AN EMPIRICAL EXAMINATION OF PRODUCTIVITY OF A CHAIN RESTAURANT USING DATA ENVELOPMENT ANALYSIS (DEA)

By
Kyu Wan Choi
Seoul National University, South Korea
Yae Sock Roh,
Central Michigan University, U.S.A.
Ji-Hwan Yoon
Kyung Hee University, South Korea

ABSTRACT

The use of benchmarking models plays an increasingly important role for firms in determining the efficient allocation of resources. This research empirically examines the efficiency of a chain restaurant utilizing Data Envelopment Analysis (DEA). The use of factor analysis identified the most significant input variable from each categorical area: 1) capital, 2) labor, 3) environmental/location, and 4) management efficiency. The sample was drawn from a chain restaurant primarily engaged in franchising. The study illustrates the applicability of DEA to the specifics of restaurant operations by identifying the best performing units to be benchmarked against less efficient units. The outcome of this research provides invaluable information for managers regarding how to adjust and modify available resources to convert inefficient units to efficient units. Finally, managerial implications and directions for future research are discussed.

KEYWORDS: Chain restaurant, Data Envelopment Analysis, Factor Analysis, Franchising, Managerial Efficiency.

I. INTRODUCTION

The productivity efficiency measure of a firm is of great interest to academicians as well as practitioners. However, it remains a fundamental challenge. While there is no universally accepted methodology to measure retail productivity (Donthu et al., 1998), the ratio between internal efficiency and external effectiveness (Gronroos & Ojasalo, 2004) and a ratio of outputs to inputs in specific units have been the dominant means to measure productivity in earlier studies. In practice, individual enterprises commonly rely on simple output to input ratios to measure productivity (Chen & McGinnis, 2007). Consequently, the higher ratio of output to input, *ceteris paribus*, is inarguably interpreted as more efficient.

Compared to manufacturing industries, establishing an appropriate measure of production efficiency is more difficult in service industries, particularly in restaurants (Muller, 1999). Nevertheless, there has been a considerable amount of literature that attempts to measure the efficiency of the restaurant industry. The majority of previous research has used ratio analysis or aggregate indices of market performance and control of the operation (Malhotra et al., 2006; Schmidagall, 2006). Often, cost volume profit or menu engineering analysis techniques have been popular ways to analyze the performance of individual restaurants (Kasavana & Smith, 1982; Pavesic, 1983). However, Reynolds (2003) argued that these partial–factor statistic ratios reflect limited aspects of the operations, thus may not fully explain operational efficiency. In addition, previous measurements are more appropriate assessments for a specific segment of retail industries or aggregation rather than individual establishments. As a result, an alternative technique to measure productivity in individual establishments would make the evaluation, execution, and control of managerial operations more plausible and objective.

Data Envelopment Analysis (DEA) is a mathematical programming model that provides an objective method to structure various measures into a single meaningful performance score (Keh, et al., 2006). The model was first proposed by Charnes et.al., (1978) as an evaluation instrument to measure and compare a decision-making unit's (DMU) productivity based on multiple inputs and outputs. Currently, the model has become an increasingly popular diagnostic management device and is widely used in many business disciplines such as operations research and production (Keh et al., 2007; Lozano et al., 2004), retail stores (Donthu & Yoo, 1998), advertising (Lou & Donthu, 2001), performance appraisal of salespersons (Boles et al., 1995), insurance companies (DePree et al., 1995), and non-profit service providers (Borja & Triantis, 2007; Ahn, et al., 1986). The model has even been extended to the evaluation of hospitality industries (Reynolds & Thomson, 2007; Morey & Dittman,1995; Hwang & Chang 2003; Wober & Fesenmaier, 2004).

DEA can access productivity at the retail firm or store (unit) level using multiple inputs and outputs simultaneously. This procedure provides a single relative productivity index that allows managers an analytical and diagnostic tool required to improve productivity of the individual operations (Donthu & Yoo, 1998). In DEA, efficiency is concerned with the allocation of resources among alternative uses. Thus, the technique enables the researchers to identify an efficient frontier that represents the minimum costs required for a firm to achieve a given level of output (Anderson et al, 2000). Simply put, firms with excessive inputs are considered inefficient or have failed to fully maximize resource uses.

