Impact of Multiple Word of Mouth Sources on Retail Sales

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IMPACT OF MULTIPLE WORD-OF-MOUTH SOURCES ON RETAIL SALES

Completed Research Paper

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Abstract

Consumer opinions, experiences, and product recommendations posted on online WOM sites have become a major information source in consumer purchase decisions. However, prior research has largely focused on the influence of a single source of WOM – particularly retailer-hosted WOM. This study investigates the relative impact of multiple WOM information on retail sales. We collected a panel of sales data of 148 camera products from Amazon and WOM data from both Amazon and well-known third-party websites for four months. Our analysis reveals that third-party hosted WOM has a significant impact on retail sales while retailer-hosted WOM has much less influence on its own sales. Our finding suggests that third-party hosted WOM is an important source of information for online retail customers. We raise questions about the value and influence of retailer-hosted WOM in the presence of reputable third-party hosted WOM sources.

Keywords: Online word-of-mouth, electronic commerce, experience goods
Introduction

Consumer opinions, experiences, and product recommendations posted online are becoming a major source of information in consumer purchase decisions (Dellarocas 2003; Godes and Mayzlin 2004; Senecal and Nantel 2004). Regardless of the time of day or their location, such online word-of-mouth (WOM) information can spread quickly to a large number of consumers. For a given product type, multiple sources of WOM information often co-exists and competes for consumer attention. The objective of this study is to examine the relative impact of both retailer- and third-party hosted WOM information on online retail sales, an area that has yet to be studied in the literature.

WOM information source can be classified into two types - one hosted by retailers (such as Amazon or Best Buy) and the other hosted by third party entities (such as CNet or Epinions). Extant e-commerce literature has extensively studied the WOM effect of retailer-hosted customer reviews. They have shown a positive relationship between consumer reviews and product sales at online retailers (Chen et al. 2007; Chevalier and Mayzlin 2006). These studies have motivated online retailers and online divisions of physical retailers to add customer review features to their websites. In addition, early adopters of online WOM, such as Circuit City, often touted the value of customer review features in their meetings with Wall Street analysts (Voxant FD Wire 2006). They cite that 50 percent of consumers who bought from their websites researched products using retailer-hosted WOM information. Such high profile reporting encourages the wide-spread adoption of the online customer review feature among retailers. A 2008 survey conducted by Shop.org revealed that more than 33% of the retailers added customer review features to their websites during 2007 and 2008 (O’Donnell 2008).

The popularity of online customer review features raises an important question for executives – how effective are retailer-hosted customer reviews in helping customers make purchase decisions? This question is important given the fast growth of third-party WOM websites that provide customer reviews on the very same products. The goal of this study is to investigate the relative influence of retailer-hosted WOM information in the presence of third-party WOM.

The information search behavior study suggests that retailer-hosted WOM information is not the only source of information for retailer consumers. The increasing availability of reputable third-party hosted WOM websites could reduce the value and influence of retailer-hosted WOM information. Earlier studies on consumer offline information search suggest that most consumers search multiple information sources to reduce the uncertainty in their purchase decisions (Cox 1967; Hugstad et al. 1987; Mitra et al. 1999; Murray 1991; West and Broniarczyk 1998). The ease of online information search further encourages such information search behavior.

The information adoption model extended from the technology acceptance theory implies that individuals are likely to adopt online advices or opinions when they perceive usefulness of information, source credibility, trust toward information providers, etc (Komiak and Benbasat 2006; Rabjohn et al. 2008; Ridings et al. 2002). In the context of multiple WOM information sources, consumers may use either retailer- or third-party hosted WOM information for their purchase decisions depending on their perception toward different characteristics of multiple sources. In particular, third-party hosted information are often perceived as more trust-worthy than retailer hosted WOM, especially given the wide-spread reports on retailer’ censoring of customer reviews and vendors’ falsification of customer reviews on retailer-hosted WOM information (Awad and Etzion 2007; Harmon 2004). A thorough search of news archives LEXIS/NEXIS shows that such anecdotes are almost unheard of on third-party hosted customer reviews, potentially due to lack of attention to the impact of third party-hosted WOM information. In such cases, third-party hosted WOM information could be more influence than retailer-hosted WOM. Given the existence of multiple third-party hosted WOM information, it is important to assess their relative influence on ecommerce sales, which could have significant implications for both WOM research and for ecommerce practice.

