Online-Exclusive or Hybrid? Channel Merchandising Strategies for Ship-to-Store Implementation

Necati Ertekin

Carlson School of Management, University of Minnesota, Minneapolis, MN, 55455

Mehmet Gümüş

Desautels Faculty of Management, McGill University, Montreal, Quebec, H3A 1G5

Mohammad E. Nikoofal

Ted Rogers School of Management, Ryerson University, Toronto, Ontario, M5B 2K3

Abstract

We study how merchandising products as online-exclusive (i.e., products available only online) vs. hybrid (i.e., products available both online and offline) can improve the performance of ship-to-store (STS) services, an omnichannel retail fulfillment initiative that allows customers to pick up their online orders in-store. First, using a stylized model, we theoretically demonstrate that while STS is likely to increase sales, it may also entail the risk of losing some customers by exposing them to alternative products at nearby competitors during in-store pickup visits. Online-exclusive products and hybrid products are subject to this tradeoff at different degrees. To minimize the risk of STS, we theoretically propose a channel merchandising strategy for the STS implementation. Next, we empirically test our theoretical predictions using data from an omnichannel retailer that launched the STS functionality. We also conduct an empirical counterfactual analysis to quantify the benefits of our proposed channel merchandising strategy. Overall, our theoretical model coupled with the empirical analysis suggests that to improve the performance of STS implementation, an omnichannel retailer should offer (i) products that are somewhat generic, low-priced, and with high in-store availability as online-exclusive and (ii) products that are somewhat unique, high-priced, and with low in-store availability as hybrid. The counterfactual analysis reveals that the proposed channel merchandising strategy can improve STS performance by increasing overall retail sales by another 2.7% for the focal retailer.

Keywords: Retail operations, omnichannel retailing, in-store pickup services, channel merchandising.

1 Introduction

Consumers' proficient use of digital technologies, combined with the ever-increasing demand for a tailored personal shopping experience, has drastically changed customer relationship management for retailers. Consumers now demand a seamless shopping experience in which they can utilize both online and offline channels to complete a transaction, a practice known as omnichannel shopping (Brynjolfsson et al. 2013, Bell et al. 2014). To stay competitive, many retailers have started omnichannel fulfillment initiatives that allow customers to pick up online orders in-store, have online orders shipped from stores, and access real-time in-store inventory information online. Among these initiatives, retailers consider in-store pickup of online orders to have the highest strategic priority for their companies (Forrester Consulting 2014). As of 2015, 41% of all retailers have initiated in-store pickup services, and this number is expected to increase over time (BRP 2015).

While many retailers visibly offer in-store pickup services, several industry reports indicate that a majority experience challenges with implementing such services (Shukairy 2017, Amato-McCoy 2018, Wassel 2019). If not implemented right, in-store pickup services can result in financial and customer-service related problems, which can undermine the very benefits that in-store pickup services can offer. A Retail Info Systems study estimates that 6.5% of revenues are lost due to poor implementation of omnichannel processes and technologies (Skorupa 2013). Some of the challenges associated with implementation include inventory record inaccuracy (Retail TouchPoints 2019), poor store execution (e.g., insufficient signage, poor in-store service) (Shukairy 2017), and inefficient merchandise planning across channels (Warner 2013, Amato-McCoy 2018). Our research focuses on channel merchandise planning for in-store pickup services[1].

Retailers can fulfill in-store pickup orders using either the local brick-and-mortar (BM) store inventory, a practice known as buy-online-pickup-in-store (BOPS), or the central warehouse inventory, a practice known as ship-to-store (STS) (Bell et al. 2014). There are several differences between BOPS and STS. First, products purchased through BOPS have to be available in the local BM store inventory whereas products purchased through STS do not need to physically be in the local BM store inventory. Second, BOPS allows customers to order a product online and pick it up on the same day. In contrast, since STS requires a shipment from the central warehouse to the local BM store, customers can pick up an STS order only after it arrives at the local BM store, which typically takes 3-10 days for most retailers. Third, because BOPS requires BM stores also to fulfill some online demand, it necessitates not only higher in-store inventory levels, but also inventory integration between online and offline channels. Such integration is not necessary for STS. In practice, we observe three groups of retailers offering in-store pickup services. The first group (e.g., Lowe's, Macy's, and Eddie Bauer) offers only BOPS

[1] Throughout the paper, "channel merchandise planning" refers to product allocation between online and offline channels.

and limit in-store pickup services to products available at local BM stores. The second group (e.g., Target, BestBuy, and The Home Depot) offers BOPS for products available at local BM stores and STS for products unavailable at local BM stores. The third group (e.g., L.L. Bean, Forever 21, and Lane Bryant) offers only STS for all products including those available at local BM stores[2]. The focal firm in our research is a North American multichannel retailer that represents the third group. Therefore, in this paper, we study how efficient channel merchandise planning influences the performance of STS implementation when a retailer exclusively offers STS for all products.

STS services provide convenience by enabling online customers to flexibly select where and when to pick up their orders, waiving shipping fees, and making returns low effort with no additional cost. STS services also increase store traffic by driving online customers into BM stores (Cisco 2015, CSA 2019). We conjecture that there might be a tradeoff with how STS works. On one hand, STS should expand online sales due to its essential convenience and generate additional BM store sales through cross-selling during in-store pickups. A survey by UPS indicates that, among shoppers who have placed an STS order, 45% purchased an additional product in BM stores when picking up their STS orders (UPS 2015). In our sample data, STS orders account for 17% of all online orders and 6% of all STS orders generate additional cross-selling at BM stores. On the other hand, customers visiting a BM store are likely exposed to alternative products at nearby competitor stores and may forgo their STS orders in order to purchase an alternative product from a competitor, a phenomenon known in the economics literature as the positive demand externality effect of retailers (Konishi and Sandfort 2003, Zhu et al. 2011). Subsequently, retailers may lose some of those existing customers who would have purchased online in the absence of STS. A New York Times article emphasizes this drawback by stating that "*... Initially, executives viewed the pick-up-in-store feature as a way to draw consumers into stores and encourage customers to buy more. Now, they would rather close the deal on an online order as soon as possible so shoppers do not go elsewhere or forgo the merchandise altogether.*" (Clifford 2012).

This tradeoff may not be the same for all online products. To illustrate this, consider in Figure 1 the two products offered online by the subject retailer. While the STS option is available for both products, they differ based on channel availability. The product on the left, hereafter called a *hybrid product*, is available both online and in BM stores. In contrast, the product on the right, hereafter called an *online-exclusive product*, is available only online. Practically, customers can be exposed to the positive demand externality effect during a BM store visit. For hybrid products, customers visit a BM store either to purchase a product in-store or to pick up an STS order. In contrast, for online-exclusive products, customers visit a BM store only to pick up an STS order. This suggests that hybrid products

[2] These retailers ship all STS orders from their central warehouse even if products are available in-store mainly for two reasons. First, they carry low in-store inventory (due to high holding cost or high product variety) and STS ensures low stockout risk for BM stores. Second, they do not have inventory integration between online and offline channels because online and BM stores are managed independently by two separate units, making BOPS impractical.

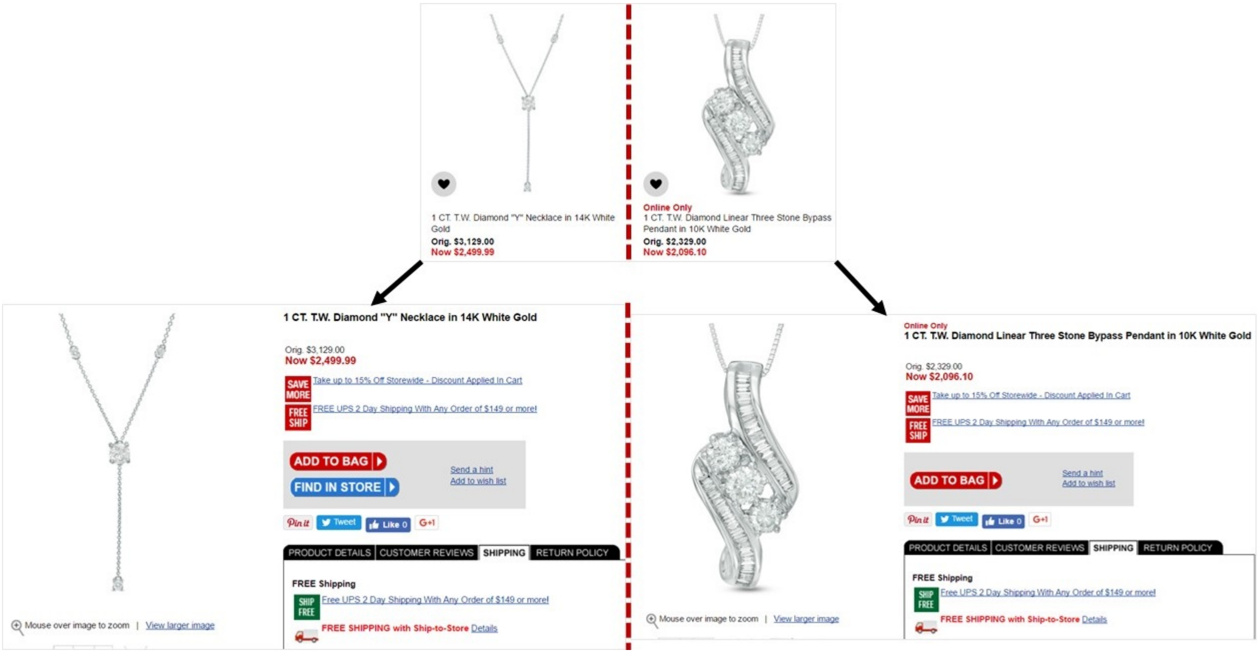


Figure 1: Hybrid product vs. online-exclusive product

are exposed to the positive demand externality effect more than their online-exclusive counterparts. Thus, the impact of the tradeoff on the STS performance is likely to be contingent on the product type. Subsequently, insights related to STS implementation would be incomplete without consideration of how such services affect sales for hybrid vs. online-exclusive products. This leads to our first research question: *How do STS services affect sales for online-exclusive vs. hybrid products?*

The aforementioned tradeoff suggests that if the potential positive demand externality effect outweighs the benefits of STS for some hybrid products, when implementing STS, retailers might be better off by merchandising them as online-exclusive instead of hybrid. This is because online-exclusive products are less likely to be exposed to the positive demand externality effect. Yet, it remains unclear how retailers can identify products that should be offered as hybrid vs. online-exclusive. For that matter, how great is the opportunity to align channel merchandise planning with the STS implementation? This leads to our second research question: *What type of products should be offered as online-exclusive vs. hybrid when implementing STS?*

We use two methodologies to answer our research questions. First, we develop a stylized model that represents the fundamental features of the STS functionality in an omnichannel retail environment and derive theoretical insights. Next, we have partnered with a multichannel jewelry retailer that operates more than 1,000 physical stores and multiple online stores under different store brand names in North America. The retailer launched STS in 2011 across all U.S. stores. The STS introduction represents an exogenous shock to the U.S. customers' purchasing options because the retailer announced the launch of STS after operationalizing the service. Therefore, the launch of STS provides a quasi-experimental setting for our research. We use 14 months of data, including sales at the product level before and after the STS implementation, at all stores and deploy a difference-in-differences estimation to provide empirical support for our theoretical insights. Using the two methodologies, we make the following contributions to the operations management literature.

