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The Probability Model of Expectation Disconfirmation Process

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This paper proposes a probability model to explore the dynamic process of customer's satisfaction. Bases on expectation disconfirmation theory, the satisfaction is constructed with customer's expectation before buying behavior and the perceived performance after purchase. The experiment method is designed to measure expectation disconfirmation effects and we also use the collection data to estimate the overall satisfaction and model calibration. The results show good fitness between the model and the real data. This model has application for business marketing areas in order to manage relationship satisfaction.

Keywords*: expectation disconfirmation theory, customer's satisfaction, stochastic model*

JEL Classification: *M31*

1. Introduction

Expectation disconfirmation theory (Boulding 1993; Cadotte, Woodruff, and Jenkins 1987; Churchill and Suprenant 1982; Oliver 1980, 1997; Oliver and DeSarbo 1988; Tse and Wilton 1988; Yi 1990; Zeithaml, Berry, and Para- suraman 1988) is to predict that customers make in advance of consumption act as a standard against which customers measure the firm's performance (Oliver 1980, 1997). It plays an important role in discussing customer satisfaction. The higher expectation of actual performance the customers have, the greater the degree of disconfirmation that may happen and this causes a lower satisfaction. This model considers satisfaction as a function which includes the difference between observed outcome (product) performance and prior expectations about the outcome's (product) performance (Kopalle and Lehmann, 2001). Thus, based on the stochastic concept, we propose the probability density function to explore the dynamic process that the satisfaction is constructed with customer's expectation before buying and the perceived performance after purchase.

The paper is organized as follows: first, we review the previous literature of expectation disconfirmation theory and its application of other researches. Secondly, we propose our model and describe its assumptions. Thirdly, the empirical data will be examined to estimate the parameters of the model. The results of model calibration will also be demonstrated. Finally, the conclusions will be explored.

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2. Literature Review

2.1. Expectation Disconfirmation Theory

Disconfirmation of expectations paradigm is conceptualized by Oliver (1980, 1997). It came from a subject of study for antecedents of satisfaction (Anderson and Sullivan, 1993). The standard approach to study the satisfaction involves comparison of prior expectations with observed performance. Thus in this theory, the customer's perception of overall satisfaction results from a comparison between expectation and outcome performance. Therefore, expectation and outcome performance are two important variables which can influence the judgment of satisfaction measure. Because customers' satisfaction is one of the crucial factor to predict the customer purchase tendency. To investigate satisfaction toward the products is also a main topic in customer behavior research. Based on expectation disconfirmation theory, a firm can increase satisfaction by increasing perceived product performance or decreasing expectations.

In the process of satisfaction judgments, first buyers may experience expectations of the specific product or service prior to purchase. Second, consumption reveals a perceive performance level of product which is influence by expectations if the difference between actual performance and expectations is perceived as being small. Hence, perceived performance may increase or decrease directly with expectations as indicated by the arrow drawn from expectations to perceived performance. Third, perceived performance may either confirm or disconfirm prepurchase expectation (Anderson and Sullivan, 1993). Fourth, satisfaction is positively affected by expectations and the perceived level of disconfirmation. When the outcome performance is object, it is difficult to increase the perceived performance. Thus, to decrease expectations is a viable alternative for the firm (Kopalle and Lehmann, 2001).

To sum up expectation disconfirmation theory, expectations provide a baseline or anchor level of satisfaction. It can also be considered as belief probabilities of what the consequence of an event will be (Oliver, 1980). In this research, we develop our stochastic model by this view of point.

2.2. Other Related Research

Anderson and Sullivan (1993) investigate the linkage between the antecedents and consequences of satisfaction. They find that the perceived performance which falls short of expectations has greater impact on satisfaction and repurchase intentions than performance which exceeds expectations. And disconfirmation is more likely to occur when performance is easy to evaluate.

Kopalle and Lehmann (2001) explore the role of disconfirmation sensitivity and perfectionism. The results show that customers who have more disconfirmation sensitivity or are more satisfied when a product performs better than expected, are hypothesized to have lower expectations. In contrast, customers who are perfectionists have higher expectations than those who are not.