The service industry, particularly franchise chain restaurants, is an exceptional candidate to apply DEA for the purpose of internal benchmarking. The justification for this claim is that, while there is a wide range of variances in competition, location, and neighborhood characteristics, each establishment in a chain restaurant still adopts identical menu concepts, standardized operating procedures, decor and design, as well as technology.

Despite the importance of measuring productivity to many service organizations, it is surprising that there has been relatively little empirical research on this topic (Johnston & Jones, 2003). Moreover, the practical use and academic study of DEA remains relatively limited in service industries, although the area has attracted growing attention in recent years. The purpose of this paper is to empirically examine the productivity of chain restaurants utilizing DEA. Section II reviews the advantages of DEA compared to conventional efficiency measures. Specific examples of previous research regarding DEA applications in the service industry are illustrated. Section III presents the research methodology. In order to extract more reliable input variables in the model, classification patterns among input variables are developed using factor analysis. Section IV discusses the empirical analysis and demonstrates how managers adopt the DEA model operationally in the individual restaurant units. Section V concludes with managerial implications and suggestions for future research.

II. LITERATURE REVIEW

Much of the performance analysis of a firm or organization is based on the efficiency principle. In the service industry, it is often challenging to measure productivity because the industry deals with perishable goods and intangible services (McLaughlin & Coffey, 1990). In addition, seasonal fluctuations and variations in sales volume make it difficult to estimate overall efficiency of the service industry at a particular point of time.

The major drawback of traditional efficiency measures is that they tend to rely heavily on the ratio between cost effective use of resources and revenue generating capability (Gronroos & Ojasalo, 2004). These univariate ratios do not consider the effects of economies of scale, identification of benchmarking policies and estimation of overall measures of firms (Keh et al., 2006). In addition, Parsons (1997) argued that the traditional productivity measure caused confusion, inconsistency and even controversy because it varies from physical value (e.g. asset turnover ratio) to monetary value (e.g. revenue/ number of employees. The previous research failed to show that the productivity of individual units should be relative to other establishments within the system where the performance must be compared and contrasted with other comparable establishments. For that reason, Donthu et al. (2005) argued that a more rigorous qualitative methodological approach is needed to measure productivity efficiency.

Contrary to conventional methods, DEA integrates both discretionary and nondiscretionary variables where the former is under managers' control, while the latter is beyond managers' control. This technique, the ratio of weighted inputs and outputs, yields a single productivity index that compares all units against the most efficient units and then suggests improvement possibilities (Reynolds, 2003; Donthu et al., 2005).

The application of DEA to measure efficiency of the chain restaurant is particularly relevant because DEA measures the relative efficiency of operating units that share the same goals and objectives. For instance, within individual restaurant outlets in the same chain, the objective of DEA is to identify the inefficient outlets that should be subject to further research or modify allocation of resources based on a single relative productivity index. Several previous studies were selected to exhibit an application of DEA to the service industry.

Banker and Morey (1986) illustrated an application of DEA with a sample of 60 fast food restaurants. They utilized 6 input and 3 output variables. For input variables, the researchers used expenditures for supplies and materials, expenditures related to labor, age of the stores, advertising expenditures allocated to the stores by headquarters, urban or rural area, and drive-in windows. On the other hand, the researchers employed breakfast sales, lunch sales, dinner sales for output variables.

Morey and Dittman (1995) evaluated 54 hotel general managers' performance based on benchmarking analysis. In order to determine the efficiency of the general managers, the study considered physical characteristics of the properties (number and mix of rooms), factors determined by the hotel market areas (competition, location) and factors controllable by the managers (operating expenditure for room division and overhead expenses) for input variables. In order to measure output, the authors used total room revenue and customer satisfaction indices. Their study identified the most efficient operations that can be benchmarked for the managers of less efficient operations. With a sample of 26 restaurants, Donthu et al. (2005) considered input variables such as expenditures associated with advertising/ promotion, managers' experience and number of employees to proxy the amount of labor employed. In addition, they considered sales and customer satisfaction for output variables.