First, our theoretical model characterizes the tradeoff that STS entails. On one hand, STS motivates previously non-shoppers to place an STS order as it offers free shipping and return options (i.e., *market expansion effect*). It also increases BM store sales because customers who place an STS order make additional purchases during in-store pickup of their orders (i.e., *cross-selling effect*). On the other hand, STS decreases sales by exposing existing customers to nearby competitors during their in-store pickup visit and motivating some of them to forgo their orders to substitute with an alternative product from competitors (i.e., *sales loss effect*). When BM stores are not in close proximity to nearby competitor stores, the benefits of STS outweigh its negative effect. Online exclusive products are fully exposed to this tradeoff. Yet, the tradeoff is less pronounced for hybrid products since customers use STS for these products only when they are not available in-store. Hence, as supported empirically, we find that STS increases sales more for online-exclusive products than for hybrid products.

Second, our theoretical model demonstrates that when BM stores are in moderate proximity to nearby competitor stores, as (i) the product price decreases, (ii) the in-store availability increases, or (iii) the proximity to competitor stores increases, it becomes less profitable for retailers to implement STS for hybrid products. Due to its convenience, STS provides customers an opportunity to lower their online purchase disutility. This disutility increases with price, so as the opportunity STS provides. Therefore, customers are less likely to use STS for low-priced products than for high-priced products. Subsequently, retailers benefit less from STS for low-priced products. Next, when the hybrid product is available in-store, STS is not an attractive option for customers because they can purchase it in-store instantly rather than waiting for the STS shipment to arrive in a few days. Therefore, as in-store inventory increases, the number of STS orders decreases and the benefit of STS implementation diminishes. Lastly, as BM stores' proximity to nearby competitor stores increases, customers who use STS become more likely to substitute their STS orders with competitors' products, increasing the sales loss effect of STS. To test these findings empirically, we use the product price information along with two proxy variables in our data. We operationalize the in-store-availability for a hybrid product as the overall inventory for that product across all stores in a given geographical region. Similarly, we operationalize the proximity to a competitor store as the ratio of all BM stores located next to a major competitor's BM store in a given geographical region. As theoretically predicted, our empirical analysis demonstrates that the effect of STS on hybrid product sales is positively moderated by the product price and negatively moderated by the in-store inventory and the proximity to the major competitor.

Third, although STS increases overall sales for hybrid products, the moderation analysis suggests that STS is likely to be less efficient for certain hybrid products. As a mitigation strategy, we theoretically propose that merchandising those hybrid products as online-exclusive during the STS implementation should increase the performance of STS. Despite losing some demand from BM store customers, retailers can still be better off with such channel merchandising because it works as a counter-strategy to reverse the demand loss to competitors. To empirically quantify the potential benefits of the proposed strategy, we conduct a counterfactual analysis. We find that hybrid products that can be targeted for the proposed strategy constitute 24% of all hybrid products, yet account for only a small portion of overall sales. We estimate that merchandising such products as online-exclusive when implementing STS could increase overall sales by 2.7%. Our counterfactual analysis confirms the theoretical insights that retailers should implement STS by offering products that are (i) somewhat unique (i.e., difficult to substitute), high-priced, and with low in-store availability as hybrid and (ii) somewhat generic (i.e., easy to substitute), low-priced, and with high in-store availability as online-exclusive.

2 Related Literature

The omnichannel environment presents new challenges and opportunities for retailers, which, in turn, has given rise to several academic studies recently. Rigby (2011), Brynjolfsson et al. (2013), and Bell et al. (2014) offer a good practical discussion regarding the challenges and opportunities of omnichannel retailing. Initial works on omnichannel retailing have focused on marketing and information systems and explored the impact of marketing communication strategies on customer migration between channels (Ansari et al. 2008), cross-channel competition with product selection, geography, and location (Brynjolfsson et al. 2009, Forman et al. 2009), the change in pricing and store assistance level in the presence of consumer returns (Ofek et al. 2011), self-matching pricing policy between channels in a competitive environment (Kireyev et al. 2017), and consumer channel choice in grocery stores (Chintagunta et al. 2012) as well as in health insurance customer support services (Jerath et al. 2015). Recent papers have explored omnichannel retailing with an emphasis on retail operations. They study how several retail operational performance and efficiency metrics can be influenced by click-stream information from the online store (Huang and Mieghem 2014), the introduction of showrooms (Bell et al. 2018), the manufacturer's optimal product design strategy (Luo and Sun 2016), the change in return period policy (Ertekin and Agrawal 2021), and in-store pickup services of online orders (Gallino and Moreno 2014, Akturk et al. 2018, Gallino et al. 2017, Gao and Su 2017).

Among these papers, ours is closely related to studies on in-store pickup services. In this sub-stream, Gallino et al. (2017) empirically demonstrate how launching STS increases a retailer's overall sales dispersion (i.e., the degree of equality in the sales contribution of different products) within a class of products that are classified based on the long-tail phenomenon. The authors show that STS implementation results in a sales shift from high-selling to low-selling products without any change in the overall retail sales. Our paper differs from Gallino et al. (2017) because we (i) focus on the implementation of STS with respect to channel merchandise planning and (ii) classify products based on channel availability, which allows us to assess the effect of STS with respect to channel availability. In the same stream, Gallino and Moreno (2014) and Akturk et al. (2018) empirically examine the impact of BOPS and STS, respectively, on a retailer's aggregated online and BM store sales and demonstrate that both functionalities decrease online sales and increase physical store sales due to the channel shift effect. We extend this stream by (i) measuring the impact of STS on hybrid vs. online-exclusive product sales and (ii) demonstrating how channel merchandise planning can improve the performance of STS. In a theoretical paper, Gao and Su (2017) study the impact of the BOPS functionality on physical store inventory management and channel coordination for a multichannel retailer where (i) there is a single product, (ii) by definition, BOPS orders are fulfilled using in-store inventory; hence, a BOPS transaction can be completed only if the product is available in the selected store, and (iii) inventory information is provided to online customers only after the BOPS implementation. Our setting is different as we study the impact of the STS functionality on online consumer channel and product selection at a multichannel retailer where (i) there are two types of online products (i.e., hybrid and online-exclusive), (ii) by definition, STS orders are fulfilled using online warehouse inventory; hence, an STS transaction can be completed even if the product is not available in the selected store, and (iii) inventory information is provided to online customers even before the STS implementation. Overall, we contribute to the omnichannel retailing literature by (i) developing a theoretical model to demonstrate how retailers should implement the STS functionality with respect to channel merchandise planning and (ii) empirically supporting our theoretical predictions.

Our study is also relevant to the literature on product variety (e.g., van Ryzin and Mahajan (1999), Rajagopalan (2013)) and assortment decisions (e.g., Cachon et al. (2005), Kok et al. (2009)) within the context of retail operations. Motivated by the pioneering work that first analyzed "long-tail products" (i.e., niche products that are typically unavailable in offline stores and account for a large share of online sales) (Brynjolfsson et al. 2003), we observe that this literature stream mainly categorizes retail products into long-tail, medium-tail, and popular products. Next, considering that long-tail products are likely to be carried by online channel, popular products are likely to be carried by offline channel, and medium-tail products can be present in both channels, this stream focuses on the comparison of online and BM stores to document the presence of the long-tail phenomenon. Among them, Brynjolfsson et al. (2009) demonstrate that online stores face significant competition from BM stores when selling popular products, but are virtually immune to competition when selling long-tail products. Brynjolfsson et al. (2011) highlight that the long-tail phenomenon may also be attributed to the low search costs associated with online stores. Zentner et al. (2013) examine the impact of consumer channel shift from offline to online on the consumption of long-tail and popular products. The long-tail phenomenon is also present in our data. In addition, when one considers the sales contribution of each product, our product categorization of hybrid vs. online-exclusive products is consistent with the product categorization based on the long-tail phenomenon. Along these lines, our research contributes to this stream by demonstrating that STS has varying effects on sales of online-exclusive vs. hybrid products that are classified based on channel availability, rather than based on the long-tail phenomenon.

3 Theory Development with Analytical Modeling

In this section, we develop a stylized model to establish the theoretical foundations of the effects of (i) STS implementation on retail sales for online-exclusive vs. hybrid products and (ii) channel merchandising on the performance of STS implementation. In the next subsection, we discuss the business context that motivates our analytical model. Then, we define our modeling framework. Lastly, we analyze the analytical model and derive theoretical predictions to later empirically test in section 4.

