기술혁신의 경쟁우위에 대한 entrepreneurial 접근

Competitive Advantage of Product Innovation and Entrepreneurial Approach on Innovation

김원준*, 이정동**, Subrata K. Sen***. K, Sudhir****

* KAIST (wonjoon.kim@kaist.ac.kr)
** Seoul National University (leejd@snu.ac.kr)
*** Yale School of Management (subrata.sen@yale.edu)
****Yale School of Management (k.sudhir@yale.edu)

Abstract

This paper develops and defends the concept of *reference-quality* in consumer choice, demonstrating its impact on aggregated market demand. The concept of reference-quality refers to an internal standard against which observed qualities are compared in consumer choice behavior. In doing so, we examine and reveal the formation mechanism and the structure of reference-quality in the U.S. wireless phone market. Consequently, we recognize and introduce a brand-specific reference both in price and product quality in aggregated product demand which enable us to measures the responsiveness of market demand to the innovation of a certain brand.

1. INTRODUCTION

This paper develops and defends the concept of *reference-quality* in consumer choice, demonstrating its impact on aggregated market demand. The concept of reference-quality refers toan internal standard against which observed qualities are compared in consumer choice behavior. In doing so, we examine and reveal the formation mechanism and the structure of reference-quality in the U.S. wireless phone market. Consequently, we recognize and introduce a brand-specific reference both in price and product quality in aggregated product demand which enable us to measures the responsiveness of market demand to the innovation of a certain brand.

Most research on reference formation in consumer behavior has been centered on consumers' price perception and its effect on market demand, since Kahneman and Tversky have introduced the Prospect Theory in 1979. The concept of reference price is that the standard to which consumers compare against observed price are internal. Grounded in psychology and the Prospect Theory (Kahneman and Tversky 1979), previous approaches assumed two alternative viewson how reference prices may be formed (Kalyanaram and Winer 1995; Mazumdar and Papatla 2000). The one view is that consumers remember the past prices – *temporal price* – and decide how much they should pay for a brand (Kalwani et al. 1990; Kalyanaram and Little 1994; Lattin and Bucklin 1989; Winer 1986) and the other view is that a reference price is formed during a purchase occasion based on the observed price of other brands – *contextual price* – (Hardie et al. 1993; Mayhew and Winer 1992). Both the temporal price and contextual price seem to be relevantas reference prices (Rajendran and Tellis 1994; Mazumdar and Papatla 2000). However, an important question remains unanswered. Do consumers consider only price when they form their reference? What about product quality?

Surprisingly, economists and marketers have not fully appreciated the roleof reference formation that plays in consumers' perception of product quality. Most previous studies have assumed that consumers' perceptions and expectations of product quality are constant both contextually and temporally and that reference plays no role, although Tverksy and Simonson (1993) demonstrated that the reference-dependent evaluation of an attribute applies not just to price but to all other product quality. Recently, studies on the compromise effect, whereby brands gain share when they become intermediate options in a choice set, have considered the contextual-reference concept in consumers' quality perception. (Simonson 1989; Simonson and Tversky 1992; Tversky and Simonson 1993; Kivetz, Netzer, and Srinivasan 2004). However, the research in compromise effect has been limited to experiments where subjects had only a few choice alternatives. Still, these studies did not recognize that consumers' reference formation in quality perception may have significant impact on aggregated market demand and play important role in probabilistic choice models.

Hardie et al. (1993) also examined the existence of reference-quality at individual level using scanner panel data for refrigerated orange juice market, when they explore consumers' behavior of loss averseness. They found that the multinomial logit models with reference-dependent price and product quality perform better than the one without reference and the one with temporal reference price. However, they use the price and product quality of the last brand purchased by consumer as the reference, and did not consider consumer heterogeneity, which is imperfect and controversial. Consequently, not only the formation mechanism of reference-quality and its impact on aggregated market demand remain to be further explored, but the structure of reference-point in consumers' perception of both price and product quality remain unexamined.

