Why Online Retail Competition Does Not Always Benefit Consumers

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Abstract

Empirical studies to date have delivered mixed conclusions on the question of whether the widely acclaimed assertions of lower electronic retail (e-tail) prices are indeed true, and to what extent these benefits are able to transcend the virtual world by impacting retail prices. One explanation for the mixed conclusions is that they provide only a discrete snapshot of a limited segment of the market over a given interval of time. In this paper we use extensions to Salop’s (1979) city-around-the-lake model to examine the possible impact of an e-tail presence on conventional retailers’ decisions to relocate, retail prices, firms’ profits, and consumer welfare. Our analysis shows that many counter intuitive results are possible even in a well-known theoretical model: under some circumstances for example conventional retailers should not relocate in response to entry by an e-tailer into the retail market. Also, there are conditions under which entry by an e-tailer into the retail market can lead to increased retail prices, and increased industry profits across an industry. And, finally, consumer welfare can be increased with less competition. The underlying message of our results is that inferences regarding prices, profits, and the consumer welfare impact as a result of different e-tail and retail market configurations are not without ambiguity.
1 Introduction & Background

In the ensuing Information Age, the competitive structure of industries is swiftly being revised by the wide availability of advanced information technology and public communications infrastructure, so characteristics of the era (Sampler, 1998). Of iconic significance is the Internet; from real estate to auto insurance policies to electronic retailing, it provides its audience with ready access to a market without bounds, from the convenience of their homes. The Census Bureau of The Department of Commerce estimates total retail e-commerce sales for the fourth quarter of 2004 increased by 4.7% from the second quarter of 2004. Third quarter 2004 e-commerce increased 21.5% compared to the same period for the previous year 2003, accounting for 1.9% of total retail sales (http://www.census.gov/mrts/www/data/html/04Q4.html).

Electronic retailing, or "e-tailing", is hailed as a promise for competitively determined prices that more closely reflect the true market value of an infinite variety of products and services. But increasingly researchers are looking at the impact of the Internet on price competition: Are these benefits limited only to the segment of e-tail consumers, or is it possible that conventional retail consumers could benefit from the prowess of their online counterparts? And is e-tailing always beneficial to consumers?

As the Internet continues to evolve as a marketing channel, it is evident that companies wishing to maximize profits must do so by "operating on both sides of the digital divide." This strategy is becoming more commonplace among long-conventional, leading retailers such as Macy’s and Wal-Mart, as well as (relatively) more recent, e-tail contenders such as Gateway and E-bay. Many companies seek to capture the best of both worlds by exploiting strategies based on a formula for multi-channel competition. This should point to one possible means whereby the benefits of the Internet can transcend to traditional retail consumers as it would be difficult if not impossible to keep both market segments separate.

Intuitively, the influence of online prices on traditional retail prices should be manifested as an adjustment process that is ultimately transmitted throughout the wider market. Empirical research by Marvel (1986) showed that information had a “significant impact” on price dispersion over time in retail gasoline, with more variation at stations catering to well-informed customers than at those that catered to the less informed. He argues that the high degree of temporal price variability observed in markets with well-informed customers is due to the input of uncertainty in
those markets, and the fact that shocks introduced to such markets are more widely transmitted than in markets with less-informed customers. Research in Sweden (Asplund and Sandlin, 1999) has shown that prices in a given market are influenced by those in nearby markets, and that prices in closely located markets are interdependent. Given the ubiquity of the Internet it seems almost inevitable that the ‘virtual’ proximity of e-tail competitors should wield some influence over conventional retail prices (Goolsbee, 2001).

Recent studies hail the impact of the Internet as a catalyst for reducing prices. Brynjolfsson and Smith (2000) showed that e-tail prices for homogeneous products such as books and CDs were 9% – 16% lower than prices at conventional retailers. They interpreted this as a consequence of greater competition, lower search costs and greater market efficiency on the part of e-tailers. The data also suggested that e-tailers made smaller price changes relative to conventional retailers, which was seen as evidence of either lower e-tail menu costs (by avoiding the additional overhead incurred from having to maintain a varied stock on hand), or the presence of more informed, discriminating consumers. Providing a larger menu of products could also be beneficial from the consumer’s perspective (Brynjolfsson, Hu and Smith, 2003). Similar conclusions are echoed in many other empirical studies (Scott Morton, Zettelmeyer, and Silva-Risso, 2001; Tang and Xing, 2001; Brown and Goolsbee, 2002; Lee, Lee, Kim and Lee, 2003), although an increasing number of empirical researchers have come to challenge these consumer-friendly contentions. Some show that there are instances where e-tail prices are higher than conventional retail prices (Ancarani, 2002; Baylis and Perloff, 2002; LeBlanc and Folkman Curasi, 2002; Clay, Krishnan, Wolff and Fernandes, 2002; Schmitz and Latzer, 2002) and other instances where price dispersion is wider (Gosain and Lee, 2001; Ashton, 2004). These conflicting results betray an inherent shortcoming among empirical studies: They can at best provide only a snapshot of the market over a particular interval of time for a limited variety of products. In fact, an underlying message of our results is that predicting prices and whether consumers are better or worse off as a result of different e-tail and retail market configurations is no easy matter - even in a theoretical model, leaving aside the complications faced in empirical work.

**Information and Segmentation** In the presence of perfect information, buyers are better able to negotiate the price of the product sold, eventually sending prices to marginal cost equivalence. However, in the absence of perfect information, buyers are forced to incur a search cost in locating a desired product, which in essence inflates the real price of the product by lowering its utility yield.
To the extent that this added cost is able to isolate certain portions of the market, monopolistic tendencies among sellers are inevitable (Stigler, 1961; Stiglitz, 1979; Bakos, 1997). Stiglitz (1989) argues that at best, imperfect information can perceptibly result in a market equilibrium characterized by a multi-tier price distribution: low search-cost individuals may be attracted to low-price stores and high search-cost individuals may go to high-price stores.

At least where it concerns e-tail versus conventional retail customers, recent empirical observations as reported in the press seem to refute Stiglitz’s notion of “multi-tier equilibrium” with a high-price and a low-price market. It has been observed that whereas only 24% of inner-city shoppers have access to the Internet compared to 41% of U.S. shoppers at large, a disproportionate 30% of shoppers in identified low-income areas have made purchases on-line, versus 27% of overall Web consumers (Crockett, 1999). Hence, although suburban online shoppers generally command more disposable income per household, their attractiveness as a consumer group is easily offset when compared to the density and mass of inner-city shoppers. Thus, for many retailers the distinction between high-income and low-income shoppers is now but a blur. Goldsborough (2002), in exploring a related phenomenon, coined the term ”e-fluentials” to describe a comparatively small group of heavy on-line users observed to influence and shape the purchasing decision of a much larger group of both off-line and online consumers.

Quality information is distinct from price information: quality information is usually more expensive to obtain. Price increases may effectively be concealed by lowering quality, and thus requires separate consideration (Nelson, 1970). One significant disadvantage of the Internet as a marketing channel is that it cannot (yet) afford consumers the ability to employ senses other than their ocular, in assessing the true worth of a purchase. In fact, more than any other, it is the one limitation that makes it essential in many instances for companies to operate in both the electronic world and in the three-dimensional world.