More recently, Reynolds and Thompson's (2007) article is of particular interest, as it justifies the use of DEA logically and systematically in the restaurant industry. They analyzed the efficiency of 62 mid-scale, full service restaurants and identified that DEA offers considerable potential and advantages for managers seeking to accurately evaluate productivity. They employed three input (server wage, number of seats, stand alone facility) and two output (daily sales, tip percentage) variables in the model. The behavioral output variable, tip percentage, was used as a surrogate for customer satisfaction.

The literature review revealed that DEA provides managers with information on the necessary actions to improve operational efficiency of the units. Typical inputs are associated with capital, human, and environmental conditions (Goldman, 1992), as well as socioeconomic and demographic (Ingene, 1984) variables. Conversely, outputs are associated with financial variables, such as sales and net income. Oftentimes, since the efficiency is associated with customer satisfaction, behavioral measures such as the amount of tips and overall customer satisfaction are used frequently for output variables.

III. RESEARCH METHODOLOGY

Application of Data Envelopment Analysis (DEA) to a Chain Restaurant

An application of DEA can be extended to a chain restaurant industry by integrating the weighted sum of outputs to the weighted sum of inputs. When one considers a restaurant being evaluated with 4 input variables (X_1, X_2, X_3, X_4) and 2 output variables (Y_1, Y_2) in the model, then the efficiency of the Restaurant 1 (h_1) is calculated in the following manner.

$$h_1 = \frac{U_1 Y_1 + U_2 Y_2}{V_1 X_1 + V_2 X_2 + V_3 X_3 + V_4 X_4}$$

The weights of U_1, U_2, V_1, V_2, V_3 and V_4 are estimated separately for each restaurant such that the efficiency is the maximum attainable. The value of the ratio of weighted outputs to weighted inputs is equal to or less than one. More specifically, by virtue of constraints, the optimal maximum value restaurant o (h_0) should not exceed 1 for every decision making unit (DMU) where the constraints refer to the ratio of “virtual output” to “virtual input”. The maximum efficiency of restaurant o (h_0) as compared with n other restaurants is calculated as follows:

$$Max \;\; h_0 = \frac{\sum_{r=1}^{s} U_r Y_{ro}}{\sum_{i=1}^{m} V_i X_{io}}$$

$$subject \;\; to \quad \frac{\sum_{r=1}^{s} U_r Y_{rj}}{\sum_{i=1}^{m} V_i X_{ij}} \leq 1 \quad \text{for all } j = 1,\ldots,n$$

$$U_r, V_i \geq 0 \;;\; r = 1,...,s \;;\; i = 1,...,m;$$

Where Y_{rj} is the r^{th} output observations for the j^{th} restaurant and X_{ij} is the i^{th} input observations for the j^{th} restaurant, s is the number of output variables and m is the number of input variables. U_r and V_i are the variable weights to be estimated by the data of all comparable restaurants that are being used to arrive at the relative efficiency of h_0.

Data Collection

To measure the efficiency of an establishment, data was collected from a sample of restaurants within the same chain that operates within the Pacific Rim region. In order to comply with assured confidentiality agreements with the CEO, the identity of the business name and the country of the restaurant chain is undisclosed. All participants were given an option of receiving a summary of the research outcome. The chain has a total of 550 establishments including 489 franchised units. In order to conduct the analysis within a homogeneous sample, company-owned stores were excluded from the sample. The research instrument used in this study was a self-administered questionnaire.

The researchers consulted with the corporate management to choose appropriate input and output variables and these variables were reviewed by a group of academicians and professional experts in the area of chain restaurant operations. In addition, a pretest of the questionnaire was mailed to store managers. These procedures clarified the wording and structure of the questionnaire's items and assured the accuracy of the vocabulary used in the study.