In addition, recognizing and evaluating the effect of reference-quality is becoming more important given the turbulent environment created by innovations in the current high-tech market. Wireless phones, PDAs, Laptops, etc. are competitively introduced with lots of new features, advanced quality, and competitive prices. The frequent introduction of new products in the high tech market creates two salient features in consumer choice which affect consumers'quality perception. First, they expand consumers' choice set, facilitating broader product comparisons. Secondly, they rapidly improve consumers'experience curve on product quality over time. Therefore, as consumers face new products with advanced and unique characteristics, their expectations (internal) with respect to quality levels develop. The internet has encouraged this evolution of consumer behavior by facilitating comparisons between broader selectionsof new products on-line. Thus, as the pace of technological innovation accelerates, consumers'expectations about product quality rapidly changes over time, which may substantiate the impact of reference-quality on product demand.

In this paper, therefore, we establish and develop consumers'reference formation behavior regarding product quality in aggregated product demand. We empirically confirm the existence of dominant reference-quality in aggregated demand using a non-nested test for random coefficient model, which encompassesconsumer heterogeneity, in the case of the U.S. wireless phone market. In addition, we further explore processes of reference formation in two ways: how consumers' references are formed and how they are structured. Are consumers' references formed inter-temporally or contextually? If so, what is the dominant reference-point of product quality in a market?

For the first question, we assume that, in the high-tech market, consumers look to current, not past quality level because of the consistent decline of price and incessant improvement of product quality. In addition, we assume that consumers may not remember past information about product quality, therefore, consumers have limited ability to compare product quality inter-temporally. We test and confirm our hypothesis that the effect of contextual reference-quality is more substantial than that of temporal reference-quality. With regard to the second question – the structure of dominant reference-quality, we assume three extreme cases of reference-quality to simplify our empirical approach and confirm the dominant reference-point in reference-quality: average, maximum, and minimum level of product quality in a given market.

Finally, the existences of dominant reference both in price and product quality in aggregated market demand enable us to introduce brand-specific reference-price and -quality. By introducing the brand-specific reference-points in price and product quality variables, we measure the responsiveness of market demand to the innovation of a certain brand's product attribute – *innovation-elasticity*. By comparing the brand-specific innovation-elasticity, we examine the competitiveness of a brand's attribute in a given market.

2. MODEL

2.1. Basic Models of Reference-Quality

Most intuitive and direct way to describe reference structure in consumer choice is a subtractive form which measures gain or loss from an actual attribute level with its absolute distance from individual reference point. Most of previous literature on reference-price assumed this subtractive form of reference formation (Kivetz et al. 2004; Rajendran and Tellis 1994; Erdem et al. 2001; Kalyanaram and Little 1994; Mayhew and Winer 1992). Adopting the conventional form of reference-price model, following is an 'absolute-reference model' for quality and price:

$$\tilde{x}^a_{ijt} = \sum\nolimits_k (x_{jkt} - \bar{x}_{ikt})$$
$$\textit{where } i = 1,\ldots, I,\ k = 1,\ldots, K, \textit{ and } j=1,\ldots,J_t \quad (1)$$

where $\tilde{x}^a_{ijt}$ is the value functions of an attribute, priceor quality, and x_{jkt} is an attribute k of product j at time t, and $\bar{x}_{ikt}$ is reference-quality of individual i on attribute k at time t. Therefore, the absolute-reference model measures an absolute distance of product quality (price)from an actual level of product quality (price).

In case of ‘relative-reference model’, we measure a consumer’s value from an attribute through a ratio between an actual level of attribute and an individual reference level (see Equation 2). Therefore, in contrast to the absolute-reference model in which the gain has positive value and the loss negative value, the gain and loss from reference point are greater or less than 1 with positive values.

$$\tilde{x}^{r}_{ijt} = \sum\nolimits_{k} (x_{jkt} / \bar{x}_{ikt})$$

where i = 1,…, I, k = 1,…, K, and j=1,…,J_t (2)

In our empirical exploration, we choose the ‘relative-reference model’ based on two reasons Supporting analyses have been abstracted due to the page constraints of Symposium’s proceedings. : first, the estimated results show that the ‘relative-reference model’ fits better than the ‘absolute-reference model’. Second, we follow consumer behavioral aspect that consumers perceive the difference of their choice alternatives in relative degree rather than absolute degree.

If we take current attribute level as reference-point whether it is price or quality, the model becomes contextual-reference model. If we take past attribute level as reference-point, the model becomes temporal reference-model.

