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Showrooms and B&M Stores: Omnichannel Strategies for Managing Customer Returns

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Abstract:

E-commerce retail has witnessed a steady growth in sales with advances in digital technologies. However, one of the primary challenges that has plagued online retail is its inability to provide customers the opportunity to "touch-and-feel" a product before purchasing, thereby resulting in a higher rate of product returns. To address this, online retailers, nowadays, are adopting various omnichannel configurations, such as operating an additional offline channel (i.e., either a showroom or a brick-and-mortar (B&M) store). This paper studies the impact of adopting such an omnichannel configuration on the retailer's profit vis-a-vis customers' strategic behavior. Using a stylized model, we first characterize the retailer's optimal pricing and return penalty decisions under three different scenarios: 1) selling the product online; 2) establishing a showroom ("Experience-in-Store-and-Buy-Online (ESBO)" channel) while selling the product online; and 3) selling the product through both B&M store and the online channel, while allowing in-store product returns ("Buy-Online-and-Return-In-Store (BORS)" channel). Additionally, we compare the retailer's profit across various scenarios and propose several key managerial insights. Based on product attributes such as product standardization and product valuation, we recommend optimal omnichannel strategies for the retailer. For example, if the product is premium and highly personalized (e.g., designer apparel), the retailer should open an additional showroom.

Keywords: E-Commerce, Omnichannel retailing, Product returns, Showrooms, Store returns

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E-commerce retail has witnessed a steady growth in sales with advances in digital technologies. However, one of the primary challenges that has plagued online retail is its inability to provide customers the opportunity to "touch-and-feel" a product before purchasing, thereby resulting in a higher rate of product returns. To address this, online retailers, nowadays, are adopting various *omnichannel* configurations; such as operating an additional offline channel (i.e. either a showroom or a brick-and-mortar (B&M) store). This paper studies the impact of adopting such an omnichannel configuration on the retailer's profit vis-a-vis customers' strategic behavior. Using a stylized model, we first characterize the retailer's optimal pricing and return penalty decisions under three different scenarios: 1) selling the product online; 2) establishing a showroom ("experience-in-store-buy-online (ESBO)" channel) while selling the product online; and 3) selling the product through both B&M store and the online channel, while allowing in-store product returns ("buy-online-and-return-in-store (BORS)" channel). Additionally, we compare the retailer's profit across various scenarios and propose several key managerial insights. Based on product attributes such as product standardization and product valuation, we recommend optimal omnichannel strategies for the retailer. For example, if the product is premium and highly customized (e.g. designer apparel), the retailer should open an additional showroom.

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History:

1. Introduction

Over the last decade, the online retailing industry has seen an unprecedented growth enabled by advances in technology-driven and internet-enabled devices - e.g. smartphones and laptops (Bell et al. 2014, Gao and Su 2016a, Bell et al. 2017). In 2018, the US e-commerce annual retail sales reached \$525 billion; it is expected to grow steadily to reach \$893 billion mark by 2020 (eMarketer 2018). Many traditional brick-and-mortar (B&M) retailers are now investing heavily in digital technology to offer an improved online shopping experience to their customers. For example, big-box retailers like Target and Kohl have invested \$7 billion and \$2 billion respectively, for digital transformation (Fortune 2017, Target 2017). Therefore, it is evident that more and more retailers are now putting their trust on digital channels.

However, these web-based digital channels come with their own set of challenges. The most compelling is the inability of customers to physically inspect and precisely evaluate a product before purchasing it (Nageswaran et al. 2020). Customers engaging in e-commerce transactions are unable to touch and feel a product before making their purchases, and they can only ascertain the product quality and conformity when they receive the product. Therefore, this leads to a large number of customers returning the products that do not fit or conform to their requirements. In this paper, we study two omnichannel strategies that can reduce customers' risk of online purchases, which, in turn, leads to lower product returns. One such strategy is to establish "showrooms" where customers can evaluate a product and subsequently, gather sufficient product information. Another omnichannel strategy is to open "brick-and-mortar (B&M) stores" that allow customers to return their online purchases in stores.

The objective of this study is to investigate how adopting an omnichannel configuration (either a showroom or a B&M store with the option of in-store returns) impacts a retailer's profit and consumers' strategic behavior. We contribute to extant literature by exploring an online retailer's decision of adopting an omnichannel configuration (adding either the ESBO or BORS channel). There has been some work done on product return strategies in omnichannel retailing in the recent past (Nageswaran et al. 2020, Gao et al. 2019, Jin et al. 2019); however, there has not been any comprehensive analysis done thus far. To the best of our knowledge, we believe that extant literature has not compared for instance, various omnichannel configurations like opening a "showroom" (i.e. adding the ESBO channel) and a "B&M store" (i.e. adding the BORS channel) with a pure online format. In this study, we aim to address the above research gap by determining the optimal retail price and return penalty under each omnichannel configuration.

1.1. Motivation and Research Questions

In the US retail industry, the figures related to product returns are staggering; according to the National Retail Federation, online retailers in the US face an average return rate as high as 30% (WSJ 2013, Shang et al. 2019b). Retailers incur a substantial cost (on an average \$6-\$18 per item) in managing the returned merchandise,especially for transporting, sorting, and processing those items (The Economist 2013). A study by Accenture estimates that the total costs of handling customer returns almost account to 4% of a typical retailer's sales (Douthit et al. 2011). The entire US retailing sector spends more than \$40 billion annually on bringing the products back to their warehouses (Shang et al. 2019a). Ryan Kelly of FedEx emphasizes the challenges of managing customer returns:

"*When you think about the things that are driving returns — from e-commerce and customer expectations to the complexity of products and manufacturer agreements — it is becoming increasingly challenging to manage them*" (FedEx 2018).

On the other hand, customers find the process of returning misfit products troublesome. In a Forrester survey, 51% of online customers expressed their concerns regarding product returns as there is an opportunity cost associated with the wait for the refund amount (Ofek et al. 2011). Additionally, some retailers even impose a fixed fee (as a return shipping or a restocking fee) for product returns (e.g. - H&M charges $5.99). In some cases, restocking fee typically ranges from 10% to 25% of the product price. However, this extra shipping fee for returning items discourages customers from buying online Abdulla et al. (2019). Not surprisingly, customers are worried about the return policy enforced by retailers. A recent study by UPS reveals that a large majority of customers (approximately 66 percent) check an online retailers' return policy before shopping online (WSJ 2017). Thus, customer returns has long been considered to be a crucial issue, thereby forcing retailers to seek strategies to mitigate the challenges of product returns.

To address the challenges associated with product returns, many retailers have started adopting a multi-channel product distribution approach by offering products through both web-based digital channels and physical offline stores (Wolf 2018). Pure-play online retailers such as Alibaba have extended their offline arms by building a large number of physical stores (JDA Software Group Inc. 2017, Wolf 2018). However, for a pure multi-channel retailer, both channels typically work in silos and have very little interaction among them (Orendorff 2018). For instance, customers cannot return (pick up) products, that they have already purchased, to (from) a store, which, in turn, lead to lower overall retail sales (Kumar et al. 2019). Fortunately, the emerging practices of omnichannel retailing do provide a more flexible, personalized, and seamless shopping experience to customers across channels (Brynjolfsson et al. 2013, Bell et al. 2014, Akturk et al. 2018, WSJ 2018). Such a unified integration of physical and digital channels can reduce the customers' uncertainty pertaining to product fitness. One possible strategy is to establish "showrooms" in addition to digital channels, where customers can browse or evaluate products, and subsequently, gather sufficient product information required for their online purchase (Bell et al. 2014, Gao and Su 2016a). This in turn, could result in significant reduction in product returns. These "showrooms" typically do not stock merchandise but allow customers to exploit the advantages of both the channels: offline availability of product information and online order fulfillment. For example, retailers like Warby Parker (WarbyParker.com) and Bonobos (Bonobos.com) have already introduced showrooms to display their products. We call the above strategy: *"Experience-in-Store-and-Buy-Online (ESBO)"*. Another popular omnichannel strategy that has received increased attention is *"Buy-Online-Return-In-Store(BORS)"* (Nageswaran et al. 2020, Gao et al. 2019). Under this scenario, a retailer opens a B&M store and allows the customers to return their misfit items to its store. A study by UPS reveals that approximately 60% online shoppers prefer in-store returns (UPS 2016). If customers do not like the product they purchased, they can easily return them to a nearby B&M store for a full refund. Thus, the presence of a B&M store would result in reducing return handling costs substantially for the retailers. Nevertheless, the effectiveness of this strategy is dependent on multiple factors, such as, the location of the B&M stores, convenience of the in-store return process, and customer waiting time to receive the refund/store credit. Example of such retailers who have implemented BORS include J.C. Penny, Apple, IKEA and J. Crew. Undoubtedly, both omnichannel strategies- namely showrooms and BORS can counterbalance the detriment of product returns and bolster overall sales.

