A Logical Framework of Comparison Shopping Effectiveness and Comparison Challenge Methodology

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Abstract

This research describes the comparison broker's role and its effectiveness measurement using a developed logical framework of comparison shopping service. And verifies that seller-led comparison challenge method provide comparison information of products to buyers more efficiently. In electronic commerce, buyer's satisfaction of purchase (S) can be defined as an interactive function between seller's competitiveness vector (P) of products that supplied to the market, and buyer's informed level vector (B) of products that is known from a lot of sources. Then the buyer's informed level can be changed through the information analysis among products by transformation process using comparison matrix (C). So the role of comparison shopping is to construct a comparison matrix and to serve it to the buyers, and to change the buyer's informed level. The changed informed level influences a buyer's satisfaction, that improved satisfaction of purchase is defined as the effectiveness of comparison shopping. As a perfect provision and usage of comparison matrix is impossible cause of cognitive limit, the most efficient method for improving the comparison effectiveness is the comparison challenge that detects the comparison elements of the largest buyer's information efficiency, and then to be compared between elementary products selectively. This research verifies the substantial superiority of comparison challenge through television market data experiments.

Keywords:

Comparison Shopping, Effectiveness Measurement, Comparison Challenge, Information Efficiency

1. Introduction

Comparison shopping is the most popular aid tool for customer buying activity on the Internet. Its functional applications of comparison are very various in many area of commerce market for general consumers and business buyers. Most researches of comparison shopping are carried out and related to electronic commerce aid [11,9,5], business model design and its application [13,8,6], demographic and empirical studies [3,4], and technical supporting functionality development [2,9,11,12], etc. But there is no effectiveness measurement study or logical analyzing framework methodology of comparison shopping itself and its functionality. Currently many studies of comparison effectiveness validation are using the method of information search. So it is need to develop of a logical framework for effectiveness measurement and validation of the comparison shopping activity and its functionality.

The main problem of this research is how to measure the effect of comparison and how to explain the role of comparison broker. There are a lot of points of view to analyze comparison function, buyer's point of view, seller's point or intermediary's point. Buyer's satisfaction of purchase at the point of buyer's purchasing is valuable. In general, buyer's satisfaction of purchase (or efficiency of purchase) can be made when the buyer wholly knows about the sellers' competitive products and its information, and then buy the product at the right condition. With the problems of geographic proximity in the traditional commerce and the problems of information overflow in the electronic commerce area, the consumer can't detect the right information of sellers' product competitive product. So, he/she does not know product information completely and there exist the market inefficiency that the buyer can't buy the right product at the right condition, and consequently can't get satisfaction of purchase.

From the point of view, buyer's satisfaction of purchase can be defined as a functional relationship between the sellers' product competitiveness information and buyer's informed level of the information of competitiveness. The information gap of buyer's informed level can be measured as a basis of inefficiency, and can provide an improving methodology (or new business model) of comparison efficiency.

This research designs a logical framework of comparison shopping as a methodological approach to measure the buyer's satisfaction of purchase and buying efficiency. Using the framework of functional relation between seller and buyer's information vectors, this research describes the role of comparison function and its effectiveness. This research proposes the comparison challenge method as an improvement tool of comparison effectiveness, verifies

with exemplary TV data [10], and discuss its applying implications.

2. Framework description of buying efficiency

This section nominates and describes about 3 elements of framework of buyer's buying efficiency. To simulate and measure buyer's satisfaction of purchase, we define it as the level of the buyer's utility achieved by purchasing a product from a set of alternatives available in the market. At the pre-purchasing phase, we assume the buyer's satisfaction depends on the true competitiveness of alternative products, and the level of buyer's awareness of the competitiveness information. For simplification of formalism and its description, let's assume traditional market situation (no comparison broker case) at first and assume price only comparison product market, then price is the competitiveness.

2.1. Product's Competitiveness Vector (P)

Product's competitiveness vector is the degree of competitiveness, product's competitiveness level by itself within space n, It is a market given true vector and can be nominate like the next.

*P Vector = 1*n Product's competitiveness vector*

$$\mathbf{P} = (p_1, p_2, p_3, \ldots\ldots, p_n), \quad \sum_{i=1}^{n} p_i = 1, 0 \le p_i \le 1$$

Market share is a representative indicator of pi. These key variables were associated with company's profitability (ex, pretax ROI). Market share data of field televisions market can be an example scenario of P vector [10]. Using the market share of TV product-category of 2001, three exemplary scenarios of P vector for 10 products space are available.