Our Focus  Our model development begins with a baseline market configuration of two conventional retailers in Salop’s (1979) model. We then add an e-tailer as in Balasubramanian’s (1998) model. From these baselines we examine competition in the e-tail channel, and then changes that are affected by an e-tailer that opens a retail outlet. The results of this latter analysis depend on whether it is too costly for conventional retailers to relocate, and if they cannot, then there are three equilibrium cases, as explored in this paper. For each market configuration we solve for equilibrium
retail and e-tail prices, conventional retailer and e-tailer profits, and total costs to consumers - our consumer welfare measure.

The critical determinant of the relative equilibrium prices, the profits to firms and the costs to consumers from the different market configurations is the magnitude of the fixed e-tail cost (including shipping and handling costs) as compared with the unit transportation cost, expressed in a measure we call the "e-tail risk index". We view the fixed e-tail cost as representative of the possible disutilities resulting from compromises with regard to asset specificity (Tirole, 2000: p. 278), given the potential customer’s limitations in fully assessing the product before purchase. Thus, the nature of the good is summarized in the fixed e-tail cost. The alternative to the e-tail channel is physically traveling to the brick-and-mortar retailer at a unit transportation cost times the distance traveled. Viewed in this light, a low e-tail risk index would be indicative of more homogeneous goods (books, CDs, etc.), as opposed to goods whose quality may be more difficult to assess (e.g., purchasing shipped Omaha steaks).

Our main findings, summarized below, are educed from a comparison of the results obtained from the different market configurations. First, if retail relocation is costly and the e-tail risk index is low, then conventional retailers should not relocate in response to entry by an e-tailer into the retail market. A low e-tail risk index would mean that the ubiquitous e-tail channel is the main competition faced by each retail outlet, and relocation does not mitigate that competition. Second, there are several conditions under which entry by an e-tailer into the retail market increases retail prices. Intuitively retail prices should fall with additional retail locations, but this expected result is confounded with the e-tailer setting two prices. Third, and related to the retail price results, industry profits are increased by the entry of an e-tailer into the retail market. Finally, we find conditions under which consumer welfare is increased with less competition - less competition in either the e-tail or retail channel locations.

The paper proceeds as follows. We next outline the structure of our model and solve for prices, profits and consumer costs in each of the various market configurations detailed above. Then we present our main results in a series of theorems. We finish with conclusions summarizing the results of the paper.
2 The Model

Our model setting is a circular spatial market [of the type analyzed by Salop (1979)] with a continuum of consumers, \( x \in [0, 1] \) spread uniformly around a unit circumference. Two conventional retailers, indexed by \( r \in \{ A, B \} \), each operate a conventional brick-and-mortar outlet selling an identical product with a normalized marginal cost equal to zero. Each consumer is in the market for one unit of the product, consumption of which yields utility \( U \in \mathbb{R}^+ \), which we assume is large enough so that demand is inelastic and retailers compete for their business. All transportation occurs along the circle and is subject to a unit cost \( t \). All customers have access to information regarding prices and each retailer is aware of the other’s offering price. The consumers’ objective is to maximize their utility, which, with inelastic demand, is equivalent to minimizing the sum of the transportation cost incurred, \( tx \), plus the price paid for the good, \( p_r \). The market is in equilibrium: each retailer enjoys the complete loyalty of a core group of consumers who, bounded by proximity, can maximize their utility by purchasing only from the nearer retailer, given the transportation costs involved (Tirole, 1988). De Frutos, Hamoudi and Jarque (1999) noted that in a circular market model, each retailer gains by locating as far as possible from competitors, hence our location of the two retailers at opposite sides of the circle (see Retailers A and B in Figure 1).

2.1 Salop’s 1979 Model

A consumer at the distance \( x \in [0, 1/2] \) from retailer \( r \) is indifferent between purchasing from either retailer if \( p_A + tx = p_B + t[1/2 - x] \). Based on this "indifference" equation we can determine retailer \( A \)’s market share as \( m_A = 2x = \frac{p_B - p_A}{t} + 1/2 \). Retailer \( A \)’s profit maximization problem is

\[
\max_{p_A} \pi_A = \max_{p_A} \left\{ p_A \left[ \frac{p_B - p_A}{t} + \frac{1}{2} \right] \right\}.
\]

Retailer \( B \) has an identical market share and profit maximization problem. Using the superscript \( s \) to indicate Salop’s (1979) model, the resulting symmetric Nash equilibrium price is

\[
p_r^s = t/2. \tag{1}
\]

Each retailer’s market share is 1/2 and profits are \( \pi_r^s = t/4 \). The maximum distance for any consumer to a retailer is 1/4 and the minimum distance is 0, giving an average distance of 1/8. The total transportation cost incurred is \( \tau_r^s = t/8 \), and the total cost to consumers is

\[
\omega^s = 2\pi_r^s + \tau_r^s = 5t/8. \tag{2}
\]
2.2 Balasubramanian’s 1998 Model

We now introduce an e-tailer into the model. Analogous to Balasubramanian’s (1998) direct retailer, this e-tailer operates a purely virtual e-tail channel. Balasubramanian’s model setup is Salop’s circular spatial market in equilibrium, in which each of several retail firms have a fixed position at equal distance from each other on the circumference and the direct retailer is sited at the center of the circular market (Figure 1).

The e-tailer offers the identical product to the consumer at an effective price of $p_e + \mu$, where the e-tail price is $p_e$ and $\mu$ is an additional fixed cost that does not vary with distance which we refer to as “the fixed e-tail cost”. It would include shipping and handling costs and could also be considered a disutility cost of purchasing electronically. The location of a consumer that is indifferent between purchasing from the e-tailer or a retailer is determined by the indifference equation $p_e + \mu = p_r + tx$, giving the indifferent consumer’s distance away from a retailer as $x = [p_e - p_r + \mu]/t$. Consumers closer to a given retailer than $x$ would purchase from that retailer, while those further away purchase from the e-tail channel.

The e-tailer’s and retailers’ market shares are respectively $m_e = 1 - 4x$ and $m_r = 2x$. Each retailer’s profit maximization problem is

$$\max_{p_r} \pi_r = \max_{p_r} \left\{ p_r \left[ 2p_e - p_r + \mu \right] \right\},$$

(3)

and the e-tailer’s profit maximization problem is

$$\max_{p_e} \pi_e = \max_{p_e} \left\{ p_e \left[ 1 - 4p_e - p_r + \mu \right] \right\}.$$

The resulting Nash equilibrium prices for the e-tail channel and the retailers are

$$p_e^b = t/6 - \mu/3 \text{ and } p_r^b = \mu/3 + t/12,$$

(4)

where we use the superscript $b$ to indicate Balasubramanian’s (1998) model. The e-tail price is positive only if

$$\mu/t < 1/2.$$

(5)

and we restrict our attention to this case for the remainder of the analysis. At these prices in (4) the indifferent consumer is located at $x = 1/12 + \mu/3t$. Each retailers’ market share is $m_r = 1/6 + 2\mu/3t$ and the e-tailer’s market share is $m_e = 2/3 - 4\mu/3t$. Profit contributions are respectively

$$\pi_r^b = [t + 4\mu]^2/72t \text{ and } \pi_e^b = [t - 2\mu]^2/9t.$$

(6)
The total fixed e-tail cost to consumers is $\tau^b_e = \mu m_e = 2\mu/3 - 4\mu^2/3t$. The average distance for any consumer to a retailer is $x/2$. Because the market share of the two retailers is $2m_r$, the total transportation cost incurred is

$$\tau^b_r = t \left[ x/2 \right] 2m_r = 2t \ x^2 = [4\mu + t]^2 / 72t.$$  \hspace{1cm} (7)

Together, the total fixed e-tail cost and transportation costs are

$$\tau^b = \tau^b_e + \tau^b_r = t^2 + 56\mu t - 80\mu^2 / 72t,$$

and the total cost to consumers is

$$\omega^b = 2\pi^b_r + \pi^b_e + \tau^b = 11t^2 + 40\mu t - 16\mu^2 / 72t.$$  \hspace{1cm} (8)

The retail price is higher than the e-tail price when $\mu/t > 1/8$. For the e-tailer, prices are decreasing in $\mu$, while for the retailer prices are increasing in $\mu$. When $\mu = 0$, the e-tailer’s market share is $2/3$, leaving $1/3$ of the market to be shared between the two retailers. Both the e-tailer’s, and the retailers’ prices are increasing in $t$, since increasing transportation costs implies increased differentiation in the market, which would make consumers’ response less elastic. In the face of e-tail competition the retailer’s price is always lower than otherwise, and thus all consumers are better off with e-tail entry.