Huang and Liu (2014) based on dynamical percept of customer satisfaction to explore the disconfirmation between expectation of pre-purchase and perceived actual performance of post-purchase. According to the stimulation of word of mouth in internet on different time points, they conduct the experiment in which expectation, perceive performance and reference point effect are manipulated. The results show that the anchoring effect and disconfirmation effect are exited. This study also finds the cognition inconsistency among three stages in the experiment. The perceived performance-satisfaction has less variance in the last stage compared to when it is paired with high-disconfirmation in the first stage, whereas perceived performance-satisfaction has more variance when paired with low-disconfirmation.

In the previous research of customer's satisfaction with disconfirmation theory, there is less research use of stochastic method to explore customers' behaviors. In this methodology, we can make calculation and prediction of future satisfaction and behavior by probability model development. Thus, we propose our model and use real data to test the model validation in the next section.

3. The Model

3.1. The Expectation

Based on Oliver (1980), we consider the expectation is a stochastic concept as a random variable x. X follows log normal distribution with the parameters μ_x and σ_{x2}. Its probability density function (pdf) is

$$f_X(x) = \frac{1}{x\sigma_\alpha\sqrt{2\pi}} exp\left[-\frac{(log\, x - \mu_\alpha)^2}{2\sigma_\alpha^{\,2}}\right] \quad , \quad x > 0 \tag{1}$$

We also consider $\alpha=log\ x$ is the normal distribution with parameter μ_α and σ_α^2.
The cumulative distribution function (cdf) of X is

$$F_X(x)=\Phi\left[\frac{(log\ x-\mu_\alpha)}{\sigma_\alpha}\right] \quad , \quad X>0 \tag{2}$$

In equation (2), Φ is the cumulative distribution function of the standard normal distribution.

3.2. The Outcome Performance

We also consider the outcome performance is a random variable y. Y follows another log normal distribution with the parameters μ_y and σ_y^2 . Its probability density function (pdf) is

$$f_Y(y)=\frac{1}{y\sigma_\beta\sqrt{2\pi}}\exp\left[-\frac{(\log y-\mu_\beta)^2}{2\sigma_\beta^{\ 2}}\right] \quad , \quad y>0 \tag{3}$$

We also consider $\beta=log\ y$ is the normal distribution with parameter μ_β and σ_β^2. The cumulative distribution function (cdf) of Y is

$$F_Y(y)=\Phi\left[\frac{(\log y-\mu_\beta)}{\sigma_\beta}\right] \quad , \quad Y>0 \tag{4}$$

In equation (4), Φ is the cumulative distribution function of the standard normal distribution.

3.3. The Joint Distribution

We consider the joint distribution of expectation(X) and outcome performance(Y) is

$$f_{XY}(x,y)=\frac{1}{2\pi xy\sigma_\alpha\sigma_\beta\sqrt{1-\rho^2}}\times \left\{exp\left[-\frac{1}{2(1-\rho^2)}\right]\times\left[\left(\frac{log\ x-\mu_\alpha}{2\sigma_\alpha}\right)^2-2\rho\left(\frac{log\ x-\mu_\alpha}{2\sigma_\alpha}\right)\left(\frac{log\ y-\mu_\beta}{2\sigma_\beta}\right)+\left(\frac{log\ y-\mu_\beta}{2\sigma_\beta}\right)^2\right]\right\} \tag{5}$$

In equation (5), ρ is the correlation coefficient of α and β and is estimate by

$$\rho=\frac{E\left[(\alpha-\mu_\alpha)(\beta-\mu_\beta)\right]}{\sigma_\alpha\sigma_\beta} \tag{6}$$

For conditional probability density function of Y given by X is

$$f_{Y|X}(y|x)=\frac{1}{y\sigma_{\beta|\alpha}\sqrt{2\pi}}exp\left[-\frac{(log\ y-\mu_{\beta|\alpha})^2}{2\sigma_{\beta|\alpha}^{\ 2}}\right] \tag{7}$$

In equation (7),

$$\mu_{\beta|\alpha}=\mu_\beta-\left[\rho\frac{\sigma_\beta}{\sigma_\alpha}(log\ x-\mu_\alpha)\right] \tag{8}$$

$$\sigma_{\beta|\alpha}=\sigma_\beta\sqrt{(1-\rho)^2} \tag{9}$$

Where $\mu_{\beta|\alpha}$ and $\sigma_{\beta|\alpha}$ are the mean and standard deviation of *Y* given by *X*. They can be calculated by (8) and (9).