Some specific product categories, such as fashion apparel, artwork, footwear, eyewear, and toys that possess many intangible and non-digital [1] attributes like personal fit, texture, color, comfort, or design, are more prone to customer returns (Gu and Tayi 2015). It is difficult to assess these non-digital attributes without physically examining a product. In this paper, we term these products as *highly customized*. Most retailers face a challenge of revealing the non-digital attributes of a highly customized product through the online channel. Thus, customers may prefer to physically examine these items (e.g. women's swimsuits) before purchase. In comparison, an offline channel provides customers the opportunity to inspect product characteristics; thereby reducing the likelihood of product returns. On the other hand, laptops, books, and DVDs, are *highly standardized*, hence, the return rates of such products are much lower. Moreover, product valuation is another important aspect that impacts product returns. Based on the valuation of the products, we group them into two categories, i.e. *high-end* [2] and *low-end*. From a customer's perspective, the hassle cost associated with product returns becomes too much for a low-end product (i.e. a grocery item) leading to a smaller number of product returns. On the other hand, for a premium product (e.g. a jewelry item) the return rate would be much higher. Thus, we categorize the products on two dimensions, i.e. product standardization and product valuation. In doing so, we endeavor to derive optimal omnichannel configurations for an e-commerce retailer, namely establishing either a showroom (or adding the ESBO channel) or a B&M store (or adding the BORS channel) by considering product returns as a key attribute. Table 1 illustrates the four combinations of product standardization and product valuation in a 2×2 matrix.

In this paper, we analyze the omnichannel configurations, i.e. opening a "showroom" (adding the ESBO channel) or a B&M store (adding the BORS channel) and how these strategies can be used

[1] Personal fit is a non-digital attribute because product fitness information cannot be easily communicated to customers over electronic media like internet.

[2] High-end products such as large electrical appliances and artworks are premium, and sold at a high price.

Table 1 Product Standardization-Product Valuation Matrix

Product Standardization	Product Valuation	
	High	Low
High	Laptop, Refrigerator, AC	Groceries, Books, DVDs
Low	Designer Apparel, Jewelry,	Footwear, Eyewear, Swimsuit

by an online retailer to mitigate the challenges associated with product returns. More specifically, we seek to answer the following research questions:

- How does the introduction of an omnichannel configuration, either a showroom (ESBO channel) or an integrated B&M store with the BORS option, affect an online retailer's profit?
- Under what conditions and for which products, is it profitable for an online retailer to introduce a showroom or an offline B&M store?
- How do the omnichannel strategies affect the online retailer's pricing and return penalty decisions?

To address these questions, we develop a stylized model to identify an online retailer's optimal pricing and return penalty decisions under three different scenarios: 1) selling only through a web-based online channel; 2) establishing a showroom (ESBO channel) while selling only through the online channel; and 3) selling through both B&M store and online channel while allowing in-store product return (BORS channel). The retailer (addressed as "she") procures and sells her product to end-customers. The product may not match a customer's expectations in terms of product *fitness* (i.e. product misfit or quality mismatch). To ensure that the customers do not hesitate to shop online because of this fit uncertainty, the retailer allows them to return their misfit products. However, the customers incur hassle costs while purchasing and/or returning products online. Additionally, the retailer charges a restocking fee (return penalty) for each item being returned. Thus, both the return penalty and hassle cost act as deterrents to customers for shopping online. In order to overcome these challenges, the online retailer intends to set up an additional physical store in the form of a showroom or a B&M store. Herein, the retailer brings such innovative strategies to mitigate the propensity of customer returns.

1.2. Contribution

A list of key insights and contributions are as follows.

First, we find and characterize further the optimal pricing and return penalty decisions under all three scenarios. From our analysis we find that as the unit return transportation cost increases, the optimal product price (optimal return penalty) decreases (increases). The reason behind this is that as the return transportation cost increases, the retailer increases the return penalty, but decreases the product price as she intends to serve more customers. Further, the retailer opts to decrease the product price in order to incentivize customers shopping online. Then, we compare the retailer's optimal pricing and return penalty decisions under the "showroom" (i.e. adding the ESBO channel) and the "B&M store" (i.e. adding the BORS channel) configuration. Herein, we find that as compared to the BORS channel, both the optimal product price and return penalty under the ESBO channel follow a threshold policy with respect to the return transportation cost. For instance, for a low transportation cost, the retail price (return penalty) under BORS is higher (lower) than that of the ESBO channel. Whereas for a moderate (and high) transportation cost, the retail price (return penalty) under BORS is lower (higher) than that of the ESBO channel.

Finally, we compare the retailer's profits across all scenarios and propose a decision support matrix for identifying the optimal omnichannel configuration based on product attributes such as product standardization and product valuation. For example, for a premium product (i.e. high-end) that is highly customized (e.g. designer apparel), we recommend that the retailer should open an additional showroom. This result implies that both "tangible" (e.g. price of a product) and "non-digital" (e.g. color, texture, or design of a product) attributes can impact the retailer's overall profitability, and influence the decision to open an offline arm. Moreover, our analyses reveal that under certain conditions, the retailer can actually be worse off when it sells products through both channels**.** We refer the reader to Table 3 for a detailed analysis of the recommended strategies.

The remainder of this paper is organized as follows. In Section 2, we discuss the related literature and position our work. In Section 3, we introduce our base model. In Section 4, we study two emerging omnichannel strategies, namely, opening either a showroom or a B&M store. In Section 5, we develop a decision support matrix and provide critical managerial insights. We conclude the paper in Section 6.

2. Literature Review

In this section, we present a brief overview of the following two streams of literature that are closely related to our paper: (i) omnichannel retailing, and (ii) customer returns.

2.1. Omnichannel Retailing

The emerging practices of multichannel and omnichannel retailing have received considerable attention in academic literature. Numerous studies have shown how a retailer should manage both a physical store and an online channel. For an excellent review on multichannel/omnichannel retailing, see Brynjolfsson et al. (2013) and Bell et al. (2014). Furthermore, Brynjolfsson et al. (2013), Saghiri et al. (2017) and Jin et al. (2018) mention how technologies, such as app-based mobile phones and internet are helping firms to overcome several obstacles, such as geographical barrier and customer ignorance by bringing markets close to a firm. Further, the authors recommend reexamining firms' existing strategies and call for new and innovative distribution systems to deliver and return products.

Gallino and Moreno (2014) empirically evaluate the worth of buy-online-pickup-in-store (BOPS) strategy and show that it leads to a reduction in online sales, but a rise in brick-and-mortar store traffic and sales. Harsha et al. (2016) compare omnichannel fulfillment strategies, such as ship-to-store and BOPS with a retailer's existing sales strategy and through experiments, showing that omnichannel strategies do lead to shorter delivery time, larger sales and greater revenue. Govindarajan et al. (2017) obtain optimal order-up-to quantities while comparing three omnichannel strategies: full integrated, partially integrated, and individual fulfillment. Govindarajan et al. (2018) generalize Govindarajan et al. (2017) by considering a network of traditional physical stores and online fulfillment centers. Gallino et al. (2016) use proprietary data from a US retailer to show that newly implemented ship-to-store functionality has increased its overall sales dispersion. (Bayram and Cesaret 2020) investigate dynamic fulfillment decisions for online orders in a ship-from-store context. Park et al. (2020) develop a mixed integer programming formulation while maximizing the expected customer showcasing utility for a retail store. Additionally, they conduct a comprehensive case study based on data obtained from 17 dealership to show the practicality of their approach.

