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NEW PRODUCT DIFFUSION: A DUAL WORD-OF-MOUTH PERSPECTIVE

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Abstract

Word-of-Mouth plays its great important role on the base of social network in affecting consumers' shopping behaviour. However, it is little known how firms make a self-suitable marketing strategy according to both online and offline WOM effect in their product diffusion. This article investigates a new product diffusion process taking both offline WOM and online WOM effect into consideration. Specifically, we compare three marketing strategies by predicting product diffusion level during its product life cycle and assist managers to improve cost efficiency. The findings indicate that product peak sales rate and cumulative sales at peak time would be highest when managers market their products only through the Internet. However, product peak adopting time is not determined by the strategy which the manager takes but impacted by the relationship between coefficients. Parameter analysis is further provided to extract more managerial insights.

Keywords: Social Networks, Word-of-Mouth, Peak Adoption Time.

1 INTRODUCTION

Word-of-Mouth (WOM) is one of the most popular and effective marketing strategies in nowadays marketing (Misner and Devine 1994), especially in the flourishing online marketplace. According to a statistical report, over 40% of all Americans actively seeks to the advice of family and friends when do shopping (Walker 1995). It is added by another study conducted by Jupiter Research in 2008 which indicates that the reliance on WOM has become so pervasive that 77% of online consumers referred to online WOM. Such an inclination towards learning about the great power of WOM has aroused significant attentions from both practitioners and scholars (Dellarocas et al. 2007; Liu 2006).

During the last two decades, the problem of how to establish a strong WOM marketing channel for new product diffusion has been becoming one of the most key issues concerned by both Fortune 500 and small and medium enterprises (Sernovitz et al. 2009). Even though a variety of studies try to investigate what cause the great power and how to improve or utilize this power of WOM, WOM marketing is yet the least understood strategy (Trusov et al. 2009). Essentially, the power of WOM is manifested by WOM effect, which refers to the consumer's information transmission power from one people to others (Chevalier and Mayzlin 2006; Wangenheim and Bayon 2004), and the information here means the opinion of experienced consumer who has used or is using the product. However, WOM effect is tightly related to social network ability. It is argued that the more social network ability someone has, the stronger WOM effect s/he has (Hong et al. 2005). Thus, examining the great effect of social network is the key precondition to study WOM effect, which leads us to much better understanding the power of WOM. Although it is important and essential, there is still a shortage of understanding how social network-WOM effect plays its great role in affecting consumer decision making and thus, impacting the whole market sales. This paper intends to the impact of heterogeneous WOM effect caused by various social networks ability on new product diffusion.

Previous researchers have investigated offline traditional WOM effect, e.g., Bass (1969) who predicts the product sales curve by dividing customer in two groups: innovators and imitators. Recently, researchers step to shift their attention to online WOM communication and a myriad of studies investigate on online WOM communication community size (Firth et al. 2006; Trusov et al. 2009), social network conceptualization (Brown et al. 2007), social network leaders (Li et al. 2010) and so on. However, it is still a lack of understanding how WOM effect impacts enterprises from firms' perspective. Moreover, to our best knowledge, there remains a dearth of investigation in studying both crucial channels in firms' marketing strategies. On the base of this research gap, this study aims to bridge these two stream of research to examine how both of offline WOM effect and online WOM effect jointly influence firms' product promotion, and further how firms make the best marketing strategy.

In this paper, based on a social contagion model, we propose a research model to explain how both of online and offline WOM effect impact firms' sales. Specifically, We extend the Bass diffusion model (Bass 1969) to study how the product is diffused by online and offline WOM effect or either of them. We establish a differential function to investigate the change of sales rate and further do parameter sensitivity analysis to observe how those coefficients (e.g., innovation coefficient, word-of-mouth coefficient) influence sales. Our study not only greatly contributes to the current literature, but provides rich practical implications. From a practical perspective, the study provides good implications to practitioners on how to design firms' marketing strategies to promote their products either online or offline or both under the consideration of their own productivity, past experience and product type.

This paper reports on a series of parameter discussions of our model that examine the joint impacts of both online and offline WOM effect on product sales. We first review previous literature on word-of-mouth effect and social networks in section 2. Then a model is established to solve the research question in section 3. Section 4 is the result analysis. In section 5, we do several numerical analyses to discover more managerial insights. At last, theoretical and practical implications are discussed.