We collected a panel data of daily sales rank information for 148 digital camera products from Amazon from June 2007 to October 2007, and the corresponding customer review information from Amazon, CNet, Epinions and DPreview for the same period. A total of 14,751 observations were collected to study the influence of multiple online WOM information on online retail sales. We apply a fixed effect model to control for product heterogeneity and use an instrumental variable approach to control for endogeneity between the WOM effect and retail sales. Our results suggest that the third-party hosted WOM information (CNet, Epinions and DPreview) have a significant impact on retailer sales, but, surprisingly, the retailer-hosted WOM have much less influence. The results suggest that customers seek product reviews from multiple WOM sources, and they rely more on third party-hosted customer reviews than retailer-hosted reviews. Our study informs executives that online retailers need to be aware of
the substantial influence of third-party-hosted WOM, and the limitation of their own WOM.

Related Literature

The study complements extant research on the influence of WOM on online sales. A number of studies on electronic commerce have analyzed the influence of retailer-hosted online customer reviews on the retail sales. These studies show that average ratings of retailer-hosted customer reviews have a positive impact on the corresponding retail sales (Chen et al. 2007; Chevalier and Mayzlin 2006). Recent studies reveal further details about the relationship between WOM information. They find that factors such as information cascades, number of reviews, self-selection effect, online recommendation systems, and reviewer’s identity moderate the influence of WOM on product sales (Chen et al. 2004; Duan et al. 2008; Forman et al. 2008; Li and Hitt 2008; Maryanchyk 2008). Our studies contribute to this stream of ecommerce studies by going beyond retailer-hosted product reviews.

Prior studies also consider the effect of online WOM on offline sale (Clemons et al. 2006; Dellarocas et al. 2003; Duan et al. 2008; Godes and Mayzline 2004; Liu 2006). However, the focus is largely limited to offline sales in movie or entertainment industries. They investigated the impact of WOM information hosted by online third-party movie review websites, such as Yahoo! Movies, on the corresponding movie’s box office revenues. The results are mixed. Some studies show that the average customer ratings hosted at third-party movie review websites are positively associated with corresponding offline movie box office sales (Clemons et al. 2006; Dellarocas et al. 2003), while others showed WOM volume has a greater impact on movie box office sales than ratings (Duan et al. 2008; Liu 2006). Our study expands our understanding to online retail environment where third-party hosted WOM information co-exists with retailer-hosted WOM.

Information search behavior literature suggests that search behavior is driven by product uncertainty (Mitra et al. 1999; Murray 1991). Once uncertainty is perceived, consumers seek information from a variety of sources to reduce uncertainty. Mitra et al. (1999) suggested that information sources can be categorized into market dominated (e.g., promotion, advertising), consumer dominated (e.g., WOM), or neutral (e.g., Consumer Report) sources. Studies have shown that consumers prefer consumer-dominated information sources when they face product uncertainty. Our study extends this literature by considering the influence of multiple consumer-dominated information sources described earlier on purchase behavior.

Our study is also related with the information adoption model. The theoretical basis of information adoption is the technology/information system acceptance literature. The technology acceptance model was developed to estimate individual perceptions of information system or technology use, and later extended into e-commerce context, such as the use of website, e-commerce transaction, or online service (Featherman and Pavlou 2003; Pavlou 2003). In particular, Rabjohn et al. (2008) applied this concept in the adoption of online recommendations or information and examined how individuals receive advice from online communities (Negash et al. 2002; Rabjohn et al. 2008; Sussman and Siegal 2003). In particular, the importance of trust has been highlighted by many researchers in the e-commerce environment (Featherman and Pavlou 2003; Jarvenpaa et al. 2000; Ridings et al. 2002). Studies show that trust has a significant impact on an individual’s information usage, purchase intention, and execute transaction online (Pavlou and Gefen 2004; Pavlou 2003; Rabjohn et al. 2008; Ridings et al. 2002; Sussman and Siegal 2005). We argue that multiple sources of WOM information have different characteristics that may influence how consumers trust the various WOM websites. The marketing literature argues that different types of information sources could generate different levels of trustworthiness and, thus have varying impact on consumer purchase decisions (Heijden et al. 2003; Mitra et al. 1999; Senecal and Nantel 2004). The trustworthiness of information represents the degree of confidence in the communicator’s intent to communicate the assertions she considers most valid (Heijden et al. 2003). This trustworthiness is positively related with the consumer’s purchase intention (Heijden et al. 2003; Mitra et al. 1999). That is, the higher the source trustworthiness of WOM information, greater is the influence on consumer purchase decision.