3.1 Business Context

The jewelry retailer operates its online and BM stores centrally such that the headquarters operationalizes decisions including inventory, pricing, and payroll. BM stores are located in shopping areas, some of which are surrounded by competitor stores. By policy, the pricing of a hybrid product is fixed across BM stores and channels. Before the STS implementation, the retailer offered its online customers different fee-based and free (only if the purchase amount is over a certain threshold) shipping options. These options were displayed along with product details. After the STS implementation, in addition to the same shipping options, a free STS option (regardless of the purchase amount) has been made available to online customers for all online purchases. By policy, STS orders are shipped within three business days from the distribution center. We differentiate the online vs. BM store phase of a customer's omnichannel experience based on where the payment is made. Customers who choose the STS option, pay online; thus, all STS sales are considered online sales.

The BM store inventory availability information (i.e., whether a product is "In stock" or "Out of stock") for a selected hybrid product was available to online customers before the STS implementation, and this service has remained unchanged after the STS implementation. The retailer has a full refund policy for returned products. Online customers are allowed to return their products to either the distribution center by mail or to any BM store, whereas BM store customers are allowed to return their purchases only to a BM store. If online customers decide to return to the distribution center, they have to prepay a return shipping fee before mailing the product.

To summarize, STS offers two major novelties to online customers. First, it enables online customers to have a free shipping option for all online purchases under a certain threshold. Second, it decreases the return hassle and removes the return shipping fee since online customers already visit the store to pick up their order and can return their order in-store if they do not like their products. We now proceed to define our modeling framework based on the business context discussed.

3.2 Modeling Framework

The model consists of an omnichannel retailer that sells online-exclusive and hybrid products denoted by o and h, respectively, at price p_i where $i \in \{o, h\}$. The main difference between hybrid and online-exclusive products is that the former is sold both online and in the BM store, whereas the latter is sold only online. Consistent with consumer returns literature (e.g., Anderson et al. (2009), Shulman et al. (2011)), customers make a purchase decision under uncertainty about product fit and resolve their uncertainty after the purchase. To simplify the model, we assume that the valuation for product i can be either high $\bar{v}$ or low $\underline{v}$ with probability α and $1-\alpha$, respectively. In case of product fit, the valuation is high and customers keep the product, whereas in case of product misfit, the valuation is low and customers return their purchase to receive a full refund p_i. Without loss of generality, we normalize $\underline{v}$ to be 0. Given the touch-and-feel experience BM stores provide, customers can assess product fit before making a purchase. Thus, we assume product fit-related returns occur only online, not at the BM store. Customers are heterogenous with respect to α such that $\alpha \sim U[0, 1]$. We define β, where $\beta \in [0, 1]$, to represent the BM store availability of the hybrid product[3].

As discussed in the introduction, we assume that customers who visit the BM store (either to pick up their STS order or to shop at the BM store) can be exposed to a better outside option at the competitor store with price p_s and valuation v_s[4]. We denote the proximity of the focal BM store to the competitor store with ζ, where $\zeta \in [0, 1]$. We assume that during their store visit, customers are able to substitute the retailer's product with a better outside option (i.e., $v_s - p_s > \bar{v} - p_h$) with probability of ζ and such a substitution is not available with probability of $1 - \zeta$. We also assume the outside option always fits.

For each product i, we define demand $D_i(sts)$ as a function of the presence of STS (i.e., $sts = 0$ before STS implementation, and $sts = 1$ after STS implementation). The decision trees in Figures 2 and 3 depict all the alternatives for customers considering the hybrid product before and after the STS implementation, respectively[5]. In what follows, we explain these alternatives and derive the expected

[3]By its very definition, $\beta = 0$ for the online-exclusive product.

[4]In practice, such an outside option can also be present in the online channel. In Online Appendix C, we extend our model to consider that possibility and demonstrate that our qualitative insights from the main model remain the same.

[5]Since $\beta = 0$ for the online-exclusive product, the decision trees for the online-exclusive product boil down to the lower branch in Figures 2 and 3, and thus are not demonstrated for brevity.

utility accordingly.

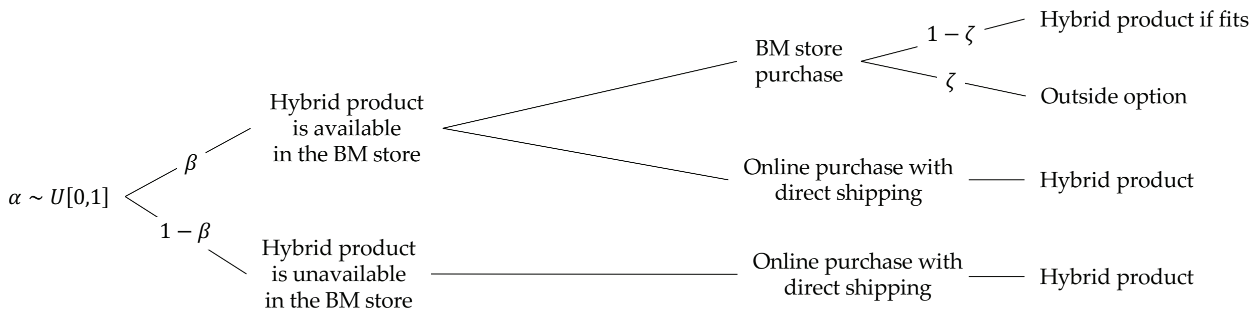


Figure 2: Customer decision tree before STS

We first consider Figure 2 that represents the scenario before the STS implementation. Customers make their purchase decision based on β. They opt for the store purchase option only if the hybrid product is available in the BM store and their expected utility is maximized by an in-store purchase. Otherwise, they opt for the online purchase option. If customers opt for the store purchase option, they incur a hassle cost c_s to visit the store. With ζ probability, these customers find a better outside option from the nearby competitor and opt for it. With $1-\zeta$ probability, such substitution is not available and thus, these customers opt for the hybrid product in case of product fit or leave without a purchase in case of product misfit. If customers opt for the online purchase option, they incur a hassle cost c_o for searching and shipping the product. After the purchase, if the product does not fit, customers return their online purchase and incur an additional non-zero return cost r_o.

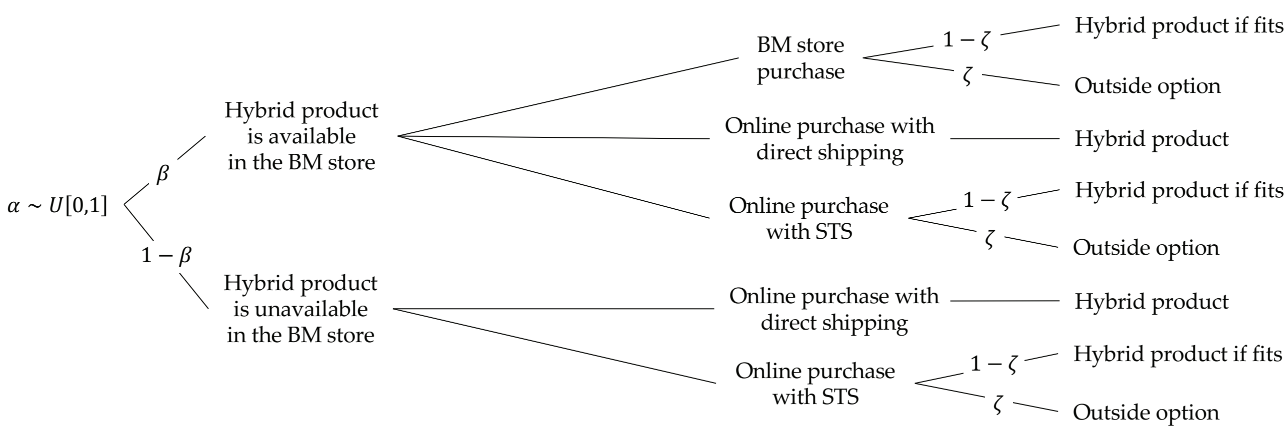


Figure 3: Customer decision tree after STS

We now consider Figure 3 that represents the scenario in which STS is implemented. In this case, in addition to all purchase options in the previous scenario, customers also have the option to order online with STS. To avoid repetition, we only explain the online purchase option with STS. If customers opt for the STS option, they incur a hassle cost h_s for not only searching the product online but also waiting for the shipment for a few days and visiting the store to pick their order up. Hence, we assume that $h_s > c_s$. With ζ probability, these customers find a better outside option from the nearby competitor and forgo their STS order. With $1-\zeta$ probability, such an alternative is not available and thus, they pick up their STS order in case of product fit or return their STS order and leave without a purchase in case of product misfit. Customers who opt for the STS option do not incur any return cost since they can assess the product fit during the pickup and, in case of a misfit, return in-store with no additional cost. To ensure that the outside option in the marketplace is always a rational alternative for consumers, we assume the expected ownership utility that the outside option offers (i.e., $\zeta(v_s - p_s)$) is greater than the highest hassle cost to visit the store (i.e., h_s).

Lastly, customers who visit the BM store, either for an in-store purchase or to pick up an STS order, can purchase additional items in the BM store. To capture this cross-selling opportunity, following Gao and Su (2017), we assume that there is an additional profit ϕ from every customer visiting the BM store. Given these alternatives, we can now formulate customers' expected utility for each choice in Table 1. Table A1 in Online Appendix A lists all the notations used in the theoretical model.