2.2. Dominant Reference Point

Important point to be noted here is that above models are proper representations in case of individual-level reference structure with *i* subscription in all functions. In case of reference-price study, most research used individual level price data using scanner data to identify the existence of consumers’ reference formation behavior at individual level (Rajendran and Tellis 1994; Erdem et al. 2001; Kalyanaram and Little 1994; Mayhew and Winer 1992). In addition, only *average price* were used as contextual reference point (Rajendran and Tellis 1994) in reference-price literature.

Here, we assume two distinctive assumptions: first we assume that individual reference-point of price and qualities are normally distributed across the population and there exists *a dominant reference-point* for each attribute in the market. Here, the dominant reference-point is the population mean of those normal distributions. Second, we assume three different contextual reference points – *maximum*, *minimum*, and *average*. Surely, the reference point will vary over individuals, attributes, and time with certain distributionsand, therefore, the dominant reference-point of an attribute will also vary over the span of quality or price in a given market. However, we take those three extreme forms of contextual reference point in order to focus on the empirical confirmation of reference-quality. Under these two assumptions, we empirically test the existence of a unique reference-point for each attribute at the market level and further examine the formation mechanism of reference-point Putler (1992) assumes the normal distribution of reference-point in his study on reference-price. In addition, he reflected asymmetric gain and loss effects on demand by incorporating truncated normal distribution in his empirical estimation. We do not incorporate the asymmetric distribution of reference-quality, since the relative-reference model embeds the asymmetric gain and loss effect. .

Therefore, the temporal reference point in our model is the past contextual reference point which has been dominant in the market during the past periods In reference price literature, the contextual price is current price of a brand chosen and the temporal reference price is past price paid for a brand by an individual. . The contextual and temporal reference model in the case of relative reference-model can be represented as follows:

<u>Relative contextual-reference model:</u>

$$\tilde{x}^{r}_{ijt} = \sum\nolimits_{k} (x_{jkt} / \bar{x}^{CT}_{ijt}) \qquad (3)$$

where i = 1,…, I, k = 1,…, K, j=1,…,J_t, and CT = maximum / average / minimum

<u>Relative temporal-reference model:</u>

$$\tilde{x}^{r}_{ijt} = \sum\nolimits_{k} (x_{jkt} / \bar{x}_{ij(t-\tau)}) \qquad (4)$$

where i = 1,…, I, k = 1,…, K, j=1,…,J_t, and τ = 1,…, T

where τ is a time lag denoting $\bar{x}_{ij(t-\tau)}$ as lagged reference quality orprice, respectively.

2.3. Demand Specification

The economic-econometric model appropriate for the verification of suggested reference-quality models is a standard random coefficient discrete choice model for demand analysis (e.g. McFadden 1984; Berry 1994; Berry, Levinsohn and Pakes 1995; Nevo 2001; Sudhir 2001). It should be noted, however, that the objective is to determine which model fits the data better rather than derivation of precise estimates.

Assume the consumer chooses in each month *t* among N_t different products. Using the typical notation for discrete choice models of demand, the indirect latent utility of consumer *i* from buying product *j* during month *t* is given by

$$U_{ijt} = d_j + \tilde{x}^a_{jt}\beta_i - \alpha_i \tilde{p}^a_{jt} + \xi_{jt} + \varepsilon_{ijt} \qquad (5)$$

where d_j represents product (brand or manufacturer) fixed effects capturing time invariant product characteristics, $\tilde{x}^a_{jt}$ are the aggregate-level reference-quality variables of product characteristics, $\tilde{p}^a_{jt}$ is the aggregate-level reference-price variables of product j, ξ_{jt} identifies the mean across consumers of unobserved (by econometrician) product characteristics and ε_{ijt} represents the distribution of consumer preferences about this mean. The random coefficient β_i are unknown consumer taste parameters for the gains/losses from reference-quality for different product characteristics, and the α_i represents the marginal utility of gains/losses of price. These taste parameters are allowed to vary across consumers according to

$$\begin{pmatrix}\alpha_i \\ \beta_i\end{pmatrix} = \begin{pmatrix}\alpha \\ \beta\end{pmatrix} + \prod D_i + \Sigma \upsilon_i$$
$$\upsilon_i \sim N(0, I_{K+1}) \qquad (6)$$

where K is the dimension of the observed characteristics vector, D_i is a d x 1 vector of consumer characteristics such as demographics, Π is a $(K+1)$ x d matrix of non-linear parameters that captures the observed heterogeneity, that is, deviations from the mean in the population of the taste parameters and marginal utility of price due to demographic characteristics D_i We do not consider consumer characteristics in our empirical estimation. .
The specification of the demand system is completed with the introduction of an outside good which is the option for the consumers not to purchase any of the brands. As usual, the mean utility of the outside good, δ_{0t}, is normalized to be constant over time and equal to zero. The observed market share of product j is given by $s_j = q_j / M$, where q_j are the units sold and M is the market size which is proportional to total populationIn this case, M is total population of U.S. who are available to purchase wireless phone. .