Upon the completion of the pretest, the questionnaire was sent to the general managers of the stores due to their specific knowledge and unique position to report on the questions being studied. Following the guidance suggested by Campbell and Julian (1966) and Heide and Weiss (1995), the researchers took a specific selection step. For instance, each questionnaire was reviewed by corporate managers to ensure the validity of the general manager's responses. The study yielded a 31% response rate (150 surveys). Among those, 26 were excluded from the sample due to incompleteness or ambiguity, bringing the final sample to 124 usable surveys. The information from the survey was combined with financial data obtained from the point of sales system in the chain restaurant.

One of the conflicting issues in the DEA model is the selection of input and output variables to measure productivity. Donthu et al. (2005) strongly emphasized the importance of variable selection because the outcome of the research is heavily dependent on the input and output variables used in the model. Their arguments led the researchers to believe that there should be a more rigorous method than those of previous studies for selecting the input and output variables for the efficiency assessment. In fact, one of the contributions of this research is the development of an innovative methodology to determine accurate and relevant input variables in the DEA model.

In determining the input and output variables, Donthu and Yoo (1998) argued that factors associated with direct costs to the store are good candidates for input variables. On the other hand, output variables such as customer satisfaction and profit should reflect the goal or objectives of the company (Donthu, et al., 2005).

The 12 input variables utilized in this study can be broadly categorized into four areas: 1) capital 2) labor 3) environmental/ location and 4) management efficiency. The primary capital input variable is the total physical size of the store measured in square meters (T_SIZE). However, T_SIZE was further decomposed into revenue generating space and non-revenue generating public space. Thus, the size of the revenue generating space (H_SIZE), the size of the kitchen (K_SIZE), the number of seats (SEAT), and the number of tables (TABLE), along with T_SIZE, were considered as input variables. Labor expenditures related to input variables included the total number of full time employees (T_EMP), the number of employees in the revenue generating public space (H_EMP), the number of kitchen employees (K_EMP) and the monthly labor cost of employees (L_COST).

Store location is considered a major environmental factor that determines customer counts (Donthu, 1998). Anderson et al. (2000) noted that differences in location may create imperfectly competitive conditions for some firms. Clearly, an attractive location has an advantageous edge that induces more traffic. Since the chain restaurant requires higher monthly rent (RENT) and a higher initial deposit (GUAT) for desirable locations, these two factors are used to represent environmental / location variables.

Morey and Dittman (1995) argued that the general manger has the ability to control certain resources and is responsible for choosing the appropriate level and mix of these allocations. Thus, management efficiency heavily depends on how managers control these resources. In the restaurant industry, overhead costs, such as energy, property operations and maintenance, advertising, and administrative general expenditures are largely controllable by the manager. As such, overhead costs (GM_COST) are used as a surrogate to reflect management efficiency. As suggested by Donthu et al. (2005), the output has a controllable nature and is gauged by sales and net income. The point of sale system for the restaurant chain provided the financial based productivity indicators of these output variables. In order to account for seasonal fluctuations of sales, yearly sales and net income were divided by 12 to conclude average monthly figures.

One of the limitations of DEA is that the outcome depends on the variables entered in the analysis. For instance, omitting important variables, including outliers and missing observations, may lead to faulty calculations of efficiency scores (Lou & Donthu, 2001; Donthu et al., 2005). Of particular concern is that the efficiency score will be adversely augmented unless the number of input and output variables is small relative to the number of observations.

Although a set of 12 input variables may be suitable to measure efficiency, such a large number may prove too cumbersome to be utilized in a decision model because some variables are partially redundant or correlated with one another. For instance, the larger restaurants are more likely to have more tables and seats. Reynolds and Thompson (2007) claimed that it is important to ensure the input variables in the model are independent of each other. Therefore, an attempt was made to reduce the dimensionality of variables by investigating patterns among input variables. The relatively large sample size justifies the use of factor analysis to extract the most influential input variable in each category.