- Projection TV: [0.194, 0.194, 0.187, 0141, 0.1, 0.062, 0.04, 0.035, 0.034, 0.011]
- Plasma/Flat panel Display: [0.348, 0.23, 0.155, 0.141, 0.101, 0.08, 0.08, 0.04, 0.02, 0.02]
- Indifferent Goods: [1/n, 1/n, 1/n, 1/n, 1/n, ...]

It is surrogated in P matrix like the next.

$$\mathbf{P} = \begin{bmatrix} P_1 \\ P_2 \\ P_3 \end{bmatrix} = \begin{bmatrix} 0.194 & 0.194 & 0.187 & 0.141 & 0.1 & 0.062 & 0.04 & 0.035 & 0.034 & 0.011 \\ 0.348 & 0.023 & 0.155 & 0.141 & 0.101 & 0.08 & 0.08 & 0.04 & 0.02 & 0.02 \\ 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 \end{bmatrix}$$

2.2. Buyer's informed level vector (B)

Buyer's informed level vector represents a level of buyer's awareness of seller's product competitiveness information. It is dependent on each buyer's situation, and is nominated to each product (Space n). Here informed level is an accuracy level of informedness.

*B Vector = 1*n Buyer's informed level vector*

$$\mathbf{B} = (b_1, b_2, b_3, \ldots\ldots, b_n), \quad \sum_{i=1}^{n} b_i = n, 0 \le b_i \le 1.$$

About B vector, each buyer has his own B. As a grand proposition of Δb_i, it is only influenced by the comparison. Like Bakos separate information search cost into quotable price information and non-quotable product information [1], this research divide buyer's informed level into before comparison level as a generic state from market and after comparison level. Then, we nominate some representative B scenario models for research purpose like the next.

- Extreme loyalty to p_1: [1, 0, 0, 0, 0, 0, 0, ...]
- Full indifference: [1/n, 1/n, 1/n, 1/n, 1/n, ...]
- General case: [0.9, 0.7, 0.5, 0, 0, 0.3, 0, 0, 0.1, 0]

It is surrogated in B matrix like the next. For the general case scenario, brand awareness can be a typical indicator.

$$\mathbf{B} = \begin{bmatrix} \mathbf{B}_1 \\ \mathbf{B}_2 \\ \mathbf{B}_3 \end{bmatrix} = \begin{bmatrix} 0.9 & 0.7 & 0.5 & 0 & 0 & 0.3 & 0 & 0 & 0.1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 & 0.1 \end{bmatrix}$$

2.3. Buyer's Satisfaction of Purchase (S)

Buyer's satisfaction of purchase is nominated as a scalar resulting from the inner product calculation between P vector and B vector. For each buyer with condition of $0 \le S_i \le 1$, $S_i = 1$ represents a fully informed level to each products' competitiveness, 0 represents non informed level to each products' competitiveness.

$$S_i = f(\mathbf{P}, \mathbf{B}) = \mathbf{P} \cdot \mathbf{B}$$

$$= (p_1, p_2, p_3, \ldots, p_n) \cdot (b_1, b_2, b_3, \ldots, b_n) = \sum_{i=1}^{n} p_i \cdot b_i$$

There are two research propositions.

Proposition 1: If a buyer fully knows about all products, overall buyer's satisfaction of purchase (S) is always 1.

If $b_i = 1$ for all i, Then, as $\sum_{i=1}^{n} p_i = 1$, $S_i = \sum_{i=1}^{n} b_i = 1$

Proposition 2: for $\exists_a$, $\exists_b$ products, if competitiveness status $p_a > p_b$ and $b_a > b_b$ (a buyer knows more about product a information than others), then $S_a > S_b$.

- **Sub proposition 2-1**: if $p_a = p_b$ and $b_a > b_b$, then $S_a > S_b$

- **Sub proposition 2-2**: if $b_a = b_b$ and $p_a > p_b$ (product a is more competitive than others), then $S_a > S_b$

3. Comparison matrix

Buyer's informed level (B) can be changed only through the information analysis among products. Comparison matrix (C) provides the transformation process of the B vector. So the role of comparison shopping is to construct a

comparison matrix [5] and to serve it to the buyers, and then change the buyer's informed level.