Let $\theta = (\theta_1, \theta_2)$ be a vector containing all parameters of the model. The vector $\theta_1 = (\alpha, \beta)$ contains the linear parameters and the vector $\theta_2 = (vec(\prod), vec(\Sigma))$ the non-linear parameters. Therefore, the utility becomes

$$U_{ijt} = \delta_{jt}(d_j, \tilde{x}^a_{jt}, \tilde{p}^a_{jt}, \xi_{jt}; \theta_1) + \mu_{ijt}(\tilde{x}^a_{jt}, \tilde{p}^a_{jt}, \upsilon_i, D_i; \theta_2) + \varepsilon_{ijt} \qquad (7)$$

$$\delta_{jt} = d_j + \tilde{x}^a_{jt}\beta_i - \alpha_i \tilde{p}^a_{jt} + \xi_{jt}$$
$$\mu_{ijt} = [\tilde{x}^a_{jt}, \tilde{p}^a_{jt}]'*(\prod D_i + \sum \upsilon_i)$$

where $[\tilde{x}^a_{jt}, \tilde{p}^a_{jt}]$ is a $(K+1)$ x 1 vector. The utility is represented with the mean utility, δ_{jt}, and a mean-zero heteroskedastic deviation from that mean, $\mu_{ijt} + \varepsilon_{ijt}$, which captures the effects of the random coefficients. Under the assumption that ε_{ijt} is distributed i.i.d. with extreme, allowing consumer heterogeneity to affect the taste parameters for the different product characteristics, equation (7) becomes full random coefficient model If we assume that ε_{ijt} is distributed i.i.d. with an extreme value type I density, the equation (16) becomes Multinomial Logit model.

3. Data and Estimation

3.1. The Data

The data set used in this paper comes primarily from NPD Techworld, a leading marketing research company in the field of the consumer electronics, information technology and imaging markets. NPD Techworld collects both point-of-sale (POS) and consumer tracking information. The data set for U.S. wireless phone market has been collected by surveying sampled consumers in all over the states from January 2000 to April 2004 (40 monthly observations). In addition, the data has been adjusted using demographic characteristicsthe surveys has been sent out in a way that istoUS Census numbers in terms ofgeography, gender, income levels, household size and age Since the surveys don not always return in the same proportions, they adjusted the data accordingly. . Then, total units sold and revenue for each product during a month was calculated by projecting up from the actual respondents For example, let's say the US population is 250 million and 25,000 respondents during a particular time period reported.of that 25,000, 1% or 250respondents reportthat they purchased a new cell phone ‘A’.By projecting up to the total population, we would say that during that time, 2.5 millionsof cell phone ‘A’ was purchased. If a particular transaction involves more than one phone being purchased, it is adjusted as well..Therefore, the data is consistent with our empirical estimation of random coefficient model, because we use the total U.S. population of the U.S. Census Bureau for the potential market size (M_t) of the market.

The original data sample included 338 wireless phone models. Product with extremely low sales volumes, models differing only in minor characteristics (phone book capacity, number of ring tones, etc.) were aggregated. As a result, our final sample contains data on 316 models from 22 manufacturers. As described in previous section, the industry has high rates of technological innovation and obsolescence The average replacement periods of the wireless phone in the U.S. are 16 months in 2000 and became 18 months during 2002 to 2004, respectively. (J.D. Power and Associate Reports, Oct. 24, 2002.), especially, during 2001 and 2002. Therefore, the panel is unbalanced and we treat each month-model pair as a single observation having the total sample size as 4847.