Research Hypotheses

Information search literature suggests that when consumers face risk in a purchase decision (Hugstad et al. 1987; Murray 1991) they search for information to reduce the perceived risk (Cox 1967). The types of information sources used in the search process is determined by product types. When the products under consideration are experience goods (e.g., cars or digital cameras), consumers prefer searching for WOM information to learn about others’ experience (Klein 1998; Villanueva et al. 2008; West and Broniarczyk 1998). While WOM has long been known as
one of the most influential information sources for consumer purchase decisions, the arrival of the Internet has significantly expanded its influence. Before the Internet, the dispersion of WOM occurred among friends and relatives in private one-on-one interactions or social interactions. The emergence of online WOM sites transforms the once private and fleeting WOM interactions to public online postings that are permanently archived and viewable to all future online consumers. Recent studies find significant WOM influence in a wide variety of experience goods, including books (Chevalier and Mayzlin 2006), movies (Dellarocas et al. 2007; Duan et al. 2008; Liu 2006), TV shows (Godes and Mayzlin 2004), video games (Zhu and Zhang 2006), and software download (Duan et al. 2009). The Internet also reduces the search costs for WOM information (Granados et al. 2008).

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influence comes from multiple online WOM sources. We therefore propose:

H1: Multiple online WOM sources, including retailer and third party-hosted customer reviews, have an impact on retail sales.

The influence of WOM on a consumer’s purchase decisions could vary across different sources. In particular, there are significant differences in the characteristics between retailer-hosted and third-party hosted WOM information which may contribute to the variations. The relative influence of multiple WOM information can be explained by the information adoption theory that has been extended from the technology acceptance literature. The information adoption theory argues that individuals are more likely to use online recommendations or information for their decisions according to their perception of value of information, such as usefulness/quality of information, source credibility, and trust toward information providers (Komiak and Benbasat 2006; Rabjohn et al. 2008; Ridings et al. 2002;). In our research context, customers perceive different value for different WOM information based on observed characteristics.

Retailer-hosted WOM has two distinct differences with third-party hosted WOM. First, it is most accessible to the retail customers. Retailer-hosted WOM information is prominently displayed with product pages. Literature in information adoption suggests that convenient access to information has a significant impact on intention to adopt (Negash et al. 2002; Pavlou 2003). The quick access to retailer-hosted customer reviews may influence consumer purchase decisions and may have greater influence than third-party-hosted WOM (Ratchford et al. 2003). Second, retailer-hosted WOM information provides not only product information but also service information to potential customers. Studies show that consumers are motivated to express their experiences with both the product itself and with the vendors (Hennig-Thurau et al. 2004). This allows customers to have a better understanding of the entire purchase experience and make more informed purchase decisions. The service information could include delivery time, return policy, etc. that are unique to the retailer and only available from retailer-hosted review systems. The information adoption theory suggests that relevance of information is an important element of usefulness which is related with individual’s intention to adopt (Rabjohn et al. 2008; Sussman and Siegal 2003).

Despite the above usefulness and convenience, third-party hosted WOM has distinct advantages over retailer-hosted WOM. In particular, third-party hosted WOM are often perceived as more trustworthy (Viswanathan et al. 2007). The trustworthiness of a retailer-hosted WOM can be challenged because of ownership bias (Helm 2000). Numerous press reports suggest that retailers are more likely to reject negative reviews submitted by customers potentially due to concerns for product sales (Awad and Etzion 2006; Harmon 2004). They report that more than 100 negative reviews on a particular games using SecuROM Digital Rights Management (DRM) were deleted from Amazon.com. The deletion increases the average rating of the game from 1.5 star rating to 3 star ratings (The register 2008). Many articles or blogs report that online retailers often reject negative reviews of books, games, or electronics. These reports lead to lower trustworthiness of retailer-hosted WOM (Chatterjee 2001). Third-party hosted WOM are not subject to censoring concerns as they are maintained by information vendors who have a strategic incentive to maintain objectivity. In addition, the anonymity in online environment also contributes to the decrease in the trustworthiness of online WOM information, particularly for retailer-hosted WOM (Senecal and Nantel 2004). The anonymous nature of online customer reviews allows manipulation by product vendors to post fake customer reviews. For example, Harmon (2004) reports that the thousands of book reviews at Amazon have been posted by
same or related people. While third-party WOM could also be subject to manipulation by product vendors, exhaustive search of news archive LEXIS/NEXIS\(^1\) shows that vendor manipulation is concentrated in retailer-hosted WOM, potentially due to their perceived impact on retail sales. The censoring and manipulation issues in retailer-hosted WOM may reduce the trustworthiness of the information, thus reducing their influence on product sales.

The above discussion shows that retailer-hosted and third-party hosted WOM information have both advantages and disadvantages. It is therefore an empirical question to assess the relative influence of third party-hosted and retailer-hosted WOM. Thus, we propose a pair of competing hypotheses:

\(H2a:\) Third party-hosted WOM information has a greater influence on retail sales than retailer-hosted WOM information.

\(H2b:\) Third party-hosted WOM information has a smaller influence on retail sales than retailer-hosted WOM information.