Table 1: Customers' expected utility under each choice

Choice	**Expected Utility**
BM store purchase	$-c_s + \zeta(v_s - p_s) + (1-\zeta)\alpha(\bar{v} - p_h)$
Online purchase with direct shipping	$-p_i - c_o + \alpha\bar{v} + (1-\alpha)(p_i - r_o)$
Online purchase with STS	$-h_s - p_i + \zeta\big[p_i + (v_s - p_s)\big] + (1-\zeta)\big[\alpha\bar{v} + (1-\alpha)p_i\big]$

3.3 The Impact of STS on Sales

Using the customer choices presented above, we now characterize the impact of STS on the demand function. We first assess the impact of STS on online-exclusive product sales. Let Δ_i^{sts}, where $i \in \{o, h\}$, denote the difference between demand functions with and without the STS option such that $\Delta_i^{sts} = D_i(sts = 1) - D_i(sts = 0)$. Delegating the details of the demand derivation to Online Appendix B, we characterize Δ_o^{sts} in the following proposition:

Proposition 1 (Online-exclusive product)**.** *The impact of STS on the demand that the online-exclusive product generates can be characterized by*

$$\Delta_o^{sts} = \underbrace{(1-\zeta)[\alpha_d - \alpha_s]^+}_{\textit{Online market expansion}} \quad + \quad \underbrace{\phi(1-\zeta)[\alpha_{sd} - \alpha_s]^+}_{\substack{\textit{Cross-selling during} \\ \textit{STS pickups}}} \quad - \quad \underbrace{\zeta\ [\alpha_{sd} - \alpha_d]^+}_{\substack{\textit{Sales loss to} \\ \textit{outside option}}}$$

where $[x]^+ = \max(x, 0)$ and the expressions for α_d, α_s, and α_{sd} are provided in Online Appendix B. The first term in the equation corresponds to the difference between the valuation of the marginal customer who is indifferent between ordering online with direct shipping and no-purchase, and the valuation of the marginal customer who is indifferent between ordering online with STS and no-purchase. Hence, it captures the additional demand that arises from online consumers who, before the STS, do not purchase the online-exclusive product due to the related hassle and potential return costs, yet purchase it post-STS once STS minimizes those costs. We term this increase the *market expansion effect* of STS.

The second term represents the additional profit for the BM store due to cross-selling during in-store pickup of all STS orders. We term this additional BM store profit the *cross-selling effect* of STS. Two different customer segments generate cross-selling. The first segment includes all the new customers captured by the market expansion effect. The second segment includes existing customers who use direct shipping before the STS implementation, yet STS after the STS implementation. This is because customers in the second segment have moderately high uncertainty for product fit and STS decreases the disutility associated with that uncertainty for these customers by providing a free in-store return option. While the initial demand for the online-exclusive product from these customers does not change, they generate an additional profit for the BM store through cross-selling during STS order pickups.

Lastly, the third term represents existing customers who also use direct shipping before the STS implementation and STS after the STS implementation for the same reason. However, during their store visit to pick up their STS order, these customers find a better substitution from the nearby competitor and forgo their STS orders even in case of product fit. Subsequently, the demand that was previously fulfilled with direct shipping is lost to the competitor after the STS implementation. We term this decrease the *sales loss effect* of STS. The overall impact of STS on online-exclusive product sales is determined by the relative comparison among the three competing effects.

Similar to the online-exclusive product, the hybrid product is also subject to the three competing effects of STS, albeit at different degrees. In particular, we characterize Δ_h^{sts} as follows:

Proposition 2 (Hybrid product)**.** *The impact of STS on the demand that the hybrid product generates can be characterized by*

$$\Delta_h^{sts} = \underbrace{(1-\beta)(1-\zeta)[\alpha_d - \alpha_s]^+}_{\textit{Online market expansion}} + \underbrace{(1-\beta)\phi(1-\zeta)[\alpha_{sd} - \alpha_s]^+}_{\substack{\textit{Cross-selling during} \\ \textit{STS pickups}}} - \underbrace{(1-\beta)\zeta\,[\alpha_{sd} - \alpha_d]^+}_{\substack{\textit{Sales loss to} \\ \textit{outside option}}}$$

Proposition 2 demonstrates that even though STS has similar three effects on the hybrid product, these effects are attenuated by a factor of $1-\beta$. When the hybrid product is available in-store, STS is not an attractive option for customers because they can purchase the hybrid product in-store instantly without the additional hassle associated with STS (i.e., searching the product online and waiting for the shipment for a few days). In contrast, the STS option can be attractive to customers particularly when the hybrid product is not available in-store. Therefore, unlike the online-exclusive product for which the entire demand is exposed to the effects of STS, the hybrid product is exposed to them only for the demand that occurs in case of in-store product unavailability, which is captured by $1-\beta$.

Proposition 2 suggests that STS might not be as efficient for some hybrid products as it is for online-exclusive products particularly when its effect is attenuated substantially. Is the effect of STS attenuated the same amount for all hybrid products? How can retailers identify hybrid products for which STS is not as efficient? To extend the practical implications of our theoretical model, in the following proposition, we characterize how the effect of STS on hybrid product sales varies with respect to (i) price p_h, (ii) in-store availability β, and (iii) proximity to the competitor store ζ, which are the three system parameters that are readily accessible by most retailers.

Proposition 3 (Sensitivity analysis for hybrid product)**.** *There exists a lower-bound $\underline{\zeta}$ and an upper-bound $\overline{\zeta}$ for ζ such that when $\zeta \in [\underline{\zeta}, \overline{\zeta}]$, Δ_h^{sts} (i) increases in p_h and (ii) decreases in β and ζ*[6]*.*

Proposition 3 lays out the sensitivity analysis of Δ_h^{sts} for a moderate level of ζ that is likely to best represent our business context. We provide the results for a low level of ζ (i.e., $\zeta < \underline{\zeta}$ - when there is a low probability of substitution due to the absence of nearby competitor stores) and a high level of ζ (i.e., $\zeta > \overline{\zeta}$ - when there is a high probability of substitution due to the close proximity of nearby competitor stores) in Online Appendix B. We note that the directions of the sensitivity analysis in those cases can differ compared to those in Proposition 3.

First, Proposition 3 indicates that as p_h increases, the impact of STS on hybrid product sales becomes more positive. Recall that STS presents an opportunity for customers to lower their online purchase disutility due to its convenience. Subsequently, it either expands the market with new customers or motivates some existing customers to change their order mode from direct shipping to STS. Since online purchase disutility increases with price, high-priced products provide more opportunity to gain by ordering a hybrid product through STS relative to direct shipping than low-priced products. Thus, as price increases, more customers prefer STS over direct shipping. For the retailer, this directly translates into more revenue from the new customers due to increased market expansion effect. It also represents more revenue from the existing customers through cross-selling. Because existing customers who switch from direct shipping to STS are less likely to be lost to the competitor when the BM store is not in close proximity to the competitor store, the resulting STS effect increases in price. Second, Proposition 3 establishes that as β increases, the impact of STS on hybrid product sales becomes more negative. When the BM store is not in close proximity to the competitor store, customers are less likely exposed to the outside option and the sales loss effect of STS is low, making the retailer better off with offering STS. In this case, when the store availability increases, more customers make their purchase in-store and thus, the proportion of customers who utilize STS decreases. Subsequently, the

[6] Throughout the paper, for the clarity of exposition, we use "increase" and "decrease" in the non-strict sense.

benefits associated with STS decrease. Lastly, Proposition 3 states that as ζ increases, the impact of STS on hybrid product sales becomes more negative. This is because as the BM store's proximity to the competitor store increases, customers who use STS become more exposed to the outside option. Subsequently, the sales loss to the outside option becomes more pronounced.

A natural question arises regarding the theoretical direction of Δ_o^{sts} and Δ_h^{sts} characterized in Propositions 1 and 2 for moderate levels of ζ. The following proposition characterizes the directional impact of STS on online-exclusive and hybrid product sales when the BM store is not in close proximity to the competitor store.

Proposition 4 (Directional impact of STS)**.** *When $\zeta \in [\underline{\zeta}, \overline{\zeta}]$, both Δ_o^{sts} and Δ_h^{sts} are positive.*

Proposition 4 establishes that when the BM store is not in close proximity to the competitor store, the retailer always benefits from the STS implementation. In this case, customers are less likely exposed to the outside option during an in-store pickup of an STS order. Therefore, the market expansion and cross-selling effects of STS outweigh its sales loss effect. Subsequently, STS increases the overall demand for both online-exclusive and hybrid products.

In summary, our theoretical model demonstrates that even if STS is beneficial for retailers, there might be a systematic variation in its effect across different product types. As such, STS might not be as efficient for all products. In the next section, we propose an approach that could be employed by omnichannel retailers to improve the performance of STS.

3.4 The Impact of Channel Merchandising

As shown in section 3.3, STS may be less efficient for some hybrid products than for online-exclusive products. In this section, we propose that merchandising those hybrid products as online-exclusive may improve the efficiency of STS. To evaluate the impact of such a merchandising strategy, we first characterize the corresponding change in demand as $\Delta^{h \to o}$, where $\Delta^{h \to o} = D_o(sts = 1) - D_h(sts = 1)$.

Proposition 5 (Channel merchandising)**.** *If the retailer implements STS by offering the hybrid product as online-exclusive, the overall demand changes by*

$$\Delta^{h \to o} = \underbrace{\beta\zeta(\alpha_{cd} - \alpha_{sd})}_{\substack{\text{Sales gain from} \\ \text{outside option}}} \quad - \quad \underbrace{\beta(1-\zeta)\phi(\alpha_{cd} - \alpha_{sd})}_{\substack{\text{Loss in cross-selling} \\ \text{during in-store purchase}}} \quad - \quad \underbrace{\beta(1-\zeta)(1+\phi)[\alpha_s - \alpha_c]^+}_{\substack{\text{BM store market} \\ \text{contraction}}}$$

where the expressions for α_c and α_{cd} are provided in Online Appendix B. Proposition 5 establishes that offering a hybrid product as online-exclusive has three competing effects. Once the hybrid product is merchandised as online-exclusive, the BM store no longer contributes to its sales. This does not necessarily mean that the retailer loses all BM store customers who were previously purchasing the hybrid product in-store. Some of the previously BM store customers continue to purchase the product online using STS, and thus do not change the demand. Some customers who previously decided to visit the BM store were lost to the competitor as they could find a better substitute. Now that visiting the BM store is not an option after the hybrid product is merchandised as online-exclusive, these customers order the product using direct shipping without being exposed to the outside option. Therefore, merchandising the hybrid product as online-exclusive brings the lost demand from those customers back to the online channel. We term this effect the *sales gain effect* of channel merchandising. Other previously BM store customers continue to purchase the product online using direct shipping when it is merchandised as online-exclusive. Even though these customers also do not change the demand for the product, they no longer generate an additional profit through cross-selling, which is represented as the *cross-selling loss effect* of channel merchandising. Lastly, the remaining previously BM store customers do not find online shopping as attractive due to its hassle cost and the high uncertainty it entails for product fit. Therefore, as captured by the *BM store market contraction effect* of channel merchandising, the retailer loses sales from these customers when merchandising the hybrid product as online-exclusive. Overall, it is optimal for the retailer to implement STS by merchandising the hybrid product as online-exclusive so long as the BM store market contraction and cross-selling loss effects are offset by the sales gain effect of channel merchandising.