This panel is supplemented by the data on the product attributes compiled by the authorsfrom several sources, primarily from epinoions (www.epinions.com), DealTime (www.dealtime.com), and manufacturers' on-line documentation. Product characteristics for which we have data include 14 categories with total 41 characteristics, such as size, weight, type and size of display, battery time, types of digital camera, etc. However, In order to examine the various reference-points in price and product characteristics both contextually and temporally, it is required to restrict the number of product characteristics variables into a few, which simplifies the scheme of analysis, on the one hand, and reduces the effect of inconsistent correlation among the variables when the reference-point changes. We also need to exclude some of the variables to reduce problems of multicollinearity. Therefore, we select 2 product characteristics base on ANOVA analysis: *Weight* and *Talk-Time*.

3.2. Estimation

We estimate the models following the algorithm used by BLP (1995). However, we are able to identify the demand side without specifying a functional form for the supply side following Nevo (2001). The key idea is to estimate the demand parameters that produce market share of a product close to the observed one. This procedure is non-linear in the demand parameters and the price is endogenous. Therefore, following Berry (1994), demand equation is constructed to be linear in the parameters so that we can use instrumental. Therefore, following Berry (1994), demand equation is constructed to be linear in the parameters so that we can use instrumental variables estimation with GMM method.

3.3. Formal Ranking of the Models

We present different models of reference-quality which based on the different assumption of reference formation mechanism, and the objective is to determine which model fits the data better. Because most of the models can not be nested in another reference-quality model, we apply the non-nested testing procedure proposed by smith (1992)Smith (1992) proposed a Cox-type non-nested test for competing models estimated by GMM. Non-nested linear regression models with heteroscedasticity and serial correlation of unknown form and differinginstrumental validity assumptions are encompassed. . For the reference-quality models, we identify two particular cases of comparisons between each pair of competing models (Vuong 1989, Villas-Boas 2002): the one is the case when two competing models are strictly non-nested (SN). The otheris overlapping model which has common explanatory variables and different additional explanatory variables (OV). Both for the strictly non-nested and overlapping model comparisons, we use Cox-type test to examine the difference of GMM criterion functions for two competing models under one of the competing hypothesis. We follow two-step procedure as proposed by Vuong (1989).
There are two competing regression models H_g and H_h as follows:

$$H_g : y = X_g \beta + u_g \tag{8}$$

$$H_h : y = X_h \gamma + u_h \tag{9}$$

where X_g and X_h are matrix of reference-quality variables and β and γ are parameters to be estimated by Simulated GMM. The Cox-type statistic to compare each pair of models is constructed by examining the behavior under H_h of the difference of the estimated GMM criterion functions for model H_h and for the alternative model H_h. Normalized and standardized and compared to a standard normal critical value, a large positive statistic in this one-sided goodness of fit test leads to a rejection of the null model H_h against H_g (Villas-Boas 2002). Final Cox-type statistic for H_h against H_g is,

$$C_T(H_h \mid H_g) \equiv \hat{g}'_T \hat{V}_g^{-1} \hat{A}_T T^{1/2} \hat{h}_T \xrightarrow{L} N(0, w_h^2) \tag{10}$$

where

$$w_h^2 \equiv p\hat{\lim}_h [\hat{g}_T]' V_g^{0-1} A_h M_H V_h M'_H A'_h V_g^{0-1} p\hat{\lim}_h [\hat{g}_T]$$

$$\text{if } w_h^2 > 0 \tag{11}$$

where $M_H \equiv I_{k_h} - \hat{H}(\hat{H}'\hat{V}_h^{-1}\hat{H})^{-1}\hat{H}'\hat{V}_h^{-1}$, and $\hat{H}_T \equiv -T^{-1}Z'_h X_h$. Therefore, large positive statistic in one-sided test leads to a rejection of the null model for H_h against H_g after it is normalized and standardized.

4. Empirical Results

4.1. Contextual Reference-Quality

Under the assumption that consumers form their reference-point for price and quality independently, we examine the contextual reference-point in consumers' quality perception in the first. Table 1 shows the estimated results of the relative-reference model with three representative reference-qualities – maximum, average, and minimum quality of each period (month) and the Cox type non-nested test for each other. The first row of the table shows the null models (H_0) with different types of contextual reference-points and the ones in the first column are the alternative models (H_1) tested. If the Cox-statistics is large, then we reject the null hypothesis. Therefore, the table is symmetric and we confirm the validity of the Cox-type tests results.