2 LITERATURE REVIEW

After defining our research questions, in this section we review related literatures from two streams of prior researches as follows: online social networks and social contagion model.

2.1 WOM and Online Social Networks

As consumers today are fast reverting to online WOM to learn about a product or make a purchase decision, WOM has been becoming more attractive by both researchers and practitioners. In addition to some industry report and surveys which indicate the key importance of WOM, i.e., a study conducted by Jupiter Research in 2008 which indicates that the reliance on WOM has become so pervasive that 77% of online consumers referred to online WOM, this is also supported by a considerable amount of research. In Trusov et al. (2010) study, it is demonstrated that the activity of customer is influenced by around one fifth of his friends' activity on the social network sites, which means consumers are more incline to resort social network sites to ask for help in the process of shopping. What's more, Godes and Mayzlin (2004) find online conversation provides a convenient and cost-effective way to estimate word-of-mouth. This study further demonstrated that the online social network WOM is a cost-efficient way to search both product and consumers comments information. Other studies give further robust supports, like, Brown et al. (2007) investigate on online word-of-mouth by using a two-stage study and examine key factors which influence consumers' attitude and purchase decisions in online condition; Trusov et al. (2009) compare the effect word-of-mouth marketing with traditional marketing modes on online social network sites' member growth. To carrying out online word-of-mouth marketing effectively, Li et al. (2010) propose an approach to evaluate the influential power of online potential customer. However, there is no study investigate the online WOM effect with offline WOM together.

With the prevalent growing of WOM, online social network is also another issue both researchers and practitioners pay attentions to. Begin with Armstrong and Hagel Iii (1996) who discuss online community value and point out that online community plays an important role in improving profits for business, the value of online social networks is increasingly noticed by researchers. Subramani and Rajagopalan (2003) subsequently study the online social networks from the aspect of online information sharing and influence. For deriving the formation of online social networks, Firth et al. (2006) investigate online community size and peak adoption time applying the Bass model (Bass 1969) which describes product diffusion process by dividing adopters into two kinds, innovator and imitator. Recently, much more researches contribute on the characteristics of online social networks, e.g., social capital (Ellison et al. 2007), cooperative behaviours (Fu et al. 2007), the role of individual profile and preference (Lewis et al. 2008; Liu 2008), economic value implications between sellers (Stephen and Toubia 2010), usage of instant messaging (Lin 2011) and so on.

2.2 Social Contagion Model

When mentioned to new product diffusion, social contagion refers to a process that people adopting the product are influenced by those who have already adopted one. Initiated by Bass (1969), the Bass model describes new product diffusion process based on social contagion theory with customers divided into innovators and imitators. In the past four decades, the Bass new product diffusion model has been applied in numerous researches. A review research on new product diffusion models in marketing and management literature is offered by Mahajan et al. (1990). As pointed out by Mahajan and Muller (1979), a diffusion model is established to depict the adoption process during a life cycle. Subsequent researches extend the Bass diffusion model and contribute on other aspects. Kalish (1985) contributes on a new product adoption with taken price advertising and uncertainty into consideration. Sultan et al. (1990) examine the applying of diffusion model with practical data through meta-analysis. Mahajan et al. (1995) generalize the Bass diffusion model and discuss its managerial implication. Firth et al. (2006) use the Bass diffusion model to predict Internet-based online community size and peak adoption time. Young (2009) examines innovation diffusion models including social contagion model in heterogeneous populations.

3 MODEL

In this section, we establish a model to help manager to predict product sales and make corresponding ordering plan when facing consumers online and offline. We assume the proportion of offline consumers is δ , where $\delta \in [0,1]$, and then online consumers account for $1-\delta$. When $\delta = 1$, it represents the seller launching his new product merely through traditional market. Simultaneously, $\delta = 0$ represents the other extreme scenario that the seller puts the product on the Internet only. For simplicity, but without loss of generality, the initial potential market is assumed to be settled, represented as N (e.g., Mahajan et al. 1995; Teck-Hua et al. 2002).