Extant literature also considers the impact of opening a physical store, while adopting omnichannel functionalities; e.g. cross-channel purchasing or showrooming, on a retailer's profit (Verhoef et al. 2015, Melacini et al. 2018, Mou et al. 2018). Bell et al. (2017) empirically show that introducing showrooms not only reduces customer returns but also increases both online and offline sales. Kumar et al. (2019) explore how establishing a new physical store affects the demand of the existing online channel and the retailer's revenue. Analyzing customer-level data from an apparel retailer, the authors find that such a strategy indeed leads to an increase in online sales, along with the retailer's revenue. Mahar et al. (2014) develop a mathematical model while examining the value of providing pickup and return from a large number of B&M stores. They suggest that only a subset of those stores should offer in-store pickup and return services. Gao and Su (2016a) analyze the impact of BOPS (buy online pick-up in store) strategy on customers' shopping behavior and recommend that BOPS may not be appropriate for all products. Gao and Su (2016b) study the effect of three different approaches of sharing information, such as physical showrooms, virtual showrooms, and availability information disclosure, on omnichannel customers who strategically make decisions on gathering product fit and availability information. Aflaki and Swinney (2017) investigate if an "inventory pooling" strategy would be beneficial for a multichannel firm while facing strategic customers. Jin et al. (2018) study the determination of optimal BOPS service area, and also compare two omnichannel fulfillment options, i.e. - BOPS and reserve-online-pick-up-and-pay-in-store (ROPS) - under different order cancellation policies. Gao and Su (2017) investigate the impact of online and offline self-order technologies on the demand of wait-sensitive customers, employment levels, and the retailer's profit. Nault and Rahman (2019) investigate the roles physical stores in mitigating online disutility costs (arising from shipping and handling costs, privacy and security issues, trust issues, difficulty in fit assessment, and lack of after-sales support associated with online purchases) for a dual-channel retailer in a competitive environment. Li et al. (2020) examine the effect of different physical showroom deployment strategies – no showrooms, showrooms with partial assortment, and showrooms with full assortment – on information service provision, pricing, and profitability of an omnichannel retailer. Recently, Lin et al. (2020) study the impact of BOPS strategy on product quality, retail price, along with the manufacturer's and retailer's profits. Additionally, they find that the adding a BOPS channel may actually benefit both the manufacturer and the retailer.

In comparison to the studies mentioned above, we investigate the optimal channel configuration for an online retailer while adopting an omnichannel strategy based on product characteristics. To mitigate the costs associated with product returns from online shoppers, a retailer tends to consider two omnichannel configurations, i.e. – establishing a physical showroom or opening a B&M store. Our study contributes to the extant literature by developing a decision support matrix in terms of the optimal omnichannel configuration.

2.2. Customer Returns

Our work also relates to literature on product returns, which is a common phenomenon in online retailing. Academics in the Marketing and Operations management areas have long been studying the impact of return policy on customers' purchase and return decisions, as well as the retailer's profit (see a few earlier works of Davis et al. (1995), Davis et al. (1998), Matthews and Persico (2005), and Matthews and Persico (2007)). Recently, (Abdulla et al. 2019) provide an extensive review of literature related to return policy design and its subsequent implications for customer behavior. Su (2009) investigates the impact of product return policy on supply chain performance in presence of customers with valuation uncertainty (i.e. customers who realize their valuations after purchase). The author finds that the optimal refund is equal to a product's salvage value and proposes mechanisms for channel coordination. Shulman et al. (2009) consider the problem of determining product price and restocking fee for a retailer facing customers with valuation uncertainty. The authors derive conditions under which the retailer is benefited by sharing product information with customers. Shulman et al. (2010) examine how reverse channel structure impacts return policies and firm's profit. Several other papers have also studied customer return policy under various settings. Akçay et al. (2013) extend the work of Su (2009) and determine the optimal order quality, price of new product, refund amount, and resale price of returned items sold as openbox items. They find that a money-back guarantee with full or partial refund policy improves the retail sales and retailer's profit. Hsiao and Chen (2014) compare two special return policies: money back guarantee and hassle-free (with less inconvenience) returns. The authors also explore the effect of those return policies on firm's profit and find conditions under which one policy dominates the other. Shang et al. (2017) study the impact of full or partial refund policy on a firm's profit when customers opportunistically return a product after "wardrobing". Shulman et al. (2011) extend Shulman et al. (2009) study within a duopolistic environment where two retailers compete in the consumer market, while selling horizontally differentiated products, and find a possibility of higher optimal restocking fee, as compared to a monopolistic scenario. Wang et al. (2019) investigate how bidirectional option contracts can be used to mitigate the downside of customer returns for a newsvendor firm.

A substantial body of literature has also investigated the implications of customer return policy on customer behaviors and retailer profitability in a multichannel context. Ofek et al. (2011) study how introducing an online channel (and subsequent costly product returns) impacts the pricing strategy and physical store assistance levels for two competing retailers. Facing higher product return rates in the online channel, Chen and Chen (2017) identify conditions for optimal channel-structure selection – offline-only, online-only, or both. Chen et al. (2018) investigate the effects of leadership and return strategies on the process, market shares, and profits in a duopoly scenario.

However, studies that consider customer returns in an omnichannel setting are limited. Especially, extant literature has so far neglected the in-store return behavior, along with the impact of such a phenomenon on a retailer's profit. Further, extant literature has been unable to come up with a comprehensive study in terms of a retailer's profitability with respect to the in-store return facility, as compared to other omnichannel configurations, e.g. showrooming. Nevertheless, Gao and Su (2016b) explore showroom as an additional option for information delivery to customers, but consider only same-channel return and full-refund policy. The authors find that the presence of showroom stores may increase customer returns. In comparison, our work analyzes both cross-channel return facility and partial refund policy adoption by the concerned retailer. Xu and Jackson (2019) study customers' perception of the return process in omnichannel retailing, and empirically investigate factors that impact the return channel loyalty. Additionally, a few recent papers have also considered an emerging omnichannel return strategy, where retailers provide online customers an opportunity to return their shopped items to physical stores. Radhi and Zhang (2019) compare the effects of same-channel and cross-channel return policies on optimal order quantities for an omnichannel retailer. The study also identifies conditions for adopting the same-channel or cross-channel return strategy. Nageswaran et al. (2020) determine the optimal refund policy of a retailer who considers either an online return strategy or in-store customer returns. Compared to Radhi and Zhang (2019) and Nageswaran et al. (2020), our study also allows the retailer an option to set up a showroom. Additionally, we explore how adopting an omnichannel strategy, such as showrooming or BOPS, does affect the retailer's profit. Gao et al. (2019) study the problem of determining the number and size of physical stores in an omnichannel setting that considers both showrooming and in-store customer returns. Jin et al. (2019) identify conditions under which either/both retailers adopt the "buy-online, return-to-physical store" (BORP) option in a duopoly setting. However, our work is significantly different from both Gao et al. (2019) and Jin et al. (2019) in omnichannel return context as it also considers a partial refund policy. Furthermore, we conduct a comparative analysis between showrooming, BORS and a pure online format. Additionally, we consider a scenario where customers may decide to exchange the returned product in a B&M store (Ertekin 2018).

3. The Model

We consider a stylized model in which a retailer ("she") sells her products in a downstream consumer market through an online channel. Ex ante, customers are uncertain whether the product fits their needs. If they buy the product online, they do not have the option of experiencing it before purchasing. Therefore, in order to incentivize the customers, and to negate the uncertainty associated with the product *match*, the online retailer provides an option of returning the items that do not conform to the customer's requirements. Herein, may we add that the product non-conformity could be in terms of "fit", "quality mismatch" or "features" offered by the product itself; and managing these product returns does pose a huge challenge for the online retailer, as we have noted earlier. Note that the notations we use throughout the paper are summarized in Table 2

We now present the assumptions related to the online retailer, the customers, and the strategic game between them. Without loss of generality, we assume that each customer ("he") intends to purchase (at most) one unit of the product. However, if he visits a store/showroom, he can inspect the product and choose it if it "fits" his taste and preference. In the realm of literature under omnichannel retailing, we assume that all customers are ex-ante uncertain if the product actually fits their needs (Gao and Su 2016b, Gao et al. 2019). Let θ $(0 < \theta < 1)$ be the probability with which the product conforms to a customer's preference, and thus he obtains a valuation of V from purchasing it (Shulman et al. 2010). Thus, θ is a measure of product conformity in terms of both fit and features. If the product does not conform to the customer's requirement, or there is a misfit, the customer does not buy the product, and returns it earning a normalized valuation of zero. Therefore, we regard $1-\theta$ as probability of misfit or more precisely, the return rate in online retailing.

