Abstract Code: 025-0570

To Enhance the Application of New Product on Trust-oriented Perspective

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POMS 23rd
Annual Conference
Chicago, Illinois, U.S.A.
April 20 to April 23, 2011

Abstract: Nowadays, product life often ranges from one to two years and even shorter. We need to find an effective way to expand our new product market. Based on trust theories, computational experiments are made to prove that the increase of the successful user experience will be substantially helpful.

Keywords: Complex networks, Multi-agents, Computational experiments, Trust

1. Introduction

Diffusion modeling has been researched extensively in a long history. Conventionally, product diffusion models have been developed to forecast the demand of a new product. Bass (1969) presented the innovation diffusion model empirically, which is depicting the S-shape pattern of the initial purchase of new consumer products of durables and precluding the study of commonly observed phenomena of the replacement sales. Concerned with cost theory and Bass model, Muller (1996) tried to find the optimal sample percent for durables and non-durables, based on the assumption that offering too many free samples is an expensive waste of a company's resources.

There are many diverse variations in different settings. For examples, in international settings, Heeler and Hustad (1980) found out that the timing to peak first purchase sales is often greatly underestimated. What are the new properties of the innovation diffusion by the Internet or digital media?

In the new era of Internet, there are many changes in the market. Although there are many important issues about the properties on Internet, like network externalities and non-diminishing-marginal benefit phenomenon, we can not name all in this paper. We now list some of the concerned properties below:

(1)*No boundaries.* The market can be unlimitedly expanded with Internet, similar to the

international settings. Mahajan, Muller and Kalish (1995) explore the conditions that influence the sequence in which products should be introduced across market. The results show that "sprinkler strategy" which is involving simultaneous entry in both markets, rather than sequentially, will improve more competitiveness.

(2)*Technology changes rapidly.* Major enhancements to browsers and software are being made every six months. (Arvind Rangaswamy, Sunil Gupta, 1999) "The link between rate of technology change and the rate of adoption" needs more exploration. Since it is common to find that product cycle varies for each type of product. For some of the software, the life expectancy are longer, as many consumers have formed their fixed user habits. For some other software, consumers keep looking for latest substitutions.

(3)*Diffusion process accelerated.* Innovation diffusion will be accelerated by Internet, and especially familiarity rates. (Prince and Simon, 2009).

(4)*Low-cost and rapid delivery*. The deep penetration of the Internet and electronic commerce incubates the digital products which can be transmitted with little additional-cost and delay by logistics delivery, where free sample assumptions of the early researches by Mahajan and Muller (1995) may not be satisfied.

When some of the settings of diffusion models have changed and rapid technology changes, strategies to accelerate the diffusion of new products are more desirable than ever.

The purpose of this paper is to find out an effective way to accelerate the market penetration to keep up with the change of modern rapid technology, taken the Internet as a diffusion media. Taking a different perspective, we originally import the theories of trust building and transfer mechanisms to explore the nature of diffusion process. We build up a multi-agent model of a virtual society network with low diffusion cost, homogeneous society structure and homogeneous consumer's disposition, simulating the trust-building and transferring process. We compare the influence on the market penetration by choosing two

different ways of trust building with buyers: direct and indirect.

A strategically suggestion can be drawn out that the development of market penetration of new products can be accelerated more successfully with direct user experience, rather than indirect user experience, which is consist with some practical facts.

The remainder of our work is organized as follows: In section 2, we have a literature review of trust theories and the underlying relationship between the diffusion and trust theories, as basic principles to the production and transfer of trust. And in section 3, we describe the rules of interactions of the agents in the models of the computational experiments. Section 4 set up the models and the value of parameters. Section 5 provides the outcomes of the experiment and discusses the managerial implications.

2. Literature Reviews

2.1 Trust

Trust has received a great deal of attention in the disciplines of psychology, sociology, political science, economics, history and socio-biology. Each discipline offers unique insights into the nature of trust and the processes through which it develops. It is not the intention of this paper to discuss in depth its definitions and differences as viewed by different researchers or disciplines. In this paper, we apply some widely-accepted views in the process of trust produce and transfer to build a virtual experimental environment.