Table 1. Cox-Test for Contextual Reference-Quality

Reference – Quality		H_0			
		No-Ref.	Min.	Ave.	Max.
H_1	Ave.	-	-	-	2.6122
	Min.	-	-	1.3741	0.6993
	No-Ref.	-	0.1312	0.2448	5.5017
GMM objective		1584.88	2017.99	1394.3	1820.04

The second column shows the non-nested test for the null hypothesis of no reference-quality against the three representative reference-qualities. However, we do not reject all three null hypotheses against any of reference-quality assumptions (*t*-values are 0.444, 0.0269, and 0.4168 for maximum, average, and minimum reference-quality as alternative hypotheses, respectively). Therefore, reference models are preferred to the models without reference.

The model with average-reference quality is preferredto the model with maximum-reference quality, since we reject the null of maximum-reference quality against average-reference quality (*t*-value: 2.6122). However, between average and minimum, the result is not conclusive. Therefore, in order to find the rank among these reference models, we compare GMM objective values that are in the last row of Table 1. Based on the GMM objective value, we conclude that average-reference model is preferred to minimum-reference model. Therefore, average quality seems to be the dominant reference-point in quality perception of consumer behavior.

4.2. Component of Reference Quality

We test the relative importance between contextual and temporal reference-quality using Cox-type non-nested test. We adopt the average quality as the current contextual reference-point based on the previous result. However, in the case of temporal reference-quality, we assume that consumers can form a different reference-point for the quality level of a lagged periodof time: *temporal dependent contextual reference-quality*. Therefore, we test three reference-points – maximum, average, and minimum – for the quality level of a lagged period of time (temporal reference-quality) against the current average reference-quality (contextual reference-quality).

The Cox-type non-nested test for average and minimum reference-quality of lagged periods (temporal reference) against the average reference-quality of current period (contextual reference) show that contextual is preferred to temporal. However, in the case of maximum reference-quality, results are not deterministic. Table 2 below shows the Cox-type non-nested test for maximum reference-qualities of lagged periods against the average reference-quality of current period.

Table 2. Cox-Test for Contextual and Temporal Reference-Quality (Maximum Quality)

Reference - Quality (MaxQuality)	H_1				
	Lag=0	Lag=1	Lag=2	Lag=3	Lag=4
H_0 Lag=0	-	0.9461	2.2306	2.3563	0.9540
GMM objective	1361.32	1621.54	1800.33	1151.20	1594.16

In the case of lag 1 and 4, temporal reference model is preferred to contextual one (t-values: 0.9561 and 0.9540, respectively), but in the case of lag 2 and 3, the result is reversed (t-values: 2.2306 and 2.3563, respectively). Therefore, whether contextual reference is more important than temporal one is not robust and deterministic in the case of maximum-reference quality. It seemsthat maximum quality levels of past periods also play significant role as reference-quality in consumers' choice behavior as current quality level does.

4.3. Contextual and Temporal Reference-Price

In the case of price, minimum-reference price is preferred to other contextual reference points, which is consistent with our hypothesis. In addition, contextual reference model with minimum-reference price is preferred to any temporal reference models supporting our hypothesis. We do not report the estimated resultshere considering the page constraint.

4.4. Competitive Advantage of Product Innovation

We introduce brand-specific reference for quality variables in order to estimate brand dependent attribute weights. The notion behind is that consumers often compare the quality of their potential alternatives with that of a certain brand. For example, consumers compare the reliability of an automobile with that of Toyota or Honda when they choose midsize cars, the quality of LCD display with that of Samsung or LG, the performance of laptop with IBM or Dell, etc. Therefore, by introducing brand-specific references for reference-quality variable, we obtain responsiveness of demand to the change (innovation) of an attribute's reference-adjusted values – *brand-specific innovation-elasticity*.

In this case, the brand-specific quality level can be average, maximum, or minimum quality of all the products which a manufacturer produces. The overall market demand becomes more elastic to the changes of an attribute's value, as the brand's dominant quality level of the attribute becomes higher Surely, the brand's quality is the dominant reference-point of a market in this case.. It is because the losses from the attribute of other products become dominant compared to gains, when the brand's quality level of theattribute which is assumed to be dominant in a market becomes higher. It is consistent with the Prospect Theory in which the asymmetric value function is steeper for losses than for gains resulting in the high elasticity of demand for losses than gainsPutler (1992) examined demand for eggs in Southern California for the period 1991 to 1983 and found that own-price elasticity for a price increase (losses in value) is -0.78, and the estimated elasticity for a price decrease is -0.33. This indicates that consumer response is nearly two and a half times greater for egg price increases (losses) than for egg price decreases (gains). .