### 2.3 E-tail Channel Competition

One response retailers may choose when faced with e-tail competition is to launch their own e-tail channel. Examples include Barnes & Noble responding to Amazon, and a host of traditional retailers (Toys ”R” Us, Macy’s, Bloomingdale’s, etc.) that have added e-tail channels to their operations. Under the assumptions of our model, this retail response results in a Bertrand Paradox solution: undifferentiated competition through the e-tail channel results in a unique equilibrium in which each charge marginal cost through the e-tail channel, which, with marginal costs normalized to zero, gives $p^c_e = 0$, where the superscript $c$ indicates e-tail competition. Consequently there are zero e-tail profits.

The indifferent consumer equates the fixed e-tail cost incurred through the e-tail channel with the retail price plus transportation cost incurred through purchasing from the retail outlet: $\mu =$
If each retailer’s market share in the retail market is \( m_r = 2x \), then their profit maximization problem is then

\[
\max_{\pi_c} \pi_c = \max_{p_r} \left\{ p_r \left[ \frac{2(\mu - p_r)}{t} \right] \right\}.
\]

The resulting equilibrium retail price is

\[ p_c = \mu/2, \tag{9} \]

which is less than \( p^b_r \) in Balasubramanian’s (1998) model. At \( p_c = \mu/2 \), and with the e-tail price at zero, the indifferent consumer is located at \( x = \mu/2t \). Each retailer’s (retail) market share is \( m_r = \mu/t \), and the e-tail market share is \( m_e = 1 - 2\mu/t \). Profits from the e-tail channel are zero and each retailer’s profits are \( \pi_r = \mu^2/2t \).

Total fixed e-tail cost to consumers is \( \tau^c_e = \mu m_e = \mu - 2\mu^2/t \). The average distance for any consumer to a retailer is \( x/2 = \mu/4t \). The total transportation cost incurred is \( \tau^c_r = t\left[\frac{x}{2}\right] 2m_r = \mu^2/2t \), and the total fixed e-tail cost and transportation costs are

\[ \tau^c = \tau^c_e + \tau^c_r = \mu - 3\mu^2/2t. \]

The total cost to consumers is

\[ \omega^c = 2\pi_c + \tau^c = \mu - \mu^2/2t. \tag{10} \]

### 2.4 The E-tailer Goes Retail and Retailers Relocate

An additional strategy for the e-tailer is to launch a conventional retail outlet as was the case of Gateway. The outcome of this increased presence by the e-tailer depends in part on whether the conventional retailers can relocate. If the conventional retailers can relocate, then it is in their interest to relocate as far as possible from each other, and from the e-tailer’s retail outlet (De Frutos et al, 1999). Thus the two conventional retailers and the e-tailer’s outlets locate equidistant from each other (Figure 2).

Assume for the moment that the e-tailer retains a positive market share in the e-tail channel after entry into the retail space and the retailers’ relocation. The consumer indifferent between purchasing from a retailer or through the e-tail channel is defined by \( p_r + tx = p_e + \mu \), giving \( x = [p_e - p_r + \mu]/t \). Because the e-tailer’s retail outlet is also competing against his e-tail channel, the consumer that is indifferent between purchasing from the e-tailer’s retail outlet and the e-tail
channel is determined by the indifference equation \( p_e + ty = p_e + \mu \), where \( y = [p_e - p_{er} + \mu]/t \) represents the distance away from the e-tailer’s retail outlet.

Each retailer’s market share is \( m_r = 2x \), the e-tailer’s retail market share is \( m_{er} = 2y \), and the e-tailer’s retail share: \( m_e = 1 - 2m_r - m_{er} = 1 - 4x - 2y \). The e-tailer’s profit maximization problem is now

\[
\max \pi_e = \max_{p_e, p_{er}} \left\{ p_e \left[ 1 - 4p_e - p_r + \mu - 2p_e - p_{er} + \mu \right] + p_{er} \left[ 2p_e - p_{er} + \mu \right] \right\}.
\] (11)

The two first-order conditions are

\[
\frac{\partial \pi_e}{\partial p_e} = t - 12p_e + 4p_r + 4p_{er} - 6\mu = 0 \quad \text{and} \quad \frac{\partial \pi_e}{\partial p_{er}} = 4p_e - 4p_{er} + 2\mu = 0,
\] (12)

where the latter equation can be more usefully written as

\[ p_{er} = p_e + \mu/2. \]

Because each retailer’s market share is determined by the same indifference equation as in Balasubramanian’s (1998) model, each retailer’s profit maximization problem is the same as (3), and the first-order condition yields

\[ p_r = [p_e + \mu]/2. \] (13)

Substituting these two prices into (12) we can solve for \( p_e \), and then for the remaining prices. Using superscript \( r \) to indicate the case when the incumbent retailers relocate, this yields

\[ p_e^r = t/6 - \mu/3, \quad p_{er}^r = t/6 + \mu/6 \quad \text{and} \quad p_r^r = t/12 + \mu/3. \] (14)

The e-tail and retail prices are the same as in Balasubramanian’s (1998) model. Consequently, each retailer’s market share and profit remains as before (see (6)).

Prices from (14) give \( x = 1/12 + \mu/3t \) (same as Balasubramanian’s (1998) model) and \( y = \mu/2t \). We note that for there to be positive e-tail share in the upper portion \( x \leq 1/6 \), which solving for \( x \) using (14) implies that \( \mu/t \leq 3/4 \). For the e-tailer profits are

\[
\pi_e^r = p_e^r m_e + p_{er}^r m_{er} = \frac{17\mu^2 - 8\mu t + 2t^2}{18t} = \frac{14\mu^2 - 11\mu t + 2t^2}{18t} + \frac{\mu [\mu t + 1]}{6t} + 1,
\] (15)

where the terms on the right hand side of the last equality are from the e-tailer’s e-tail and retail channels respectively. Comparing (15) to the e-tailer’s profit in (6), the total net gain in profit from the e-tailer’s decision to go retail is \( \mu^2/2t \).
Leaving the tedious algebra for the Appendix, the total cost to consumers is the cumulative sum of retail and e-tail profits, the fixed e-tail cost and transportation costs:

$$\omega^r = 2\pi^r_r + \pi^r_e + \tau^r = \frac{11t^2 + 40\mu t - 34\mu^2}{72t}.$$  \hspace{1cm} (16)

2.5 The E-tailer Goes Retail and Retailers do not Relocate

Consider now when the conventional retailers’ locations are effectively fixed due to high relocation costs. If the e-tailer launches a retail outlet, then it must be sited in one of the two wedges (see Figure 1) representing the e-tail segment of the market, in order to locate as far as possible from competitors. There are three possible scenarios to consider: (i) where all retail outlets (including the e-tailer’s) compete with the e-tail channel, (ii) where the e-tailer’s retail outlet competes only with the conventional retail outlets, or (iii) where the e-tailer’s e-tail channel affects prices without directly competing with its retail counterpart.

