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Economic Perspective Of Omnichannel: A Preliminary Analysis

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ECONOMIC PERSPECTIVE OF OMNICHANNEL: A PRELIMINARY ANALYSIS

Research full-length paper

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Abstract

Recent advancements in technology have not only transformed how people lead their lives, but also how they shop. Traditional single or multichannel retailing models fall short of meeting the changing customer behaviours and expectations. Many in the retailing industry believe that evolving towards seamless omnichannel model is the only way forward for the retailers. However, merely 'going omnichannel' does not guarantee success. Lack of understanding of its underlying economic rationale might render a retailer unsuccessful in the face of intense competition and a heightened need for operational efficiencies. The omnichannel strategy might even prove to be unsustainable in certain contexts. We make an attempt to explore the determinants of an omnichannel retailer's success in a competitive retail environment. Given a market currently served by traditional retailers, our analysis tries to figure out the market share an omnichannel aspirant can expect to acquire and its dependence on the price that it needs to charge for providing the additional set of services through omnichannel.

Keywords: Omnichannel retailing; Channel of distribution; Retail competition; Product valuation.

1 Introduction

In recent times, the retail environment around the world has witnessed the emergence of omnichannel retailing - a new form of retailing strategy. Historical evidences would allow one to trace the way retailing strategies evolved - from single-channel to multichannel and, then, to omnichannel. Compared to single-channel (i.e., pure offline or online) or multichannel strategies, omnichannel retailing offers to deliver enhanced value through a bouquet of services, containing services offered by both physical and digital channels, for the customers to pick and choose from. Omnichannel model is increasingly being considered to be an imminent threat to the traditional retailing strategies by many. However, mere provisioning of omnichannel services does not assure guaranteed success. In this paper, we intend to do a preliminary investigation into the economic viability of an omnichannel entrant in presence of traditional retailers.

Conventionally retailers have predominantly employed offline channels, i.e., brick-and-mortar/ physical stores, to market their products/services to the target customers. The advent of the online channel led to dramatic changes in the retailing industry as the flexibility of connecting with the customers over internet threw open enormous possibilities. Edited product assortments, personalized helps, trials, instant access to products, etc. are certain advantages that offline retailers offer (Rigby 2011). On the other hand, exhaustive product selections, recommendation services, enhanced search functionalities, convenience of anything, anytime, anywhere access, etc. are some of the advantages that online retailers enjoy (Brynjolfsson et al. 2003; Enders & Jelassi 2000; Rigby 2011). Many retailers started offering their products/services through web-based stores. To gain from advantages offered by both type of channels, many retailers went multichannel employing both offline and online channels to serve the customers. Multichannel retailers manage offline and online channels separately, with very limited integrating effects (Verhoef et al. 2015). However, the evolution of retailing models did not stop there. Recent technological developments, e.g., advancement in mobile computing, emergence of social media, etc., have given rise to a new trend – today's customers are demanding the best of both the offline and online worlds. Omnichannel strategy – a new form of retailing – is being regarded as the solution to the evolving customer expectations. An omnichannel retailer aims to satisfy the customers by offering a single seamless shopping experience by providing the flexibility to mix different touch points across disparate channels as they deem fit and avail themselves of various services being offered (Brynjolfsson et al. 2013; Williams et al. 2014; Rigby 2011).

The flexibility of interchangeably and seamlessly using the touch-points across channels is what makes omnichannel so attractive. Let alone offline or online retailers, even multichannel ones are not able to offer full range of omnichannel services as they cannot ensure this flexibility (Beck & Rygl 2015). However, this flexibility entails additional cost which the omnichannel retailer may need to recover by charging a higher price to the customers. A higher retail price may reduce the customers' incentive to buy. Moreover, contrary to the concerns expressed by many experts, omnichannel retailers have not been able to push the competitors into obsolescence. Rather retailers of different types have been witnessed to continue to coexist and compete in the same market segment. For example, brands like physical stores-based 'GKB Optical,' multichannel 'Titan Eye Plus,' and omnichannel 'LensKart' continue to operate side-by-side in the Indian eye-wear market.

In this paper, we propose to investigate the 'omnichannel retailing' phenomenon from an economic perspective by comparing its competitiveness with existing offline retailers. The extant omnichannel literature, to the best of our knowledge, is yet to discuss how the competition would play out when a retailer introduces omnichannel services in a market hitherto served by non-omnichannel retailers. In this introductory study, we look into the competition with only offline retailers. The success of the new entrant would depend on its long-term financial sustainability– what fraction of the market it manages to capture and at what price. What are the implications of the entry of an omnichannel retailer for the existing (non-omnichannel) retailers in a market? How can an omnichannel retailer ensure that the business model designed/implemented can be sustained in the long run? How would the presence of an omnichannel retailer change the overall market penetration of the product-type under consideration, if at all? In this paper, we make an attempt to throw some light on some of these aspects. We expect the insights derived from the resultant analysis would be a step forward for a retailer in deciding whether to go omnichannel or not.

2 Literature Review

With the proliferation of internet, and its potential to provide an alternate mechanism to interact with the customers, retailers needed to have a better understanding of what makes online channel so popular, and how to successfully integrate it into their business models. Choudhury and Karahanna (2008) provide a nuanced understanding of customers' adoption of internet-based channels taking into consideration different stages of the purchase process. Huang, Lurie, and Mitra (2009) show that, compared to traditional offline settings, internet reduces the differences in a customer's perceived ability to evaluate search and experience goods. Brashear, Kashyap, Musante, and Donthu (2009) and establish that online customers across geographies share many similar traits.

In many retail markets, online channels led to disruptive developments leading to "changed retail business models, the execution of the retail mix, and shopper behaviour" (Verhoef et al. 2015). It forced many retailers to contemplate going multichannel to navigate these new set of challenges. Enders and Jelassi (2000) discuss the advantages and drawbacks associated with offline and online retailing models and argue that, to alleviate the drawbacks, retailers might consider chalking up multichannel strategies with multiple points of interaction across both physical and online channels. Extensive understanding of what factors drive channel choice in a multichannel setting became imperative in optimal design and implementation of multichannel strategies. Schoenbachler and Gordon (2002) take a customer-centric view in identifying five key factors determining channel choice – perceived risk, past direct marketing experience, motivation to buy from a channel, product/ service category, and website design – in a multichannel context. Gensler, Verhoef, and Böhm (2012) assume a more integrating approach when they consider different stages of the buying process in providing a more nuanced understanding of customers' channel choice intentions.