How can retailers decide which products to merchandise as online-exclusive vs. hybrid when they implement STS? To answer this question, we characterize in the following proposition the sensitivity of $\Delta^{h \to o}$ with respect to p_h, β, and ζ.

Proposition 6 (Sensitivity of channel merchandising)**.** *There exists a lower-bound $\underline{\zeta}_c$ and an upper-bound $\overline{\zeta}_c$ for ζ such that when $\zeta \in [\underline{\zeta}_c, \overline{\zeta}_c]$, $\Delta^{h \to o}$ (i) decreases in p_h and (ii) increases in β and ζ.*

Consistent with our business context, Proposition 6 examines the channel merchandising strategy for the case when the BM store is not in close proximity to the competitor store. The directions of the sensitivity analysis can be different in other cases as demonstrated in Online Appendix B. First, Proposition 6 states that as p_h increases, the retailer benefits more from the hybrid selling strategy. This is because as p_h increases, online purchase disutility increases and fewer customers who previously decided to visit the BM store prefer direct shipping when a product is sold only online. Subsequently, the sales gain effect decreases and the BM store market contraction effect increases. Second, Proposition 6 establishes that as β increases, it becomes more profitable for the retailer to sell the product exclusively in the online channel. One might find this result counterintuitive since common wisdom suggests that higher inventory availability should generate more sales in the BM store. However, as characterized in Proposition 3, when β increases, the benefits of STS for the hybrid product diminish as well. As a result, there is more opportunity to improve the performance of STS by selling the product exclusively in the online channel and generating more sales gain from the outside option to online. Finally, when ζ increases, the retailer benefits more from the online-exclusive selling strategy. As the proximity to the competitor increases, customers who visit the store either to make an in-store purchase or to pick up their STS orders become more exposed to the outside option. Thus, selling a product in both channels entices increasingly more customers to prefer the outside option. Subsequently, the opportunity to bring the lost demand back to the online channel with the online-exclusive selling strategy increases. In summary, our analysis suggests that to improve the performance of STS implementation, omnichannel retailers should merchandise (i) low-priced products, products with high in-store availability, and products that are easy to substitute with competitor products as online-exclusive and (ii) high-priced products, products with low in-store availability, and products that are difficult to substitute with competitor products as hybrid.

In the next section, we provide empirical support for our theoretical model in two steps. First, to complement our analysis in section 3.3 regarding the effect of STS on sales, we empirically test the theoretical predictions listed in Table 2. Second, to complement our analysis in section 3.4 regarding the effect of customized merchandising strategy, we conduct an empirical counterfactual analysis.

Table 2: Theoretical predictions derived from the analytical model

#	**Prediction**	**Theoretical Support**
1	STS increases sales that online-exclusive products generate.	Proposition 4
2	STS increases sales that hybrid products generate.	Proposition 4
3	The impact of STS on sales that hybrid products generate is positively moderated by price.	Proposition 3
4	The impact of STS on sales that hybrid products generate is negatively moderated by in-store inventory.	Proposition 3
5	The impact of STS on sales that hybrid products generate is negatively moderated by proximity to competitor stores.	Proposition 3

4 Empirical Analysis

In this section, we first explain the empirical setting for the analysis, describe our data, and introduce our identification strategy. Next, we examine the STS effect on sales and deploy several robustness tests to validate our results. Lastly, we conduct a counterfactual analysis to explore the potential effect of an alternative channel merchandising strategy on STS performance.

4.1 Empirical Setting, Unit of Analysis, and Data

The retailer operates several store brand names in North America. Each store brand name has an online store and multiple BM stores. We study the two primary store brand names, hereafter called *Alpha* and *Sierra*, that are located in the U.S. and Canada, respectively. In August 2011, the retailer enhanced the integration of online and BM stores for Alpha by introducing an STS option for all online purchases. This option was not made available for Sierra online customers at that time.

For the empirical analysis, we obtain from the retailer 14 months of transaction-level data between January 2011 and February 2012 (i.e., seven months before and seven months after the STS implementation at Alpha) covering all Alpha and Sierra online and BM stores. Each online transaction includes a customer address. Each BM store transaction includes the address of the BM store where the transaction took place. Using the address information, we assign each transaction to a media market (MM). A MM is a geographical region where the population within that region is exposed to the same or similar media offerings including television, radio, newspaper, or Internet content (Wikipedia 2020). For the U.S., we use MMs defined by the Nielsen Company as designated market areas (DMAs)[7]. For Canada, we use MMs defined by Statistics Canada (i.e., the national statistical office of Canada) as census metropolitan areas (CMAs). We map all online transactions in our dataset to 212 MMs (i.e., 183 DMAs in the U.S. and 29 CMAs in Canada) with a BM store presence[8].

We aggregate data over multiple transactions to obtain a sales figure for a given product. We define our main unit of analysis as a triplet of stock keeping unit (SKU)-MM-month (denoted by i, j, and t, respectively) and aggregate transactions over the triplets. This allows us to (i) achieve reasonable statistical power (due to fine temporal aggregation), (ii) maintain key variables relevant to our theoretical predictions, and (iii) study the dynamics between offline and online channels in more refined geographical regions. The data originally consist of 26,608 online-exclusive and 4,278 hybrid products offered throughout the analysis period. Yet, not all SKUs generate sales in all MMs. Thus, the aggregation results in 2,890,160 units for the analysis of online-exclusive products and 3,407,082 units for the analysis of hybrid products.

4.2 Mapping Theoretical Model to Empirical Data

Consistent with our theoretical model, we define our dependent variable $Sales_{ijt}$ as the natural logarithm of dollar sales from non-returned purchases of SKU i at MM j in month t. To capture cross-selling that STS orders generate, we account BM store purchases that a customer made during in-store pickup of her STS order for online sales of the SKU in that STS order. We do not account such BM store purchases for BM store sales.

The three key parameters in the theoretical predictions are product price (p_i), in-store inventory

[7] Researcher(s)' own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the Nielsen data are those of the researcher(s) and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

[8] Only 2.7% of all online transactions belong to MMs where there is no BM store presence. For our analysis, we assign these transactions to the closest MM with a BM store. To ensure robustness, we exclude these transactions and repeat our analysis. We find our results are robust to the exclusion of those online transactions.

availability (β), and the proximity of the BM store to the competitor store (ζ). We operationalize p_i as the natural logarithm of price for SKU i ($Price_i$) and β as the overall inventory for SKU i in month t across all BM stores at MM j ($StoreInv_{ijt}$). To operationalize ζ, we obtain store-level data indicating whether a BM store is located in a shopping area where the major competitor of the retailer also has a BM store. Then, using this data, we construct $ProxComp_j$ that represents the ratio of MM j's BM stores that are located in a shopping area in which the major competitor has a BM store as well[9].

In addition to the variables relevant to our theoretical model, we also use several control variables in our empirical analysis. We use product category and MM fixed effects ($ProductCategory_i$ and MM_j) to control for differences in sales across different product categories and MMs. We control for customer demographics using three variables. $CustGender_{ijt}$ represents the ratio of all female customers to all customers who purchase SKU i at MM j in month t. $CustAge_{ijt}$ represents the average age group (i.e., an ordinal variable ranging between 1 and 13) of all customers who purchase SKU i at MM j in month t. $CustIncome_{ijt}$ represents the average household income group (i.e., an ordinal variable ranging between 1 and 9) of all customers who purchase SKU i at MM j in month t[10]. Lastly, we use month and year fixed effects ($SeasonalityControls_t$) to isolate the STS effect from the seasonality effect on sales. Table 3 contains descriptive statistics for the time-variant and time-invariant variables.

4.3 Identification Strategy

We identify the causal effect of STS on sales by deploying a difference-in-differences (DiD) estimation. The DiD approach measures the post-STS change in sales for a subpopulation that was exposed to the STS implementation (i.e., *treatment group*) relative to that for another subpopulation that was not exposed to the STS implementation (i.e., *control group*). From an empirical identification standpoint, by estimating double differences between the treatment and control groups, the DiD approach addresses two concerns that are common to most empirical studies. First, by estimating the difference in sales across time but within each group, it eliminates any time-invariant unobserved heterogeneity (or omitted variable bias) (Card and Krueger 1994). Second, by estimating the difference between the differences obtained in the first step, it eliminates any time trend in sales.

We consider online-exclusive and hybrid products at Alpha (for which STS was offered) as the treatment group and those at Sierra (for which STS was not an option throughout the data period) as the control group. This is because customers visiting an online/BM store in the U.S. (i.e., treatment group) were exposed to the STS option; however, customers visiting an online/BM store in Canada

[9]The major competitor had already started to offer STS by 2011 when the subject retailer implemented STS.

[10]The subject retailer obtains customer-level information from a major marketing and information management service provider that collects, analyzes, and manages consumer and business data for its clients using its market-wide customer database along with the clients' transaction-level data.