Case 1: All retailers compete with the e-tail channel  This first case is shown in Figure 3(a) - assuming that the e-tailer established its retail outlet in the lower half. In this case all retailers, including the e-tailer’s retail outlet, compete with the e-tail channel.

The consumer indifferent between purchasing from the e-tail channel or a retailer is defined by 

$$p^r + tx = p_e + \mu,$$

which can be rewritten as 

$$x = \frac{p_e - p^r + \mu}{t}. \hspace{1cm}$$

Similar to the previous scenario where retailers relocate, let 

$$y = \frac{p_e - p^r + \mu}{t}.$$  

We assume for the moment that 

$$x + y \leq \frac{1}{4},$$

that is, the e-tailer has a (weakly) positive market share in the lower half of Figure 3(a). The total e-tail market share is represented by the wedge on the upper half of Figure 3(a) and the two smaller segments between 

$$x$$ and 

$$y$$ on the lower half:

$$m_e = 2[1/4 - x] + 2[1/4 - x - y] = 1 - 4x - 2y.$$  

The e-tailer’s retail market share is 

$$m_{er} = 2y$$

thereby giving the e-tailer a total market share of 

$$1 - 4x.$$  

The e-tailer’s profit maximization problem is 

$$\max_{p_e, p_{er}} \pi_e = \max_{p_e, p_{er}} \left\{ p_e \left[ 1 - 4\frac{p_e - p^r + \mu}{t} - 2\frac{p_e - p_{er} + \mu}{t} \right] + p_{er} \left[ 2\frac{p_e - p_{er} + \mu}{t} \right] \right\}, \hspace{1cm} (17)$$

which is identical to (11). In addition, the conventional retailers’ profit maximization is the same as (3), and the first order condition yields (13). The same factors determine market share for the
retailers and the e-tailer in this case as when the retailers can relocate; consequently, prices are as in (14), retailer profits are the same as in (6), and e-tailer profits are as in (15). Moreover, because the same proportions of consumers are covered by the two retailers, the e-tailer’s retail outlet, and the e-tail channel, the total fixed e-tail cost and transportation costs are given by (31) in the Appendix, and the total cost to consumers is given by (16).

Consider the constraint \( x + y \leq 1/4 \). At the equilibrium prices in this case given by (14) and (15), this constraint is satisfied if

\[
\mu/t \leq 1/5.
\]

(18)

Thus, (18) defines Case 1, and when this constraint is satisfied prices and profits are the same regardless of whether or not retailers can relocate.

**Case 2: E-tailer’s retail outlet competes directly with conventional retailers**  This second case is depicted in Figure 3(b) - again assuming that the e-tailer’s retail outlet is in the lower half. In this case there is no e-tail presence in the lower half, leaving the e-tailer’s retail outlet to compete directly with the conventional retailers, while the e-tail channel competes with the conventional retailers in the upper half of Figure 3(b).

In the upper half of Figure 3(b), as before, the consumer that is indifferent between either purchasing from the e-tail channel or from a retailer is defined by \( p_r + tx = p_e + \mu \), giving \( x = [p_e - p_r + \mu]/t \). In the lower half of Figure 3(a) the consumer that is indifferent between purchasing either from the e-tailer’s retail outlet or a retailer is represented by \( z \) and is defined by \( p_{er} + t[1/4 - z] = p_r + tz \), giving \( z = [p_{er} - p_r]/2t + 1/8 \). In the case where the e-tail channel is unable to capture any market share in the lower half of Figure 3(b), the cost at \( z \) of purchasing from the e-tail channel must be no less than the cost of purchasing from either one of the pure retailers, or the e-tailer’s retail outlet:

\[
p_{er} + t[1/4 - z] = p_r + tz \leq p_e + \mu.
\]

(19)

With these definitions we can write the three market shares as \( m_r = x + z \), \( m_e = 1/2 - 2x \), and \( m_{er} = 1/2 - 2z \). For the conventional retailers the profit maximization problem is

\[
\max_{p_r} \pi_r = \max_{p_r} \{ p_r [x + z] \} = \max_{p_r} \left\{ p_r \left[ p_e - p_r + \frac{\mu}{t} + \frac{p_{er} - p_r}{2t} + \frac{1}{8} \right] \right\},
\]

and their first-order condition is

\[
\frac{\partial \pi_r}{\partial p_r} = \frac{p_e - 3p_r + \mu}{t} + \frac{p_{er} - p_r}{2t} + \frac{1}{8} = 0.
\]

(20)
For the e-tailer the profit maximization problem is

\[
\max_{p_e, p_{er}} \pi_e = \max_{p_e, p_{er}} \{ p_e M_e + p_{er} M_{er} \} = \max_{p_e, p_{er}} \left\{ p_e \left[ \frac{1}{2} - 2x \right] + p_{er} \left[ \frac{1}{2} - 2z \right] \right\}
\]

\[
= \max_{p_e, p_{er}} \left\{ p_e \left[ \frac{1}{2} - 2p_e - p_r + \mu \right] + p_{er} \left[ \frac{1}{2} - 2p_{er} - p_r - \frac{2}{t} \right] \right\}.
\]

The two first-order conditions are

\[
\frac{\partial \pi_e}{\partial p_e} = \frac{1}{2} - \frac{4p_e - 2p_r + 2\mu}{t} = 0 \quad \text{and} \quad \frac{\partial \pi_e}{\partial p_{er}} = \frac{1}{4} - \frac{2p_{er} - p_r}{t} = 0. \quad (21)
\]

Using the superscript $n2$ to denote this second case when retailers cannot relocate, solutions to the
three first-order conditions in (20) and (21) give the following prices

\[
p^n_{e} = \frac{7t}{36} - \frac{7\mu}{18}, \quad p^n_{er} = \frac{7t}{36} + \frac{\mu}{9} \quad \text{and} \quad p^n_r = \frac{5t}{36} + \frac{2\mu}{9}. \quad (22)
\]

Prices from (22) give $x = 1/18 + 7\mu/18t$ and $z = 11/72 - \mu/18t$.

The net profits for the retailers and for the e-tailer are, respectively

\[
\pi^n_{r} = \frac{25t^2 + 80\mu t + 64\mu^2}{864t} \quad \text{and} \quad \pi^n_{e} = p^n_{e} M_e + p^n_{er} M_{er} = \frac{49t^2 - 112\mu t + 136\mu^2}{432t} \quad (23)
\]

Checking our constraint (19) we have

\[
\frac{7t}{24} + \frac{\mu}{6} \leq \frac{7t}{36} + \frac{11\mu}{18},
\]

which simplifies to

\[
7/32 \leq \mu/t. \quad (24)
\]

The inequality in (24) represents the upper limit of the ratio between the fixed e-tail cost and
the marginal transport cost such that the e-tailer’s retail outlet and e-tail channel do not directly
compete. As such, (24) defines the range over which Case 2 applies.