To become successful, retailers have been prescribed to offer omnichannel services – a mashup combining the advantages and flexibilities of online and offline stores – to the customers. According to Brynjolfsson et al. (2013), this new development would affect retailer strategies; rather than taking a transactional approach, retailers are expected to assume a broader perspective while interacting with customers through multiple touch points. Bell et al. (2014) guide the retailers on how to adapt to such an environment. Retailers have been advised to take a customer-centric perspective and inspect their activities in reference to two critical functions – information and fulfilment – to devise the right omnichannel strategy. Ailawadi and Farris (2017) emphasize that retailers would find it increasingly difficult to manage omnichannel models using traditional retailing metrics and recommend a set of metrics specifically designed to keep track of distribution and marketing activities in an omnichannel scenario. Gao and Su (2017) study effective information-delivery mechanisms for omnichannel customers. Ishfaq et al. (2016) discuss the way to realign physical distribution processes of an offline retailer to achieve omnichannel objectives. Picot-Coupey et al. (2016) identify challenges faced by online retailers in their efforts to become omnichannel and also discuss ways to navigate the challenges. Hübner et al. (2016) take up a similar exercise for multichannel retailers and offer a set of guidelines to effectively manage their transition to become omnichannel entities. Saghiri et al. (2017) propose a multi-dimensional framework to help retailers "develop, run and monitor omni-channel systems".

Despite its growing acceptance among retailers, existing literature is still in a nascent stage (Verhoef et al. 2015) and till now has mostly been dealing with conceptualisation of the notion of omnichannel and implementation strategies. Retailer performance is one aspect which, to the best of our knowledge, has still not been explored in omnichannel context. Competitive retailer/channel performances have extensively been studied in a dual-channel context (Chiang et al. 2003; Tsay & Agrawal 2004; Cattani et al. 2006; Cattani et al. 2004; Cai et al. 2009; Dan et al. 2014). In this paper, we make an attempt to study omnichannel performance when facing competition from other types of retailers. We would also like to investigate the impact the additional cost vs. enhanced value trade-off has on omnichannel performance.

3 The Model

It is needless to mention that a complete picture would have been presented had we considered retailers of all types (i.e., pure offline, pure online, and multichannel) competing with the concerned omnichannel retailer. However, taking into account all strategies would complicate the situation making this exercise unmanageable. For simplicity's sake we have considered the incumbent retailers to follow only offline strategies. We would see in the following sections, even considering only one type of retailers serving the market before the omnichannel retailer's entry, makes the subsequent calculations mathematically intractable. Even if we consider that the market was being served by online or multichannel retailers instead, before omnichannel services were introduced, we could follow the same approach in studying performance dynamics of the competing retailers.

In a market being served by single-channel and/or multichannel retailers, a retailer offering omnichannel services offer enhanced values to the customers. Now this extent of value enhancement depends on the competing models. Competing against offline (or online) retailers, omnichannel value enhancement would happen in two ways - by providing opportunity to the customers to avail themselves of online (or offline) services and by providing flexibility to pick and choose amongst this basket containing both offline and online services as they deem fit during the purchase process. Pitted against multichannel competitors, value enhancement happens only through the latter component mentioned above, i.e., the added flexibility of allowing customers choose their preferred modes of interaction with the retailer. It is self-explanatory that the extent of value enhancement would be greater when the omnichannel retailer is competing against single-channel retailers compared to multichannel ones. The extent of omnichannel value enhancement would depend on our assumption about the competitors' channel strategies, but the nature of the subsequent treatment would not change.

We focus on experience goods as these products typically involve multiple interactions between the customers and the retailer. We assume that the retailers offer similar variations of the product and an identical set of services to help the customers during the buying process and, hence, are not in a position to differentiate themselves on the basis of price. Thus, for modelling purposes, we can assume all the existing offline retailers to be represented by a single retailer R1. Sensing a business opportunity to attract customers with an enhanced set of services, a retailer intends to enter the market with omnichannel services. Or, one of the existing offline retailers contemplates becoming omnichannel. In either case, we designate this retailer as R2. We also assume that none of the retailers can sustain a loss for a prolonged period of time and, hence, adoption of predatory pricing[1] policies is not feasible.

For a customer contemplating buying the product from one of the competing retailers, some of the steps in the entire purchase process may involve choice, trials, order, personalization, delivery, and payment. For an offline-only retailer, a customer will have to choose from among the options available at the store, and may need to make multiple visits to the store for order, personalization, and delivery. Omnichannel, on the other hand, will give the flexibility to the customer to mix various touch points between online and offline storefronts of the same retailer. For example, a customer can soak in the rich product information, reviews and tips, advices, inventory information available online, put some of her choices of jewellery in the online cart, go to an offline store on a specified date to try those out, and order through either of the channels with delivery to be done at her place of choice and time. In other words, the omnichannel retailer would provide higher flexibility to the customers to interact with different channels across different phases of the shopping experience as they deem fit, and avail themselves of various services being offered. This added flexibility adds value to the customer.

While the rich and interactive product-related information hosted online help the customer perform better product-fit assessment, the close coupling between physical and digital channels adds to the customer's ease to complete the purchasing process. However, the additional value being offered has a cost on top of the cost of providing only offline services. This additional cost comes in the form of expenses incurred for putting up and maintaining the additional infrastructure required to provide the additional set of services. Competing with offline retailers, the concerned omnichannel retailer would not only have to maintain a physical store-based store front like its competitors, but it would also have to add online presence to its business model. Establishing and maintaining a full-fledged online presence would result in adding another cost item in the retailer's books. Moreover, every time a customer interacts with the retailer through one of the touch-points, ensuring that customer experience remains consistent and complementary has its cost implication. The omnichannel retailer has to ensure perfect operational synergy and informational availability regarding customer interactions across all possible points of interaction between the customer and the retailer. Creation of an organisational environment where different departments closely collaborate with each other is imperative for creating successful omnichannel experience for the customers. Seamless exchange of customer data captured and created at different touch-points among different departments - i.e., marketing, products, social media, merchandising, customer service, IT, etc. - is crucial for ensuring coordination across channels. Data-driven understanding of customer behaviours and expectations would help the retailer better serve the customers. As predatory pricing is not a feasible option, the omnichannel retailer has to salvage this additional infrastructural and coordination cost it would have to incur from the customers. Hence, omnichannel retail price would have to be set higher than the offline retail price.

Table 1 provides a list of notations used for mathematical formulation in this paper.