Table 3: Descriptive statistics

Variable	Treatment Group						Control Group					
	Pre-STS		Post-STS				Pre-STS		Post-STS			
	Mean	SD	Mean	SD	Δ	p-val	Mean	SD	Mean	SD	Δ	p-val
1. *Sales*	0.28	1.15	0.66	1.46	-0.38	0.00	0.23	1.04	0.57	1.62	-0.35	0.00
	1.02	2.19	1.26	2.42	-0.24	0.00	1.81	2.66	2.29	2.88	-0.48	0.00
2. *StoreInv*												
	0.65	0.77	0.67	0.77	-0.02	0.00	0.71	0.59	0.74	0.59	-0.03	0.00
3. *ProxComp*	0.76	0.21	0.76	0.21	0.00	1.00	0.46	0.26	0.46	0.26	0.00	1.00
	0.79	0.23	0.79	0.23	0.00	1.00	0.48	0.30	0.48	0.30	0.00	1.00
4. *CustGender*	0.49	0.26	0.49	0.28	0.00	0.34	0.46	0.12	0.46	0.12	0.00	0.93
	0.45	0.24	0.44	0.24	0.01	0.00	0.44	0.28	0.44	0.28	0.00	0.84
5. *CustAge*	5.17	1.81	5.17	1.98	0.00	0.52	5.08	1.39	5.08	1.39	0.00	0.28
	5.35	1.85	5.33	2.00	0.02	0.00	4.87	2.65	4.87	2.66	0.00	0.71
6. *CustIncome*	5.50	0.98	5.50	1.07	-0.00	0.01	5.42	0.78	5.41	0.78	0.00	0.02
	5.24	1.01	5.24	1.09	-0.00	0.07	5.11	1.39	5.11	1.39	0.00	0.69
7. *Price*	5.04	1.02	5.04	1.02	0.00	1.00	5.16	0.98	5.16	0.98	0.00	1.00
	5.28	0.87	5.28	0.87	0.00	1.00	5.27	0.96	5.27	0.96	0.00	1.00
Sample Size	2,768,850						121,310					
	3,152,380						254,702					

Notes: (1) For each variable, the first and second rows indicate online-exclusive products and hybrid products, respectively.

(2) *Sales* represents both online and BM store sales for hybrid products and only online sales for online-exclusive products.

(3) *ProxComp* and *Price* are time-invariant whereas the other variables are time-variant.

(4) Δ: Within group mean difference between pre-STS and post-STS; p-val: p-value from t-test that compares pre-STS and post-STS means.

(i.e., control group) were not exposed to this option.

Since we have longitudinal data, we specify the DiD model as a longitudinal panel data regression model. In all our analyses, we use fixed-effect model because the Hausman tests suggest that the random effect formulation is not consistent. Thus, we specify our model as follows:

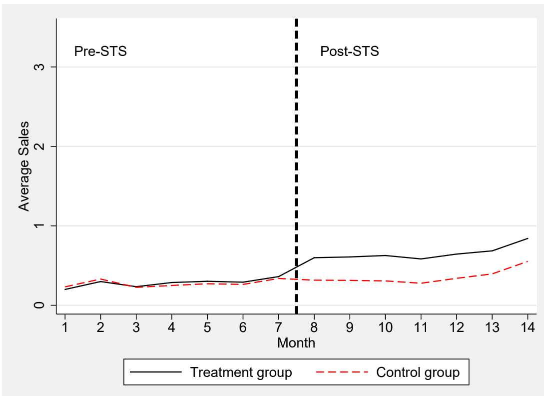
$$Sales_{ijt} = \beta_0 + \beta_1 Treatment_{ij} \times After_t + \beta_2 After_t + \boldsymbol{Controls_{ijt}\beta_C} + u_i + v_j + \varepsilon_{ijt} \tag{4.1}$$

where u_i represents the fixed effect for product i, and v_j represents the fixed effect for MM j. $After_t$ is a binary variable that equals one for the time periods after the STS implementation and zero for the time periods before the STS implementation. $Treatment_{ij}$ is another binary variable that indicates whether SKU i at MM j is offered at the treatment stores ($Treatment_{ij} = 1$) or at the control stores ($Treatment_{ij} = 0$). The coefficient of interest to test Predictions 1 and 2 is β_1 in Equation (4.1).

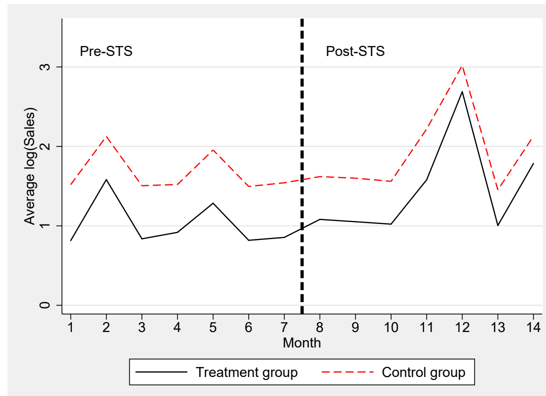
To explore whether the impact of STS on hybrid product sales is contingent on price, in-store inventory, and proximity to the competitor stores (i.e., Predictions 3, 4, and 5), we estimate a triple difference model. We specify the fixed-effect triple difference model as follows:

$$Sales_{ijt} = \beta_0 + \beta_1 Treatment_{ij} \times After_t + \beta_2 After_t + \beta_3 After_t \times Price_i + \beta_4 Treatment_{ij} \times After_t \times Price_i + \beta_5 After_t \times StoreInv_{ijt} + \beta_6 Treatment_{ij} \times StoreInv_{ijt} + \beta_7 Treatment_{ij} \times After_t \times StoreInv_{ijt} + \beta_8 After_t \times ProxComp_j + \beta_9 Treatment_{ij} \times After_t \times ProxComp_j + \boldsymbol{Controls_{ijt}\beta_C} + u_i + v_j + \varepsilon_{ijt} \quad (4.2)$$

The coefficients of interest to test Predictions 3, 4, and 5 are β_4, β_7, and β_9, respectively, in Equation (4.2). In all the estimations, we account for heteroscedasticity using robust standard errors clustered at the MM level.



(a) Online-exclusive products



(b) Hybrid products

Figure 4: Average monthly sales based on matched data

For the DiD approach to be valid, there should not be a systematic difference between treatment and control groups, and it should satisfy the parallel trends assumption. To achieve these, akin to Xu et al. (2017), Bafava et al. (2018), and Calvo et al. (2020), we first conduct propensity score matching between treatment and control group SKUs as detailed in Online Appendix D. The matching process results in 23,095 matched online-exclusive products (that map with 2,550,212 observations) and 3,881 matched hybrid products (that map with 3,006,822 observations), which we use throughout our analyses. Next, we examine the parallel trends assumption in two ways. First, using the matched data, we plot in Figure 4 the average monthly sales for treatment and control group SKUs. We observe that the pre-STS trends between treatment and control groups for both types of products seem to be similar. Post-STS, while the treatment group sales for both online-exclusive and hybrid products increase slightly, the control group sales seem to follow the pre-STS trends. This observation is consistent with the parallel trends assumption. Second, we formally test whether pre-STS sales between the two groups evolved in parallel by estimating the following model using only pre-STS observations in our matched datasets:

$$Sales_{ijt} = \beta_0 + \beta_1 Treatment_{ij} \times Trend_t + \beta_2 Trend_t + \boldsymbol{Controls_{ijt}\beta_C} + u_i + v_j + \varepsilon_{ijt} \quad (4.3)$$

where $Trend_t$ counts the number of months since the beginning of the dataset. A statistically significant

β_1 in this specification would indicate that the pre-intervention trends of the treatment and control groups are not parallel, violating the parallel trends assumption. Table 4 demonstrates the results from the estimation of Equation 4.3 for online-exclusive product sales and hybrid product sales. Both regressions generate an estimate of β_1 with a *p-value* > 0.17, suggesting that the parallel trends assumption holds for our matched datasets.

Table 4: Parallel trends assumption test on the matched datasets

Variable	**Online-Exc.**	**Hybrid**
$Treatment \times Trend$	-0.00	-0.00
	(0.003)	(0.001)
$Trend$	-0.01***	-0.01***
	(0.003)	(0.002)
$Controls$	YES	YES
Sample size	1,275,106	1,503,411

Notes: (1) Clustered robust standard errors are presented in parentheses.
(2) *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

4.4 Empirical Findings

4.4.1 The Impact of STS on Sales

Having established the suitability of the DiD approach for our empirical setting, we now examine the impact of STS on sales of online-exclusive and hybrid products. Model-1 in Table 5 demonstrates the results of the estimation of Equation (4.1) for online-exclusive products. We find the DiD estimator for online-exclusive products ($\beta_1 = 0.13$) is positive and significant. This indicates the STS implementation increases the sales that online-exclusive products generate by 13%, supporting Prediction 1. We next explore how much of this increase comes from the online orders (with either direct shipping or STS) of online-exclusive products vs. the cross-selling that STS orders of online-exclusive products generate at BM stores during in-store pickups. To do so, we estimate Equation (4.1) for online-exclusive products after excluding the cross-selling sales from the dependent variable $Sales_{ijt}$. Model-2 demonstrates the results from this estimation. We find in a seemingly unrelated regression that the DiD estimators in Model-1 ($\beta_1 = 0.13$) and Model-2 ($\beta_1 = 0.12$) are significantly different ($\chi^2(1) = 835.32$, $p-value = 0.00$). This suggests that of the 13% sales increase effect of the STS implementation, (i) 12 percentage points represent the sales increase for online-exclusive products at Alpha online store and (ii) 1 percentage point represents the cross-selling that STS orders of online-exclusive products generate at Alpha BM stores during in-store pickups.

Model-3 in Table 5 demonstrates the results of the estimation of Equation (4.1) for hybrid products. We find that the DiD estimator for hybrid products ($\beta_1 = 0.05$) is positive and statistically significant. This indicates the STS implementation increases online and BM store sales that hybrid products generate by 5% at Alpha, supporting Prediction 2. Similar to the method we followed for online-exclusive products, we estimate Equation (4.1) for hybrid products after excluding the cross-selling sales from the dependent variable and demonstrate the results under Model-4 in Table 5. When we compare the coefficients with three digits in a seemingly unrelated regression, we find that the DiD estimators in Model-3 ($\beta_1 = 0.0496$) and Model-4 ($\beta_1 = 0.0483$) are significantly different ($\chi^2(1) = 317.64$, $p - value = 0.00$). This suggests that of the 4.96% sales increase effect of the STS implementation, (i) 4.83 percentage points represent the sales increase for hybrid products at Alpha online and BM stores and (ii) 0.13 percentage point represents the cross-selling that STS orders of hybrid products generate at BM stores during in-store pickups. It is worth noting that the ratio of sales from cross-selling to the overall effect of STS is smaller for hybrid products than for online-exclusive products. This is indeed expected because BM store sales at the focal retailer account for the majority of all sales. Thus, sales from cross-selling generated by STS orders (i.e., only a certain portion of online orders) of hybrid products can only represent a very small portion of all hybrid product sales at online and BM stores.