The retailer introduces either one of the omnichannel configurations with the objective of reducing product returns:

Table 2 Table of the Notations

Notations	Description of the Notation
V :	Valuation of the product when it matches a customer's preference
θ :	Probability with which the product conforms to a customer's preference, $0 \leq \theta \leq 1$
h_o :	Hassle cost to customers associated with online shopping
h_r :	Hassle cost to customers associated with online return
x :	Distances that a customer travels while visiting a store, $x \in [0,1]$
k:	Unit travel cost when customers visit an offline store
F_1:	Fixed facility cost of establishing a showroom
F_2:	Fixed facility cost of establishing a B&M store
t :	Unit return transportation cost to a retailer when customers return through online
c :	Unit production cost to a retailer
Π:	Retailer's profit
p:	Retailer's price in both channels
f:	Penalty to customers who return through the online channel (Refund amount, $p - f \geq 0$)
B, I, II :	Index for base model, showroom and store cases respectively

- Showroom: The first option is through opening a showroom or an experience store. Customers may inspect the product in a physical experience store and then place the order online. We call this strategy "*Experience-in-Store-and-Buy Online (ESBO)*". This reduces the misfit uncertainty of customers before they make their purchase decisions after experiencing and testing the product.
- B&M Store: The second option is through opening a B&M store. Additionally, the retailer provides more flexibility to the customers by allowing them to return their misfit items to the store. We call this strategy "*Buy-Online-Return-in-Store (BORS)*".

We use p to denote the unit retail price that remains same across channels. Cavallo (2017) finds that 70% retailers keep the online and offline prices identical; even the percent is as high as 92% for clothing products to save customers' time effort from price matching. We assume that product price is a common knowledge among the customers. The unit cost of procurement is c. The firm incurs a unit cost t for each item returned through the online channel. The unit return transportation cost t measures the retailer's operational efficiency in managing customer returns. We use Π to denote the profit of the retailer. The sequence of events are as follows.

Event 1: The online retailer decides whether to open a showroom (or an experience store) or a B&M store (adding either ESBO or BORS channel).

Event 2: The retailer determines her market price p and return penalty f (wherever required).

Event 3: Each customer decides whether to purchase the product from which channel to purchase.

Event 4: After receiving the delivery of the product purchased online, the customer decides whether to return the product once the misfit uncertainty gets resolved.

3.1. The Benchmark: Retailer with only Online Store

As a benchmark, we first analyze a scenario where the retailer operates an online store only. We call this strategy as the "*Buy-Online-and-Return-Online (BORO)*". Herein, customers cannot evaluate certain features of the product if they purchase it from an online channel. Even though a customer can gather product information by other means, such as word-of-mouth and online reviews, he makes the decision of keeping the product once he receives it based on whether the product conforms to and fits his requirements. The customer incurs a hassle cost $h_o > 0$ from buying it online (cost of inconvenience in web-browsing, waiting time, and concerns for delivery) (Jing 2018, Gao et al. 2019). With probability θ, he likes the product and keeps it. With probability $1-\theta$, he is dissatisfied with the product and returns it. Here, the customer incurs a hassle cost $h_r > 0$ while returning the product Nageswaran et al. (2020). Additionally, for each unit of return, a retailer imposes a fixed return fee (financial penalty, such as restocking fee or shipping charge) f, where $0 \leq f \leq p$. A retailer typically levies such an amount to mitigate customer returns (Shulman et al. 2009, 2010, 2011). For example, in US, H&M charges $5.99 as a restocking fee (H&M 2019).

Next, we derive customers' expected utility from purchasing the product online. If a customer likes the product, he obtains an utility of $V - p - h_o$. If he dislikes the product, he incurs a total hassle cost of $(h_o + h_r)$ and a penalty of f in returning the product. The expected utility of a customer from purchasing the product through the online channel is given by

$$\mathcal{U}_o^B = \theta(V - p - h_o) + (1-\theta)(-h_r - h_o - f).$$

Customers purchase the product if $\mathcal{U}_o^B \geq 0$. The retailer earns a unit margin of $p - c$ by selling one unit of the product, and incurs a cost of $t - f$ for each unit of product returned. In doing so, the retailer solves the following profit maximization problem

$$\begin{aligned} &\max_{p,f} \left\{\Pi_o^B(p) = \theta(p-c) - (1-\theta)(t-f)\right\} \\ &s.t. \mathcal{U}_o^B \geq 0 \end{aligned} \tag{1}$$

In the following lemma, we determine the retailer's optimal pricing decision while she maximizes her profit.

LEMMA 1. *If the online retailer receives customer returns online, the optimal retail price is given by* $p_o^B = \frac{\theta V - h_o - (1-\theta)(h_r + f_o^B)}{\theta}$.

Lemma 1 characterizes the optimal retail price under the benchmark scenario. The retailer squeezes out all the surplus from the customers and sets the maximum possible price. Substituting the value of p_o^B, we get $\Pi_o^B = \theta(V - c) - h_o - (1-\theta)(h_r + t)$. Further, we assume that $\theta(V - c) - h_o - (1 - \theta)(h_r + t) \geq 0$ which is the individual rationality constraint; otherwise, the online retailer has no incentive to operate in the consumer market.

4. Omnichannel Retailing Strategies and Mitigation of Customer Returns

In this section, we analyze two special omnichannel retailing strategies: opening a showroom (adding the ESBO channel) and a B&M store (adding the BORS channel); then, we compare the retailer's profit under both strategies. Retailers have come up with such innovative strategies to mitigate the propensity of customer returns in omnichannel retailing. Under both omnichannel strategies, the retailer establishes a physical store (either a showroom or a B&M store). We assume that customers are heterogeneous with their physical distance from the store. Let x denote the distance between a customer and the store. While visiting the physical store, a customer incurs a travel cost of kx, where k denotes the unit travel cost to visit the store. Consistent with extant literature (see Gao et al. 2019), we assume that x is uniformly distributed on the standard Hotelling line between 0 and 1.

4.1. Opening a Physical Showroom: Adding the ESBO Channel

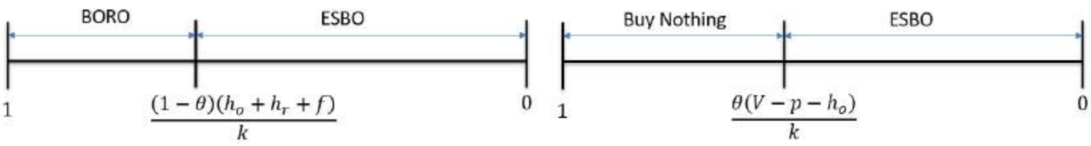
Some online retailers have come up with physical showrooms or experience stores (e.g. Warby Parker and Bonobos) to help customers reduce their misfit uncertainty by displaying a few sample items. Typically, retailers offer a special type of offline service in an experience store (operated by themselves or a third party), where customers can physically examine and test the products (Bell et al. 2017, Li et al. 2020). However, customers are not provided the option to buy those products from the experience store. Once customers do like a product after evaluating it in the showroom, they can buy and get the product delivered through the online channel. Given that customers visit a showroom only for product experience and trial, it requires lesser floor space, and thus involves lower infrastructural cost as compared to a conventional brick-and-mortar store (The Economist 2016, Gao et al. 2019). The fixed facility cost of establishing the showroom is given by F_1.

We use the index I to denote the scenario where the retailer establishes a showroom in addition to her online channel. Once a customer visits the showroom, he incurs a travel cost kx. If he likes the product, he obtains an utility of $V - p - h_o$. If he dislikes the product, he does not purchase anything and obtains an utility of zero. The expected utility of a customer located at x from inspecting the product in the showroom and purchasing it online is given by

$$\mathcal{U}_o^I = \theta(V - p - h_o) - kx$$

Further, the expected utility of a customer from directly buying the product online without inspecting it (under the BORO strategy) is given by $\mathcal{U}_o^B = \theta(V-p) - h_o - (1-\theta)(h_r + f)$. We consider two distinct cases: (i) Case $\mathrm{S}_i^{\mathrm{I}}$, $\mathcal{U}_o^B \geq 0$, i.e. $p \leq \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}$, and (ii) Case $\mathrm{S}_{ii}^{\mathrm{I}}$, $p > \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}$. These two cases characterize customer x's optimal shopping behavior. In Figure 1, we show how

Figure 1 **Customer Segmentation if a showroom is opened**



(a) A fraction of customers prefers BORO (b) No customer prefers BORO

customers are segmented in the above two cases. The following lemma summarizes the strategic customer behavior (see Figure 1). Next, Lemma 2 illustrates how the consumer market are segmented based on the customers' purchasing behaviors.