The diffusion process of the product is as follows. In the first, the retailer sells the product to online consumers and offline consumers respectively. Afterwards consumers take interactions with their friends. Specifically, online consumers share the information with their friends through their online social networks. We assume online consumers' word-of-mouth coefficient is higher than offline consumers based on Keller Fay research (Keller 2006)'s result that one third of word-of-mouth are derived from 15% consumers who acquire information mainly from the Internet to spread to their friends. Prior studies on online word-of-mouth have obtained similar results, e.g. Brown et al. (2007) point out "Online consumers are more active and discerning, are more accessible to one-on-one processes..." (i.e., online consumers have more opportunities to introduce products or services to their friends). Therefore, the same number of customers online could impact more potential customers' purchase decisions than offline. Consequently, β_1 and β_2 denote the word-of-mouth coefficient of traditional consumers and online consumers respectively, and $\beta_1 < \beta_2$. The negative of β_1 and β_2 represent for negative word-of-mouth effect which have passive effects on sales, that is, remaining potential consumers are informed about unfavourable information on the product or service. In this study, we focus on positive word-of-mouth effect as past researches like Robinson and Lakhani (1975), thus $\beta_2 > \beta_1 > 0$. What's more, β_1 and β_2 are reflection of customers' offline and online social network ability as well. That is, with more social network ability, consumer would influence more people. Our key notations are summarized in Tabel 1.

N :	Initial potential market
$x(t)$:	Cumulative sales during $(0,t]$
$\dot{x}(t)$:	Sales rate at time t
α :	Innovation effect parameter
β :	Imitation effect/WOM effect parameter
δ :	Proportion of offline consumers

Table 1 Summary of Model Notation

In view of the diffusion process, potential market can be divided into four groups: offline consumers who purchase the product without others' influences, offline consumers whose purchase decisions are impacted by other people, online consumers who purchase the product without any recommendations and online consumers whose purchase decisions are influenced by their online social networks. Different with the customers classification of Bass (1969) as only two groups, innovators and imitators, we denote specifically the four groups respectively as: offline innovators, offline imitators, online innovators and online imitators. Besides β_1 and β_2 represent the imitation effect, we use α to stand for innovation effect. Hence, the proportions of offline innovators and online innovators are respectively: $\delta\alpha$ and $(1-\delta)\alpha$, where we assume the offline and the online consumer's innovation coefficients are the same. According to the product diffusion process, we extend the Bass diffusion

model to describe the product sales and distribution status during the product life cycle. That is, at a certain time the sales rate $\dot{x}(t)$ concludes four parts: sales for offline and online innovators, and sales for offline and online imitators. Hence, we obtain the sales rate function which is equivalent to the sum of innovation coefficient and word-of-mouth coefficient multiplied by the remaining potential market $(N - x(t))$, where $x(t)$ represents for the cumulative sales during the period of $(0, t]$.

$$\dot{x}(t) = \left[\underbrace{\delta\alpha}_{\text{offline innovators}} + \underbrace{\beta_1 \frac{\delta x(t)}{N}}_{\text{offline imitators}} + \underbrace{(1-\delta)\alpha}_{\text{online innovators}} + \underbrace{\beta_2 \frac{(1-\delta)x(t)}{N}}_{\text{online imitators}} \right] \underbrace{(N-x(t))}_{\text{remaining potential market}},$$

which can be simplified as

$$\dot{x}(t) = \left[\alpha + \beta_1 \frac{\delta x(t)}{N} + \beta_2 \frac{(1-\delta)x(t)}{N} \right] (N - x(t)). \quad (1)$$

According to the differential equation of the product sales, information about the sales status, such as the product peak adoption time, can be extracted. Applying the results of Bass (1969), we conclude as following,

- The product peak adoption time T^* , the peak sales rate $\dot{x}(T^*)$ and the corresponding cumulative sales $x(T^*)$ can be expressed as

$$T^* = 1 / (\alpha + \beta) \ln(\beta / \alpha) \quad (2)$$

$$\dot{x}(T^*) = N(\alpha + \beta)^2 / 4\beta \quad (3)$$

$$x(T^*) = N(\beta - \alpha) / 2\beta \quad (4)$$

where $\beta = \delta\beta_1 + (1-\delta)\beta_2$. However, the premise of the existence of peak sales rate and peak adoption time is that $\beta > \alpha$ should be satisfied.