[1] In such a strategy, a firm reduces its prices with an objective to destroy its competitors or to deter new players from entering the market (Areeda & Turner 1975)

Notation	Description
R1	Offline retailer already serving the market
R2	The retailer offering omnichannel services
p_1	Retail price at which R1 offers it product in the market
p_2	Retail price at which R2 offers it product in the market
U1	Net utility derived by a customer from R1
U2	Net utility derived by a customer from R2
X	Random variable denoting a customer's valuation of R1's product
0	Lower limit of the distribution of random variable X
V	Upper limit of the distribution of random variable X
Y	Random variable denoting the 'increment factor' by which a customer's valuation increases, relative to offline services, in the presence of the omnichannel services
1	Lower limit of the distribution of random variable Y
β	Upper limit of the distribution of random variable Y
W	Random variable denoting a customer's valuation of R2's product
$h(x)$	Probability density function associated with the random variable X
$g(y)$	Probability density function associated with the random variable Y
$f(w)$	Probability density function associated with the random variable W

Table 1. Notations used in Mathematical Formulation

To find answers to our research questions, we need to analyze the competitive dynamics when both the players – the offline retailer R1 and the omnichannel retailer R2 – are present in the market. To facilitate the analysis, we first look into two distinct scenarios – when the market is served by just one of them – either R1 or R2 – and then consider the scenario involving both of them. So we consider the market dynamics in three scenarios – when only offline player R1 is serving the market, when only the omnichannel player R2 is serving the market, and when both R1 and R2 are serving the market.

3.1 When only the offline retailer is serving the market

Let us assume that R1 offers the product at a price p_1 in the market. R1 provides a bouquet of offline services – edited assortments, personal help from experienced salespersons, opportunity to test/try on/experience the product, convenient return policy, etc. (Rigby 2011) – at the stores to help the customers with the required information. Depending on their assessments about the product's utility in satisfying their individual needs, customers assign certain values to it. This is termed as customer's valuation of a product which is nothing but the value a customer expects to derive from that product.

We assume the valuation of the product offered by R1 not to be homogeneous across the customers. Rather, we denote customer's valuation of the product by R1 by a random continuous variable X. In extant literature, heterogeneity in customers' valuations has often been captured in the form of uniform distribution (Simchi-Levi et al. 2004; Bernstein et al. 2009). However, this assumption – i.e., customers' judgments are uniformly distributed across a given range – is rather restrictive (Hauser et al. 1996). One would rather expect that fractions of potential customers having different product valuations to be different. For example, fractions of customers having extreme valuations at either end of the range would be small. Hence, we assume a triangular distribution to more reasonably capture the heterogeneity in customer valuations. In the absence of historical data, the assumption is found to be reasonable when the underlying distribution is unknown, and subject matter experts can be consulted to find out the maximum, minimum and the most likely values of the distribution's support (Jannat & Greenwood 2012; Kotz & van Dorp 2004). We consider X to have a symmetric triangular distribution with 0 and V as the lower and upper limits, i.e., X ~ Triangular [0, V/2, V][2]. The net utility U1 that a customer expects to derive from buying the product from R1 depends on her product valuation and the retail price p_1.

So, we have, U1 = (X - p_1) (1)

When only the offline retailer R1 is serving the market, only the customers deriving positive net utility from R1 would buy the product. So, in this case, the market penetration achieved by R1, would depend on p_1, the retail price charged by R1, and X, the perceived customer valuation of the product.

Let us denote the probability that a randomly selected customer would derive positive net utility from buying the product from R1 by Pr(U1 > 0).

So, Pr(U1 > 0) = Pr(X – p_1 > 0) = Pr(X > p_1) (2)

We also know that, $\Pr(X > p_1) = \int_{x>p_1} h(x)dx$, (3)

when *h(x)* is the probability density function (pdf) associated with X.

Based on the results provided by Glickman and Xu (2008), we have the expressions for the pdf *h(x)* -

$$h(x) = \begin{cases} \frac{4x}{V^2}, for \ \ 0 \le x \le \frac{V}{2} \\ \frac{4(V-x)}{V^2}, for \ \ \frac{V}{2} \le x \le V \end{cases} \quad (4)$$

Using the value of *h(x)* from equation (4) in equation (3), we get -

$$\Pr(U_1 > 0) = \begin{cases} (1 - \frac{2p_1^2}{V^2}), for \ \ p_1 \le \frac{V}{2} \\ \frac{2}{V^2}(V - p_1)^2, for \ \ p_1 \ge \frac{V}{2} \end{cases} \quad (5)$$

These expressions denote the market fraction that R1 would be able to capture. If, for example, p_1 assumes the values 0, V/2, and V, R1 would be able to acquire market fractions of 1, 0.5, and 0 respectively. Similarly, for V = 10, R1 would be able to capture 68% and 32% market shares for offering the product at prices 4 ($p_1 = 4$) and 6 ($p_1 = 6$), respectively.

3.2 When only the omnichannel retailer is serving the market

In this scenario, retailer R2 alone is serving the market with an omnichannel business model by offering its product at a retail price p_2. We have already seen that as the R2 needs to pass on the additional cost of providing omnichannel services to the customers, the omnichannel retail price p_2 would have to set higher than p_1, i.e., $p_2 \ge p_1$.

Enhanced convenience and better product-fit assessment made possible by the omnichannel services may lead to increase in product valuation among the customers. The increase in product valuation has traditionally been captured by a fixed 'increment factor' in existing literature, where every customer's valuation would increase by the same ratio (Bernstein et al. 2009). However, the heterogeneity in customer characteristics means different customer's valuations could be differently affected by the introduction of omnichannel services. It is reasonable to expect that there will be a substantial percentage of customers who would derive additional value from R2. So, we consider a random continu-

[2] X having a symmetric distribution, the modal value becomes equal to V/2.

ous variable Y that would refer to this valuation increment factor. For reasons mentioned above, we assume Y to follow a symmetric triangular distribution with a lower limit of 1 and an upper limit of β, i.e., Y ~ Triangular [1, β/2, β], where β > 1. We further assume that X and Y are independent of each other. The product valuation in case of R2, W, would be denoted by the product of these two random variables X and Y. The net utility a customer derives from buying from R2 is denoted by U2.