To assess the extent of dimensionality among the variables, the twelve input variables were factor analyzed. The primary purpose of this procedure was to define the underlying structure among the variables in the analysis. Factor analysis offers a tool for analyzing the structure of the correlations among a large number of variables by defining sets of highly correlated variables known as factors. These factors are assumed to represent dimensions within the data (Hair et al., 2006). The technique allows researchers to reduce the dimensions of a data set from 12 variables to a smaller set of factors with a negligible sacrifice of information.

A question arises as to the criteria for the number of factors to be extracted. Although the most commonly used techniques such as latent root criterion consider factors having eigenvalues greater than 1 as significant, an exact quantitative basis for deciding the number of factors to be extracted has not been fully developed. Therefore, it is argued that one cannot rule out the possibility that the subset data could contain as many factors as in the original data set (Hair et al., 2006).

IV. STATISTICAL ANALYSIS AND RESULTS

Table 1. exhibits descriptive statistics for the input and output variables employed in the research. The first two variables represent output variables. All sales and expenses are expressed on a monthly basis. On average, a restaurant has 84 seats and 8 full time employees. Average monthly sales and net income for the stores are $53,579 and $10,433, respectively, resulting in a profitability ratio of (NI/SALES) of 19.5%. The high standard deviation of GM_COST indicates a substantial variation in management effectiveness to control overhead expenses.

Table 1. Descriptive Statistics of Candidate Variables

Variables	Definition	Descriptive Statistics		
		Mean	Median	S.D
SALES	Avg. Monthly Sales ($)	53579.01	47135.98	27691.03
NI	Avg. monthly Net income ($)	10433.13	9222.26	5983.25
T_SIZE	Total Size (m^2)	195.50	158.68	183.93
H_SIZE	Revenue generating space (m^2)	133.70	115.70	64.30
K_SIZE	Kitchen Size (m^2)	41.95	33.06	24.57
SEATS	Number of seats	84.00	75.00	40.16
TABLES	Number of Tables	23.32	20.00	13.14
T_EMP	Total employees	8.13	7.00	3.97
H_EMP	Employees work at Hall	3.73	3.00	2.17
K_EMP	Kitchen Employees	3.75	4.00	1.67
SALARY	Monthly Salary ($)	10252.24	9580.90	5431.99
RENT	Monthly Rent ($)	4431.95	3586.43	3844.27
GUAT	Initial Deposit ($)	105820.43	102469.52	82371.32
GM_COST	Overhead Expenses ($)	4094.24	3074.09	4271.92

Table 2. presents factor loadings by applying an orthogonal (VARIMAX) rotation meaning that the factors remain uncorrelated throughout the rotation process. The primary reason to utilize VARIMAX, as apposed to the unrotated factor matrix, is that the latter does not offer a completely clean set of factor loadings. Thus, orthogonal rotation technique improves the interpretation.

The research revealed that there is a significant difference in eigenvalues between factor 4 and factor 5. It shows that the first four factors have eigenvalues of 0.9 or greater, while the fifth factor has a value of 0.573. For the purpose of this study, the researchers selected the four factors having eigenvalues greater than 0.9 to represent the original data set. Thus, factor 5 has been discarded. In sum, using a varimax rotation and eigenvalues of 0.9, items with factor loadings of .5 or higher were retained.

The values that loaded on Factor I (T_SIZE, H_SIZE, K_SIZE, SEAT, TABLE) represent the physical size or capital investment of the facility. The values for Factor II (T_EMP, H_EMP, K_EMP, L_COST) denote labor related domain. Factor III (RENT, GUAT) represents environmental/ location and factor IV (GM_COST) represent overhead costs which serve as surrogates for management effectiveness. Since the factor loading indicates the correlation between the original variables and the factors, the higher factor loading value signifies the degree of importance of a particular factor. Therefore, the researchers selected the most significant input variable that represents a factor in each category. This procedure yielded four input variables: 1) size of revenue generating public space (H_SIZE), 2) number of full time employees (T_EMP), 3) monthly rent (RENT), and 4) overhead costs (GM_COST).