4 ANALYSIS

On the basis of our model, in this section we attempt to analyse the various situations that the manager takes different strategies. Three kinds of strategies are taken into consideration, they are, facing traditional market (offline market) only, facing online market only and facing both offline consumers and online consumers. The product peak adoption time would be different and the peak sales rate also is different under various strategies. Correspondingly, the profits would be different, and the manager needs to strike a balance between the sales and his capacity for pursuing higher profits. We study from the sales aspect to watch the differences among the three strategies. Consequently, according to our study, the manager makes strategy decision depending on his circumstances.

4.1 Facing traditional market only (i.e. $\delta = 1$).

This case is the same as the Bass diffusion model, where the manager launches the product only through traditional market and the word-of-mouth effect (imitation effect) is homogenous among offline consumers. Thus, under this strategy, the product peak adoption time T^t , the peak sales rate $\dot{x}(T^t)$ and the corresponding cumulative sales $x(T^t)$ are respectively $T^t = 1 / (\alpha + \beta_1) \ln(\beta_1 / \alpha)$, $\dot{x}(T^t) = N(\alpha + \beta_1)^2 / 4\beta_1$ and $x(T^t) = N(\beta_1 - \alpha) / 2\beta_1$, where $\beta_1 > \alpha$ is needed to be satisfied. These results have been proved in accordance with practical data of durable products by Bass (1969).

4.2 Facing online market only (i.e. $\delta = 0$).

In this strategy, the manager launches a new product through the Internet only. For example, a number of retailers merely have online store but have no entity shop maybe because of the higher rent or the expensive management fee of entity shop. In this case, the word-of-mouth effect are also homogenous among online consumers, then the peak sales rate would be reached at $T^o = 1/(\alpha + \beta_2)\ln(\beta_2/\alpha)$, the peak sales rate are $\dot{x}(T^o) = N(\alpha + \beta_2)^2 / 4\beta_2$ and the corresponding cumulative sales during the period of $(0, T^o]$ are $x(T^o) = N(\beta_2 - \alpha) / 2\beta_2$, with the condition that $\beta_2 > \alpha$.

From the results of the above two strategies, we obtain that:

- At the peak time, the sales rate under the strategy of facing online consumers only is higher than facing only traditional consumers. Moreover, the corresponding cumulative sales from the beginning to the peak time under the strategy of facing online customers only is also higher than facing traditional customers only.

Proof. From the expressions of $\dot{x}(T^t)$, $x(T^t)$ and $\dot{x}(T^o)$, $x(T^o)$, it is obviously that $\dot{x}(T^o) > \dot{x}(T^t)$ and $x(T^o) > x(T^t)$ while $\beta_2 > \beta_1 > \alpha$ is satisfied.

As the higher of the peak sales rate and also the corresponding cumulative sales while facing online consumers only, it is expected the peak adoption time might be reached earlier. However, it is surprising that the product peak adoption time is not assured to be earlier even when the word-of-mouth coefficient is higher.

- The product peak adoption time under the strategy of facing only online consumers would be earlier than facing only traditional consumers when $(\alpha + \beta_2)\ln(\beta_1/\alpha) > (\alpha + \beta_1)\ln(\beta_2/\alpha)$ is satisfied. On the contrary, if $(\alpha + \beta_2)\ln(\beta_1/\alpha) < (\alpha + \beta_1)\ln(\beta_2/\alpha)$, the peak adoption time would arrived later instead. Moreover, in the case that $(\alpha + \beta_2)\ln(\beta_1/\alpha) = (\alpha + \beta_1)\ln(\beta_2/\alpha)$, the peak adoption time would come at the same time under the two strategies, facing traditional consumers or online consumers.