Zucker (1986) discussed 3 central modes of trust production: (1) process-based, tied to past or expected exchange; (2) characteristic-based, tied to person, based on social characteristics; (3) institutional-based, tied to formal societal structures, based on individual or firm-specific attributes or on intermediary mechanisms.

Noteberg (1999) made an empirical research to prove that for new users, recommended trust can be used to establish the initial trust relationship and a strong trust relationship can be established with a vendor through direct experience, in line with Zucker’s modes of trust

production of characteristic-based and process-based.

Strub and Priest (1976), Milliman and Fugate (1988) described an extension pattern of trust production that trust can be transferred from another person or group to the trustor who has little or no direct experience.

2.2 The underlying relationship of Innovation Diffusion and Trust

Bass(1969) relied on the diffusion theory to mimic the S-shaped growth patterns of new durable products. He set up a diffusion model that both the effect of innovation (p) and imitation effect (q) are taken into consideration. At each point of time T,

$$P(T) = p + q / mY(T). \quad (1)$$

The coefficient of innovation (p) can be initiated by the firm like advertising and other methods. The coefficient of imitation effect (q) reflects the importance of interactions among buyers and potential buyers. $Y(T)$ is the number of previous buyer.

Mahajan et al. (1990) interpreted that Bass framework has internal influence in terms of word-of-mouth and personal communications. However, this interpretation does not specify how the consumer interactions of social networks stimulate the innovation effect (p) and imitation (q).

Rogers (1995) gave an insight into the means by which information about an innovation is transmitted. He pointed out that it consists of both the mass media and interpersonal communications. And members of a social system have different propensities for relying on mass media when seeking information about an innovation. Interpersonal communications are important influences in determining the speed and the shape of the S-shaped pattern of the diffusion process in a social system. Product samples widely used to demonstrate a product's superiority and to convince a potential customer to try a new product. Jain, Mahajan, and Muller (1995) study the impact of two types of sampling on diffusion patterns: neutral sampling (where the sampling is not targeted at opinion leaders and innovators) and target

sampling (where sampling is by design targeted at opinion leaders and innovators).

This is also true in the context of trust theories. (1)Mass media (e.g. advertising), interpersonal communications (e.g. world-of-mouth) , free sample can be taken as different ways to build and transfer trust. (2)Consumer disposition to trust, or characteristic-based trust, refers to customer's individual traits that lead to expectations about trustworthiness. Dan J. Kim (2008) made an empirical study to prove that consumer disposition to trust have a positive significant effect on trust building.

3. PRINCIPAL ASSUMPTIONS IN NEW PRODUCT DIFFUSION

Based on the widely recognized views of trust, some of principal assumptions are set up to characterize our experimental model.

3.1 Risk aversion society for new product

Risk aversion is the reluctance of a person to accept a bargain with an uncertain payoff rather than another bargain with more certain. That is to say, most of risk-aversion consumers will be more easily to adhere to the old product. Admittedly, in reality and most contexts of trust theories and diffusion theories, e.g. Dan J. Kim (2008), Rogers (1995), members of a social system have different propensities and inclinations for different ways of trust building. However, since our purpose is to make a general comparison, ceteris paribus, on the influence of direct and indirect media to build trust, the settings in this model make a homogeneous character assumption-risk aversion, to simplify the simulation process without loss of the generality.

3.2 Balance on investment and profit

For most companies, new product diffusions by mass media or samples imply expensive investment. One company has their unique marketing policy, which includes the details of

proportions of the investment for diffusion media and rates of reinvestment and retained profit. A practically important concern here is to forecast the growth of advanced generations of a product during the early stages of product penetration or before launch. And the consideration of the “Profit Maximization” principle will be precluded. Thus, in this model, we assume that all the profit earned will be reinvested to the market to accelerating diffusion.

3.3 Energy Dissipation in Diffusion

In the context about innovation diffusions, relevant costs including variable costs, carrying inventory costs, and consumer waiting costs are usually taken into consideration. (Mehdi Amini, Tina Wakolbinger, Michael Racer, Mohammad G. Nejad, 2012) As an analogy, we make a simplified assumption that in each step of the intermediary agent movement, they will consume or cost the some amount of energy, and the intermediary agent longevity will diminish with time.