The element c_{jk} of comparison matrix **C** is a degree of comparability between product j and product k. Comparability is depend on the number of the comparison. Product space n is the number of items in a certain comparison site that a buyer will search for selection.

$$\mathbf{C}=\begin{bmatrix} c_{11} & c_{12} & c_{13} & \cdots\cdots & c_{1n} \\ c_{21} & c_{22} & c_{23} & \cdots\cdots & c_{2n} \\ c_{31} & c_{32} & c_{33} & \cdots\cdots & c_{3n} \\ \cdots\cdots & \cdots\cdots & \cdots\cdots & c_{jk} & \cdots\cdots \\ c_{n1} & c_{n2} & c_{n3} & \cdots\cdots & c_{nn} \end{bmatrix}$$

Comparison matrix can be nominated like the next.

$\mathbf{C}=[c_{jk}]$ for $j = 1,\ldots, n$, and $k = 1,\ldots, n$.

$$0 \le c_{jk} \le 1,\ c_{jk} = c_{kj},\ c_{jj} = 1$$

Where $c_{jk} = 0$ nominates no comparability between product j and product k, and 1 nominates full comparability. There exist a lot of limitation of the normal comparison broker who provide a comparison matrix service. Such as broker's fairness assurance, comparison analysis capability (# of comparison) problem, and comparison complexity (# of attributes) problem are representative. If we consider only the number of comparison, then a general broker's **C** could be like the next.

$$\mathbf{C}=\begin{bmatrix} 1 & 1/n & 1/n & \cdots\cdots & 1/n \\ 1/n & 1 & 1/n & \cdots\cdots & 1/n \\ 1/n & 1/n & 1 & \cdots\cdots & 1/n \\ \cdots\cdots & \cdots\cdots & \cdots\cdots & 1 & \cdots\cdots \\ 1/n & 1/n & 1/n & \cdots\cdots & 1 \end{bmatrix}$$

3.1 Transformation of B

In this section, a grand proposition for this research is described.

Grand Proposition: Buyer's informed level(b_i) can be changed through the information analysis among products.

Through the transformation process with comparison matrix, comparison broker's role is defined as $b_i^{old} \Rightarrow b_i^{new}$, so we can define as $\mathbf{B}^{new} = g(\mathbf{C}, \mathbf{B}^{old})$.

3.2 Comparison function of g(C, B)

Comparison matrix does transform a buyer's B vector. So this research defines the comparison function of transformation like as.

$$b_i^{new} = Max(C_{i1} \cdot b_1^{old}, C_{i2} \cdot b_2^{old}, C_{i3} \cdot b_3^{old}, \ldots\ldots, C_{in} \cdot b_n^{old})$$

The comparison function g(C,B) of informed level transformation has a lot of characteristics like the next.

1. $0 \le b_i \le 1$ for all i
2. $\Delta b_i \ge 0$ for all i
3. $b_i^{new} \le \max(b_i^{old})$ for all i.
4. If $C_{in}b_n^{old} = MAX(\ldots.) > C_{ii}b_i^{old} = b_i^{old}$ for all i, then $b_i^{new} = C_{in}b_n^{old}$
5. If $\Sigma\, b_i^{old} = 0$ for all i, $\Sigma\, b_i^{new} = 0$ for all i

Above characteristics are inherited from the definition of buyer's satisfaction of purchase. If there is no initial information of the product, additional information gain by comparison is impossible.

3.3 Effectiveness of comparison

The changed buyer's informed level influences a buyer's satisfaction, and that improved satisfaction of purchase are defined as the effectiveness of comparison shopping. New buyer's satisfaction of purchase (S^{new}) is the converged information efficiency value after considering the comparison between the products.

$$S^{new}{}_i = f(\mathbf{P}, \mathbf{B}^{new}) = f(\mathbf{P}, g(\mathbf{C}, \mathbf{B}^{old})) = \mathbf{P} \cdot g(\mathbf{C}, \mathbf{B}^{old})$$

Next the buyer's satisfaction improvement is the effectiveness of the comparison function.

$$\Delta S = S^{new}{}_i - S^{old}{}_i$$

Where S^{old} is the buyer's satisfaction before comparison. And S^{new} is the buyer's satisfaction after comparison activity by the buyer *i*.

3.4 Comparison broker's role

From the above description of comparison matrix, the role of comparison broker is defined like in Figure 1 as the supporting service to construct a comparison matrix and to serve it to the buyers, and to improve the buyer's informed level.