Relationship of peak times	Conditions
$T^* > T^t > T^o$	$(\alpha + \beta_1)(\alpha + \beta_2)\ln\frac{\beta}{\alpha} > (\alpha + \beta)(\alpha + \beta_2)\ln\frac{\beta_1}{\alpha} > (\alpha + \beta)(\alpha + \beta_1)\ln\frac{\beta_2}{\alpha}$
$T^t > T^* > T^o$	$(\alpha + \beta)(\alpha + \beta_2)\ln\frac{\beta_1}{\alpha} > (\alpha + \beta_1)(\alpha + \beta_2)\ln\frac{\beta}{\alpha} > (\alpha + \beta)(\alpha + \beta_1)\ln\frac{\beta_2}{\alpha}$
$T^t > T^o > T^*$	$(\alpha + \beta)(\alpha + \beta_2)\ln\frac{\beta_1}{\alpha} > (\alpha + \beta)(\alpha + \beta_1)\ln\frac{\beta_2}{\alpha} > (\alpha + \beta_1)(\alpha + \beta_2)\ln\frac{\beta}{\alpha}$
$T^* > T^o > T^t$	$(\alpha + \beta_1)(\alpha + \beta_2)\ln\frac{\beta}{\alpha} > (\alpha + \beta)(\alpha + \beta_1)\ln\frac{\beta_2}{\alpha} > (\alpha + \beta)(\alpha + \beta_2)\ln\frac{\beta_1}{\alpha}$
$T^o > T^* > T^t$	$(\alpha + \beta)(\alpha + \beta_1)\ln\frac{\beta_2}{\alpha} > (\alpha + \beta_1)(\alpha + \beta_2)\ln\frac{\beta}{\alpha} > (\alpha + \beta)(\alpha + \beta_2)\ln\frac{\beta_1}{\alpha}$
$T^o > T^t > T^*$	$(\alpha + \beta)(\alpha + \beta_1)\ln\frac{\beta_2}{\alpha} > (\alpha + \beta)(\alpha + \beta_2)\ln\frac{\beta_1}{\alpha} > (\alpha + \beta_1)(\alpha + \beta_2)\ln\frac{\beta}{\alpha}$
$T^* > T^t = T^o$	$(\alpha + \beta_1)(\alpha + \beta_2)\ln\frac{\beta}{\alpha} > (\alpha + \beta)(\alpha + \beta_2)\ln\frac{\beta_1}{\alpha} = (\alpha + \beta)(\alpha + \beta_1)\ln\frac{\beta_2}{\alpha}$
$T^t = T^o > T^*$	$(\alpha + \beta)(\alpha + \beta_2)\ln\frac{\beta_1}{\alpha} = (\alpha + \beta)(\alpha + \beta_1)\ln\frac{\beta_2}{\alpha} > (\alpha + \beta_1)(\alpha + \beta_2)\ln\frac{\beta}{\alpha}$

$T^t = T^o = T^*$	$(\alpha + \beta)(\alpha + \beta_2) \ln \frac{\beta_1}{\alpha} = (\alpha + \beta)(\alpha + \beta_1) \ln \frac{\beta_2}{\alpha} = (\alpha + \beta_1)(\alpha + \beta_2) \ln \frac{\beta}{\alpha}$
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Table 2 The relationship of peak times among the three strategies.

Hence, the peak adoption time is depended on the relationship between innovation coefficient and imitation coefficients. According to this result, the manager is able to make appropriate ordering plans and inventory arrangement with estimated coefficients values based on prior experiences.

4.3 Facing both traditional market and online market (i.e. $0 < \delta < 1$).

We have presented the expressions of peak adoption time, peak sales rate and cumulative sales at peak time under this strategy as (2), (3) and (4). Because of $\beta_1 < \beta = \delta\beta_1 + (1 - \delta)\beta_2 < \beta_2$, we get:

- The peak sales rate and the cumulative sales at peak time would be in the middle of the above two cases. That is, $\dot{x}(T^t) < \dot{x}(T^*) < \dot{x}(T^o)$, $x(T^t) < x(T^*) < x(T^o)$.
- The relationships of the peak adoption time under the three strategies in different conditions are described in Table 1.

It is not necessarily that the peak adoption time would reach earlier when the word-of-mouth effect is higher, but it is influenced by the coefficients of innovation and word-of-mouth together. From our results, the manager according to actual market conditions estimates the model parameters and then decides marketing plan and inventory plan.