Therefore, the higher the brand-specific innovation-elasticity is, the more competitive-advantageous the brand in its attribute category of a product. We define the brand-specific innovation-elasticity as the (competitive) *demand-advantage* of a brand in an attribute category. Specifically, the demand-advantage is determined by where the brand-specific reference-quality is located within the quality span of all products and to what degree other products provide attribute's value to consumers compared to the brand-specific reference-quality.

In our estimation of brand-specific innovation-elasticity, we use the model with minimum reference-price and average reference-quality variables within the contextual reference framework. Although it seems that the temporal reference quality plays significant role in consumers' choice decision, we restrict our analyzing framework into the contextual reference in order to examine the (competitive) demand-advantage in a simple and intuitive way. In our empirical examination of the U.S. cellular phone market, we adopt three major manufacturers' product quality and price – Nokia, Motorola, and Samsung – as the reference-point for price and quality.

Based on the estimated result We do not include the estimated results due to page constraint.

, we create a map of demand-advantage for three attributes we estimated as follows:

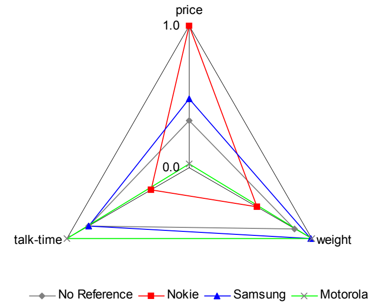
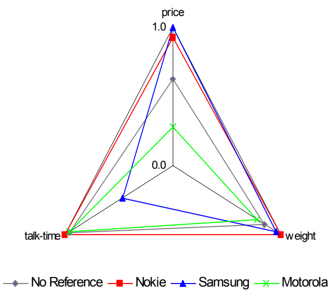


Figure 1. Map of Demand-Advantage in the U.S. Cellular Phone Market

In the figure 1, all the coefficients have been normalized to the maximum coefficient value in each attribute category. As expected, Nokia's demand-advantage is positioned toward price than other quality attributes showing strong demand-advantage in pricing. In contrast, Motorola has strong demand-advantage in quality, both in weight and talk-time. Samsung's demand-advantage is placed in-between two brand's demand-advantages close to market average.

In order to examine the dynamic changes in demand-advantage for each manufacturer, we estimate the model with manufacturer-specific reference-variables – price, weight, and talk-time – for the 3 time segments independently.



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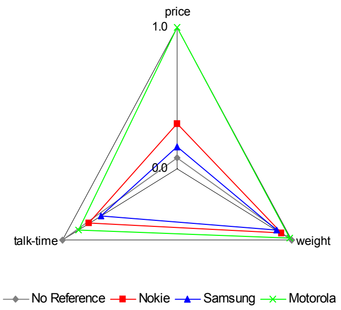
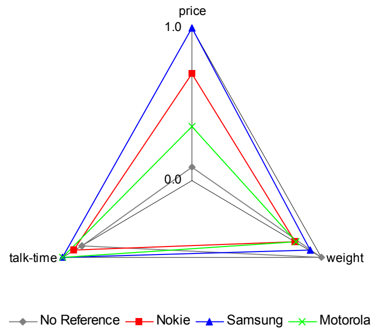


< 2nd Periods: 2002 >



<3rd Periods: 2003>

Figure 2. Map of Demand-Advantage in the U.S. Cellular Phone Market

Figure 2 shows the dynamics of demand-advantage. In the 1st period, both Nokia and Samsung show demand-advantage in price, unlike the result from total periods, figure 1. Nokia shows balanced demand-advantages in all three attributes with high estimated coefficients for each reference-variable. This balanced demand-advantage is matched with the highest market share of Nokia in the 1st period. In the 2nd period, all the coefficients for reference-quality variables are significant as well as only Motorola's coefficient in reference-price variables. Therefore, we can not compare the demand-advantage for price. However, demand-advantage in quality shows that all three major firms have comparable advantages. Samsung's demand advantage in talk-time has increased in 2nd period compared to 1st one. In the 3rdperiod, all the coefficients for reference-quality variables are significant, in contrast to the insignificant coefficients for all reference-price variables. In this period, all three manufacturers show comparable demand-advantage over the quality attributes, weight and talk-time. Samsung's demand-advantage over the quality reached the highest among the manufacturers. This Samsung's development in demand-advantage matches with their growth in market share in the 3rd period as shown in figure 3.