**Empirical Approach**

**Research Context**

We analyze the hypotheses using a panel data of daily product sales rank and WOM information from Amazon.com and three third-party WOM websites. We chose digital cameras as the research context for this study. Digital cameras are a typical example of experience goods with a large number of product attributes. Many of the attributes such as color effect, usability, and LCD screen display are experiential in nature. Consumer reviews for digital cameras thus offer an indispensable source of information. Moreover, the digital camera market is extremely competitive. More than one hundred unique models are available during our study period. The sheer number of available choices makes it difficult for consumers to compare camera models with similar technical characteristics, further highlighting the importance of consumer reviews in the digital camera market.

We collected information on all Canon and Nikon digital camera models sold by Amazon.com, including sales ranks, customer review ratings, number of reviews, release dates, and prices daily for the period of June 2007 through October 2007. We chose Canon and Nikon are the most popular brands in digital cameras and represent major camera manufacturers in general. Amazon is one of the most popular online retailers and is well-known for its extensive consumer reviews. For third-party WOM sites, we collected corresponding daily customer review data on digital cameras from three well-known WOM sites - CNet, Epinions, and DPreview. Epinions is a general WOM site that elicits customer reviews on a wide range of products. CNet and DPreview are specialized information providers that offer product information, descriptions, professional reviews, and user reviews on electronic products and digital cameras, respectively. By using Amazon Standard Identification Numbers (ASINs) and product names, we matched the Amazon product list with those from CNet, Epinions and DPreview. We also routinely updated our data sets to include new products introduced at Amazon and third party WOM sites during the study period. In total, we obtained 148 products for the analysis.

**Variables**

**Dependent Variable**

Our objective is to analyze the influence of multiple WOM information on Amazon sales. However, we do not have absolute measure of Amazon sales. Prior studies have addressed this problem by identifying a Pareto relationship between a product’s sales rank at Amazon and its actual sales (Brynjolfsson et al. 2003; Chevalier and Goolsbee 2003; Ghose et al. 2009). The relationship suggests a negative correlation between the log value of product sales and the log value of its sales rank. We leverage this relationship for our analysis and use the negative log value of Amazon sales rank as the dependent variable.

\(^1\) We found around 2100 articles or news related with the manipulation or censoring issues at online retailers websites while around 20 articles at third-party review websites. We used a couple of keywords, such as manipulation, censoring, modification of consumer/product reviews on online retailers vs. third-party review sites.
Independent Variables

The key independent variables of this analysis are WOM ratings from Amazon and the three third-party WOM websites. In addition to these WOM variables, we use Amazon’s most recent ratings, prices, and number of reviews, number of days since product release and product fixed effect as the control variables (Chevalier and Mayzlin 2006; Li and Hitt 2008). We include the most recent review at Amazon because these reviews are listed at the top of product review pages, thus they may have an additional influence on a customer’s purchase decisions. The number of reviews is included as it is known to be correlated with the unobserved product diffusion process at Amazon (Chevalier and Mayzlin, 2006; Li and Hitt 2008). Amazon price is included as price variation is known to affect product sales (Chen et al. 2007; Li and Hitt 2008). We also include product fixed effects to control for unobserved time-invariant product heterogeneity that might affect Amazon sales.

Table 1 provides a description of the key variables used in our analysis, and Table 2 presents the summary statistics of the variables. The table shows that Amazon average sales rank is 4,010 with a standard deviation of 7,767, suggesting significant variations in product sales. The average customer rating is 4.23 (out of 5) for Amazon, 7.75 (out of 10) for CNet, 4.20 (out of 5) for Epinions, and 4.27 (out of 5) for DPreview, respectively. The summary statistics also reveal that Amazon has more reviews on digital cameras than any of the third-party WOM networks.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AmzSalesRank_{i,t}</td>
<td>Sales rank of product i at day t at Amazon.com</td>
</tr>
<tr>
<td>AmzRating_{i,t}</td>
<td>Average customer rating of product i at day t at Amazon.com</td>
</tr>
<tr>
<td>CNetRating_{i,t}</td>
<td>Average customer rating of product i at day t at CNet</td>
</tr>
<tr>
<td>EpinionRating_{i,t}</td>
<td>Average customer rating of product i at day t at Epinions</td>
</tr>
<tr>
<td>DPreviewRating_{i,t}</td>
<td>Average customer rating of product i at day t at DPreview</td>
</tr>
<tr>
<td>AmzNumReview_{i,t}</td>
<td>Number of reviews of product i at day t at Amazon.com</td>
</tr>
<tr>
<td>CNetNumReview_{i,t}</td>
<td>Number of reviews of product i at day t at CNet.com</td>
</tr>
<tr>
<td>EPNumReview_{i,t}</td>
<td>Number of reviews of product i at day t at Epinions.com</td>
</tr>
<tr>
<td>DPNumReview_{i,t}</td>
<td>Number of reviews of product i at day t at DPreview.com</td>
</tr>
<tr>
<td>AmzPrice_{i,t}</td>
<td>Price offered by Amazon.com for product i at day t</td>
</tr>
<tr>
<td>AmzMostRecent_{i,t}</td>
<td>The most recent review rating of product i at day t at Amazon.com</td>
</tr>
<tr>
<td>NumOfDaySinceRelease_{i,t}</td>
<td>Date since release of product i at day t at Amazon.com</td>
</tr>
</tbody>
</table>