3.4 Difference between the trust of Direct-experience, Indirect-experience

In the process of trust building and transferring, the different modes of the diffusion from disseminator to receiver, i.e. different diffusion intermediary agents, will lead to different trust level change and then result accumulatively different buying decisions. In this paragraph, we explicitly explained how we set up the three key parameters to describe the change of trust level for process-based trust, specific trust and general trust respectively.

Zucker (1986) discussed the 3 kinds of mechanism of trust building: process-based trust, characteristic-based and institutional-based trust. And Noteberg (1999) pointed out that much stronger trust relationship can be established with a vendor through direct experience (i.e. process-based trust) than indirect experience.

And in the context about the transferring mechanism of indirect experience, the concept of specific trust and general trust are concerned. Specific trust is associated with a specific retailer or specific intermediary agent. General trust is associated with institutional-based trust. For example poor legislation on false advertising or deceptive advertising will lead to less general trust in society. Both the general trust and the specific trust have positive effects on buying behaviors. Kenning (2008) argues that the influence of specific trust on buying behavior increases when customers have lower levels of general trust.

It is plausible to assume that in a risk-aversion society network, lower level of general trust and higher level of specific trust. In short, we suppose the following function should be satisfied:

$$\Delta DTL > \Delta GTL > \Delta STL \tag{2}$$

Here, *DTL* is the trust level built by direct experience. *GTL* is the general trust built by mass media. *STL* is the specific trust built by specific intermediary agent. Δ means the change value of trust for the occurrence of an event mentioned above.

3.5 Coexistence of rational consumption and irrational consumption

At the beginning, when a new product launches into in the market, it is not known for consumers. Most of the members in the society are rational and risk aversion, which are willing to adhere to the old product. However, there are some small probabilities of the phenomenon of irrational purchase, e.g. an impulse purchase (Piron F, 1993; Verplanken B., Herabadi A,2001). That is: rational consumption and irrational consumption coexist.

4. MODELS AND PARAMETERS

Given this issue of interest –the effects on accelerating the market penetration by direct or indirect marketing strategies–two simulation scenario models were developed for the computational study. Fig.1 shows the main process of the simulation model for the

accelerated diffusion based on direct experience. Fig.2 shows the indirect experience.

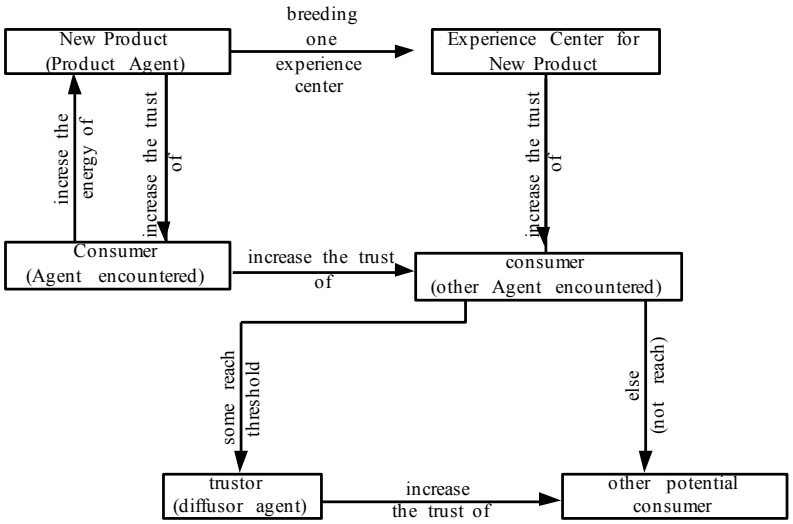

Figure 1. Accelerated Diffusion Model-Based on Direct Experience (EC Policy)