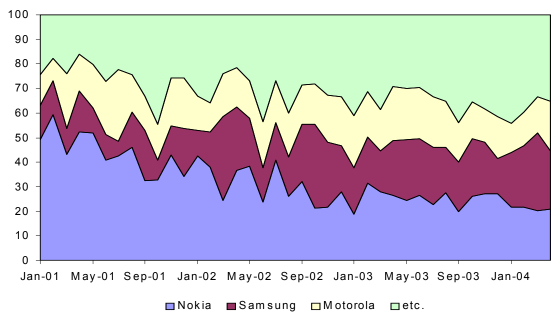
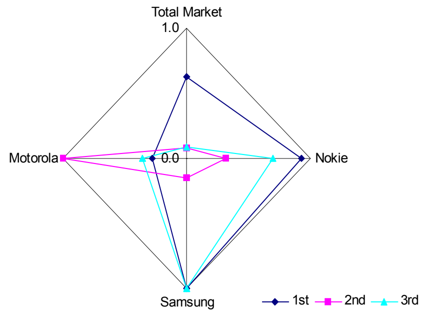
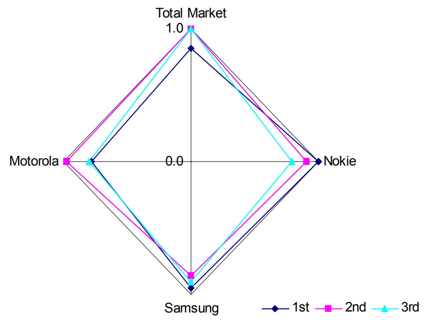


Figure 3. Percentage Market Share of U.S. Cellular Phone Market

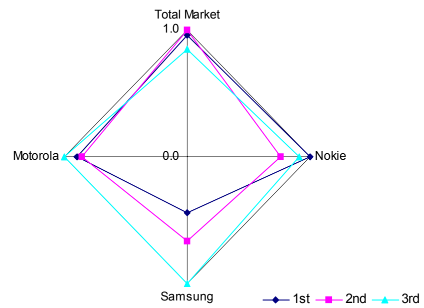
The relationship between the demand-advantage and the manufacturers' performance in the market become apparent with time-dependent demand-advantage map as shown in figure 4.



< Price >



<Weight >



< Talk-time >

Figure 4. Map of Demand-Advantage in the U.S. Cellular Phone Market

The figure 4 shows the time-dependent demand-advantage for price. In this figure, the demand-advantage is highest for Nokia in the 1st period, and Motorola in the 2nd, and Samsung in the 3rd period, which correspond to the development patterns of market share in figure 3. However, the time-dependent demand-advantages are all comparable in quality attributes. In case of the talk-time, the Samsung's demand-advantage has developed over the periods and reaches highest value at the 3rd periods corresponding to its market share growth.

Consequently, we find that the demand-advantage explains well the market development patterns. In addition, it captures attribute-specific product advantage in consumers'internal mechanism of product evaluation. In the case of U.S. cellular phone market, the demand-advantage in price plays a significant role for manufacturers' market performance then that in quality.

5. Conclusion

This paper introduced the concept of *reference-quality* in consumer choice. The concept of reference-quality refers to an internal standard against which observed qualities are compared in consumer choice behavior. We empirically confirmed the existence of dominant reference-quality in aggregated demand using a non-nested test for random coefficient model, which encompasses consumer heterogeneity, in the case of the U.S. wireless phone market. In addition, we confirmed the processes of reference formation.

In the case of contextual reference quality, average level of product quality is the dominant reference quality in aggregated market demand for U.S. wireless phone. However, in the case of price, minimum price is the dominant reference point of consumers' choice decision. In addition, consumers' seems to consider both current and past level of product quality as their reference qualityand in contrast to more significant role of current price than past price.

The existences of dominant reference both in price and product quality in aggregated market demand enable us to introduce brand-specific reference-price and -quality. By introducing the brand-specific reference-points in price and product quality variables, we measured the responsiveness of market demand to the innovation of a certain brand's product attribute – *innovation-elasticity*. By comparing the brand-specific innovation-elasticity, we could examine how competitiveness of a brand's attribute has evolved over the past few yearsin the U.S. wireless phone market.

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