The equation (7), demonstrate the concept of expectation disconfirmation theory in which the outcome performance (we consider as random variable *y*) is influenced by the prior expectation (we consider as random variable *x*). Then according to the conditional probability (equation (7)), we can calculate the different level of disconfirmation as satisfaction or dissatisfaction and finally predict the overall satisfaction. The detail of the description is in the next section and the real data will be also demonstrated to test this model.

3.4. The Model of Expectation Disconfirmation Theory

According to expectation disconfirmation theory (Oliver, 1977, 1980), if the outcome performance (we denote as *Y*) is larger than expectation (we denote as *X* which is considered as a constant quantity x_0), then the customer will feel satisfy. Thus, it can be present in equation (10).

$$\begin{aligned} &P\left(Y > x_0 \middle| X = x_0\right) \\ &= 1 - \int_o^{x_0} f_Y(y|x_0)\, dy \\ &= 1 - \int_0^{x_0} \frac{1}{y\sigma_{\beta|\alpha}\sqrt{2\pi}} exp\left[- \frac{\left(log\ y - \mu_{\beta|\alpha}\right)^2}{2\sigma_{\beta|\alpha}^{\ 2}} \right] dy \end{aligned} \tag{10}$$

On the other hand, if the outcome performance (we denote as *Y*) is smaller than expectation(we denote as *X* which is considered as a constant quantity x_0) , then the customer will feel dissatisfy. Thus, it can be present in equation (11).

$$\begin{aligned} &P\left(Y < x_0 \middle| X = x_0\right) \\ &= \int_o^{x_0} f_Y(y|x_0)\, dy \\ &= \int_0^{x_0} \frac{1}{y\sigma_{\beta|\alpha}\sqrt{2\pi}} exp\left[- \frac{\left(log\ y - \mu_{\beta|\alpha}\right)^2}{2\sigma_{\beta|\alpha}^{\ 2}} \right] dy \end{aligned} \tag{11}$$

4. The Empirical Data Analysis

4.1. The Database

We use survey data from customer's satisfaction of mobile phone use. This database is got from a mobile phone retailer company during 1 January to 30 March in 2014. This survey is about detecting a new mobile on sale. First, the respondents are asked to fulfill the questionnaires of the expectation before they purchase this new mobile phone. Then the data of outcome performance evaluation and the overall satisfaction are collected after one week. There are 5000 customers recruited by the company and 4012 respondents complete the whole process of survey. The respondent rate is 80.24% which includes 2487 (62%) males and 1525(38%) females. There are 1455(36%) respondents between 20-30 ages, 1982(49%) respondents between 31-40 ages and 575(15%) between 40-50 ages.

The data includes the measurement of the expectation, the outcome performance evaluation and the overall satisfaction with Likert seven point scale. The items of expectation and outcome performance evaluation are developed by Dodds et al.(1991) such as the product reliable, product quality and service quality are included in the measurement. The reliability of expectation and outcome performance evaluation demonstrates that the standardized Cronbach's α of expectation and outcome performance evaluation are respectively 0.913 and 0.962.The overall satisfaction is based on Kotler (2003) and measured by include using customer complaint rate, negative affect/emotions, reluctance to switch, customer service, first choice and search motivation. The standardized Cronbach's α of overall satisfaction is 0.922.

Then we use half of this data to estimate the parameters of the model and another half to test the predictive validity.

4.2. The Parameters Estimation

We use MLE (maximum likelihood estimate) to estimate the parameters in our model. Let L denote the total likelihood and n is the sample size. Then

$$
\begin{aligned}
&L(\mu_\alpha,\mu_\beta,\sigma_\alpha{}^2,\sigma_\beta{}^2,\rho)\\
&=\prod_{i=1}^{n} f_{XY}(\mu_\alpha,\mu_\beta,\sigma_\alpha{}^2,\sigma_\beta{}^2,\rho)\\
&=\left(\frac{1}{2\pi xy\sigma_\alpha\sigma_\beta\sqrt{1-\rho^2}}\right)^n \times \\
&\left\{ exp\, n\left[-\frac{1}{2(1-\rho^2)}\right]\times\left[\left(\frac{\log x-\mu_\alpha}{2\sigma_\alpha}\right)^2-2n\rho\left(\frac{\log x-\mu_\alpha}{2\sigma_\alpha}\right)\left(\frac{\log y-\mu_\beta}{2\sigma_\beta}\right)+\left(\frac{\log y-\mu_\beta}{2\sigma_\beta}\right)^2\right]\right\}
\end{aligned}
\tag{12}
$$