Since our research measures the multiple WOM effect, the concern for multicollinearity among WOM ratings is particularly severe. Table 3 reports the correlation among key independent variables. The correlations among WOM ratings are relatively high. The highest correlations are between the Amazon- and the CNet-hosted customer ratings (0.67), and between the CNet- and the DPreview-hosted customer ratings (0.65). We analyzed the variance inflation factor (VIF) to measure the significance of the multicollinearity problem. The VIF values of all reviews are less than 2.0, which indicate that the level of multicollinearity is not severe enough to affect the regression results. Furthermore, we center all WOM rating variables to reduce the multicollinearity problem (DeMaris 2004).

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2 We standardized CNet review ratings for empirical analysis
Table 2. Basic Statistics of Key Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
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</thead>
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<td>AmzSalesRank_{i,t}</td>
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<td>7,767.00</td>
<td>1.00</td>
<td>96,353.00</td>
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<td>AmzRating_{i,t}</td>
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<td>0.46</td>
<td>1.50</td>
<td>5.00</td>
</tr>
<tr>
<td>CNetRating_{i,t}</td>
<td>7.75</td>
<td>1.09</td>
<td>4.00</td>
<td>10.00</td>
</tr>
<tr>
<td>EpinionRating_{i,t}</td>
<td>4.20</td>
<td>0.55</td>
<td>2.00</td>
<td>5.00</td>
</tr>
<tr>
<td>DPreviewRating_{i,t}</td>
<td>4.27</td>
<td>0.25</td>
<td>3.26</td>
<td>5.00</td>
</tr>
<tr>
<td>AmzMostRecent_{i,t}</td>
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<td>1.17</td>
<td>1.00</td>
<td>5.00</td>
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<td>92.10</td>
<td>1.00</td>
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<td>29.72</td>
<td>1.00</td>
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<tr>
<td>EPNumReview_{i,t}</td>
<td>24.02</td>
<td>24.36</td>
<td>1.00</td>
<td>141.00</td>
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<tr>
<td>DPNumbReview_{i,t}</td>
<td>66.69</td>
<td>88.82</td>
<td>1.00</td>
<td>517.00</td>
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<td>969.49</td>
<td>674.71</td>
<td>1.00</td>
<td>2,882.00</td>
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Table 3. Correlation of Key Variables after taking logarithm

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<td>[1] SalesRank</td>
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<td>[2] AmzRating</td>
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<td>[3] CNetRating</td>
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<tr>
<td>[4] EpRating</td>
<td>-0.20</td>
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<td>0.28</td>
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<tr>
<td>[5] DPRating</td>
<td>-0.12</td>
<td>0.58</td>
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<tr>
<td>[6] AmzNum</td>
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<td>0.28</td>
<td>0.34</td>
<td>0.23</td>
<td>1</td>
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<td>[7] CNetNum</td>
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<td>0.35</td>
<td>0.04</td>
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<td>[8] EpNum</td>
<td>0.01</td>
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<td>0.27</td>
<td>0.16</td>
<td>0.54</td>
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<td>1</td>
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<tr>
<td>[9] DPNumb</td>
<td>-0.26</td>
<td>0.52</td>
<td>0.49</td>
<td>0.39</td>
<td>0.52</td>
<td>0.67</td>
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3 We address Endogenity between Amazon sales and number of reviews in the section 5.
Research Methodology

Empirical Model

We use a log-linear model for the analysis. The log-linear model has been widely used in prior studies (see e.g. Chevalier and Goolsbee 2003; Chevalier and Mayzlin 2006) on the relationship between WOM and retail sales because it allows a change in WOM to contribute to a certain percentage change rather than an absolute change in product sales. This assumption is appropriate because popular products are likely to see higher absolute changes in sales level than obscure products due to scale effect. In addition, the Pareto relationship between product sales and sales rank implies a negative linear relationship between the log values of product sales and sales rank. As such, we can use negative log value of Amazon sales rank in place of Amazon sales in the log linear model. Our model for the effects of multiple WOM is as follow:

\[
-\ln(A_{it}) = \beta_1 \ln(A_{it}) + \beta_2 \ln(CNet_{it}) + \beta_3 \ln(EP_{it}) + \beta_4 \ln(DP_{it}) + \beta_5 \ln(AM_{it}) + \beta_6 \ln(AMMostRecent_{it}) + \beta_7 \ln(AMMostRecent_{it}) + \rho_i + \epsilon_{it}
\]