5 SENSITIVITY ANALYSIS

After clarifying the sales status under the three strategies, we do parameter sensitivity analysis to extract more managerial insights for improving market efficiency in this section. By using MATLAB, we apply the following parameter values which are derived from prior empirical researches (e.g., Mahajan et al. 1990; Sultan et al. 1990): $\alpha \in \{\alpha_h, \alpha_l\} = \{0.03, 0.01\}$, $\beta_1 \in \{\beta_{1h}, \beta_{1l}\} = \{0.15, 0.1\}$, $\beta_2 \in \{\beta_{2h}, \beta_{2l}\} = \{0.4, 0.3\}$, $\delta \in \{\delta_l, \delta_h, 1\} = \{0, 0.3, 0.5, 1\}$, and the condition $\beta_2 > \beta_1 > \alpha > 0$ is also satisfied.

5.1 Effect of innovation coefficient α on sales

The innovation coefficient presents the proportion of innovators who make purchase decisions without others influence. Because of the settled potential market, as the higher of the quantity of innovators, the quantity of imitators who influenced by who have already buy the product would be lower. We analyse the innovation effect under the third strategy that facing both offline and online consumers.

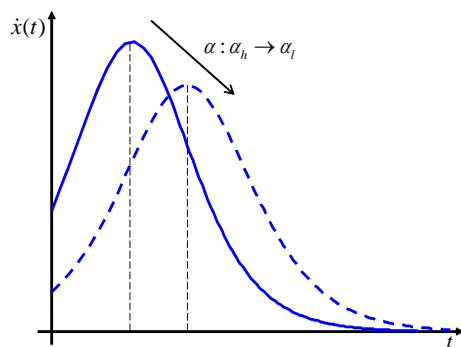


Figure 1 Sensitivity of α on sales rate.

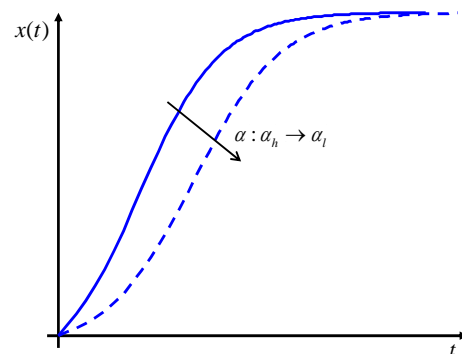


Figure 2 Sensitivity of α on total sales.

From the expressions of peak adoption time, peak sales rate and cumulative sales as (2), (3) and (4), we obtain:

- The product peak adoption time is decreasing with the innovation coefficient, and the peak sales rate is increasing with it. However, it is surprising that the cumulative sales at peak time decrease with the innovation coefficient.

Proof. These results are obtained straight from the derivatives of equations (2), (3) and (4) on innovation coefficient α that $\partial T^* / \partial \alpha < 0$, $\partial \dot{x}(T^*) / \partial \alpha > 0$ and $\partial x(T^*) / \partial \alpha < 0$. The sales rate and the cumulative sales are compared respectively under the high and the low innovation coefficient.

As show in Figure 2 and Figure 3, it is in accordance with the results we conclude above. What's more, the market tends to reach saturation state early when the innovation coefficient is high. In the practical business, if the manager finds his customers are more likely to buy the product spontaneously, he should prepare for the earlier coming of peak time with more sales rate in advance.

5.2 Effect of imitation coefficient β on sales

As the general imitation coefficient β equals to $\delta\beta_1 + (1-\delta)\beta_2$, where the parameters β_1 and β_2 are stand for imitation coefficient of offline consumers and online consumers, both the change of β_1 and β_2 would lead to the change of β in the same direction. That is, either the increase of β_1 or β_2 , the general imitation coefficient β will increase in proportion. Thus we find,

- Both the product peak sales rate and the cumulative sales at the peak adoption time are increasing with the imitation coefficient, which is no matter the offline imitation coefficient or online imitation coefficient.

Proof. It can be proved on the basis that $\partial \dot{x}(T^*) / \partial \beta > 0$, $\partial x(T^*) / \partial \beta > 0$.

Although with higher imitation coefficient the product is sold faster, the product peak adoption time is not necessarily arrived earlier. It is hard to compare the product adoption time, which can be seen in the following figures where we vary the value of offline and online word-of-mouth coefficient as $\{\beta_{1h}, \beta_{1l}\}$ and $\{\beta_{2h}, \beta_{2l}\}$.