So, we have, U2 = (W – p_2) = (XY – p_2) (6)

Let us assume *g(y)* to be the pdf associated with the random variable Y. Based on the results provided by Glickman and Xu (2008), we have the following expressions for the pdf *g(y)* -

$$g(y)=\begin{cases}\dfrac{4(y-1)}{(\beta-1)^2},\ for\ \ 1\le y\le\dfrac{(1+\beta)}{2}\\ \dfrac{4(\beta-y)}{(\beta-1)^2},\ for\ \ \dfrac{(1+\beta)}{2}\le y\le\beta\end{cases} \tag{7}$$

To calculate the market fraction acquired by R2, we need to find out the pdf *f(w)* of the product W (= XY). The pdf of W can be obtained from the following expression (Glickman & Xu 2008) -

$$f(w)=\int_{x_1}^{x_2} g(\frac{w}{x})h(x)\frac{1}{x}dx \tag{8}$$

where (x_1, x_2) denotes the specified support interval of *x*, taking into consideration the corresponding values of *w*. Now, if the probability that a randomly selected customer would derive positive utility from transacting with R2 is denoted by Pr(U2 > 0), we can calculate its value in the following way –

$$\Pr(U_2>0)=\Pr(W-p_2>0)=\Pr(W>p_2)$$

$$\text{or, } \Pr(U_2>0)=\int_{w>p_2} f(w)dw \tag{9}$$

Deriving the pdf of W would require consideration of the following four different cases in which the values of *x* and *y* lie in their respective domains –

i. 0 ≤ *x* ≤ V/2 and 1 ≤ *y* ≤ (1+β)/2
ii. 0 ≤ *x* ≤ V/2 and (1+β)/2 ≤ *y* ≤ β
iii. V/2 ≤ *x* ≤ V and 1 ≤ *y* ≤ (1+β)/2
iv. V/2 ≤ *x* ≤ V and (1+β)/2 ≤ *y* ≤ β

Each of the cases defines a space for *w*, within which the pdf of W would have to be calculated using the expressions (4), (7), and (8). Let us assume that $f_n(w)$ denotes the pdf of W corresponding to the n^{th} case listed above and each $f_n(w)$ would constitute a part of the overall pdf $f(w)$.

Upon further calculations, we get the following expressions for different components of $f(w)$ –

$$f_i(w)=\begin{cases}\dfrac{16}{(\beta-1)^2V^2}w[\ln(\dfrac{1+\beta}{2})-(\dfrac{\beta-1}{\beta+1})],\ for\ \ w\in(0,\dfrac{V}{2})\\ \dfrac{16}{(\beta-1)^2V^2}[\dfrac{2w}{(1+\beta)}-\dfrac{V}{2}+w\ln(\dfrac{V(1+\beta)}{4w})],\ for\ \ w\in(\dfrac{V}{2},\dfrac{V(1+\beta)}{4})\end{cases} \tag{10}$$

$$f_{ii}(w)=\begin{cases}\dfrac{16}{(\beta-1)^2V^2}w[\ln(\dfrac{1+\beta}{2\beta})+(\dfrac{\beta-1}{\beta+1})],\ for\ \ w\in(0,\dfrac{V(1+\beta)}{4})\\ \dfrac{16}{(\beta-1)^2V^2}[\dfrac{\beta V}{2}-w+w\ln(\dfrac{2w}{\beta V})],\ for\ \ w\in(\dfrac{V(1+\beta)}{4},\dfrac{\beta V}{2})\end{cases} \tag{11}$$

$$f_{iii}(w)=\begin{cases}\frac{16}{(\beta-1)^2V^2}[3w-\frac{3V}{2}+(w+V)\ln(\frac{V}{2w})],\ for\ \ w\in(\frac{V}{2},\frac{V(1+\beta)}{4})\\ \frac{16}{(\beta-1)^2V^2}[(\frac{\beta-1}{\beta+1})w+\frac{V(\beta-1)}{2}+(w+V)\ln(\frac{2}{1+\beta})],\ for\ \ w\in(\frac{V(1+\beta)}{4},V)\\ \frac{16}{(\beta-1)^2V^2}[\frac{V(3+\beta)}{2}-w\frac{(3+\beta)}{(\beta+1)}+(w+V)\ln(\frac{2w}{V(1+\beta)})],\ for\ \ w\in(V,\frac{V(1+\beta)}{2})\end{cases} \quad (12)$$

$$f_{iv}(w)=\begin{cases}\frac{16}{(\beta-1)^2V^2}[\frac{V(2\beta+1)}{2}-2w(\frac{2\beta+1}{\beta+1})+(w+\beta V)\ln(\frac{4w}{V(1+\beta)})],\ for\ \ w\in(\frac{V(1+\beta)}{4},\frac{\beta V}{2})\\ \frac{16}{(\beta-1)^2V^2}[(w+\beta V)\ln(\frac{2w}{1+\beta})-\frac{V(\beta-1)}{2}-w(\frac{\beta-1}{\beta+1})],\ for\ \ w\in(\frac{\beta V}{2},\frac{V(1+\beta)}{2})\\ \frac{16}{(\beta-1)^2V^2}[2(w-V\beta)+(w+V\beta)\ln(\frac{V\beta}{w})],\ for\ \ w\in(\frac{V(1+\beta)}{2},\beta V)\end{cases} \quad (13)$$

Here the maximum value that β has been assumed to be 2, i.e., the maximum amount by which the introduction of omnichannel services can increase a customer's valuation is 100%. Calculating the market fraction captured by R2 using the expression (9) would involve considering the piece-wise pdfs, i.e., $f_n(w)$s, as represented by the equations (10) to (13). Depending on the relative magnitudes of V and β, the segment, over which the equation (9) is to be integrated, is divided into 10 sub-segments, and appropriate $f_n(w)$s would have to be selected to map *f(w)* onto these different sub-segments.

As specified in equations (10) - (13), $f_n(w)$s have different expressions depending on the range of values *w* can assume. We have the parameter values, i.e., V = 10 and β = 1.5, associated with the situation being considered here. The following diagram provides a visual mapping of piece-wise pdf expressions with different ranges of values *w* can take. In the diagram, $f_n^j(w)$ refers to the j[th] expression associated with n[th] piece-wise pdf expression. For example, we know from equation (10) that the component $f_i(w)$ has two expressions associated with it – one applicable to the range [0, V/2] and the other to [V/2, V(1+ β)/4]. We denote these expressions by $f_i^1(w)$ and $f_i^2(w)$, respectively.

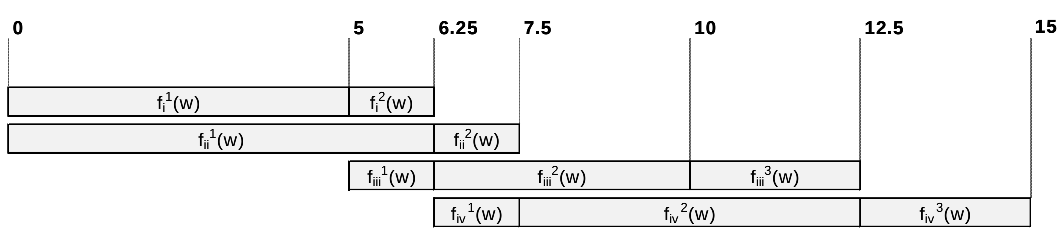

Figure 1. Representative visual mapping of piece-wise pdf expressions

The upper and lower limits for different expressions were accordingly calculated, e.g., V/2 = 0, V(1+ β)/4 = 6.25, etc. Now, to calculate the market fraction retailer R2 would be able to capture at a retail price p_2, each of the expressions mentioned in the diagram, along with the appropriate upper and lower limits, is to be considered.