We differentiate $L(\mu_\alpha,\mu_\beta,\sigma_\alpha{}^2,\sigma_\beta{}^2,\rho)$ respectively regarding μ_x, σ_x^2, μ_y, σ_y^2 and ρ set them equal to zero. That is,

$$
\begin{cases}
\dfrac{\partial\mu_\alpha}{\partial} L(\mu_\alpha,\mu_\beta,\sigma_\alpha{}^2,\sigma_\beta{}^2,\rho)=0\\
\dfrac{\partial\mu_\beta}{\partial} L(\mu_\alpha,\mu_\beta,\sigma_\alpha{}^2,\sigma_\beta{}^2,\rho)=0\\
\dfrac{\partial\sigma_\alpha{}^2}{\partial} L(\mu_\alpha,\mu_\beta,\sigma_\alpha{}^2,\sigma_\beta{}^2,\rho)=0\\
\dfrac{\partial\sigma_\beta{}^2}{\partial} L(\mu_\alpha,\mu_\beta,\sigma_\alpha{}^2,\sigma_\beta{}^2,\rho)=0\\
\dfrac{\partial\rho}{\partial} L(\mu_\alpha,\mu_\beta,\sigma_\alpha{}^2,\sigma_\beta{}^2,\rho)=0
\end{cases}
\tag{13}
$$

We take the solutions of (13) as MLE for μ_x, σ_x^2, μ_y, σ_y^2 and ρ.

Finally, we use our empirical data which has been described in previous section to estimate these five parameters. The results are in table 1.

Table 1. *The Parameters Estimate*

μ_α	σ_α^2	μ_β	$\sigma_{\beta 2}$	ρ
5.53	0.24	6.88	0.42	1.42

4.3. The Predictive Validity

To test the fitness of real overall satisfaction and the calculation results of probability, we use the 0.5 as threshold level of probability. Then we calculate the rate of rule fitting of all samples and conduct the chi-square testing to test the results which are shown in table 2.

Table 2. *The results of chi-square testing*

	satisfaction	**dissatisfaction**
Fitness rate	97.88%	95.41%
X^2=14532 (p<.00)		

The rate of fitness is higher than 95% in all scenarios and the chi-square testing are significant. Then prediction analysis shows good fitness between the model and the real data.

5. Conclusion

The contribution of this research is to propose a stochastic model and use mathematical formula to demonstrate the expectation disconfirmation theory. We also use the real data to test our model and show good fitness. This model provides practical application of expectation disconfirmation theory. The marketing managers can predict customer's satisfaction by estimating their perceived outcome performance or expectation. To increase the overall satisfaction, there are two strategies the company can adopt. One is to control the expectation of customers before purchasing. The advertising of new product on sale or other promotion tactics play an important role to influence customers' expectation when new product arrival. Thus these promotion strategies should avoid making much highest expectation that actual product performance cannot reach. According to disconfirmation theory, the higher expectation of actual performance that customers have, the greater degree of disconfirmation may happen and this causes the lower the satisfaction. Another strategy is to increase the performance of this new product. Because the overall satisfaction is the result of comparing the expectation and product performance. When the expectation keeps the same quantity, the higher performance may case higher overall satisfaction. In the future, the marketing managers can use these two strategies to increase customers' satisfaction.

The limitation of this research is we use survey data to measure the research variables (expectation, the outcome performance evaluation and the overall satisfaction) in mobile phone market. In the future, other industrial data can also be conduct in this model to predict their business partnership satisfaction.

There are also some factors we don't consider in our measurement such as brand preference, use experiments and so on. These factors may influence the results of satisfaction. Thus, in the future, the experiment method can be conduct to collect the data. Then the other variables which we don't focus on can be controlled. It case the results of predicting will be more accurate when these disturbance variables are excluded.

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