LEMMA 2. *When the online retailer opens a "showroom", there exists two distinct cases:*

(a) Case S_i^I*: If* $0 \le x \le \frac{(1-\theta)(h_o+h_r+f)}{k}$*, it is optimal for a customer to choose ESBO; if* $\frac{(1-\theta)(h_o+h_r+f)}{k} < x \le 1$*, it is optimal to choose BORO.*

(b) Case S_{ii}^I*: If* $0 \le x \le \frac{\theta(V-p-h_o)}{k}$*, it is optimal for a customer to choose ESBO; if* $\frac{\theta(V-p-h_o)}{k} < x \le 1$*, it is optimal not to purchase.*

The lemma implies that, depending on the value of p, there could be two distinct cases. If $p \le \frac{\theta V-h_o-(1-\theta)(h_r+f)}{\theta}$ (the retail price is relatively low), i.e. $\mathcal{U}_o^B \ge 0$, customers buy the product online irrespective of them visiting the showroom. However, there could be other scenarios from the customer behavior perspective: visit the showroom and buy online, and buy online without visiting the showroom. A customer located at x prefers ESBO strategy if $0 \le x \le \frac{(1-\theta)(h_o+h_r+f)}{k}$ and to buy from the online channel if $\frac{(1-\theta)(h_o+h_r+f)}{k} < x \le 1$. If $0 \le x \le \frac{(1-\theta)(h_o+h_r+f)}{k}$, a customer is located closer to the showroom. Hence, he will purchase the product from the online channel after experiencing it in the showroom and finding it a good match. The retailer's problem is to decide the retail price, p, and the return shipping fee, f that maximize her profit:

$$\text{Case } \mathrm{S}_i^{\mathrm{I}}: \max_{p,f} \left\{ \Pi_i^I(p,f) = \theta(p-c) - \left(1 - \frac{(1-\theta)(h_o+h_r+f)}{k}\right)(1-\theta)(t-f) \right\} - F_1 \tag{2}$$
$$s.t.\ p \le \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}.$$

If $p > \frac{\theta V-h_o-(1-\theta)(h_r+f)}{\theta}$, i.e. $\mathcal{U}_o^B < 0$, some customers do not buy the product at all because of high retail price. Then, there could be two optimal customer behaviors: (i) visit the showroom and buy online, and (ii) do not purchase at all. Thus, a fraction of customers buys the product from online channel, only after inspecting it in the showroom. A customer located at x prefers ESBO strategy if $x \le \frac{\theta(V-p-h_o)}{k}$; otherwise he prefers not to purchase. Then, the retailer solves the following optimization problem:

$$\text{Case } \mathrm{S}_{ii}^{\mathrm{I}}: \max_{p} \left\{ \Pi_{ii}^I(p) = \theta(p-c)\frac{\theta(V-p-h_o)}{k} \right\} - F_1 \tag{3}$$

$$s.t.\ p > \frac{\theta V - h_o - (1-\theta)(h_r + f)}{\theta}.$$

Next, in Proposition 1, we characterize the optimal retail price and return penalty decisions when the retailer establishes a showroom.

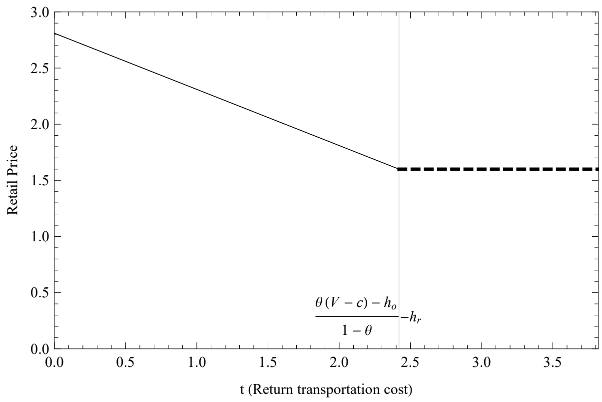
PROPOSITION 1. *When the online retailer opens a "showroom", the optimal retail price and return penalty are as follows:*

(a) Case S_i^I: For low unit return transportation cost ($t \leq \frac{\theta(V-c)-h_o}{1-\theta} - h_r$), the optimal retail price and penalty are given by $p_i^I = V - \frac{(1+\theta)h_o+(1-\theta)(h_r+t)}{2\theta}$ and $f_i^I = \frac{t-h_o-h_r}{2}$.

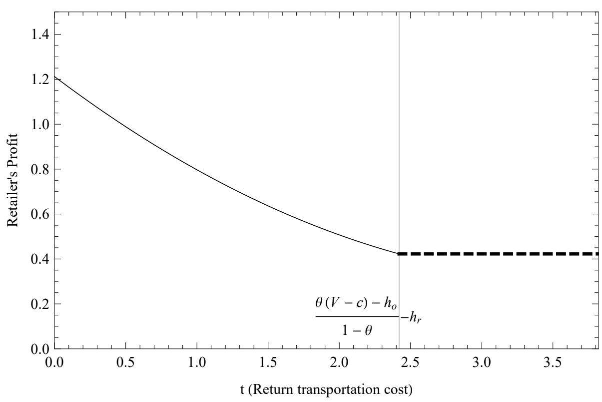
(b) Case S_{ii}^I: For high unit return transportation cost ($t > \frac{\theta(V-c)-h_o}{1-\theta} - h_r$), the optimal retail price is given by $p_{ii}^I = \frac{V+c-h_o}{2}$.

Proposition 1 determines the optimal retail price and refund policy for the online channel in presence of a showroom. From Proposition 1(a), we find that if the transportation cost related to reverse logistics is low, the retailer keeps the return penalty low and thus can serve all customers. However, some customers who reside far from the showroom will not visit it. As the travel cost to showroom is high, they choose to purchase the product online, and evaluate it later. Conversely, from Proposition 1(b), we find that if the unit return transportation cost is high, the retailer keeps the return penalty high, and serves only a fraction of customers who visit the showroom. These customers in turn evaluate the product before making a purchase decision. The remaining customers do not buy the product at all, as the return penalty is high. Figure 2a and 2b highlight the impact of the unit return transportation cost on the optimal retail price and retailer's profit, respectively.

Figure 2 Impact of t on retailer's market price and profit.



(a) Retailer's market price as a function of t



(b) Retailer's profit as a function of t.

In the next corollary, we examine how h_o, h_r, and t affects the retailer's profit under the "showrooming" strategy as compared to the BORO strategy.

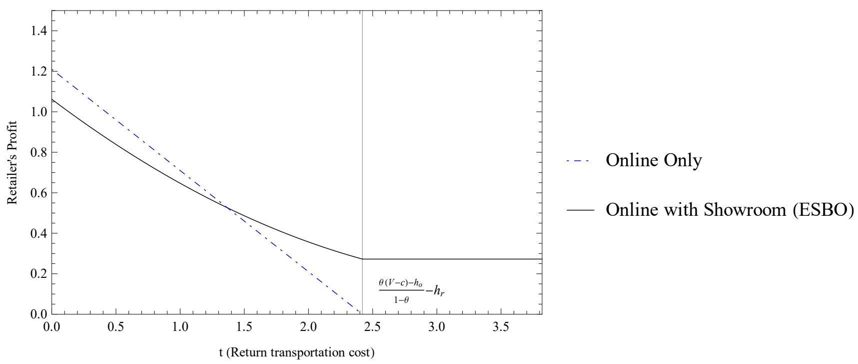
Corollary 1. *The benefit of establishing a showroom as compared to the pure online channel is increasing in h_o, h_r, and t.*

It becomes clear from Corollary 1 that when the hassle cost related to online buying and returning as well as the transportation cost associated with online returns increase, more number of customers would prefer to buy the product after inspecting it in the showroom. Thus, retailer's profit difference between "with showroom" and "without showroom" scenarios increases when either of h_o, h_r, or t increases. Next in Proposition 2, we compare the "showroom" strategy to the pure online channel and highlight the benefit of establishing a showroom.

Proposition 2. *Compared to the BORO-only benchmark, the retailer benefits from establishing a showroom when* $t \geq \frac{\sqrt{4F_1k}}{1-\theta} - h_o - h_r$.

The result in Proposition 3 follows from comparing the retailer's profit with and without establishing a showroom. When the reverse transportation cost (t) is low, the retailer sets a low return penalty. As a result, the customers prefer online shopping as compared to visiting the showroom. The retailer finds no incentive to open a showroom in addition to the existing online channel. On the other hand, when t is high, the retailer sets a high return penalty. As a result, some of the customers choose not to buy from the online channel. To attract these customers, the retailer establishes an additional showroom to reduce misfit uncertainty.