Again leaving the tedious algebra for the Appendix, the total cost to consumers is the sum of
retail and e-tail profits, and the fixed e-tail cost and transportation costs:

\[
\omega^n = 2\pi^n_{r} + \pi^n_{e} + \omega^n e = \frac{179t^2 + 304\mu t - 136\mu^2}{864t} \quad (25)
\]

Case 3: E-tail channel affects prices without gaining a share in lower portion of the market

Consider the constraints from Cases 1 and 2, that is (18) and (24). Combining those constraints leaves

\[
1/5 \leq \mu/t \leq 7/32. \quad (26)
\]
In this case - Case 3, the e-tail channel does not share in the lower half of the market (see Figure 3(a)), although its e-tail prices can impact retail prices by providing consumers an alternative channel and price. To determine prices and profits based on $\mu/t$ in this interval, we reformulate the e-tailer’s profits in the first case as a constrained optimization using a Lagrangian, where the market shares are as in Case 1, that is, $m_e = 1 - 4x - 2y$ and $m_{er} = 2y$:

$$
\max_{p_e, p_{er}} L_e = \max_{p_e, p_{er}} \left\{ p_e \left[ 1 - 4 \frac{p_e - p_r + \mu}{t} - 2 \frac{p_e - p_{er} + \mu}{t} \right] + p_{er} \left[ 2 \frac{p_e - p_{er} + \mu}{t} \right] + \lambda \left[ \frac{1}{4} - \frac{p_e - p_r + \mu}{t} - \frac{p_e - p_{er} + \mu}{t} \right] \right\},
$$

where the last term embeds the constraint $x + y \leq 1/4$. When the constraint is not binding we have the same optimization solution as (17). When the constraint is binding the first two necessary conditions are similar to (12) but with an additional term from the constraint,

$$
\frac{\partial L_e}{\partial p_e} = t - 12p_e + 4p_r + 4p_{er} - 6\mu - \frac{2\lambda}{t} = 0, \quad \frac{\partial L_e}{\partial p_{er}} = 4p_e + 2\mu - 4p_{er} + \frac{\lambda}{t} = 0,
$$

and the third condition is $\frac{\partial L_e}{\partial \lambda} = 0$ which results in the constraint satisfied with equality. When this constraint is binding the relevant competing price for the conventional retailers is $p_{er}$, so we can use the conventional retailers’ first-order condition from the second case, (20), as the necessary condition for the conventional retailers to maximize profits. Using the superscript $n3$ to denote the case when the constraint $x + y \leq 1/4$ binds, the prices that result from these four equations are

$$
p_e^{n3} = \frac{7t}{26} - \frac{19\mu}{26}, \quad p_{er}^{n3} = \frac{7t}{52} + \frac{5\mu}{13} \quad \text{and} \quad p_r^{n3} = \frac{2t}{13} + \frac{2\mu}{13},
$$

and the shadow price of the constraint is $\lambda = \frac{32\mu t}{13} - \frac{7t^2}{13}$. The e-tail price, $p_e^{n3}$, is positive if $\mu/t < 7/19$, which is satisfied by the combined constraint (26).

We can solve for market share and profits of the retailers and the e-tailer. As in Case 2, in the upper half consumers are indifferent between a retailer and the e-tail channel at $x$, and in the lower half between a retailer and the e-tailer’s retail channel at $z$. The market share for the e-tail channel is $m_e = 1/2 - 2x$ and for the e-tailer’s retail outlet it is $m_{er} = 1/2 - 2z$. Each retailer’s market share in $m_r = x + z$. By substituting the results obtained in (27), which are different from the prices that resulted in Case 2, we deduce that: $x = 11/26 - 41\mu/26t$ and $z = 3/26 + 3\mu/26t$.

The profit contributions from the e-tail channel and e-tailer’s retail outlet respectively are

$$
\frac{49t^2 - 175\mu t + 114\mu^2}{676t} \quad \text{and} \quad \frac{49t^2 + 98\mu t - 120\mu^2}{1352t}.
$$
Together this yields a total net profit contribution of

$$\pi_n^3 = 3 \frac{49t^2 - 84\mu t + 36\mu^2}{1352t}.$$  \hspace{1cm} (28)

Each retailer’s net profit contribution is

$$\pi_r^3 = \frac{6t^2 + 12\mu t + 6\mu^2}{169t}.$$  \hspace{1cm} (29)

In this final case, again leaving the tedious algebra for the Appendix, the total cost to consumers is the sum of retail and e-tail profits, the fixed e-tail cost and transportation costs:

$$\omega^3 = 2\pi_r^3 + \pi_e^3 + r^3 = \frac{1055t^2 - 4676\mu t + 15732\mu^2}{2704t}. \hspace{1cm} (30)$$

### 3 Main Results

The critical determinant of the relative equilibrium prices, the profits to firms and the costs to consumers from the different market configurations is the magnitude of the fixed e-tail cost as compared with the unit transportation cost - our “e-tail risk index”: $\mu/t$. Our main results concern retail relocation, retail prices, profits and consumer welfare - and all make use of the e-tail risk index.

**Retail Relocation** When conventional retailers do not relocate in response to the e-tailer’s entrance into the market with a retail outlet, three separate cases can be identified according to the e-tail risk index:

- **Case 1** is when the e-tail risk index is low ($\mu/t \leq 1/5 = .2$).
- **Case 2** is when the e-tail risk index is high ($\mu/t \geq 7/32 = .2188$).
- **Case 3** is when the e-tail risk index is moderate ($1/5 = .2 < \mu/t < .2188 = 7/32$).

These three cases correspond to those in our earlier analysis. Our first theorem states when conventional retailers should choose not to relocate in response to an e-tailer’s launch of a retail outlet. Table 1 summarizes the profits and total cost to consumers from our earlier analysis.

**Theorem 1** When an e-tailer enters the retail market and relocation is costly, if the e-tail risk index is less than .2623, then conventional retailers should not relocate.
Table 1: Profits and Total Cost to Consumers

<table>
<thead>
<tr>
<th>Model</th>
<th>(\pi_r)</th>
<th>(\pi_e)</th>
<th>(\omega)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balasubramanian</td>
<td>(\pi^b_r = \frac{[t + 4\mu]^2}{72t})</td>
<td>(\pi^b_e = \frac{[t - 2\mu]^2}{9t})</td>
<td>(\omega^b = \frac{11t^2+40\mu t-16\mu^2}{72t})</td>
</tr>
<tr>
<td>E-Tail Competition</td>
<td>(\pi^c_r = \frac{\mu^2}{2t})</td>
<td>(\pi^c_e = 0)</td>
<td>(\omega^c = \frac{\mu - \mu^2}{2t})</td>
</tr>
<tr>
<td>Retailers Relocate</td>
<td>(\pi^r_r = \frac{[t^2+4\mu^2]}{72t})</td>
<td>(\pi^r_e = \frac{17\mu - 8\mu t^2 + 2t^2}{18t})</td>
<td>(\omega^r = \frac{11t^2+40\mu t-34\mu^2}{72t})</td>
</tr>
<tr>
<td>Retailers DNR Case 1</td>
<td>(\pi^{n1}_r = \frac{[t + 4\mu]^2}{72t})</td>
<td>(\pi^{n1}_e = \frac{11\mu^2-8\mu t^2+2t^2}{18t})</td>
<td>(\omega^{n1} = \frac{11t^2+40\mu t-34\mu^2}{72t})</td>
</tr>
<tr>
<td>Retailers DNR Case 2</td>
<td>(\pi^{n2}_r = \frac{25t^2+80\mu t+64\mu^2}{288t})</td>
<td>(\pi^{n2}_e = \frac{49t^2-112\mu t+136\mu^2}{144t})</td>
<td>(\omega^{n2} = \frac{179t^2+304\mu t-136\mu^2}{288t})</td>
</tr>
<tr>
<td>Retailers DNR Case 3</td>
<td>(\pi^{n3}_r = \frac{6t^2+12\mu t+6\mu^2}{108t})</td>
<td>(\pi^{n3}_e = \frac{349t^2-84\mu t+36\mu^2}{1344t})</td>
<td>(\omega^{n3} = \frac{1055t^2-4676\mu t+15732\mu^2}{2704t})</td>
</tr>
</tbody>
</table>