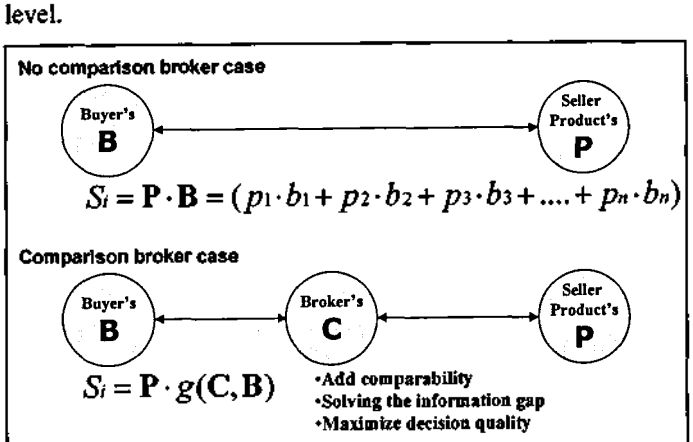

Figure 1. Role of comparison broker.

4. Comparison Challenge method

If a perfect comparison matrix is possible, then all c_{jk} =1. But it is impossible because of the comparability problem. As a perfect provision and usage of comparison matrix is impossible because of cognitive limit, the most efficient method for improving the comparison effectiveness is the comparison challenge that detects the comparison elements of the largest buyer's information efficiency, and then to be compared between elementary products selectively.

Comparison challenge method enables that ideal comparison condition through comparison challenge at some degree like in Figure 2. The number of challenge inherited the same problem of the number of comparison. But broker can't challenge selectively, because of its fairness condition

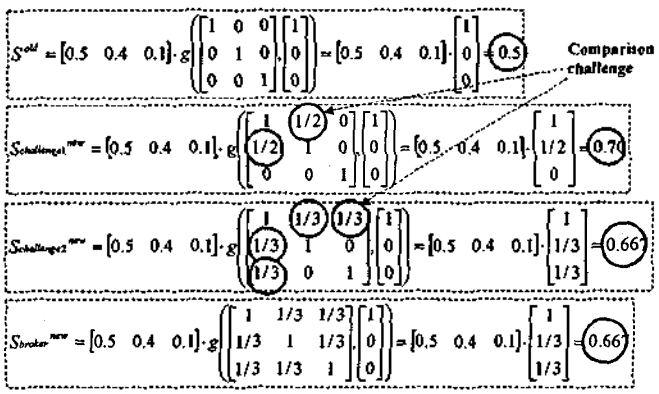

Figure 2. Illustration of comparison challenge.

Let's see the illustration of comparison challenge in Figure 2. Using $\mathbf{P}=[0.5 \quad 0.4 \quad 0.1]$, $\mathbf{B}=[1 \quad 0 \quad 0]$, it shows and compares four satisfactions of purchase calculation. Those are satisfaction of old as an initial state, first challenge, second challenge, and general comparison broker. From this illustration procedure, we can analogize the effectiveness of challenge. The comparison efficiency (buyer's satisfaction of purchase) decreases inversely proportional to the number of comparisons (Challenges) like in Figure 3. Using the illustration data in Figure 2, exemplary efficiency gain by comparison challenge is calculated as 0.7-0.667=0.003.

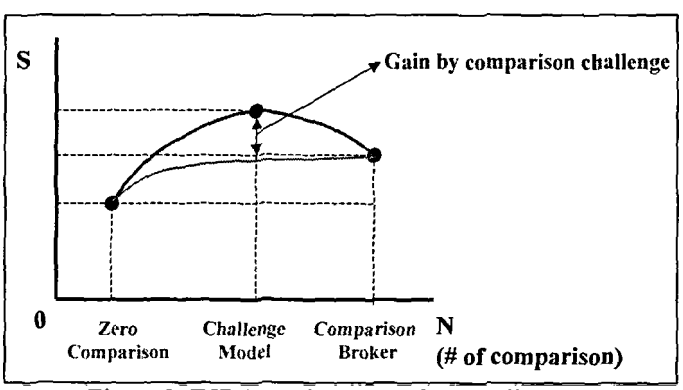

Figure 3. Efficiency by comparison challenge.

We can get some observations intuitively about applying the comparison challenge method.

Observation 1: Optimal number of comparison exists, but nobody knows.

Observation 2: Buyer's satisfaction of purchase can be improved by offering the competitive information (comparison challenge), not by impossible perfect comparison.

From these derived observations, we can think about some issues Such as who are relevant to challenge the comparison. As an answer, maker may challenge comparison because they know perfectly their own competitiveness and others. And limited number of sponsor can challenge the comparative advertisement. But it is not the role of comparison broker, cause of intermediary fairness.