Table 5: Estimation results for online-exclusive and hybrid product sales

Variable	**Online-Exclusive**		**Hybrid**				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
$Treatment \times After$	0.13***	0.12***	0.05***	0.05***	0.25***	0.36***	0.42***
	(0.024)	(0.024)	(0.005)	(0.005)	(0.030)	(0.032)	(0.033)
$After$	0.03	0.03	0.64***	0.64***	0.56***	0.45***	0.46***
	(0.024)	(0.024)	(0.006)	(0.006)	(0.029)	(0.030)	(0.032)
$After \times Price$					-0.02**	-0.02***	-0.02***
					(0.005)	(0.005)	(0.005)
$Treatment \times After \times Price$					0.04***	0.05***	0.04***
					(0.006)	(0.006)	(0.006)
$After \times StoreInv$						0.10***	0.10***
						(0.009)	(0.009)
$Treatment \times StoreInv$						0.01	0.01
						(0.017)	(0.017)
$Treatment \times After \times StoreInv$						-0.09***	-0.09***
						(0.009)	(0.009)
$After \times ProxComp$							0.02
							(0.017)
$Treatment \times After \times ProxComp$							-0.07***
							(0.017)
$StoreInv$			2.73***	2.73***	2.73***	2.71***	2.71***
			(0.005)	(0.005)	(0.006)	(0.016)	(0.016)
$Controls$	YES	YES	YES	YES	YES	YES	YES
R^2	0.24	0.24	0.42	0.42	0.42	0.42	0.42
LR	-	-	-	-	189.63***	152.93***	170.65***
Sample size	2,550,212	2,550,212	3,006,822	3,006,822	3,006,822	3,006,822	3,006,822

Notes: (1) Clustered robust standard errors are presented in parentheses.
(2) *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

We now assess the moderating effects of price, in-store inventory, and proximity to the major competitor on the impact of STS implementation for hybrid products. Model-5 adds the *Price* triple interaction terms to Model-3. Model-6 adds the *StoreInv* triple interaction terms. Model-7 adds the

ProxComp triple interaction terms, which becomes equivalent to the estimation of Equation (4.2). The *LR* tests for nested models indicate that moving from Model-3 to Models 5, 6, and 7, in steps, increases model fit significantly at each step. Thus, we use Model-7 to test Predictions 3-5. We find that the triple difference estimators ($\beta_4 = 0.04$, $\beta_7 = -0.09$, and $\beta_9 = -0.07$) are significant with the expected signs, supporting Predictions 3, 4, and 5. Our empirical results testify the theoretical insights that STS is likely to be more beneficial for high-priced hybrid products, hybrid products with low in-store inventory, or hybrid products that have a low probability for substitution with competitor products.

As demonstrated in Online Appendix E, we also conduct several robustness tests. We find that our results are robust to potential systematic differences between treatment and control groups as well as alternative model specifications, variable constructions, and explanations.

To summarize, our analyses highlight two phenomena regarding the effect of STS in our empirical setting: first, STS increases sales more for online-exclusive products than for hybrid products. Second, even though hybrid products, on average, benefit from STS, the moderation analysis suggests that, for low-priced hybrid products with high in-store availability and a high probability for substitution with competitor products, the retailer is likely to not benefit as much by offering STS. In the next section, we empirically examine an alternative merchandising strategy that, when targeted to those hybrid products, aims to improve the efficacy of the STS implementation.

4.4.2 The Impact of Channel Merchandising Strategy

In this section, we extend our analysis to empirically quantify the potential impact of an alternative merchandise planning strategy on the performance of STS implementation. In particular, we aim to estimate the counterfactual change in sales that could have occurred if the retailer implemented STS for certain hybrid products by merchandising them as online-exclusive. We provide the details of our counterfactual analysis in Online Appendix F. Here, we demonstrate the results from the counterfactual analysis and interpret them in accordance with the theoretical findings described in section 3.4.

There are 3,179 hybrid products in the treatment group. Using the counterfactual analysis, we quantify the change in net sales for each of the 3,179 hybrid products if they had been offered as online-exclusive and sold only online when implementing STS (i.e., $\Delta_i^{h\to o}$). Figure 5 illustrates the barplot of the natural logarithm of estimated $\widehat{\Delta_i^{h\to o}}$ for the treatment group hybrid products. The maroon and gray shaded areas represent the hybrid products for which $\widehat{\Delta_i^{h\to o}}$ is estimated to be positive and negative, respectively. We estimate that the proposed strategy would generate additional sales for 24% of all treatment group hybrid products (i.e., 771 hybrid products in the maroon shaded area) and decrease sales for 76% of them (i.e., 2,408 hybrid products in the gray shaded area). This suggests that the retailer could have increased the sales more if she had implemented STS for the hybrid products in the maroon shaded area by offering them as online-exclusive. To quantify this increase, we calculate the percent sales contribution of each hybrid product to overall retail sales that all 3,179 hybrid products generate and plot the cumulative sales contribution in Figure 5. The dotted black line and the dashed red line represent the cumulative sales contribution under the current practice and under the proposed strategy, respectively. We find that merchandising hybrid products in the maroon shaded area as online-exclusive can increase overall sales by 2.7% for the subject retailer. We also observe that hybrid products that can be targeted for the proposed strategy are those that generate low sales for the retailer.

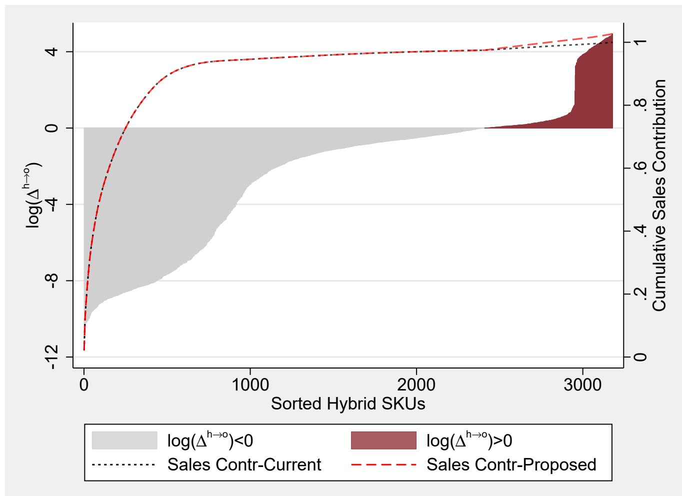


Figure 5: The effect of the proposed strategy on individual hybrid products and overall sales

$$log(\widehat{\Delta_{ijt}^{h\to o}}) = \beta_0 + \beta_1 Price_i + \beta_2 StoreInv_{ijt} + \beta_3 ProxComp_j + \boldsymbol{Controls_{ijt}\beta_C} + u_i + v_j + \epsilon_{ijt} \tag{4.4}$$

To further characterize which products should be offered as hybrid vs. online-exclusive, we estimate Equation 4.4 within a random effect panel regression setting. The variable $\widehat{\Delta_{ijt}^{h\to o}}$ in Equation 4.4 is estimated in the counterfactual analysis for each observation that belongs to hybrid products in the treatment group for the post-STS period. We also replace the dependent variable with a binary variable that takes the value of 1 for positive $\widehat{\Delta_{ijt}^{h\to o}}$ and 0 for negative $\widehat{\Delta_{ijt}^{h\to o}}$. We then estimate Equation 4.4 using a logit specification. In Table 6, Model-1 provides the result from the linear model estimation, and Model-2 provides the results from the logit model estimation. We find that the effect of the proposed strategy is likely to be more negative as $Price$ increases (i.e., $\beta_1 = -0.07$ and $\beta_1 = -1.97$) and more positive as $StoreInv$ and $ProxComp$ increase (i.e., $\beta_2 = 1.58$ and $\beta_2 = 0.94$; $\beta_3 = 0.14$ and $\beta_3 = 3.64$). This suggests that retailers should implement STS by offering low-priced products, products with high availability, and products that have a high probability for substitution with competitor products as online-exclusive and high-priced products, products with low availability, and products that have a low probability for substitution with competitor products as hybrid. These findings are consistent with the theoretical findings characterized in Proposition 6.[11]

[11] As a robustness test, using propensity score matching, we first identify online-exclusive products that are similar to

Table 6: Estimation results for $\widehat{\Delta_{ijt}^{h \to o}}$

Variable	**(1)**	**(2)**
Price	-0.07***	-1.97***
	(0.000)	(0.011)
StoreInv	1.58***	0.94***
	(0.001)	(0.005)
ProxComp	0.14***	3.64***
	(0.001)	(0.022)
Controls	YES	YES
Sample size	1,376,060	1,376,060

Notes: (1) Robust standard errors are presented in parentheses.
(2) *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

5 Conclusion

Order fulfilment to end-customer is the crux of retailing, offline and online alike. STS is the latest addition to omnichannel retailing, where the boundaries between offline and online shopping experience for customers become blurred. The benefits of STS to shoppers are well-documented: (i) STS enables customers to pick up their products from the nearest location, which helps them reduce the shipping cost, and (ii) it allows customers to return the product easily if it does not meet their expectations. Even though it is a bonus for customers, the impact of STS on retail sales is less clear particularly because of the variation in the operationalization of STS implementation. Using analytical and empirical analyses, this paper examines how channel merchandise planning influences the performance of STS. More specifically, we first derive a theoretical model to (i) examine the impact of STS on sales for online-exclusive products (i.e., products available only online) vs. hybrid products (i.e., products available both online and offline) and (ii) explore what type of products should be offered as hybrid vs. online-exclusive when implementing STS. We use a utility-based customer choice model where customers are heterogenous in terms of how likely they are to return a product because of misfit. Next, using a set of difference-in-differences models and a counterfactual analysis on the proprietary dataset from an omnichannel retail that launched STS, we empirically (i) test our theoretical predictions to identify the effect of STS on retail sales performance and (ii) demonstrate that customized channel merchandise planning can improve the performance of STS.