**Proof:** When the e-tail risk index is low (Case 1), retail profits are the same whether or not conventional retailers relocate (see (6)). When the e-tail risk index is moderate (Case 3), retail profits if conventional retailers do not relocate (see (29)) are greater than the retail profits if they relocate (see (6)). Finally, for \(\mu/t < .2623\) (a subset of Case 2), retail profits if conventional retailers do not relocate are given in (23), and these retail profits are greater than the retail profits if they relocate (see (6)). Q.E.D.

When the e-tail risk index is low, the e-tail channel is competitive even for consumers that are between retailers located relatively close to each other. Therefore, the ubiquitous virtual presence of the e-tailer makes relocation a relatively costly and economically futile option. That is, a retailer’s location relative to the location of other retailers does not affect their profits so that costly relocation is not profit-maximizing. Moreover, even when the e-tail risk index is moderate or in the lower segment of high (less than .2623), profits are higher for conventional retailers if they do not relocate, because even at these levels the e-tail channel is a stronger competitive force than the location of the e-tailer’s retail outlet.

In practice, this means that if the e-tail risk index is in the range defined in Theorem 1 it effectively reduces costs to customers buying online. For example, if a bookstore in a conventional shopping mall faces its most important competition from online bookselling, then physically relocating relative to other conventional retail bookstore outlets will not increase profits. Thus, for conventional retailers of homogeneous products such as books and CDs, physical relocation is not a viable response in the face of online competition, given the virtually unlimited reach of the e-tailer.

If the e-tail risk index is low, retail relocation also has implications for social welfare. This is given in the following corollary.
Table 2: Prices

<table>
<thead>
<tr>
<th>Model</th>
<th>( p_r )</th>
<th>( p_e )</th>
<th>( p_{er} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balasubramanian</td>
<td>( p^b_r = \mu/3 + t/12 )</td>
<td>( p^b_e = t/6 - \mu/3 )</td>
<td></td>
</tr>
<tr>
<td>E-Tail Competition</td>
<td>( p_e = \mu/2 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retailers Relocate</td>
<td>( p^r_e = t/6 - \mu/3 )</td>
<td></td>
<td>( p^r_{er} = t/6 + \mu/6 )</td>
</tr>
<tr>
<td>Retailers DNR Case 1</td>
<td>( p^r_{n1} = t/12 + \mu/3 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retailers DNR Case 2</td>
<td>( p^r_{n2} = t/36 + 2\mu/9 )</td>
<td>( p^n_e = 7t/36 - 7\mu/18 )</td>
<td>( p^n_{er} = 7t/36 + \mu/9 )</td>
</tr>
<tr>
<td>Retailers DNR Case 3</td>
<td>( p^r_{n3} = 2t/13 + 2\mu/13 )</td>
<td>( p^n_e = 7t/26 - 19\mu/26 )</td>
<td>( p^n_{er} = 7t/52 + 5 )</td>
</tr>
</tbody>
</table>

Corollary 1  When an e-tailer enters the retail market and retail relocation is costly, if the e-tail risk index is low, then conventional retailers not relocating is social welfare maximizing.

Proof: If the e-tail risk index is low (Case 1), then retail profits, e-tail profits, and the total cost to consumers are given in (6), (15) and (16) respectively - independent of whether retailers relocate. Q.E.D.

As the Corollary to the theorem shows, because neither individual retail or e-tail profits nor consumer costs are affected by relocation, if relocation is costly then relocation is a net loss to social welfare. Therefore, if the e-tail risk index is low, then it is Pareto optimal for conventional retailers not to relocate.

Retail Prices  It is straightforward that competition in the e-tail channel causes retail prices to fall relative to a "pure-play" e-tailer, of the type depicted in Balasubramanian’s (1998) model. Additional retail competition, however, does not always decrease prices. Our second theorem shows that under certain circumstances additional retail competition from an e-tailer with a retail outlet increases retail prices. Table 2 summarizes prices from our earlier analyses.

Theorem 2  If retail relocation is not costly, then an e-tailer’s retail outlet weakly increases retail prices. Otherwise, if the e-tail risk index is less than .2 and between .2188 and .25, then an e-tailer’s retail outlet increases retail prices.

Proof: If retail relocation is not costly, then retailers relocate and the conventional retailers prices are the same as in Balasubramanian’s (1998) model. From (14) (and (4))we find that \( p^r_r (= p^b_r) < p^r_{er} \).
Otherwise, Case 1 applies for $\mu/t \leq .2$ and Case 2 for $.2188 \leq \mu/t < .25$. Comparing $p^b_r$ from (4) with the conventional retail prices in Cases 1 and 2 ($p^r_r$ from (14)) as Case 1 conventional retail prices are the same as when retailers can relocate; $p^{n2}_r$ from (22)) we find that $p^b_r = p^r_r < p^{n2}_r$. Thus, conventional retail prices are equal or higher when the e-tailer has a retail outlet. For Case 1 from (4) and (14) we have $p^b_r < p^r_r$. For Case 2 from (4) and (22) we have $p^b_r < p^{n2}_r$ if $\mu/t < .25$. Q.E.D.

When retail relocation is not costly, the response by conventional retailers to retail entry by the e-tailer is to relocate and maintain their prices as before to compete with the e-tail channel. The e-tailer, however, sets its retail outlet price to compete with its e-tail channel price (see the bottom of Figure 2) and in this way the e-tailer is a multi-channel monopolist. As a result, the e-tailer charges a higher price at its retail outlet than conventional retailers so that it may skim greater profit from those consumers whose next best alternative is to purchase from the e-tail channel. Therefore, compared to a pure-play e-tailer - Balasubramanian’s (1998) model - retail prices faced by consumers are the same for those closer to the conventional retailers and are higher for those closer to the e-tailer’s retail outlet.

If retail relocation is costly, such that conventional retailers do not relocate, then there are different cases to consider. If the e-tail risk index is low (Case 1), then the results are the same as when the conventional retailers relocate (described above) - conventional retail prices are the same as, and the e-tailer's retail outlet prices are higher than, retail prices with a pure-play e-tailer.

If the e-tail risk index is high (Case 2), then conventional retail prices are higher than retail prices with a pure-play e-tailer because competition on one end of each conventional retailer’s market is with the e-tailer’s retail channel rather than with the e-tail channel. If the e-tail risk index is high - but not too high - then prices at the e-tailer’s retail outlet are higher than retail prices with a pure-play e-tailer for the same reason - the e-tailer’s retail outlet competes with conventional retailers. In spite of this, if the e-tail risk index is higher than .25, then competition from the e-tail channel is mitigated by a relatively high disutility costs and retail prices with a pure-play e-tailer are greater than those at the e-tailer’s retail outlet. Interestingly, when the e-tail risk index is moderate the same situation arises whereby relative to retail prices in a scenario with a pure-play e-tailer, conventional retail prices are higher but the e-tailer’s retail outlet price is lower.