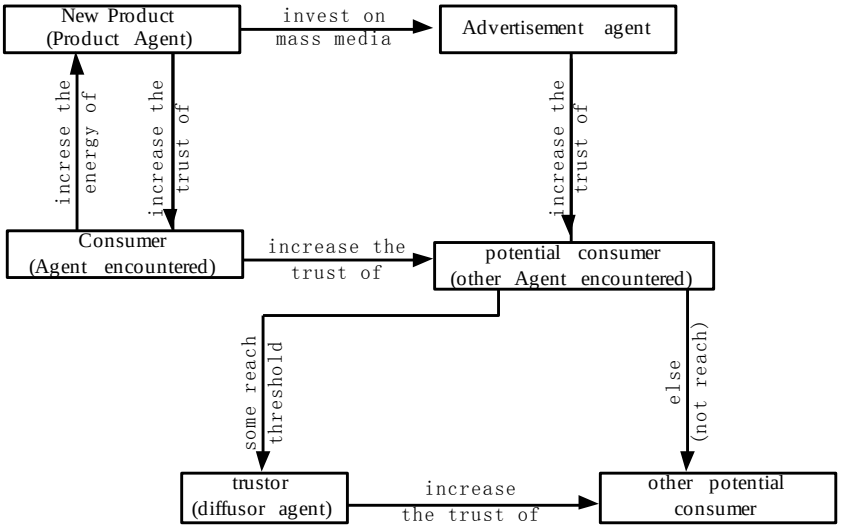

Figure 2. Accelerated Diffusion Model-Based on Indirect Experience (MM Policy)

As shown in Fig.1, once a firm makes one direct transaction on new product, it will realize some revenue from this trade, i.e. energy increased, and then invest some facilities to accelerate the diffusion process by increase the probability of direct experience, e.g. sending out free samples or building experience center. Here, we choose the word- “experience center” to depict precisely both the product and the service provided. Since Experience Center (EC) for customers provides free service and samples, no energy or revenue will generate from this process and actually it is costly, which means the energy of EC will diminish with time and

vanish at last.

In Fig.2, a firm applies a marketing strategy of indirect experience. Similarly, it will make some profit from a initial transaction and gain energy. The difference from Fig. l is the investment strategy-"mass media". Mass Media (MM), as a kind of an indirect way to transmit the trust, have the ability to contact numerous receivers, but generate less trust than direct way- EC. In this model, mass media disseminate a lot of advertisement agents to act as a intermediary agent to diffuse trust information.

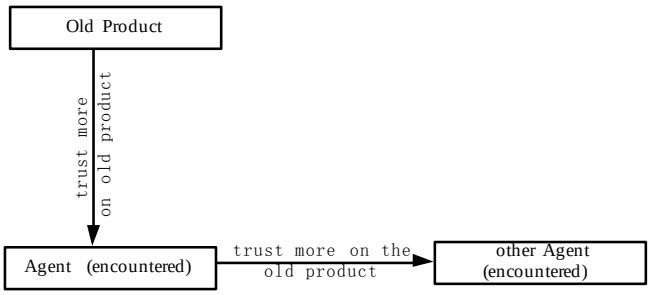

Figure 3. Deceleration Agent in Diffusion Model

As shown in Fig.3, old product still exist in the market, and for the most consumers' propensity for risk aversion, they will choose the recognized product. And trust on the recognized product can be more easily transferred. If we define $\Delta\, STL_b$ as the trust value increase on the recognized product by specific trust(more details in Section 3.4) and$\Delta\, STL_g$ as the new product, the requirement need to be satisfied:

$$\Delta\ STL_b > \Delta\ STL_g. \tag{3}$$

The main different properties of the EC& MM are described in Table 1. The definition of parameters and groups are shown in Table 2. The unchanged parameter values, ranges in the computational experiments are summarized in Table 3.

Table 1. Main Different Properties of EC and MM

Properties	EC	MM
Natality	One transaction generate one EC	One transaction generate 20 MM.
Initial moving energy	2000	2000
Energy Consumption per step	1	1
Δ *TL* for encountered consumers	20(Δ *DTL*)	1(Δ *GTL*)
Acceptors	All consumers	Potential Consumers (no fixed user habit for old product)

Table 2. Groups and Parameters

Group (subgroup)	Set	Quantity	*TL* range	Δ *TL*
Product	S	$m+n$	-	-
(New Product)	S_g	m	-	Δ *DTL*
(Old Product)	S_b	n	-	-Δ *DTL*
Medium	-	-	-	
(EC)	-	-	-	Δ *DTL*
(MM)	-	-	-	Δ *GTL*
Buyer	D	N_D	-	-
(Adopter of New Product)	D_r	N_r	TL_r	Δ *STLg*
(Adopter of Old Product)	D_b	N_b	TL_b	Δ *STLb*
(Potential consumer)	D_y	N_y	TL_y	