Figure 3 Retailer's profit comparison with respect to t



4.2. Opening a B&M Store: Adding the BORS Channel

In this section, we discuss another flexible omnichannel retailing strategy, namely Buy-Online-Return-In-Store (BORS). Under this scenario, customers who buy products online, have a flexibility of returning misfit products for free (no return penalty) to a B&M retail store owned and operated by the online retailer (UPS 2016, WSJ 2016, Gao et al. 2019, Nageswaran et al. 2020). Online customers are mostly inconvenienced by two contrasting characteristics of returns: (i) paying a restocking fee in case he returns online (27% of customers), and (ii) irritation of traveling to a physical store for returning a product (21% of customers) (UPS 2016). Another UPS study, conducted in 2018, reveals that 58% online customers in the US, preferred in-store returns, whereas 45% customers actually returned products in conventional stores (UPS 2018). Retailers can fulfill customer demands from either channels and allow customers to return misfit products in both the channels. Many retailers, such as Walmart and H&M, have already adopted such a strategy to mitigate customers' valuation risk. We use the index II to denote the scenario where the retailer builds a conventional B&M store in addition to her online channel.

In a B&M store, customers purchase an item if it is available there. If a customer visits the store, he can inspect all attributes of the product and test it before making a purchase decision. The misfit uncertainty is best revealed at the store, and hence, he can purchase it if he likes it. We assume that he does not return the item once purchased from the store. A customer located at x incurs a travel cost kx while visiting the physical store, where k is the unit travel cost.

Under the above omnichannel strategy, a customer can buy a product from either a retail store or an online channel. If he visits the retail store, he can physically examine and test the product and then purchases only if he likes it. If he likes the product, he obtains an utility of $V-p$. If he dislikes it, he does not purchase anything and obtains an utility of zero. The expected utility of a customer from inspecting the product and further purchasing it in the physical store is given by

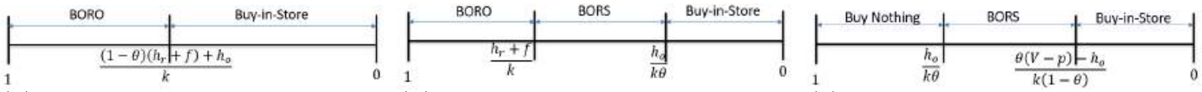
$$\mathcal{U}_s^{II} = \theta(V-p) - kx.$$

Thus, the retailer faces no customer returns from a physical store. If the customer chooses to purchase the product from the online channel, he returns it if he dislikes it. At this point, he has an added flexibility to return the disliked item to a retail store. Thus, he chooses to return the misfit item either through the online channel or to a retail store. If the customer returns it to a retail store, he incurs a cost equivalent to kx. Additionally, he incurs a hassle cost h_o from buying the product online. If he likes the product, he obtains an utility of $V-p$ with probability θ. If he dislikes it, he obtains an disutility of kx with probability $1-\theta$. Thus, the expected utility of a customer under BORS is given by

$$\mathcal{U}_o^{II} = \theta(V-p) - h_o - (1-\theta)kx.$$

Further, the expected utility of a customer from purchasing (and returning, if required) the product through the online channel is given by $\mathcal{U}_o^B = \theta(V-p) - h_o - (1-\theta)(h_r+f)$. We consider three distinct cases: (i) Case $\mathrm{S}_i^{\mathrm{II}}$, $p \leq \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}$ and $f \leq \frac{h_o\delta}{\theta} - h_r$, where no customer prefers the BORS, (ii) Case $\mathrm{S}_{ii}^{\mathrm{II}}$, $p \leq \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}$ and $f > \frac{h_o \delta}{\theta} - h_r$, where a fraction of customers prefer the BORS, and (iii) Case $\mathrm{S}_{iii}^{\mathrm{II}}$, $p > \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}$ and $f > \frac{h_o \delta}{\theta} - h_r$, where no customer prefers the BORO. These three cases characterize customer x's optimal shopping behavior. The strategic customer behavior is characterized in Lemma 3 (see Figure 4).

Figure 4 Customer Segmentation if a B&M Store is opened



(a) No customer prefers the BORS (b) A fraction of customers prefer the BORS (c) No customer prefers the BORO

Lemma 3. *When the online retailer opens a "B&M store", there exists three distinct cases:*

(a) Case S_i^{II}: If $0 \leq x \leq \frac{(1-\theta)(h_r+f)+h_o}{k}$, it is optimal for a customer to buy from the B&M store; if $\frac{(1-\theta)(h_o+h_r+f)}{k} < x \leq 1$, it is optimal choose BORO.

(b) Case S_{ii}^{II}: If $0 \leq x \leq \frac{h_o}{k\theta}$, it is optimal for a customer to buy from the B&M store; if $\frac{h_o}{k\theta} < x \leq \frac{h_r+f}{k}$, it is optimal to choose BORS; if $\frac{h_r+f}{k} < x \leq 1$, it is optimal to choose BORO.

(c) Case S_{iii}^{II}: If $0 \leq x \leq \frac{h_o}{k\theta}$, it is optimal for a customer to buy from the B&M store; if $\frac{h_o}{k\theta} < x \leq \frac{\theta(V-p)-h_o}{(1-\theta)k}$, it is optimal to choose BORS; if $\frac{\theta(V-p)-h_o}{(1-\theta)k} < x \leq 1$, it is optimal not to purchase.

In Figure 4, we show how customers are segmented in all three cases. It may be noted that, in cases (i) and (ii), the retailer covers the whole spectrum and fulfills all customer demands.

However, from Figure 4(a) (explained in Lemma 3(a)), we observe that $\mathcal{U}_o^{II}$ is dominated by both $\mathcal{U}_s^{II}$ and $\mathcal{U}_o^{B}$. Thus, the customers find no incentive in buying online and returning to the store. In the following lemma, we express this finding.

Lemma 4. *If $f \leq \frac{h_o}{\theta} - h_r$, no customer prefers the buy-online-return-in-store (BORS) strategy.*

From Lemma 4 we find that if $f \leq \frac{h_o}{\theta} - h_r$, i.e. if the return penalty is too low, customers would choose to return the misfit products online, rather than paying a a visit to the B&M store. Similarly, customers located far from the B&M store do not want to incur an additional cost of visiting the store. Conversely, customers close to the B&M store directly purchase the product from the B&M store. In this case, she acts like a multichannel retailer in absence of cross-channel returns and solves the following optimization problem:

$$\mathrm{Case}\mathrm{S}_i^{\mathrm{II}} : \max_{p,f} \left\{ \Pi_i^{II}(p,f) = \theta(p-c) - \left(1 - \frac{(1-\theta)(h_r+f)+h_o}{k}\right)(1-\theta)(t-f) \right\} - F_2 \qquad (4)$$

$$s.t.\ p \leq \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}$$

Next, we discuss the cases (ii) and (iii) where $f > \frac{h_o\delta}{\theta} - h_r$. If $\mathcal{U}_o^B \geq 0$, i.e. $f > \frac{h_o\delta}{\theta} - h_r$ and $p \leq \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}$, the retailer keeps the product price low to serve all the customers, and return penalty high to discourage them from returning the products. In Case $\mathrm{S}_{ii}^{\mathrm{II}}$, a customer prefers to visit the B&M store and purchase the product if $0 \leq x \leq \frac{h_o}{k\theta}$, to buy online and return the disliked one in a retail store (BORS) if $\frac{h_o}{k\theta} < x \leq \frac{h_r+f}{k}$, and to buy from (and return to, if required) pure online channel if $\frac{h_r+f}{k} < x \leq 1$. Under this scenario, the retailer solves the following optimization problem:

$$\begin{aligned} \mathrm{Case}\mathrm{S}_{ii}^{\mathrm{II}} : \max_{p,f} & \left\{ \Pi_{ii}^{II}(p,f) = \theta(p-c) - \left(1 - \frac{h_r+f}{k}\right)(1-\theta)(t-f) \right\} - F_2 \\ s.t.\ p \leq & \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}. \end{aligned} \tag{5}$$

If $\mathcal{U}_o^B < 0$, i.e. $p > \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}$, due to high retail price, only a fraction of customers either buy the product from the B&M store or return the disliked product to the store. A customer prefers to visit the B&M store and purchase if $0 \leq x \leq \frac{h_o}{k\theta}$, and buy online and return to a store if $\frac{h_o}{k\theta} < x \leq \frac{\theta(V-p)-h_o}{(1-\theta)k}$. Under this scenario, the retailer solves the following optimization problem:

$$\begin{aligned} \mathrm{Case}\mathrm{S}_{iii}^{\mathrm{II}} : \max_{p} & \left\{ \Pi_{iii}^{II}(p) = \theta(p-c)\frac{\theta(V-p)-h_o}{(1-\theta)k} \right\} - F_2 \\ s.t.\ p > & \frac{\theta V - h_o - (1-\theta)(h_r+f)}{\theta}. \end{aligned} \tag{6}$$

Next, in Proposition 3, we characterize the optimal retail price and return penalty decisions when the retailer establishes a B& store.