**Profits** In Table 1 we show the results for each market configuration compared on the basis of retail profits ($\Pi_r$), and e-tail profits ($\Pi_e$). In each configuration all customers are served and the
market is covered. An increased presence in the market - either by a pure-play e-tail or by an e-tailer with a retail outlet - can increase profits. The next theorem shows that an e-tailer’s retail outlet increases industry profits.

**Theorem 3** Industry profits are higher when the e-tailer sells through both an e-tail channel and a retail outlet than when the e-tailer sells only through the e-tail channel.

*Proof:* First consider when retailers relocate. Conventional retail profits are the same as when the e-tailer sells only through the e-tail channel. For the e-tailer, profits from (15) are greater than those in (6).

Now consider when retailers do not relocate. In Case 1 conventional retail profits are the same as when the e-tailer only sells through the e-tail channel, and e-tailer profits from (15) are greater than those in (6) - both as above. In Case 3 conventional retailer profits in (29) are greater than those in (6), and e-tailer profits in (28) are greater than those in (6). Finally, in Case 2 e-tailer profits are higher in (23) than those in (6). However, conventional retailer profits in (23) are only greater than those in (6) if the e-tail risk index is less than .3061, and the sum of e-tailer and conventional retail profits (noting there are two conventional retailers) in (23) is greater than the sum of those in (6). Q.E.D.

A mixed channel strategy by the e-tailer yields higher profits for both the conventional retailers as well as for the e-tailer. Allowing the e-tail and retail ventures to compete directly facilitates optimization by way of market forces, rather that artificially imposing an upper limit on the market share of any given channel (Figure 4(a)). Even when the e-tail channel is unable to gain a foothold in the southern portion of the market, this outcome is mitigated by the positive externalities resulting from the retailers’ proximity (Stahl, 1982; Tirole, 2000: p. 286), while the e-tailer is still free to exploit a competitive advantage of access to the more remotely located segments of the market. One such externality is the lower search cost for customers, that effectively increase the aggregate demand for the product, a worthwhile strategy if this increased demand is not offset by increased price competition.

Lal and Savary (1999) provides yet another explanation for the apparent favorable outcome of a mixed-channel strategy for the retailer: in the three-dimensional world, search cost accrues from having to visit more than one store in finalizing the decision to purchase. Since the Internet allows foregoing the actual trip, search cost for internet-searching customers now essentially amounts to
the cost of the trip required to make the purchase. When the cost of undertaking that trip is higher than the cost of physically visiting an additional store, the Internet essentially increases the consumer’s search cost. Faced with this higher search cost the consumer may elect to remain loyal to the product with which he is familiar rather than to search for one that may command more desirable attributes, effectively reducing price elasticity. Thus even when the introduction of the e-tail channel does not effectively increase market share, it may provide a buffer to the possible retaliation of the conventional retailer by allowing the retailer to leverage "brand" loyalty.

**Consumer Welfare**  Our measurement of consumer welfare is the total cost to consumers, $\omega$. This measure includes payments to retailers and e-tailers plus the transportation costs, aggregated over all consumers. In Table 1 we show the results for each market configuration compared on the basis of total cost to consumers ($\omega$). Not surprisingly, Salop’s (1979) model yields higher total cost to consumers, $\omega^s$, and higher retailer profits, $\pi^s$, than any other market configuration.

Intuitively, we would expect e-tail channel competition to favor consumers. In fact, e-tail channel competition would cause the price to fall to zero, $p_e^c = 0$, leaving only the fixed disutility or other e-tail cost as the most consumers would have to bear. In addition, retail prices would have to compete with this marginal cost pricing in the e-tail channel. However, as we show in our next result, when retail relocation is not costly and conventional retailers relocate, there is a range of the e-tail risk index where consumers are better off with a single e-tailer in both the e-tail channel and in the retail market.

**Theorem 4** *If the e-tail risk index is greater than .3515 and retail relocation is not costly, then the relocation of conventional retailers in response to the e-tailer’s e-tail channel and retail outlet is more beneficial to consumer welfare than e-tail channel competition.*

*Proof:* If $\mu/t > .3515$, then from a comparison of (16) and (10) it is straightforward that $\omega^r > \omega^e$. Q.E.D.

At particularly high levels of the e-tail risk index, such as levels higher than .3515, the fixed e-tail cost is sufficiently dominant that some consumers that would otherwise purchase through the e-tail channel because of price choose to travel and purchase through the retail outlets. Consequently, those consumers benefit from an additional retail location and the relocation of the original conventional retailers that results.
An alternative but equivalent interpretation can be made based on the riskiness of the good purchased. A relatively high e-tail risk index is indicative of goods that are asset specific and would therefore carry greater risk for consumers who purchase via the e-tail channel. The entrance of an additional retailer reduces this risk by providing another retail outlet; furthermore, the subsequent relocation of the incumbents means that the transportation cost for a large segment of consumers is also reduced. Thus, there is a level of fixed e-tail cost beyond which the advantage of lower e-tail prices from e-tail competition are dominated by the risk of purchasing through the e-tail channel.

In our two-retailer version of Balasubramanian’s (1998) model the e-tailer is separate from the two retailers. When the e-tailer enters the retail market in our model, the e-tailer effectively adds another retail location from which consumers can purchase. We expect that an additional retail location increases retail competition, thereby decreasing retail prices, which in turn puts downward pressure on e-tail prices, making consumers better off. But, as our next theorem shows, when the e-tail risk index is moderate and retail relocation is costly so that conventional retailers cannot relocate, an additional retail presence from the e-tailer decreases consumer surplus.

**Theorem 5** If the e-tail risk index is moderate, between .2 and .2947, and retail relocation is costly, then consumers are better off with a pure-play e-tailer (Balasubramanian, 1998) than when the e-tailer enters the retail channel and conventional retailers do not relocate.

**Proof:** If .2 < \( \mu/t \leq .2188 \), then from a comparison of (30) and (8) it is straightforward that \( \omega^3 > \omega^b \). If .2188 \( \leq \mu/t < .2947 \), then from a comparison of (25) and (8) it is straightforward that \( \omega^2 > \omega^b \). Q.E.D.

The intuition is as follows. When the e-tail risk index is low (Case 1) consumers are affected more significantly by transportation costs, and each retail location including the e-tailers’ retail location competes with the e-tail channel. As the e-tail risk index increases into the range covered by our Case 3, the e-tail channel has no share in the lower portion (of Figure 3(a)), meaning all consumers in the lower portion purchase from retail locations and pay transportation costs rather than e-tail costs as they would in Balasubramanian’s (1998) model. Because the e-tailer chooses its e-tail price to compete with conventional retailers on the upper portion, and its retail price to compete with conventional retailers on the lower portion, customer costs are increased due to the additional transportation costs incurred in the lower portion. However, as transportation costs fall relative to e-tail costs (i.e., the e-tail risk index increases), additional transportation costs paid
by consumers in the lower portion is less important, and the additional retail location increases consumer welfare.