The dependent variable, $-\ln(A_{it})$, denotes the negative log value of the sales rank of product i at day t at Amazon. $A_{it}$, $CNet_{it}$, $EP_{it}$, and $DP_{it}$ are the key independent variables that represent the average customer ratings on Amazon, CNet, Epinions, and DPreview respectively for product i on day t. We control for the product price, the number of cumulative Amazon reviews, the most recent Amazon review rating and the product age as these variables may influence product sales. Since our sample comprises of 148 different products, there is significant heterogeneity across products. We control for heterogeneity by including fixed effects in Equation (1). The fixed effect $\rho_i$ captures idiosyncratic attributes of each product, which controls for observed and unobserved differences between products. In addition, the influence of product age on product sales may differ across products. Some products enjoy a fleeting reputation with quick drops in sales after introduction, while other products are more sustainable with less sales decrease over time. To control for the differences in sales trend, we allow the coefficient on product age to vary across products (Duan et al. 2008).

In Equation (1), the coefficients on the WOM rating variables, $\beta_1$, $\beta_2$, $\beta_3$, and $\beta_4$ capture the effects of retailer- and third party-hosted WOM information on the sales respectively. Hypothesis 1 suggests $\beta_1$, $\beta_2$, $\beta_3$, and $\beta_4$ are positive. Hypotheses 2 suggests the magnitude of the coefficient on the retailer-hosted WOM $\beta_1$ could be different from the coefficients on third-party hosted WOM $\beta_2$, $\beta_3$, and $\beta_4$.

Prior studies noted endogeneity between the number of Amazon reviews and sales because online WOM is not only a driving factor in retail sales, but also an outcome of retail sales (Godes and Mayzlin 2004). A major contributing factor of the endogeneity problem is unobserved product characteristics that could influence both product sales and WOM. To address this problem, we use a panel data approach that uses fixed effect to control for these product characteristics. Moreover, we leverage the time difference between Amazon’ sales rank and customer reviews. While the Amazon’ sales rank represents the current sales of a product and is updated hourly, Amazon reviews reflect customer experience with the products in the past. In the case of electronics, Amazon.com typically ships products within 2~3 days, and it takes customers days or weeks to learn about the product before they post reviews online. Therefore, today’s sales do not influence today’s WOMs (Chevalier and Mayzlin 2006; Etzion and Awad 2007). We further address the concern by dropping products with high sales ranks, because sales ranks for these products are updated infrequently and may not represent current sales. We also use instrument variables in our regression analysis. We choose lagged review variables as instrument variables because they satisfy two key conditions. First, lagged review variables are highly correlated with the current review variables. Second, lagged review variables do not correlate with the shock in current Amazon sale ranks as the shock in current Amazon sale rank cannot influence review variables in past periods (Aggarwal et al. 2007; Duan et al. 2008; Joshua and Krueger 2001; Wooldridge 2001)

Refinement

One possible cause of the variations in WOM influence is that these WOM may contain different number of customer reviews. Prior studies have suggested that consumers perceive higher number of reviews to be more representative of the consensus about product quality (Chen and Xie 2008; Maryanchyk 2008). In addition, a large
number of reviews may reduce a consumer’s concerns about vendor manipulation. These studies indicate that the influence of a WOM on retail sales could be moderated by the number of reviews contained in the network. To control for the moderating effect, we model the coefficient for each WOM as a function of the number of reviews contained in the respective WOM source. That is,

\[
\begin{align*}
\beta_1 &= \gamma_{10} + \gamma_{11}\ln(\text{AmzNumReview}_n) \\
\beta_2 &= \gamma_{20} + \gamma_{21}\ln(\text{CnetNumReview}_n) \\
\beta_3 &= \gamma_{30} + \gamma_{31}\ln(\text{EpNumReview}_n) \\
\beta_4 &= \gamma_{40} + \gamma_{41}\ln(\text{DPNumReview}_n)
\end{align*}
\] (2)