Table 2. Varimax –Rotated Loadings

Full set of variables	Factor			
	1	2	3	4
T_SIZE	**.628**	.169	.010	.015
H_SIZE	**.906**	.307	.092	.082
K_SIZE	**.721**	.326	.223	.048
SEAT	**.749**	.401	.239	.075
TABLE	**.588**	.199	.159	.401
T_EMP	.360	**.859**	.202	.233
H_EMP	.321	**.828**	.195	.100
K_EMP	.417	**.738**	.314	.075
SALARY	.347	**.738**	.387	.247
RENT	.281	.189	**.595**	.065
GUAT	-.006	.193	**.572**	.120
GM_COST	.063	.158	.137	**.765**
EIGENVALUE	6.479	1.384	.972	.908

Table 3. shows the correlation matrix for the input and output variables used in the research. As expected, all input variables are positively correlated with output variables. The size of revenue generating public space (H_SIZE) has a significant positive

relationship with sales. As H_SIZE represents the primary revenue generating area, the allocation of space has a great impact on sales.

Table 3. Correlations between input and output variables used in the model

	SALES	NI	H_SIZE	T_EMP	RENT	GM_COST
SALES	1					
NI	.666	1				
H_SIZE	.593	.420	1			
T_EMP	.851	.553	.583	1		
RENT	.299	.156	.629	.199	1	
GM_COST	.342	.184	.143	.395	-.007	1

DEA reflects the performance of an individual establishment based on an efficient frontier with scores ranging from 0 to 1. The higher the value, the more efficient the unit; therefore, an efficiency score of 1 means the decision making unit (DMU) is lying on the efficient frontier. Table 4. depicts each of the units in the chain restaurant and their efficiency scores, corresponding benchmarking units and their associated weights. The Scores in % in column 2 of Table 4. indicate the best possible efficiency attainable by an establishment based on the prescribed inputs and outputs. The study found a wide range of efficiency levels among the chain's restaurants. Given the measures used in the evaluation for efficiency, 12% (15) of the restaurants were operating at maximum efficiency of 100%. On the other hand, restaurant 2 (R2) has an efficiency score of 61.9% implying that it achieved only 61.9% of its maximum efficiency. Stated differently, as compared to 100 % efficient restaurant sets, R2 has room to improve its efficiency score by 38.1% (100% minus 61.9%). Due to differences in the internal structure of the individual restaurants, each restaurant may improve its efficiency by adjusting inputs and outputs relevant to its unique operations.

In terms of benchmarking, R1 has a 100% efficiency score. That is to say that R1 is currently operating on the efficient frontier. This unit can be used as a benchmark for less efficient units. The benchmark, usually called the frontier, must represent efficiency at least at the level of observed best practice. No true observation should be more efficient than displayed by the frontier (Charnes, et al. 2001) The reference count in the last column

Table 4.Summary of efficiency findings for selected restaurants

Unit Name	Score in %	Benchmarking Restaurants	Reference Count
R1	100.0	.	9
R2	61.9	R7(.111), R67(.226), R71(.572), R88(.123)	0
R3	36.5	R7(.055), R48(.051), R67(.896), R88(.467)	0
R4	100.0	.	1
R5	64.8	R67(.050), R71(.697), R88(.749)	0
R6	32.1	R48(.038)), R67(.739), R88(.238)	0
R7	100.0	.	59
R8	27.1	R67(1.446), R71(.211)	0
R9	69.1	R7(.067), R67(.299), R71(.1.352), R88(.311)	0
R10	59.4	R1(.174), R7(.061), R67(.202), R71(.480)	0
	.	.	.
	.	.	.
	.		.
R115	33.5	R67(.141), R71(.152), R88(.151)	0
R116	100.0	.	11
R117	61.2	R67(.481), R71(.904)	0
R118	100.0	.	8
R119	31.1	R7(.035), R67(.478), R71(.330), R88(.002)	0
R120	54.7	R7(.110), R48(.047), R67(.077), R88(.226)	0
R121	62.5	R67(.341), R71(.759), R88(.666)	0