5. Evaluation analysis

In this section, this research evaluates and analyzes the effect of comparison challenge method using the scenarios of B vector, and scenarios of P vector that described in section 2. Basically we used three B vector cases that described in section 2.2, B_1(extreme loyalty to one product), B_2(full indifference), B_3(General case). And then examined four measurement of comparison efficiency such as S^{old}, $S_{broker}{}^{new}$, $S_{challenge}{}^{new}$ and $\Delta S = S^{new} - S^{old}$.

For example $\{P_1, B_1\}$ case: when the buyer has extreme loyalty to product 1 that has supreme competitiveness of market share, this research verifies that comparison efficiency curve decreases inversely proportional to the number of comparisons like in the result of Table 1 and Figure 4.

	B_1 (Extreme loyalty)				
	S^{old}	$S_{broker}{}^{new}$	ΔS_{broker}	$S_{challenge}{}^{new}$	$\Delta S_{challenge}$
P_1 (Projection TV)	0.194	0.273	0.081	0.325	0.131
P_2 (Plasma Display)	0.348	0.413	0.065	0.479	0.131
# of Challenge (# of comparison)	# of comparison=0	# of comparison=1 0		# of comparison=4,4 2→1 challenge 3→1 challenge 4→1 challenge 5→1 challenge	

Table 1. Evaluation result by cases

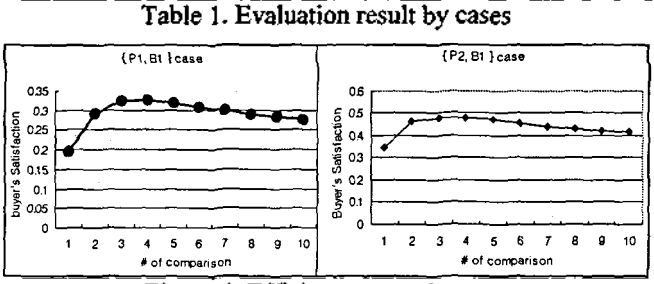

Figure 4. Efficiency curve by cases

5.1 Implications from analysis

From the observations of evaluation test by B scenario cases, we found some remarking result and implications. For differentiated goods of B_1 and B_3, $\Delta S_{challenge}$ is always higher than ΔS_{broker}.

The next part of this section is remarkable implications of comparison challenge method.

Implication 1: Challenging to the more informed level products increase the buyer's satisfaction of purchase more effectively. So, $\Delta S \propto \Delta b_i$

Implication 2: The more competitive product's comparison challenge to the product of more informed level increase the buyer's satisfaction of purchase. So, $\Delta S \propto \Delta b_i$, then $\Delta S \propto |pi|$

Implication 3: Product of no competitiveness has no ΔS by comparison challenge.

Implication 4: Buyer of indifferently informed level (fully informed level) has no ΔS effect by any comparison challenge and ordinary comparison broker

5.2 Derived challenge strategies

From the previous implications and observations, we can find the seller who is most relevant to challenge the comparison. The seller can challenge comparison because they know perfectly their own competitiveness and the buyer's informed level to his product and others'. Limited number of advertising sponsor can challenge the comparative advertisement [7,6]. And comparison broker can't challenge because of fairness problem.

As a research result, we propose and promote seller oriented comparison challenge strategies. By formalizing the challenge relationship (challenger-challengee) of 1:1, M:1, M:1, and more extremely M:M challenge relationship consideration, using competition challenging types within competition grid of competitiveness and informedness, and considering the comparison complexity (evaluated # of attributes) additionally, the challenge strategies can be elaborated.

6. Conclusion

As the research contributions, this research describes the comparison broker's role and its effectiveness measurement using a developed logical framework of comparison shopping service. For those results, research defined an interactive function between seller's competitiveness vector (P) of products and buyer's informed level vector (B) to valuate buyer's satisfaction of purchase (S) scalar. And developed the buyer's informed level transformation process of functional approach using comparison matrix (C) to explain the improvement of buyer's informed level. So the role of comparison shopping is defined and the effectiveness of comparison shopping is measured. As the most efficient method for improving the comparison effectiveness, the comparison challenge is proposed and verifies that seller-led comparison challenge method provide comparison information of products to buyers more efficiently. This research verifies the substantial superiority of comparison challenge through television market data experiments.

There exist more research to be done. It needs more sensitivity analysis over buyer group, product characteristics, and by scenario classification. More strategy research and development needs for applying the comparison challenge.

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