The above equations decompose the influence of WOM ratings into two components: (1) the influence of the WOM information sources represented by the coefficients \(\gamma_{10}, \gamma_{20}, \gamma_{30}, \gamma_{40}\). These coefficients capture a WOM source’s reputation, popularity, and other characteristics that may affect a consumer’s use and perception of the source⁴; and (2) the influence of customer reviews represented by the second set of terms in equation (2). The incremental influence of each customer review captured by the coefficients \(\gamma_{11}, \gamma_{21}, \gamma_{31}, \gamma_{41}\). These coefficients are of particular interest as they identify the incremental influence of customer reviews for each of the sources. If consumers perceive different levels of trustworthiness or informativeness in customer reviews across multiple WOM information, the difference will be reflected in the coefficients. We thus expand equation (1) as follows:

\[
- \ln(\text{AmzSalesRank}_i) = \gamma_{10}\ln(\text{AmzRating}_n) + \gamma_{20}\ln(\text{CNetRating}_n) + \gamma_{30}\ln(\text{EpinionsRating}_n) + \gamma_{40}\ln(\text{DPreviewRating}_n) + \gamma_{11}\ln(\text{AmzNumReview}_n) + \gamma_{21}\ln(\text{CNetRating}_n)\ln(\text{CnetNumReview}_n) + \gamma_{31}\ln(\text{EpinionsRating}_n)\ln(\text{EpNumReview}_n) + \gamma_{41}\ln(\text{DPreviewRating}_n)\ln(\text{DPNumReview}_n) + \beta_1\ln(\text{AmzPrice}_i) + \beta_2\ln(\text{AmzNumReview}_n) + \beta_3\ln(\text{AmzMostRecent}_i) + \beta_4\ln(\text{NumOfDaySinceRelease}_i) + \beta_5\ln(\text{CnetNumReview}_n) + \beta_6\ln(\text{EpNumReview}_n) + \beta_7\ln(\text{DPNumReview}_n) + \rho_i + e_{it}
\] (3)

**Results**

Column 1 in Table 4 presents the results for Equation 1. The model fits the data well with an R-square of 82.44%. The coefficients on the control variables show that product sales are positively and significantly associated with WOM volume and recent customer review rating, while negatively associated with product prices. The results are consistent with findings in prior WOM studies.

For the key WOM variables, we find that all three third-party-hosted WOM have a significant impact on Amazon sales. But, surprisingly, Amazon-hosted WOM has little influence on Amazon sales. This result does not support our Hypothesis 1 that both retailer- and third-party hosted WOM have significant influence on retail sales. However, this is consistent with the view that the low online search costs encourage consumers to seek multiple opinions to make better decisions when purchasing experience goods (Mitra et al. 1999). The easy accessibility of retailer-hosted WOM does not preclude the customers from visiting third-party WOM.

The insignificant influence of retailer-hosted WOM, however, supports our hypothesis 2 that the impact of third-party-hosted WOM is significantly higher than that of the retailer-hosted WOM. The coefficients of CNet, Epinions, and DPreview (3.08, 1.81, and 3.76 respectively) are positive and significant while the coefficient of Amazon is not significant (0.23). The coefficients of third-party WOM indicate that for each 1% increase in average review ratings at CNET, Epinions and DPreview, we observe a 3.1%, 1.8%, and 3.7% increase in Amazon sales, respectively. The results suggest that the trustworthiness enjoyed by third-party-hosted WOM is more important to digital camera consumers than the potential convenience and informativeness provided by retailer-hosted WOM. This highlights the importance of online trust in ecommerce transactions (Jarvenpaa et al. 1999; Pavlou 2003).

Column 2 in Table 4 separates the influence of WOM into two components: the influence of the WOM source, and the influence of customer reviews. The refinement increases the fit of model from 82.46% to 89.09%. We first consider the influence of sources. The coefficients on Amazon, CNET, EPinion and DPreview are 0.38, 0.56, 0.29, and 3.92, respectively. The first three are insignificant while the coefficient on DPreview is highly significant. The

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⁴ Technically, these coefficients represent the influence of a network rating on retail sales when the network contains exactly one customer review (i.e. the log value of number of reviews takes the value of zero).
results suggest that the WOM influence of Amazon, CNET and EPinion is mainly due to the customer reviews posted on these sites. However, the WOM influence of DPreview goes beyond customer reviews. The information source itself increases credibility and influence of its WOM. While we do not have data to fully explain what makes the source unique, one possible explanation is that DPreview is the only online WOM source that specializes in digital camera reviews and enjoys a higher reputation among camera shoppers than other WOM sources. We next consider the influence of customer reviews for each of the sources. The coefficients are all significant, but vary across sources. The marginal influence of Amazon customer reviews is the lowest (0.22) among the four sources, while the influence of CNET customer reviews is the highest (2.06), followed by DPreview (0.88) and Epinion (0.65). Comparing the coefficients suggests that, for the same number of customer reviews, the influence of Amazon is nine times smaller than CNET, four times smaller than DPreview, and three times smaller than Epinion. Our result again shows that consumers are more influenced by WOM in third-party sources than that on retailer-hosted sources, suggesting they bestow more trust on third-party sources.