Our theoretical model reveals a trade-off regarding the effect of STS. On one hand, STS expands the market by bringing new customers who were previously non-shoppers because of high shipping and return costs in the online channel (i.e., *market expansion effect*). It also increases BM store sales through cross-selling when online customers make an additional purchase during in-store pickup of their STS orders (i.e., *cross-selling effect*). On the other hand, online customers who visit a BM

hybrid products and then replicate the entire counterfactual analysis using this matched sample. Our insights remain the same even when we restrict our data to only similar hybrid and online-exclusive products.

store to pick up their STS orders can be exposed to alternative products at nearby competitor stores. Subsequently, some customers may forgo their STS orders to substitute with an alternative product from a nearby competitor. Demand from these customers is likely to be lost because of STS since that demand would have been fulfilled online in the absence of STS (i.e., *sales loss effect*). While the effect of STS depends on the magnitude of the three competing effects, when BM stores are not in close proximity to competitor stores, as supported empirically, our theoretical model predicts that STS increases online-exclusive product sales. While not as much, it also increases hybrid product sales. STS is not as efficient for hybrid products as it is for online-exclusive products because customers use STS for hybrid products only when these products are not available in stores. We later extend our analysis to explore the heterogenous effect of STS on hybrid products with respect to product price, in-store inventory availability, and proximity of BM stores to competitor stores. Both theoretical and empirical analyses demonstrate that the benefits of STS for hybrid products might decrease as the price decreases, the in-store inventory increases, or the proximity to competitor stores increases.

The heterogenous effect of STS suggests that even though STS increases aggregate sales, there might be an opportunity for retailers to further improve the performance of STS. We propose that retailers can benefit more from the STS implementation by offering some hybrid products as online-exclusive. With this channel merchandising strategy, some BM store customers who would normally make an in-store purchase order those products using either direct shipping without being exposed to competitor products or STS. Subsequently, retailers can regain some of the demand lost to competitors and generate additional revenue. We, however, caution retailers because not all BM customers may find online shopping as attractive, particularly if they have high uncertainty for product fit, and leave without a purchase when hybrid products are merchandised as online-exclusive. We find that the benefits of the proposed channel merchandising strategy outweigh its loss for low-priced hybrid products, hybrid products with high in-store availability, or hybrid products that have a high probability for substitution with competitor products. The result about in-store availability may seem counterintuitive because higher inventory levels should ideally increase BM store sales. However, as in-store inventory increases, customers use STS services less frequently, and thus the benefits of STS become less pronounced. Hence, merchandising those hybrid products as online-exclusive increases the use of STS and its benefits. In a counterfactual analysis, we estimate that the proposed merchandise planning could have increased hybrid product sales by 2.7% if followed by the retailer when implementing STS.

5.1 Implications for STS Implementation

Most retailers have already initiated STS services, and many others are expected to implement them in near future. Our paper shows that beyond mimicking the trend and implementing STS just to stay competitive in the industry, retailers can indeed benefit substantially if they pay close attention to the operationalization of STS implementation. Otherwise, a poor implementation may result in not only costly channel integration investments but also unexpected sales loss to alternative products in the marketplace. Our results provide several key managerial implications for omnichannel retailers to improve the performance of STS implementation.

First, we suggest that omnichannel retailers consider channel merchandise planning when implementing STS. A more refined classification of hybrid vs. online-exclusive products during the STS implementation may improve the performance of STS. In particular, for run-off-the-mills hybrid products that are characterized as low-priced, highly stocked in BM stores, and somewhat generic (i.e., easy to substitute), retailers may lose sales potentially due to exposing STS customers to alternative products at nearby competitor stores when these customers visit BM stores to pick up their STS orders. Therefore, a direct implication of our study is that retailers can improve the performance of STS by merchandising (i) somewhat generic products that are low-priced with high in-store inventory as online-exclusive and (ii) somewhat unique products that are high-priced with low in-store inventory as hybrid.

Second, given the limited BM store space, many retailers often consider two dimensions to determine their BM store assortment: product breadth (i.e., variety of products) and product depth (inventory level for each product). Typically, the BM store space is utilized through either more variety with each having lower inventory (i.e., large product breadth and shallow product depth) or less variety with each having more inventory (i.e., narrow product breadth and high product depth). Our results suggest that to improve the benefits of STS, retailers should have a large product breadth and a shallow product depth for hybrid products in BM stores. This way, hybrid products will have low in-store inventory as suggested by our channel merchandising prescription. In addition, having a large product breadth at BM stores will likely increase cross-selling opportunities since customers who go to a BM store to pick up their STS orders will be exposed to more options that can either complement their original purchase or induce more impulse shopping.

Third, while our simple prescription assumes that a product can be either a run-off-the-mill product or a somewhat unique and premium product, in practice, retailers may have many products that do not clearly fall in one of the two categories. In such cases, we suggest that retailers classify a product to channel-merchandise based on its bare minimum characteristics and take additional actions to proactively change other characteristics. For instance, a somewhat unique, high-priced product with high inventory can still be merchandised as hybrid. Yet, the in-store inventory for this product can later be lowered to make it consistent with our channel merchandising prescription and aligned with the large product breadth, shallow product depth BM store assortment. As demonstrated in our theoretical and empirical analyses, reducing inventory will likely increase the benefit of STS for that product.

Lastly, our suggestion about merchandising some hybrid products as online-exclusive is based on a cost-benefit analysis in which the cost is represented by the BM store sales the retailer loses, and the benefit is represented by the additional online sales the retailer generates. We acknowledge that the decision to sell a product online, in physical stores, or in both channels calls for more consideration beyond the simple effect of STS, such as the traffic a product generates in physical stores, the effect of a product on the overall store attractiveness for the regular walk-in customers, whether the product is complementary or substitutive in the BM store assortment, or cost of inventory management in physical stores vs. warehouses. Therefore, retailers might be hesitant to merchandise some hybrid products as online-exclusive. In such cases, our study suggests that retailers should be aware of the potential negative effect of STS on run-off-the-mill hybrid products. Even so, we believe the benefits of our suggested strategy can still be achieved through relatively low effort initiatives without actually removing a hybrid product from BM stores. For instance, as previously suggested, retailers can lower the inventory for run-off-the-mill hybrid products to minimize the negative effect of high-inventory on the performance of STS. Also, some retailers offer a curbside pickup (or drive-through pickup) option that allows customers to pick up their online orders without leaving their cars. This will likely help minimize the negative effect of nearby competitor stores that our study highlights for run-off-the-mill hybrid products. As such, online customers who use curbside pickup without leaving their cars will be less likely exposed to alternative products at nearby competitors.

5.2 Limitations and Future Research Suggestions

As in any empirical research, there are also certain limitations in our study. First, as with BOPS (Gallino and Moreno 2014), STS may also increase "research-online-purchase-offline" behavior for hybrid products and motivate some existing online customers to complete their purchase in BM stores, rather than online. While this may shift the demand from online to offline, the overall sales remain the same so long as customer purchase behavior is the same between the two channels. Thus, we do not focus on this channel shift and assume that it has a negligible effect on channel merchandising for STS implementation. Future research can explore how channel merchandising during STS implementation improves sales when customers shifting from online to offline exhibit different purchase behavior between the two channels. Second, while our analytical model characterizes theoretical effects such as market expansion or sales loss to outside options, empirically, we can only measure how these effects collectively manifest themselves in sales. Future research can quantify the magnitude of each theoretical effect in a controlled lab experiment or using consumer-level data from competing retailers. Third, even though the major competitor had already started to offer STS by the time the focal retailer was launching it, we do not have full information regarding the presence of STS offerings for all other potential competitors. It might be likely that the effect of STS is shorted-lived if some of those competitors started to respond with similar STS offerings. This can potentially be explored by future research analytically in a sequential game setting where competing retailers launch STS in a dynamic fashion. Fourth, we study a jewelry retailer where the products are relatively expensive due to the material value, majority of transactions (i.e., 82%) include only a single item, customers mostly make infrequent purchases for rare events (e.g., wedding, proposal, Mother's Day, etc.), and a majority of customers do not make a repurchase in the future. Potentially due to all these, the cross-selling rate for STS transactions (i.e., 6%) at the focal retailer is substantially lower than the 45% cross-selling rate claimed in an industry survey (UPS 2015), and the market expansion effect is likely to drive the major benefits of STS. For more traditional retailers where products are less expensive and customers make more frequent purchases (e.g., department stores or apparel retailers), STS may create more cross-selling opportunities, yet its market expansion effect may not be as prominent due to having a relatively firm customer base. Future research can empirically examine the impact of channel merchandising on the performance of STS for more traditional retailers. Fifth, our suggestions regarding merchandising a hybrid product as online-exclusive do not consider all the relevant costs and benefits of removing a hybrid product from the physical store channel. Research that focuses on channel merchandising can benefit from our work since we demonstrate that the effect of STS is another factor that needs to be considered when making the channel availability decision for a product. Finally, our study focuses particularly on retailers that fulfill an in-store pickup order using only the central warehouse inventory (i.e., STS). In practice, many other retailers adopt a hybrid fulfillment model and use (i) BOPS if the item is available in-store and (ii) STS otherwise. The initial insights from our theoretical model suggest that this hybrid fulfillment model amplifies all three theoretical effects identified in Proposition 2.[12] Future research can examine how omnichannel retailers should integrate their central warehouse inventory with in-store inventory and determine the channel availability for a product when operating under this hybrid fulfillment model.

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[12]The analysis can be provided by the authors upon request.

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