Let us assume the following parameter values: V = 10, β = 1.5, and p_2 = 4. To calculate the contribution from $f_i^1(w)$, the expression $f_i^1(w)$ has to be integrated over the range [4, 5] as the value of p_2 falls within the range concerned. However, to calculate the contribution from $f_i^2(w)$, the concerned expression needs to be integrated over the entire corresponding range [5, 6.25] as p_2 falls on the left-hand side of the lower limit 5. In case, the value of p_2 is higher than the upper limit associated with any expression, the contribution from the concerned expression would be zero.

We calculate the contributions from the each of the piece-wise pdf expressions and, adding all the contributions, we get a value of 0.7910 (approx.). It means that, for V = 10, β = 1.5, and p_2 = 4, retailer R2 would capture approximately 79.10% of the market.

Now, with same V and β, and p_2 assuming a value of 6, we have to compare the current p_2 value with the respective upper and lower limits applicable for different $f_n^j(w)$s to find R2's market share. Here, the contribution from $f_i^1(w)$ would be zero as the concerned upper limit is lower than p_2; contributions from $f_i^2(w)$, $f_{ii}^1(w)$, and $f_{iii}^1(w)$ would decrease as p_2 is higher than the respective lower limits; but contributions from all other $f_n^j(w)$s would remain same to the case with p_2 = 4. Adding up the contributions from the $f_n^j(w)$s, we get a value of 0.5312 (approx). It means that, for V = 10 and β = 1.5, retailer R2 would capture approximately 53.12% of the market if it sets p_2 at a value of 6.

As shown above, when only R2 is serving the market, the market penetration depends on p_2, the retail price at which R2 offers the product, V, the distribution parameter associated with customer valuations of the services of the offline-only channel, and β, the valuation increment parameter associated with R2's omnichannel offerings.

3.3 When both the offline and omnichannel retailers are serving the market

The presence of both the players complicates the scenario. A customer's decision of buying the product would depend on whoever is providing the customer with higher positive net utility. Here, the customers can be divided into the following segments -

i. Segment 1: Customers who fail to derive positive utility from either of the retailers
ii. Segment 2: Customers who derive positive utility from R1, but not from R2
iii. Segment 3: Customers who derive positive utility from R2, but not from R1
iv. Segment 4: Customers who derive positive utility from both, but higher utility from R1
v. Segment 5: Customers who derive positive utility from both, but higher utility from R2

R1's market share will be determined by customers in segments 2 and 4. Segments 3 and 5 would decide R2's market share. Segment 5 represents those customers of R2 who would have purchased from R1, had R2 not been there. Thus segment 5 represents those customers who would drift away from R1 once R2 introduces omnichannel services. Segment 3, the other contributor to R2's market share, represents expansion, if any, in the market.

Arriving at closed form expressions for any of the segments would be cumbersome. Sections 3.1 and 3.2 provide analytical expressions for calculating the market shares acquired by retailer R1 and R2, respectively, when each of them is serving the market alone. However, as shown in Section 3.2, assessment of R2's product valuations involve considering multiple number of piece-wise pdf expressions applicable over different ranges of values. The dependency of R2's product valuations on R1's product valuations and involvement of multiple piece-wise pdf expressions makes the exercise of finding closed-form analytical expressions for segments 4 and 5 mathematically intractable. We, therefore, resort to a numerical study to investigate the competitive dynamics when both R1 and R2 are present in the market. If the numerical study can validate the results obtained analytically in sections 3.1 and 3.2, we can reasonably believe the results even when both retailers are involved.

4 Numerical study

Upper limits of the distributions of X and Y (i.e., V and β, respectively), retail prices fixed by the retailers R1 and R2 (i.e., p_1 and p_2, respectively), and the population size of the target customers are taken as the inputs for simulation purposes. We use MATLAB routine for simulation purposes.

Our analysis in section 3.1 established that, with V = 10, retailer R1, operating alone, can hope to capture 68% and 32% of market shares when offering its product at retail prices 4 and 6, respectively. MATLAB-based simulation results, using same parameter values, report the market shares at 68.03% and 37.98% respectively. Similarly, section 3.2 reports that, with V = 10 and β = 1.5, retailer R2, when serving alone, can expect to capture approximately 79.10% and 53.12% of the market shares at retail prices (p_2) 4 and 6, respectively. MATLAB-based simulation reports R2's market shares to be 79.08% and 53.09%, respectively. Thus, the numerical study is in sync with the analytical results.

When R2 enters the market, the market fraction it can expect to capture depends on what fraction of the customers it can lure away from R1 and also what fraction of the hitherto untapped market it can convert into its own customer base. R2's performance depends on the offline price p_2 and the enhanced valuation it offers, which is captured by β. Lower p_2 and/or higher β would lead to better performance by R2 and vice versa. Here, we aim to study the effect of omnichannel retail price, p_2, and enhanced value provided to the customers by the omnichannel retailer on the relative performances of the retailers R1 and R2. We consider two different values of p_1 – the lower one on the left and the higher one on the right side of the modal value of the distribution representing the customer valuations of R1's product. A lower market fraction already being served by R1 means R2 can expect to convert a higher fraction of hitherto untapped customers into buyers and vice versa.

The results of the analyses have been shown below. In each of the graphs, five legends keys have been used. 'prob_R1' and 'prob_R2' refer to the market shares garnered by retailer R1 and R2, respectively, when they do not have any competition. 'frac_R1' and 'frac_R2' refer to the market fractions captured by R1 and R2, respectively, when both the retailers are competing against each other. 'Mkt+' refers to the market expansion that takes place once retailer R2 enters the market which hitherto was being served only by R1. For the study, a target market of population size 1,000,000 has been considered. The value of V has been assumed to be 10 for this purpose.

We consider two different values of the offline retail price p_1 – 4 and 6 – to study scenarios where the offline retailer R1 has already been catering to more than and less than 50% of the market before R2 introduces omnichannel services. For each p_1 value, we study retailer performances for three different values of β – 1.3, 1.4, and 1.5. As mentioned earlier, a β value of 1.4 indicates that, by virtue of its omnichannel services, retailer R2 can offer maximum perceived value increment of 40% and so on.