| Table 4. Fixed Effect Model Results: - Amazon’s Log Sale Rank as Dependent Variable |
|---------------------------------|---------|---------|
| Variables                       | Coefficients | Coefficients |
| Ln(AmzRating_{i,t})             | 0.23     | (1.19)   |
| Ln(CNetRating_{i,t})            | 3.08***  | (0.96)   |
| Ln(EpinionRating_{i,t})         | 1.81***  | (0.37)   |
| Ln(DPreviewRating_{i,t})        | 3.76*    | (1.64)   |
| Ln(AmzRating_{i,t}) *Ln(AmzNumReview_{i,t}) | 0.22**  | (0.09)   |
| Ln(CNetRating_{i,t}) *Ln(CnetNumReview_{i,t}) | 2.06*** | (0.68)   |
| Ln(EpinionRating_{i,t}) *Ln(EpinionNumReview_{i,t}) | 0.65*** | (0.13)   |
| Ln(DPreviewRating_{i,t}) *Ln(DPreviewNumReview_{i,t}) | 0.88*** | (0.29)   |
| Ln(MostRecent_{i,t})            | 0.15**   | (0.06)   |
| Ln(AmzPrice_{i,t})              | -0.52*** | (0.07)   |
| Ln(AmzNumReview_{i,t})          | 0.38**   | (0.11)   |
| Ln(CNetNumReview_{i,t})         | -1.86    | (1.32)   |
| Ln(EpNumReview_{i,t})           | 0.23     | (0.14)   |
| Ln(DPNumReview_{i,t})           | -0.04    | (0.25)   |
| R-Square                        | 82.46%   | 89.09%   |
| Number of Observations          | 14,751   | 14,751   |

*** p<0.001; ** p<0.01; * p<0.5; Fixed effect & individual product diffusion process included, but not reported

Conclusion

This study has a number of implications for the WOM and e-commerce literatures. First, our result extends prior literature by showing that consumers often search for information from a variety of WOM sources beyond what is provided by retailers. Extant search costs literature has shown consumers search multiple websites for price information (Bakos 1997; Ghose et al. 2009; Granados et al. 2008). Our result extends our findings by noting that such search behavior applies to WOM information as well. Understanding how such search behavior affects firm’s pricing, marketing and product positioning strategies would be interesting future studies. Second, our result indicates the importance of considering the presence of multiple information sources in WOM studies. Prior WOM literature has mostly studied the influence of single WOM source and often obtained mixed results. One possible explanation of the mixed results could be the presence of alternative WOM sources not considered in these studies. Third, our result suggests that not all WOM information is equal. Their influence varies with host types. In
particular, we find a significant difference between retailer-hosted and third-party hosted WOM information. This suggests consumers treat the two types of sources differently even though they all feature reviews provided by consumers. Our result complements recent studies on factors that moderate the influence of WOM and indicates that consumer perception of the host could have a significant influence on the value of such information. Finally, our studies contribute to literature on online trust. While we do not have direct measures of online trust, our results are consistent with a long stream of literature that suggests consumers generally trust information provided by retailers or vendors less than that provided by neutral sources. Even when WOM information is generated by fellow consumers such information could be censored or manipulated by the host.

The implications of our results are significant for online retailers. Many online retailers hold the view that hosting customer reviews on their sites can increase sales (e-Consultancy and Bazaarvoice 2007; eMarketer 2007). Our result suggests that retailers have exaggerated benefits from hosting their own WOM systems. The results indicate that the retailers could benefit from forming information hosting alliance with third-party WOM websites to influence consumer perceptions. Of course, if alliances are perceived biased then they may have little benefit. However, retailers can pro-actively link to other neutral websites for verification which may have both positive and negative influence on sales depending on the consumer feedback.

Our research has several limitations. First, since we only collected Canon and Nikon data, our analysis is limited to these well-known products. Extending the study to lesser-known products would be helpful in assessing the influence of online WOM on products in the long tail of sales distribution (Ghose et al. 2006). Also, our study is limited to digital cameras. Comparing other types of products to electronics will generalize our findings. Second, unlike survey research, we did not measure consumers’ perceived trustworthiness on WOM information and are thus limited in interpreting why WOM information from different sources varies in their influence on retail sales. Measuring the underlying consumer perception on WOM could reveal new insights into motivations behind our finding. Third, we did not analyze the information content of online WOM. Text-data mining techniques could be used in the future to identify to what degree the difference in WOM influence is due to systematic variations in information contents. Finally, our study highlighted the influence of WOM from a major online retailer and three third party review providers. However, consumers may be influenced by other WOM sources or from other media, such as online recommendations, blogs (Dewan and Ramaprasad 2007), promotional e-mails from retailers, or discussions in online forums. Incorporating these factors in future studies will provide a more comprehensive understanding of the influence of online information on retail sales.

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