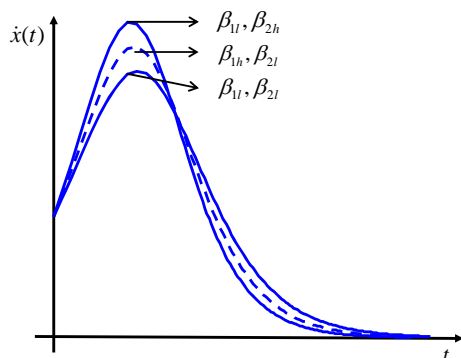


Figure 3 Sensitivity of β on sales rate.

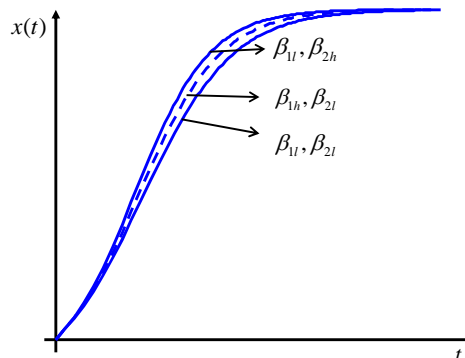


Figure 4 Sensitivity of β on total sales.

5.3 Effect of δ on sales

We have concluded the change of the product peak adoption time, the peak sales rate and the corresponding cumulative sales under three different strategies in section 4. In this part, we extend the conclusion in a more generalized circumstance by investigating the effects of proportion of offline consumers on sales status.

As $\partial\beta/\partial\delta < 0$, the effect of δ on sales is contrary to the effect of imitation coefficient β . That is,

- The product peak sales rate and the corresponding cumulative sales declines as the increase of δ , proportion of offline consumers.

Similarly, it is not definite how the peak adoption time varies with the proportion of offline consumers. We also figure the change of sales out. Learning from the conclusion, the manager should relax his inventory while the offline consumers account for more.

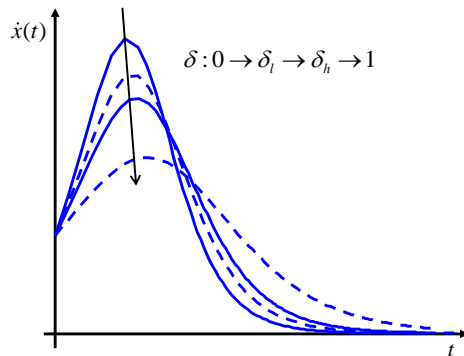


Figure 5 Sensitivity of δ on sales rate.

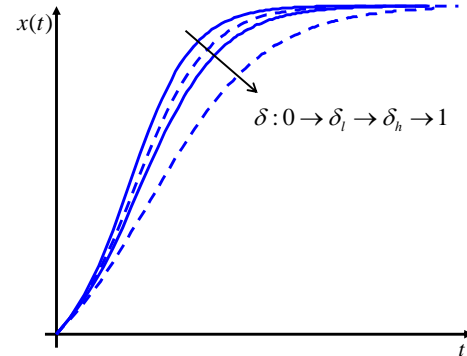


Figure 6 Sensitivity of δ on total sales.

6 DISCUSSION

The great power of WOM on product diffusion is one of the key issues both practitioners and researchers concern. Our study examines this problem from the aspect of new product diffusion level during its product life cycle. This paper focuses on the study of product sales with taken online social networks into consideration by extending the classic Bass diffusion model. As we point out, the product sales would be impacted because of the heterogeneous of word-of-mouth effect between offline consumers and online consumers. Furthermore, we investigate parameter sensitivity analysis to gain more insights.

6.1 Implication for theory

In recent years, there has been an increasing interests in studying the WOM effects. It is generally agreed by IS as well as marketing researchers that the WOM effect plays an important role in affecting consumers purchase behavior and attitude to product (e.g., Berman 2005; Cheema and Kaikati 2010). Our research contributes on these literatures in two important areas.