Figures 1(a) – 1(c), shown below, show that retailer R1, operating with a retail price p_1 = 4, achieves a market penetration of around 68% when it is the sole provider of the product in the market. R2's market share depends on two factors – what fraction of retailer R1's customers it can lure away from R1 and what fraction of non-buyers (who have not been buying from R1) it can convert into buyers. Setting p_2 closer to p_1 might even allow retailer R2 to make retailer R1's operating model unsustainable by capturing a substantial portion of R1's customer base. For example, in the context of Figure 1(a), with R2's market entry, R1's market share decreases to approximately 11.77%, 26.20%, and 41.81% when p_2 is set to 4.5, 4.75, and 5, respectively. R1 will go out of business if it fails to sustain itself with this reduced market share. It is evident from Figures 1(a) – 1(f) that while retailer R2's market share decreases as p_2 moves away from p_1, increasing β leads to increasing market shares for R2. This p_2 vs. β trade-off signifies that the ability to offer a higher level of services is expected to provide R2 more freedom regarding pricing. For example, as displayed in Figures 1(a) – 1(c), R2 can expect to capture around 42% of the target market by setting p_2 at 5.25, 5, or 4.75, while offering maximum perceived value increments of 30%, 40%, or 50%, respectively. The trends observed in Figures 1 have interesting implications for the coexistence of both the retailers in the market. Figures 1(a) – 1(c) show that R1 and R2 enjoy equal market shares when R2 charges roughly around 4.9, 5.1, and 5.4 for offering maximum perceived value increments of 30%, 40%, and 50%, respectively. Depending on the additional value it offers, R2 can find out the retail price that would allow it to share equal fractions of the realized market share[3] with its competitor R1.

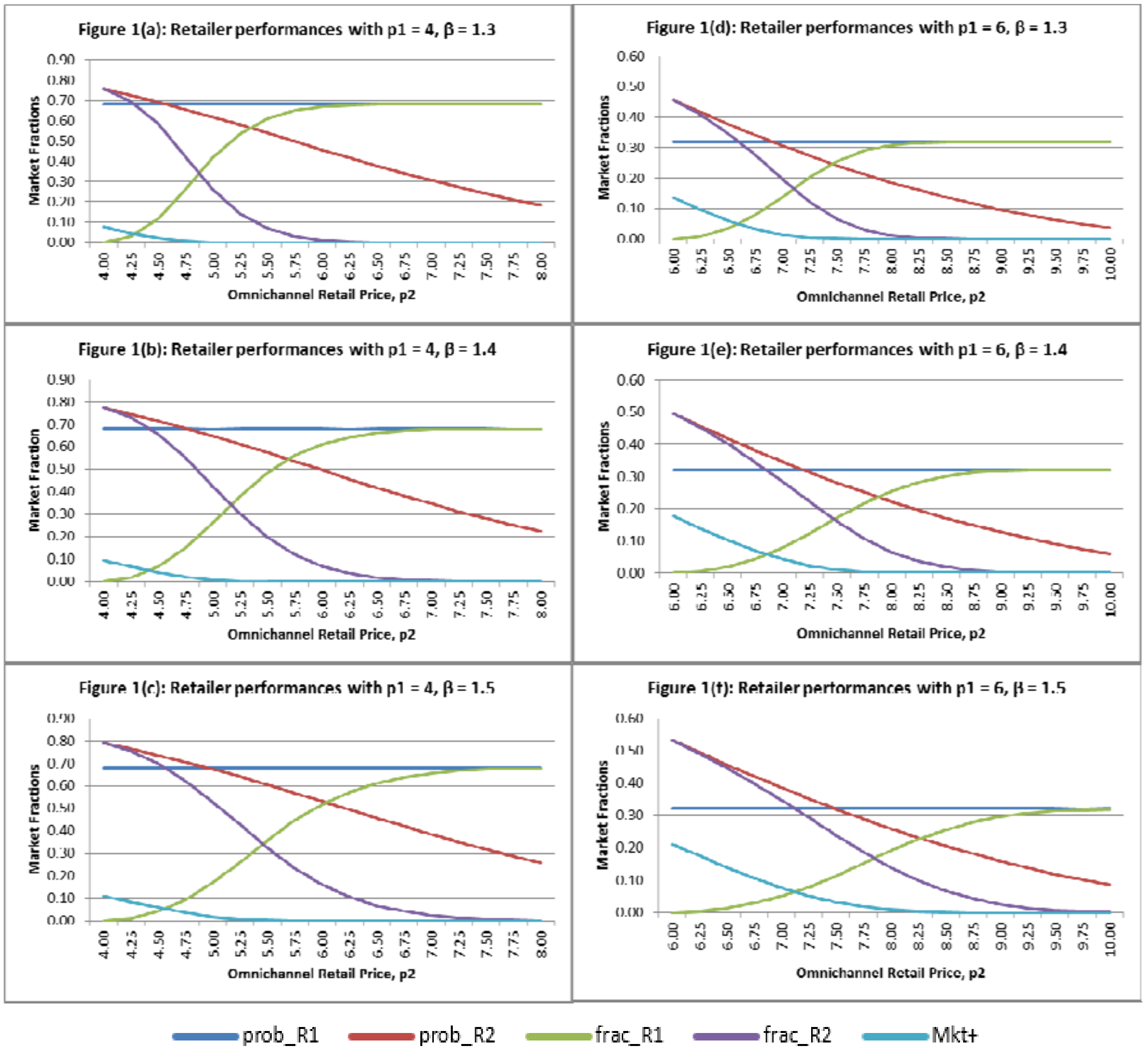

Figure 2. Retailer performances with changing p2

An interesting aspect we wanted to explore is whether omnichannel R2's market entry leads to market expansion, i.e., increased market penetration for the product being considered. With additional services being provided, R2 may entice some of the customers who have so far not been deriving positive net utility from R1's offerings. This fraction of customers, i.e., non-buyers converted into buyers, represents the extent of market expansion[4] made possible due to R2's entry. Figures 1(a) – 1(f) exhibit

[3] Realised market share here refers to the section of target customers who are buying from either of the retailers

[4] Market expansion has been calculated by deducting the market share of R1 when it was serving the market alone from the combined market shares of R1 and R2 when both of them are present in the market.