Proposition 3. *When the online retailer opens a "B&M store", the optimal retail price and return penalty are as follows:*

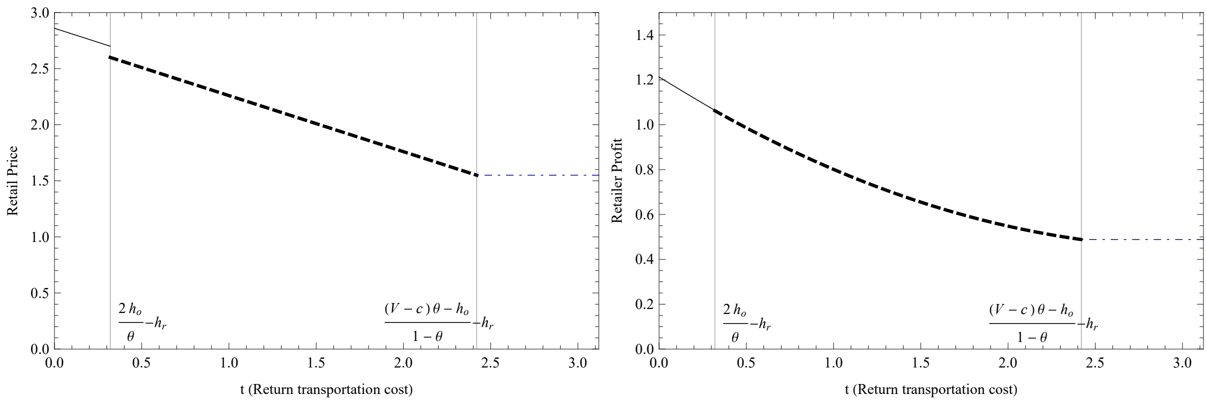
(a) Case S_i^{II}*: For low unit return transportation cost (* $t \leq \frac{h_o}{\theta} - h_r$*), the optimal retail price and return penalty are given by:* $p_i^{II} = V - \frac{h_o+(1-\theta)(h_r+t)}{2\theta}$ *and* $f_i^{II} = \frac{(1-\theta)(t-h_r)-h_o}{2(1-\theta)}$.

(b) Case S_{ii}^{II}*: For intermediate unit return transportation cost (* $\frac{h_o}{\theta} - h_r < t \leq \frac{\theta(V-c)-h_o}{1-\theta} - h_r$*), the optimal retail price and return penalty are given by:* $p_{ii}^{II} = V - \frac{2h_o+(1-\theta)(h_r+t)}{2\theta}$ *and* $f_{ii}^{II} = \frac{t-h_r}{2}$.

(c) Case S_{iii}^{II}*: For high unit return transportation cost (* $t > \frac{\theta(V-c)-h_o}{1-\theta} - h_r$*), the optimal retail price is given by* $p_{iii}^{II} = \frac{\theta(V+c)-h_o}{2\theta}$.

The three cases in Proposition 3 show how the optimal retail price and return shipping fee vary with unit return transportation cost across the three cases. In Case $\mathrm{S}_i^{\mathrm{II}}$, we find that as the transportation cost related to reverse logistics is low, no customer prefers BORS strategy for shopping. Thus, all the customers either purchase directly from the B&M store or follow the BORO strategy. The retailer keeps the return penalty low so that she can serve all the customers. As the return penalty is kept low, the customers who have already spent the hassle cost to buy it online, are not willing to pay an additional travel cost for returning the item in store. Thus, she acts like a multichannel retailer in absence of cross-channel returns. In Case $\mathrm{S}_{ii}^{\mathrm{II}}$, the unit return transportation cost is moderate. In this case, a customer located at x either visits the B&M store or follows the BORO or the BORS strategy so that he maximizes his utility. The competition between these strategies intensifies, thus resulting in a lower price and retailer's profit as compared to Case $\mathrm{S}_{i}^{\mathrm{II}}$. Finally, in Case $\mathrm{S}_{iii}^{\mathrm{II}}$, we find that as the unit return transportation cost is high, no customer prefers the BORO strategy for shopping. Hence, all customers either visit the B&M store or follow a BORS strategy for shopping from the retailer. Because of high return penalty and misfit uncertainty, these customers visit the store for either purchasing or returning a product. The remaining customers do not buy the product. Proposition 3 also highlights how the retailer's profit changes with respect to t. Intuitively, a higher return transportation cost makes online shopping less attractive to customers, and thus, the retailer's market price and profit (weakly) decrease in each case. Figure 5a and 5b highlight the impact of the return transportation cost on the optimal retail price and retailer's profit, respectively.

Figure 5 Impact of t on retailer's market price and profit



(a) Retailer's market price as a function of t (b) Retailer's profit as a function of t

Corollary 2. *(a)* $p_i^{II} > p_{ii}^{II}$ *and* $f_i^{II} < f_{ii}^{II}$.

From Corollary 2 we find that the retail price in Case $\mathrm{S}_{i}^{\mathrm{II}}$ is higher than that in Case $\mathrm{S}_{ii}^{\mathrm{II}}$. Further, the return penalty in Case $\mathrm{S}_{ii}^{\mathrm{II}}$ is higher than that in Case $\mathrm{S}_{i}^{\mathrm{II}}$. The reason behind this as follows: the unit return transportation cost (t) is lower in Case $\mathrm{S}_{i}^{\mathrm{II}}$ as compared to Case $\mathrm{S}_{ii}^{\mathrm{II}}$. In Case $\mathrm{S}_{i}^{\mathrm{II}}$, as t is low, the retailer sets a low return penalty, but keeps the retail price high to extract more surplus from customers. However, in Case S_{ii}^{II}, the retailer sets a high return penalty to compensate for the high cost of reverse logistics. But, she offers a low retail price to attract more customers for shopping. In Proposition 3, we show the influence of h_o, h_r, and t on the relative benefit of establishing a B&M store. Next, in Proposition 4, we compare the retailer's pricing and return penalty decisions under the "showroom" (adding the ESBO channel) and the "B&M store" (adding the BORS channel) configuration.

PROPOSITION 4. *a) The retail prices under ESBO and BORS channels have the following orders:*
$$\begin{cases} p_i^{II} > p_i^{I}, & \text{if } t \leq \frac{h_o}{\theta} - h_r \\ p_{ii}^{II} < p_i^{I}, & \text{if } \frac{h_o}{\theta} - h_r < t \leq \frac{\theta(V-c)-h_o}{1-\theta} - h_r \\ p_{iii}^{II} < p_{ii}^{I}, & \text{if } t > \frac{\theta(V-c)-h_o}{1-\theta} - h_r \end{cases}.$$
b) The return penalties under ESBO and BOPS channels have the following orders:
$$\begin{cases} f_i^{II} < f_i^{I}, & \text{if } t \leq \frac{h_o}{\theta} - h_r \\ f_{ii}^{II} > f_i^{I}, & \text{if } \frac{h_o}{\theta} - h_r < t \leq \frac{\theta(V-c)-h_o}{1-\theta} - h_r \end{cases}.$$

Our results from Proposition 4 reveal that if the value of t is low, the retail price (return penalty) under BORS is higher (lower) than that of ESBO channel. This is because the total number of items returned is lower under BORS than that under ESBO. As a result, the retailer sets a low (high) return penalty, and keeps the retail price high (low) under BORS, as compared to the ESBO channel. When the value of t is moderate, the retailer charges a higher return penalty under the BORS channel, as compared to the ESBO channel. This leads to a lower retail price under BORS, as the retailer intends to serve all customers. Finally, when the value of t is high, no customer prefers the BORO strategy for shopping. However, the total demand under the BORS channel is higher than that under ESBO. Thus, the retailer sets a higher market price under the ESBO channel compared to the BORS channel.

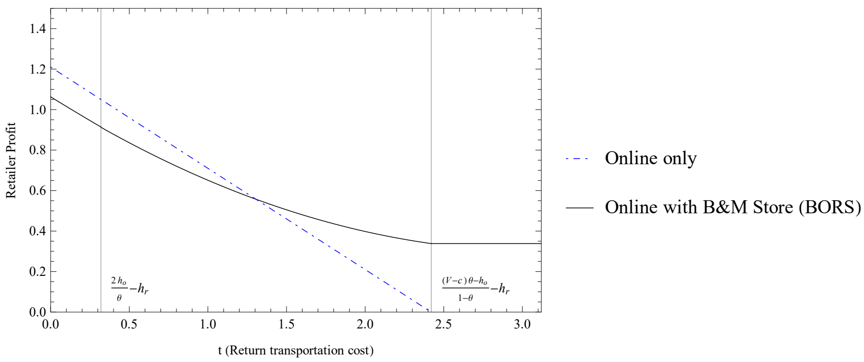
COROLLARY 3. *The benefit of establishing a B&M store as compared to the pure online channel is increasing in h_o, h_r, and t.*

From Corollary 3, we find that if the hassle cost of purchasing and returning online, as well as the transportation cost associated with online returns increase, more and more number of customers would prefer not to buy online. They would rather prefer to purchase from a physical B&M store after evaluating the product. Thus, the retailer's profit difference between "with B&M store" and "without B&M store" increases when either of h_o, h_r, or t increases. Next in Proposition 5, we compare the "B&M store" (extending BORS channel) configuration as compared to the pure online channel and show the benefit of establishing a B&M store.