First, although it is generally acknowledged that consumers in different areas (i.e., online and offline) can mostly affected by online or offline WOM effect, there is little research in investigating how these types of WOM effect impact firms' marketing strategies. Although several researchers have started to recognize the importance of WOM effect which could greatly influence consumers behaviors, most studies examine this effect from either online or offline perspective (e.g., Engel et al. 1969; Godes and Mayzlin 2009; Richins 1983). It is not clear how these two channels jointly impact consumer behaviors from firms' perspective, more detail, online and offline WOM are two essential ways firms should consider in designing their marketing strategies. Our study deepen the research with systematic understanding of a particular model design, and it is imperative to study these dual channels together.

Second, on the base of the original Bass Model which describes product diffusion process by dividing adopters into two kinds, innovator and imitator. Our study not only apply this theory into a new environment (i.e., online WOM diffusion), but extend it into a more complex context, namely, considering both online and offline WOM effect. The findings of our study testified that it is reasonable, which indicate that there are different WOM effects by either online or offline WOM or both, and it is also fit the original one.

6.2 Implications for practice

The results of this study have several strategic implications for most businesses.

First, considering the heterogeneous of word-of-mouth effect caused by both online and offline social networks which influence the diffusion process of product or service, managers are able to make appropriate ordering plans and inventory arrangement in advance which could reduce unnecessary inventory costs or salvage costs.

Second, based on our results, we can understand that managers had better to make corresponding marketing strategy depending on their capacities, e.g., the manager could promote his product or service through offline customers only to avoid product surplus if he is not able to hold relatively high stock.

Third, according to the parameters sensitivity analysis, the manager is able to cope with the change of certain market factors in advance. For instance, as the popularity of social network sites, the number of online consumer increases, and then the peak sales rate would increase as well as the cumulative sales at peak time. Furthermore, the increases of innovators would lead to the peak adoption time arrived earlier and the rise of peak sales rate as well as the cumulative sales. Realizing those conditions, managers can make corresponding reaction in advance to avoid product stock out.

Fourth, the parameter value can be obtained from past relevant information for precisely forecasting. Several existing researches have estimated these parameters values, as Sultan et al. (1990) report that the average value of innovation coefficient and imitation coefficient are respectively 0.03, 0.38. In addition, from our past study relating to online marketplace investment with more than 200 small and medium enterprises in Wuxi, Hangzhou, Guangzhou (the most developed areas in China), we found that most of the companies indicated that the proportion of online sales revenue account for approximate 20 percent of whole sales according to their tracing the bills. After making sure these parameters' value, the managers is able to improve their profits and cut costs because of better forecasting on product diffusion.

6.3 Limitations and further research

Despite all efforts, this study suffers several limitations which serve as suggestions for future research. First of all, in our study, we take online and offline WOM effect into our consideration respectively, which may neglect the behaviour caused by both online and offline WOM together, namely, we do not consider the interaction effect of online and offline WOM effect. More detail, actual consumer purchase behaviour may be caused by the mixture of online and offline WOM effect rather than only one aspect. For example, an online consumer who is partially impacted by online WOM cannot be promoted to the actual behaviour. However, after s/he is affected by offline WOM, the actual behaviour happens. It is very common in the actual environment like such examples occur. Although it is very difficult to measure, maybe we can model such effect by parameters. We try to supplement this part and take this factor into consideration with more complex model.

Second, product type may be another factor inhabiting our contribution to both researches and practitioners. In this study, we focus on durable product which one customer would purchase once during the product life cycle. However, for frequently purchased product, consumers are likely to come back to buy if the product is good. In this circumstance, consumers purchase behaviour are also impacted by consumer repeat purchase behaviour. On the base of our analyses above, we can conclude that different product may bring different results. Thus, we can try to categorize product into relatively detailed classifications and do more analyses in the future research.

Third, a lack of taking price into our consideration is another limitation. Price has its greater power to solve many problems in the reality. For example, decreasing product price can be formulating a strong both online and offline WOM effect, which could firmly change the diffusion rate of the product and also alter the peak point of the whole process. From an economic perspective, decrease a reasonable level of price can not only promote the demand, but speed the diffusion rate, which may increase the whole sales and profits. Thus, trying to take price into consideration is also essential in further studies.

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