Table 3. Groups and Unchanged Parameter Values

Set	*S*	*Sg*	*D*	*Dr*		*Db*		*Dy*
Parameters	m/ n	Δ *DTL*	N_D	Δ *STLg*	TL_r	Δ *STLb*	TL_b	TL_y
Value	1	20	0	5	(10,+∞)	-10	(-∞,0)	[0,10]

5. COMPUTATIONAL EXPERIMENTS AND OUTCOMES

Given a simulation model above and a selected parameter combination, we complete the simulation experiment as follows. First, we generate a random social network, each including 50 consumer agents. Using each of EC scenario model and MM scenario model, we replicate the computational experiment of the new product diffusion process 300 times, and get totally 600 sets of results that can provide us a large sample statistic analysis.

We setup a model of a risk-aversion society, as a baseline for further comparisons. Figure 2 shows the initial moment. The circles in the center of the screen stand for the product agents, and the color of the circles tell that the red stands for the new product provider, and black for the old product. The ratio of red to black is equal to *m/ n*. The symbols of body shapes are the consumer agents, who walk randomly in the land. Here, we define the color of

the buyer agents, yellow for potential consumers, red for adopters for new products and black for adopter of old product. Figure 5 shows the ultimate situation after 5000 steps. The numbers besides the consumer agents show the value of *TL*. The numerous white spots on the screen are the EC or MM agents, who are generated by the direct transaction of product providers and then act as intermediary agents to disseminate trust information.

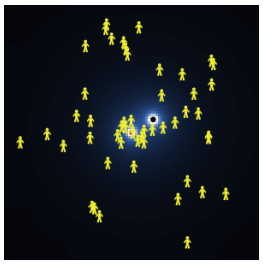

Figure 4. Initial Situation

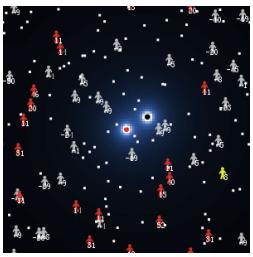

Figure 5. Ultimate Situation

5.1 Experiment Results

We are interested in the speed and scale of the product diffusion, in which the expected value and deviation are the most important issues. Since the aggregation of adopters of new product form the diffusion process, the most concerned number of N_r will be discussed at following.

Figures 6 and Figures 7 show the change process of the mean of N_r in blue solid line, and the standard deviation red dot dash line. It is glad to see that all the curves of N_r are going upwards. Here, we get the first obvious findings:

Finding 1: Both EC policy and MM policy lead to diffusion acceleration.

As shown in Figure 6, the highly convex curve in red dot dash proclaims a high volatility of the range of diffusion, at which we are not satisfied. In the first 1/5 period of the process, the standard deviation is very close to mean value. That implies a big risk to make no diffusion at a rather long time.

Finding 2: MM policy leads to higher risk at the initial stage.