PROPOSITION 5. *Compared to the BORO-only benchmark, the retailer benefits from establishing a B&M store when* $t \geq \begin{cases} \frac{\sqrt{4F_2k}-h_o}{1-\theta} - h_r, & \text{if } t \leq \frac{h_o}{\theta} - h_r \\ \sqrt{\frac{4F_2k}{1-\theta}} - h_r, & \text{if } \frac{h_o}{\theta} - h_r < t \leq \frac{\theta(V-c)-h_o}{1-\theta} - h_r \end{cases}.$

Our result from Proposition 5 follows from comparing the retailer's profit with and without establishing a B&M store. When the unit return transportation cost (t) is low, the retailer sets a low return penalty. As a result, customers prefer online shopping as compared to visiting the B&M store. The retailer in turn finds no incentive to open a B&M store in addition to the online channel. On the other hand, when t is high, the retailer sets a high return penalty. As a result, some of the customers choose not to buy from the online channel, thus, to attract those customers, the retailer establishes an additional B&M store.

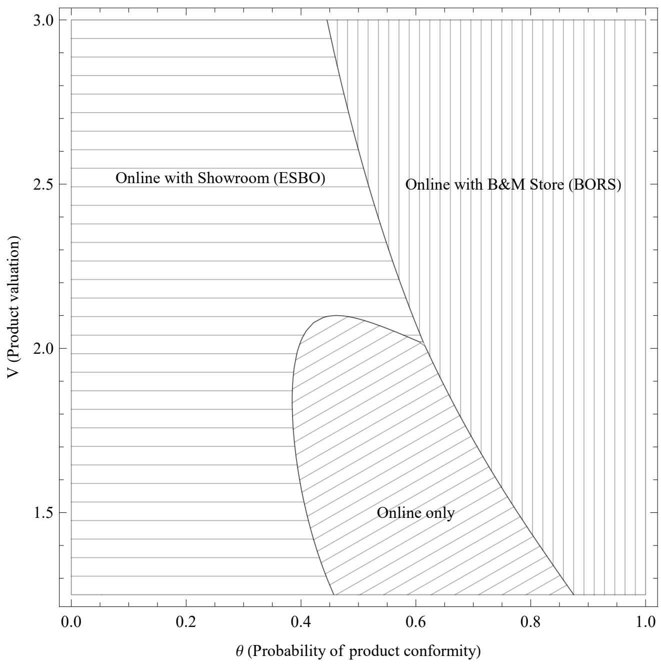
Figure 6 Retailer's profit comparison with respect to t



5. Decision Support Matrix based on the Product Valuation and the Extent of Product Standardization

We first consider the potential impact that the product characteristics, namely the extent of product valuation and product standardization, can have on determining the online retailer's optimal omnichannel strategy. As mentioned earlier, the misfit uncertainty associated with online purchases leads to the retailer incurring significant costs in managing product returns. In the absence of tactile and experiential information, a customer cannot rightly assess whether the product attributes would match his preferences. Once purchased, the customer keeps the product if it conforms to his expectations or returns it otherwise. However, the problem of misfit uncertainty assumes a less severe form in case of standardized products as it is comparatively easy to convey the product attributes over a digital medium. With an increase in product customization, the customer's need to assess the non-digital, tactile, and experiential product attributes (e.g. color, texture, or design) increases. Typically, these attributes are inherently more difficult to communicate without physical inspection. Thus, higher standardization leads to lower misfit-uncertainty among customers resulting in low return rates (i.e. higher values of θ) and vice versa. While modeling the strategic behavior exhibited by customers, we have used the fit-probability θ (the probability of a product conforming to a customer's preference) as a proxy for product standardization.

Figure 7 Optimal omnichannel configuration based on product categories



Based on these product attributes, we analyze if a strategy of establishing an offline channel turns profitable for the online retailer. The model also allows us to predict which offline channel strategy, i.e. – a showroom or a B&M store –would actually be optimal for the online retailer. Figure 7 shows optimal channel strategies for different combinations of product valuation, and the extent of product standardization. For example, if the product is premium and highly customized (e.g. designer apparel, electronic gadgets), the online retailer should open an additional showroom. Whereas if the product is premium and highly standardized (e.g. large electrical appliances such as washing machine or refrigerator), the retailer should establish an additional B&M store. On the other hand, if the product is low-valued and highly customized (e.g. eyewear), she prefers to open an exclusive showroom. Finally, if the product is low-valued and highly standardized (e.g. books, DVDs), she may choose to open an extra B&M store or opt to continue as an online retailer depending on the product return rate and valuation. These results imply that both "tangible" (e.g. price) and "non-digital" (e.g. color, texture, or design of a product) attributes can affect an online retailer's overall profitability, and thus influence the decision to open an offline arm. Based on the our analyses, we further develop a decision support matrix (see Table 3) that can suggest a retailer her optimal omnichannel configuration based on the product characteristics.

Table 3 Omnichannel configurations based on product standardization and product valuation

Product Standardization	Product Valuation	
	High	Low
High	Online with B&M Store (BORS channel)	Online with B&M Store (BORS channel)/ Online only
Low	Online with showroom (ESBO channel)	Online with showroom (ESBO channel)

6. Conclusion

In the last decade, the traditional retailing industry has been disrupted by the rapid emergence of digital channels. Even though these digital channels come with multiple positive characteristics, one major drawback that they suffer from is their inability to allow customers to resolve the misfit uncertainty associated with online shopping. As a result, product categories like apparels, footwear and toys face high customer returns (Nageswaran et al. 2020). On the other hand, products such as books and groceries are highly standardized; and hence, the return rate is typically very low. When customers return products, retailers incur a substantial cost in managing the returned merchandise (i.e. cost of transporting, sorting, and processing the returned products). Customers too find the process of returning misfit products troublesome. Therefore, in order to overcome such difficulties, retailers nowadays, are looking at various omnichannel strategies to mitigate customer's fit uncertainty. We develop a stylized model to identify a retailer's optimal pricing and return penalty decisions under three different scenarios: 1) Selling a product only through an online channel; 2) Establishing a showroom (adding an "experience-in-store-buy-online (ESBO)" channel) while selling the product online, and 3) Selling the product through both B&M store and online channel while providing an option of in-store returns (adding a "buy-online-and-return-in-store (BORS)" channel).The objective of this study has been to investigate how adopting an omnichannel configuration (either opening a showroomor B&M store) impacts a retailer's profit and customers' strategic behavior. As an extension, we also analyze a scenario, where a customer may decide to exchange his misfit product with an appropriate variant, while returning the misfit product in a B&M store.

We first determine and further characterize the optimal product price and return penalty under three scenarios. Our results show that determining optimal omnichannel configuration depends on several factors - e.g. product return rate, customer's valuation of the product, cost of reverse logistics, hassle costs associate with purchasing and returning online, etc. If the return rate of the product is high (e.g. designer apparel, eyewear, footwear etc.), it is best to open an additional showroom, where the customers can experience it before the purchase. If the product is standardized, and the valuation is high (e.g. electric appliances), the retailer establishes a B&M store.

Additionally, we find that, if the product is standardized and the valuation is low (e.g. books and DVDs), the retailer chooses to sell through either the online channel or the B&M store. Based on the insights above, we develop a decision support matrix that can help the retailer determine an optimal omnichannel configuration with respect to product characteristics.

Our paper is one of the first endeavors in terms of analytically modeling a truly realistic phenomenon in terms of product returns and exchanges in an omnichannel context. Nevertheless, this study could be extended in several ways. One could look at a multi-player model analyzing the competitive dynamics between traditional and omnichannel retail. Importantly, Empirical validation of the decision support matrix would be extremely useful for online retailers. Analyzing the impact of omnichannel strategies on the entire supply chain by adding the decisions of the manufacturer could be another interesting future research avenue.

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