that maximum market expansion happens when R2 matches R1's retail price and the extent of market expansion erodes fast as p_2 moves away from p_1. Moreover, higher β has been observed to lead to higher market expansion. Increasing p_2 and/or decreasing β make R2 offer lesser and lesser net utilities to the customers leading to decreasing extents of market expansion. From Figures 1(a) – 1(c), market expansion is around 7.60%, 9.42%, and 11.11% when $p_1 = p_2 = 4$ and R2 offers a maximum perceived value increment of 30%, 40%, and 50% respectively. The corresponding extents of market expansion, as displayed in Figures 1(d) – 1(f), are 13.63%, 17.57%, and 21.07%, respectively, when $p_1 = p_2 = 6$. It can be observed that, despite having a higher retail price, R2 manages to lead to greater extents of market expansions in scenarios represented by Figures 1(d) – 1(f). In situations where R1's market share is already substantially high, R2 would find it difficult to convert non-buyers into buyers and would have to depend on luring customers away from R1 to build its own customer base. Where it is not, R2 succeeds in building a substantial fraction of customer-base through market expansion. Thus, if a large fraction of the market is being served by the existing offline retailer R1, omnichannel retailer R2 has to sustain itself primarily by eating into R1's market share. Otherwise, R2 can build its customer base both by drawing customers away from R1, and expanding the buyer-base.

Figures 1(a) – 1(f) show that closer the value of omnichannel retail price p_2 to offline retail price p_1 and higher the perceived value addition through omnichannel services, higher would be R2's market share. However, additional values come at a cost, and R2's ability to set p_2 closer to p_1 would depend on this additional cost R2 incurs to provide the omnichannel services. For illustration, let us assume that R2 incurs an additional variable cost per unit product to provide omnichannel services. Table 2 summarizes simulation results representing retailer performances in two cases – when R2 incurs additional costs of 1 and 2 per unit product to provide maximum perceived value increment of 50%.

Offline Price, p_1	Variable Cost of Providing Omnichannel Services (per unit)	Omnichannel Price, p_2	R1's Market Share (approx.)	R2's Market Share (approx.)	Market Expansion (approx.)	R2's Share in Realized Market[5] (approx.)
4	1	5	16.96%	52.88%	1.85%	75.72%
6	1	7	4.94%	34.58%	7.53%	87.50%
4	2	6	51.83%	16.14%	0.00%	23.75%
6	2	8	19.01%	13.78%	0.86%	42.03%

Table 2. Retailer Performances with β = 1.5 and variable cost for providing omnichannel services

Instead of considering the concerned variable cost to be a proportion of the offline retail price p_1, we have assumed it to take an absolute value. Offline retail price p_1 ought to have many components – cost of raw materials, cost of providing offline services, and profit margin for the offline retailer R1, to name a few. As we are only concerned about the cost to be incurred for the additional set of services, assuming absolute values for it would be more appropriate. As reported in Table 2, with β = 1.5, p_1 = 4, and p_2 = 5, R2 manages to obtain approximately 75.72% of the realized market share. However, when p_1 = 6 and p_2 =7, the corresponding share of R2 is 87.50%. Thus, higher offline price would lead R2 to produce better competitive performance vis-à-vis R1. This observation is also supported by other instances when the variable cost of providing omnichannel services is 2 instead of 1.

5 Concluding remarks

Advancement of technology led to the emergence of 'connected customers' who increasingly started demanding the best of both offline and online retail services (Malhotra et al. 2016). To cater to the

[5] Calculated as the ratio of R2's market share to the combined market share of both the retailers

changing customer expectations and behaviors, omnichannel retailing was introduced. Customers were given the flexibility to transit seamlessly among various touch points of offline and online channels as per his/her will and convenience. Since omnichannel promises to fulfil customer's wish list of services in its entirety, it is being considered as the ultimate form of the retailing business model. However, adoption of omnichannel strategy does not guarantee automatic success. Rather, as argued in this paper, some of the determinants of an omnichannel retailer's success in an entrenched market would be - (a) available room for getting market share through expansion of the market; (b) prevalent retail price being offered by existing retailers; (c) estimate of perceived value addition being proposed through omnichannel; and (d) the additional cost the retailer has to incur for providing these additional services. As shown, the acquired market share of the omnichannel retailer would be determined by a delicate balance of these factors. To the best of our knowledge, omnichannel performance in a competitive scenario is one area which has not still been explored in existing literature. Through this paper, we aim to contribute in that direction. Moreover, the content of the paper has significant practitioner implications. The insights provided in here might help an omnichannel aspirant to look into relevant aspects of the existing market, take into consideration its own cost structure, and do what-if analyses to see what strategy best suits its goal.

The analysis done in the paper is a bit restrictive in the sense that the existing market is considered to be served only by offline retailers when omnichannel is being introduced. While this can be the first step towards more involved economic analysis, it would be interesting to see how the competition unfolds when all types of retailers - offline, online, multichannel, and omnichannel - are present in the target market and are vying for a share of it. We hope researchers would be interested in analyzing more involved models where different types of retailers coexist in the market. Moreover, we have considered the product valuations and valuation enhancements to follow triangular distributions. Similar exercise can be carried out considering other types of distributions to see if the findings are consistent. Additionally, empirical data can be collected from the field regarding product valuations and how omnichannel services influence customer valuations. This data can be used to decide the distribution types to be used during the simulation exercise.

References

Ailawadi, K.L. & Farris, P.W., 2017. Managing Multi- and Omni-Channel Distribution: Metrics and Research Directions. *Journal of Retailing*, 93(1), pp.120–135. Available at: http://dx.doi.org/10.1016/j.jretai.2016.12.003.

Areeda, P. & Turner, D.F., 1975. Predatory Pricing and Related Practices under Section 2 of the Sherman Act. *Source: Harvard Law Review*, 88(4), pp.697–733.

Beck, N. & Rygl, D., 2015. Categorization of Multiple Channel Retailing in Multi-, Cross-, and Omni-Channel Retailing for Retailers and Retailing. *Journal of Retailing and Consumer Services*, 27, pp.170–178. Available at: http://dx.doi.org/10.1016/j.jretconser.2015.08.001.

Bell, D.R., Gallino, S. & Moreno, A., 2014. How to Win in an Omnichannel World. *MIT Sloan Management Review*, 56(1), pp.45–54.

Bernstein, F., Song, J.-S. & Zheng, X., 2009. Free Riding in a Multi-Channel Supply Chain. *Naval Research Logistics (NRL)*, 56(9), pp.745–765.

Brashear, T.G. et al., 2009. A Profile of the Internet Shopper: Evidence from Six Countries. *Journal of Marketing*, 17(3), pp.267–282.

Brynjolfsson, E., Hu, Y. (Jeffrey) & Smith, M.D., 2003. Consumer Surplus in the Digital Economy: Estimating the Value of Increased Product Variety at Online Booksellers. *Management Science*, 49(11), pp.1580–1596.