4 Conclusions

Our research addressed the two-main questions. First we examined the ongoing debate regarding the impact of online prices on off-line prices, developing a general hypothesis that embraces the conflicting results to date regarding this relationship. Second we extended earlier models regarding e-tail/retail competition to include mixed channel market configurations in making assertions about which may be most beneficial to customers. Our formulation began with a circular market model that comprised two conventional retailers each maintaining a “brick-and-mortar” presence, and an e-tailer opening up an e-tail channel, all selling a homogeneous product to an evenly distributed group of consumers with inelastic demand. We used a unit “transportation cost” to distinguish between consumers according to the additional costs they were forced to incur in order to be able to purchase the product, and a fixed cost of purchasing from the e-tail channel that was the same for all consumers. To this basic market configuration of two retailers (Salop, 1979), and the addition of a single e-tailer (Balasubramanian, 1998), we allowed conventional retailers to enter the e-tail channel and the e-tailer to establish a retail presence, where the latter could induce the conventional retailers to relocate if relocation costs were sufficiently low.

Our analysis yielded three main results. First, if the e-tailer established a retail presence and fixed e-tail costs are low relative to unit transportation costs - our e-tail risk index, then the existence of any relocation costs causes the conventional retailers to retain their original locations and not relocate. This occurs because when the e-tail risk index is low, the e-tail channel competes directly with each retail channel - both conventional and the e-tailer’s retail presence - and relocating does not change the nature of that competition.

Second, if the fixed e-tail costs are high relative to the unit transportation costs, then consumer surplus is higher when a single firm is in the e-tail channel together with an e-tailer’s retail presence that causes the conventional retailers to relocate than it is when there is competition in the e-tail channel. This occurs in spite of marginal cost pricing in the e-tail channel, and it is because when the e-tail risk index is high the magnitude of the fixed e-tail cost mitigates the impact of the marginal cost pricing that obtains in the e-tail channel, making that channel less competitive. The
implication is that for goods for which physical inspection is necessary, or shipping is costly or potentially damaging to the product, competition in the e-tail channel is not as beneficial to some consumers as an additional retail location.

Third, when relocation costs are high, there is a moderate range of the e-tail risk index where consumer surplus is higher if the e-tailer does not establish a retail presence. That is, some consumers are better off having less retail locations to select from. This is because of the nature of competition in this range of the e-tail risk index where the conventional retailers compete with the e-tail channel for part of their market share, and the e-tailer’s retail channel for another part of their market share. In this situation the e-tailer’s two channels do not compete so its joint pricing decisions become separate decisions, removing the downward pressure on its two prices.

In the context of numerous empirical studies of e-tail and retail prices, and by extension the implications these studies draw relating lower prices to increased consumer surplus, our results show that profits and consumer surplus do not necessarily follow prices that result from increased competition.

5 Appendix

The E-tailer Goes Retail and Retailers Relocate: Total Cost to Consumers The total fixed e-tail cost to consumers is

$$\tau_e^r = \mu m_e = \mu[1 - 4x - 2y] = 2\mu/3 - 7\mu^2/3t.$$  

As in Balasubramanian’s (1998) model, the transportation cost incurred to the two retailers is $[4\mu + t]^2/72t$ from (7). The average distance is $y = \mu/4t$. The transportation cost incurred to the e-tailer’s retail outlet is then $t [\mu/4t] m_{er} = \mu^2/4t$, and the total transportation cost incurred is

$$\tau_r^e = \frac{[4\mu + t]^2}{72t} + \frac{\mu^2}{4t} = \frac{t^2 + 8\mu t + 34\mu^2}{72t}.$$  

Together, the total fixed e-tail cost and transportation costs are

$$\tau^r = \tau_e^r + \tau_r^e = \frac{t^2 + 56\mu t - 134\mu^2}{72t},$$  

and the total cost to consumers is

$$\omega^r = 2\pi_r^r + \pi_e^r + \tau^r = \frac{11t^2 + 40\mu t - 34\mu^2}{72t}.$$  

The E-tailer Goes Retail and Retailers do not Relocate: Total Cost to Consumers in Case 2

The average distance for any consumer in the upper portion to a retailer is \( x/2 \). The total fixed e-tail cost to consumers is
\[
\tau_e^{n2} = \mu m_e = \mu[1/2 - 2x] = 7\mu/18 - 7\mu^2/9t.
\]

The average distance for any consumer in the lower portion to a retailer is \( z/2 \). The market share for each retailer in the upper portion is \( x \), and in the lower portion it is \( z \). Thus, the transportation cost incurred to the two retailers’ outlets is
\[
2t \left[ x^2/2 + z^2/2 \right] = t[x^2 + z^2] = \frac{137t^2 + 136\mu t + 800\mu^2}{5184t}.
\]

The average distance from a consumer purchasing from the e-tailer’s retail outlet is \([1/4 - z]/2\). The transportation cost incurred to the e-tailer’s retail outlet is
\[
t_m er[1/4 - z]/2 = t [1/2 - 2z](1/4 - z)/2 = t/16 - tz/2 + t z^2 = \frac{49t^2 + 56\mu t + 16\mu^2}{5184t},
\]
and the total transportation cost incurred is
\[
\tau_r^{n2} = \frac{31t^2 + 32\mu t + 136\mu^2}{864t}.
\]

Together, the total fixed e-tail cost and transportation costs are
\[
\tau^{n2} = \tau_e^{n2} + \tau_r^{n2} = \frac{31t^2 + 368\mu t - 536\mu^2}{864t},
\]
and the total cost to customers is
\[
\omega^{n2} = 2\pi_r^{n2} + \pi_e^{n2} + \tau^{n2} = \frac{179t^2 + 304\mu t - 136\mu^2}{864t}.
\]

The E-tailer Goes Retail and Retailers do not Relocate: Total Cost to Consumers in Case 3

The structure of total fixed e-tail costs and transportation costs is the same as in Case 2, but with prices from (27). The average distance for any consumer in the upper portion to a retailer is \( x/2 \). The total fixed e-tail cost to consumers is
\[
\tau_e^{n3} = \mu m_e = \mu[1/2 - 2x] = -9\mu/26 + 82\mu^2/26t.
\]

The average distance for any consumer in the lower portion to a retailer is \( z/2 \). The transportation cost incurred to the two retailers’ outlets is
\[
2t[x^2/2 + z^2/2] = t[x^2 + z^2] = \frac{5t^2 - 34\mu t + 65\mu^2}{26t}.
\]
The average distance for a consumer purchasing from the e-tailer’s retail outlet is \( [1/4 - z]/2 \), so the transportation cost incurred to the e-tailer’s retail outlet is

\[
t_m \frac{[1/4 - z]}{2} = \frac{49t^2 - 84\mu t + 36\mu^2}{2704t},
\]

and the total transportation cost incurred is

\[
\tau^3_r = \frac{569t^2 - 3620\mu t + 6796\mu^2}{2704t}.
\]

Together the total fixed e-tail and transportation costs are

\[
\tau^3 = \frac{569t^2 - 4556\mu t + 15324\mu^2}{2704t},
\]

and the total cost to consumers is

\[
\omega^3 = 2\pi^3_r + \pi^3_c + \tau^3 = \frac{1055t^2 - 4676\mu t + 15732\mu^2}{2704t}.
\]

6 References


Tang, Fang-Fang and Xing, Xiaolin, "Will the growth of multi-channel retailing diminish the pricing efficiency of the Web?" *Journal of Retailing*, 77, (2001), 319-333

Figure 3(a): E-tailer Goes Retail: All Retailers Compete with E-tail Channel

Figure 3(b): E-tail has no Presence in lower half