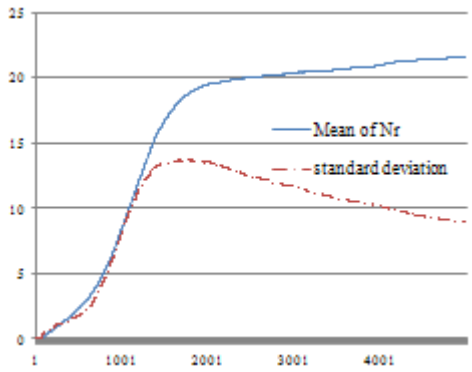

Figure 6. N_r In Indirect Experience Model

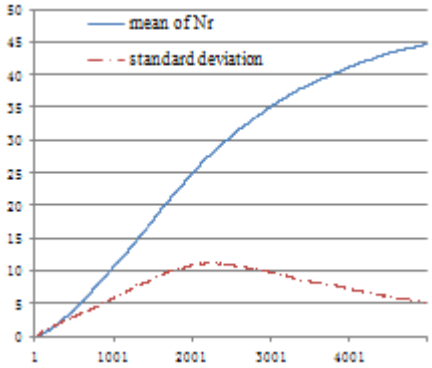

Figure 7. N_r In Direct Experience Model

Figure 8 compare the difference of the change process of the mean of N_r between the two models. The mean of *Nr* in direct experience model is the blue solid line, and the mean of *Nr* in indirect experience model is the red dot dash line. Obviously, the *Nr* of direct experience model stands above the indirect one. There is a distinct inflection point in the line of indirect experience model, which makes it more like the classical curve-"S shape" product diffusion curve. The range of diffusion in the direct experience model goes very steady upwards, with little speed reduction. There is also an interesting finding that there is a tangency point at a 1/3 of the process. That is to say, MM policy can get higher accelerated velocity at the initial stage of new product diffusion.

Finding 3: EC policy leads to a larger range of diffusion all the time.

Finding 4: MM policy is helpful to accelerate the diffusion process at the initial stage.

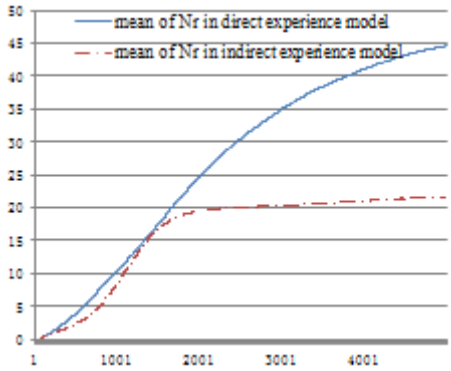

Figure 8. Comparison of N_r in Two Models

5.2 Managerial implications

Since the number of N_r represents the adopters of new products, we may interpret mean

value of N_r as the range of diffusion, and standard deviation of N_r as volatility of diffusion range, or risk on launching.Overall, EC policy, i.e. to increase the opportunity for consumers' direct experience, shows advantages in many aspects than MM policy. These advantages are the range of diffusion, the accelerated velocity, and risk control. An interesting phenomenon is that MM policy has some ability to accelerate the diffusion at the initial stage. Meanwhile, it can increase the risk of diffusion. An important implication of this phenomenon is that MM policy can be adopted at the initial launch stage to act as an auxiliary diffusion method.

6. CONCLUSIONS

In this article, we designed two computational experiments by stimulating the situation of building and transferring process in the market. We can compare two kinds of marketing policy: Policy 1 is to increase the opportunities for consumer direct experience; Policy 2 is to increase the opportunities for consumer indirect experience. In short, we named Policy 1 as EC policy, characterized by direct experience center for consumers, and named Policy 2 as MM policy, characterized by mass media.

Theories on the trust building and transferring are imported to the new product diffusion models. And it is interesting to find EC policy wins MM policy at the range of diffusion, the accelerated velocity, and risk control. An interesting phenomenon is found that MM policy has some ability to accelerate the diffusion at the initial stage. Precluding the serious drawbacks of increasing the risk of diffusion, MM policy can play as an auxiliary diffusion method at the initial stage.

There are some limitations to this study. Firstly, since the trust formation process is difficult to observe and measure, we can only utilized practitioners' and academics' conceptual models of trust building and transferring. There may be some details which may not support the actual nature of the trust formation process from a consumer's perspective.

And secondly, the implicit assumption of this model is that the social system is homogenous and fully connected. However, some fundamental phenomena about the properties of social network, which are directly influence the speed and spatial pattern of diffusion, have not been fully explained yet. New theories about partially connected and small-world networks will boost further research.

Nevertheless, this study offers some meaningful contributions. Firstly, on academic point, the current research proposes a way to investigate the market scale based on trust building and transferring on time variant process. This interactive process based on multi-agent models can be a new way to discuss the market scales in a dynamic way. Secondly, the results are practical that they can encourage e-commerce regulatory agencies to take more effective ways to increase the market size and decrease volatility of the market, which is beneficial to the whole society, both the buyers and sellers.

ACKNOWLEDGEMENT

This research was supported by the Natural Science Foundation of Fujian under Grant 2011J01383.

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