Brynjolfsson, E., Hu, Y.J. & Rahman, M.S., 2013. Competing in the Age of Omnichannel Retailing. *MIT Sloan Management Review*, 54(4), pp.23–29.

Cai, G.G., Zhang, Z.G. & Zhang, M., 2009. Game Theoretical Perspectives on Dual-channel Supply Chain Competition with Price Discounts and Pricing Schemes. *International Journal of Production Economics*, 117(1), pp.80–96.

Cattani, K. et al., 2006. Boiling Frogs: Pricing Strategies for a Manufacturer Adding a Direct Channel that Competes with the Traditional Channel. *Production and Operations Management*, 15(1), pp.40–56.

Cattani, K.D., Gilland, W.G. & Swaminathan, J.M., 2004. Coordinating Traditional and Internet Supply Chains. In D. Simchi-Levi, S. D. Wu, & Z.-J. M. Shen, eds. *Coordinating Traditional and Internet Supply Chains*. New York: Springer Science & Business Media, pp. 643–677.

Chiang, W.K., Chhajed, D. & Hess, J.D., 2003. Direct Marketing, Indirect Profits: A Strategic Analysis of Dual-Channel Supply-Chain Design. *Management Science*, 49(1), pp.1–20.

Choudhury, V. & Karahanna, E., 2008. The Relative Advantage of Electronic Channels: A Multidimensional View. *MIS Quarterly*, 32(1), pp.179–200.

Dan, B. et al., 2014. Pareto Improvement Strategy for Service-Based Free-Riding in a Dual-Channel Supply Chain. *Asia-Pacific Journal of Operational Research*, 31(6), p.1450050. Available at: http://www.worldscientific.com/doi/10.1142/S021759591450050X.

Enders, A. & Jelassi, T., 2000. The Converging Business Models of Internet and Bricks-and-Mortar Retailers. *European Management Journal*, 18(5), pp.542–550.

Gao, F. & Su, X., 2017. Online and Offline Information for Omnichannel Retailing Online and Offline Information for Omnichannel Retailing. *Manufacturing & Service Operations Management*, 19(1), pp.84–98.

Gensler, S., Verhoef, P. & Böhm, M., 2012. Understanding Consumers' Multichannel Choices across the Different Stages of the Buying Process. *Marketing Letters*, 23(4), pp.987–1003.

Glickman, T.S. & Xu, F., 2008. The Distribution of the Product of Two Triangular Random Variables. *Statistics and Probability Letters*, 78(16), pp.2821–2826. Available at: http://dx.doi.org/10.1016/j.spl.2008.03.031.

Hauser, D., Tadikamalla, P. & Katz, J.M., 1996. The Analytic Hierarchy Process in an Uncertain Environment: A Simulation Approach. *European Journal of Operational Research*, 91(1), pp.27–37.

Huang, P., Lurie, N.H. & Mitra, S., 2009. Searching for Experience on the Web: An Empirical Examination of Consumer Behavior for Search and Experience Goods. *Journal of Marketing*, 73(2), pp.55–69.

Hübner, A., Wollenburg, J. & Holzapfel, A., 2016. Retail Logistics in the Transition from Multi-Channel to Omni-Channel. *International Journal of Physical Distribution & Logistics Management*, 46(6/7), pp.562–583.

Ishfaq, R. et al., 2016. Realignment of the Physical Distribution Process in Omni-Channel Fulfillment. *International Journal of Physical Distribution & Logistics Management*, 46(6/7), pp.543–561.

Jannat, S. & Greenwood, A.G., 2012. Estimating Parameters of the Triangular Distribution Using Nonstandard Information. In *Proceedings of the Winter Simulation Conference.* p. 89.

Kotz, S. & van Dorp, J.R., 2004. *Beyond Beta: Other Continuous Families of Distributions with Bounded Support and Applications*, World Scientific. Available at: http://www.worldscientific.com/worldscibooks/10.1142/5720.

Malhotra, A. et al., 2016. *Retail in the Era of the Connected Customer: Perspectives on How Indian Retailers Can Win in Today's World of Connected Customers*, Available at: http://rls.net.in/wp-content/uploads/2016/11/AT_Kearney_RLS_Summit_Whitepaper_Final.pdf.

Picot-Coupey, K., Huré, E. & Piveteau, L., 2016. Channel Design to Enrich Customers' Shopping Experiences: Synchronizing Clicks with Bricks in an omni-channel perspective – the Direct

Optic case. *International Journal of Retail & Distribution Management*, 44(3), pp.336–368.

Rigby, D., 2011. The Future of Shopping. *Harvard Business Review*, 89(12), pp.1–17.

Saghiri, S. et al., 2017. Toward a Three-Dimensional Framework for Omni-Channel. *Journal of Business Research*, 77(April), pp.53–67. Available at: http://dx.doi.org/10.1016/j.jbusres.2017.03.025.

Schoenbachler, D.D. & Gordon, G.L., 2002. Multi-Channel Shopping: Understanding What Drives Channel Choice. *Journal of Consumer Marketing*, 19(1), pp.42–53. Available at: http://www.emeraldinsight.com/doi/abs/10.1108/07363760210414943.

Simchi-Levi, D., Wu, S.D. & Shen, Z.-J.M. eds., 2004. *Handbook of Quantitative Supply Chain Analysis: Modeling in the E-Business Era* 1st ed., New York: Springer Science & Business Media.

Tsay, A.A. & Agrawal, N., 2004. Channel Conflict and Coordination in the E-Commerce Age. *Production and Operations Management*, 13(1), pp.93–110. Available at: http://doi.wiley.com/10.1111/j.1937-5956.2004.tb00147.x.

Verhoef, P.C., Kannan, P.K. & Inman, J.J., 2015. From Multi-Channel Retailing to Omni-Channel Retailing: Introduction to the Special Issue on Multi-Channel Retailing. *Journal of Retailing*, 91(2), pp.174–181. Available at: http://dx.doi.org/10.1016/j.jretai.2015.02.005.

Williams, C. et al., 2014. *The Omnichannel Opportunity: Unlocking the Power of the Connected Consumer*, Available at: https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/consumer-business/unlocking-the-power-of-the-connected-consumer.pdf.

Xu, G. et al., 2014. Coordinating a Dual-Channel Supply Chain with Risk-Averse under a Two-Way Revenue Sharing Contract. *International Journal of Production Economics*, 147, pp.171–179. Available at: http://dx.doi.org/10.1016/j.ijpe.2013.09.012.