R122	27.3	R48(.040), R67(.512), R88(.100)	0
R123	37.1	R7(.089), R67(.008), R71(.096), R88(.522)	0
R124	27.3	R7(.148), R67(.257)	0

of Table 4. indicates the number of restaurants that can be used for reference to improve their operations. For instance, while 9 restaurants can emulate the operations of R1, R2 cannot be used for benchmarking for any other restaurants as it has a 0 reference count. Conversely, R2 can benchmark R7, R67, R71, and R88 for improvement.

For the practical use of the outcome as described within Table IV, in terms of labor efficiency as measured by the total number of employees, R2 can improve its efficiency in the following manner: The benchmarking partners for R2 are R7, R67, R71, and R88 with corresponding weights λ values of .111, .226, .572, and .123 respectively. A detailed discussion on computation on λ values may be found in Torgerson et al (1996) and Zhu (2000). Currently, the number of employees for R2 is 7, 15 for R7, 2 for R67, 3 for R71, and 4 for R88. By multiplying a weighted λ value to a matching number of employees of each store, R2 needs only 4.325 (15*0.111+2*0.226+3*0.572+4*0.123) employees in order to be efficient. Stated differently, R2 has 2.675 excessive employees. A similar procedure can be repeated to measure inefficiency of other controllable variables.

It is interesting to observe that restaurants with lower efficiency scores do not require a large number of benchmarking partners. For instance, R124 has a poor efficiency ratio of 27.3% but has only two benchmarking units (R7, R67). Another important finding of the analysis is that restaurants with higher sales or net income do not necessary mean they are efficient restaurants. For instance, restaurants 26(R26) and 32(R32) have the highest sales and net income respectively. However, they have efficiency ratios of 80.23% and 44.80%, respectively. These findings are consistent with Morey and Dittman (1995) who argued that low profit units could still be relatively efficient if the competitive environment is especially difficult. This outcome suggests that units must be managed to maximize operating efficiency as opposed to increasing the revenue or net income.

V. MANAGERIAL IMPLICATIONS AND FUTURE RESEARCH

Management in the chain restaurant should consider the DEA method as an analytical and diagnostic tool to improve productivity efficiency. Managers should evaluate the applicability of DEA for their operations and its potential to achieve the desired level of performance. While there has been considerable research incorporating the productivity measure of the service industry, specifically in the restaurant sector, there has been insufficient investigation into methodological instruments which support the benchmarking process. The traditional productivity measure, simple output-input ratio, offers only specific operational attributes (Reynolds & Thompson, 2007). DEA allows managers to identify the most efficient establishments and compare them against relatively inefficient units. By so doing, managers can determine the magnitude of inefficiency and suggest alternative strategies to produce an optimal level of efficiency.

Several important managerial implications emerge from this study. First, it is important to note that the resources of the units change over time. Thus, management should monitor efficiency on a regular basis as a part of an on-going management responsibility. More importantly, performance should be monitored over an extended period to determine an unbiased assessment of efficiency measure. By so doing, corporate management can identify less efficient individual stores and offer advice as a part of on-going managerial support. Second, incentive compensation for chain restaurant managers is predominately based on sales of individual stores. However, it is difficult to distinguish whether this performance is actually attributable to the efforts of the efficient manager or demand. In this regard, manager's efficiency must be taken into consideration when determining any kind of incentive arrangements.

In terms of the future research, it is particularly interesting to note that the ownership structure of chain restaurants consist of both company owned units and franchised units. Previous research showed that each chain restaurant employed different proportions of company owned and franchised units to increase the efficiency and competitive advantage for the chain (Castrogiovanni et al., 2007; Roh, 2002; Bradach, 1994). According to agency theory, company owned unit managers do not bear the full costs of shirking and perquisite consumption because they are compensated by a fixed salary (Brickly et.al, 1991; Norton, 1988). However, since the franchisees are the residual claimants, franchisee units will have more incentive to be efficiently operated than that of company-owned units.

