which the information system is synchronized with actual inventory at the store. When ticket-switching occurs, the information system incorrectly registers the existence of a larger number of expensive items and fewer cheap items than the actual state of inventory. When several ticket-switching incidents occur at the same store, this accumulated mismatch between actual and information system based inventory levels could wreak havoc with effective inventory management. The consequences of such a mismatch include stock-outs of expensive items (that generally have higher margins), excessive inventory of the cheap item that is invisible to the information system, and increased inventory and storage cost of cheap items. When the cheap item is perishable, its increased inventory has the potential to result in higher loss due to 'unsalables'.

A majority of ticket-switching cases go unreported. The news media generally pick up such incidents only when a large number of items, high monetary value, celebrity, or some bizarre person/*modus operandi* is involved. For example, a customer at a San Francisco Bay Area Target store was caught affixing home-made bar codes to packages of LEGOs that allowed him to purchase expensive sets at substantial discounts [13]. He apparently then sold these items through eBay and made about $30,000 per year from these sales. In another case, two couples were charged with defrauding Wal-Mart stores about $1.5 million across 19 states over the last decade where a home computer was used to print bar codes of cheaper items meant to be ticket-switched [18]. The suspects then allegedly either sold the merchandise elsewhere or returned them for store gift cards. These suspects apparently avoided detection in part by visiting stores during the busiest periods. A Colorado University freshman used bar codes printed in his dorm room with 'Barcode magic' to buy big-ticket electronic gadgets cheap