While Yoo et al. (1998) explored the overall competitiveness between franchise and non-franchise organizations by comparing operating efficiency at the state level, little or no efficiency comparison has been made within the same system. The aforementioned studies may open the avenue to future research, making it worthwhile to investigate efficiency measures between franchised and company-owned units within the same chain restaurant. The outcome of the research should offer important managerial direction as to the optimal mix of ownership alternatives to maximize overall efficiency for chain restaurants.

REFERENCES

Ahn ,T., Charnes, Cooper, A.(1988). Some Statistical and DEA Evaluations of Relative Efficiencies of Public and Private Institutions of Higher Learning. *Socio- Economic Planning Sciences*, 22(6). 259-269.

Anderson R, I Fok, Zumpano L Elder H. (2000). The efficiency of franchising in the residential real estate Brokerage Market. *Journal of Consumer Marketing*,1988, 15(4). 386-396.

Anderson, F.I., Robert, F., John, S. (2000). Hotel industry efficiency: an advanced linear programming examination. *American Business Review*, January, 40-48.

Banker, R.D., Charnes, A.C., Cooper, W.W., 1984. Models for estimation of technical and scale inefficiencies in data envelopment analysis. *Management Science,* 30, 1078-1092.

Banker, R.D., Morey, R., 1986. Efficiency analysis for exogenously fixed inputs and outputs. *Operations Research*, 34 (4), 513-521.

Bloom, G.F. (1972). Productivity in the Food Industry: Problem and potential. Cambridge, MA: MIT Press

Borja, A & Triantis, K(2007). A conceptual framework to evaluate performance of non-profit social service organizations, *International Journal of Technology Management*, 37(1/2), 147-161.

Boles, J. Donthu, N, Lohtia , R(1995). Salesperson evaluation using relative performance efficiency: the application of data envelopment analysis. *Journal of Sell Sales Manage*ment, 15(3). 31-49.

Bradach, J. (1994). Chains within Chains: The Role of Multi-unit Franchisees. *Harvard Business School*, Working Paper 94-072.

Brickley, J. and Dark, F. H. (1987). The Choice of organizational form. *Journal of Financial Economics*, 18 (2), 401-420

Campbell, D., Julian, C (1966). Experimental Designs for Research, Skokie, IL: Rand McNally.

Castrogiovanni, G., Combs, J., Justis, R. (2007). Resource Scarcity and Agency Theory Predictions Concerning the Continued Use of Franchising in Multi-outlet Networks, *Journal of Small Business Management*, 44(1). 27-44.

Charnes, A.C., Cooper, W.W., Rhodes, E., 1978. Measuring efficiency of decision making units. *European Journal of Operations Research,* 3, 429-444.

Charnes, A.C., Cooper, W.W., Lewin, A.Y., Seiford, L.M. (2001). Data Envelopment Analysis: Theory, Methodology, and Application. Kluwer Academic Publishers, Norwell, MA.

Chen, W. & McGinnis, L. (2007). Reconciling ratio analysis and DEA as performance assessment tools. *European Journal of Operational Research*, 178 (1), 277-291.

Donthu, N., Yoo, B., 1998. Retail productivity assessment: using data envelopment analysis. *Journal of Retailing* ,60, 98-106.

Donthu N., Hershberger, E.K., Osmonbekok, T., (2005) Benchmarking marketing productivity using data envelopment analysis. *Journal of Business Research,* 58, 1474-1482.

Doutt, J.T., 1984. Comparative Productivity Performance in Fast-Food Retail Distribution. *Journal of Retailing*, 60(Fall), 98-106.

Farrell, M., 1957. The measurement of productive efficiency. *Journal of Royal Statistical Society Series* General 120 (Part 3), 253-281.

Goldman, A.(1992). Evaluating the performance of Japanese Distribution System, *Journal of Retailing,* 68(1),11-39

Gronroos, C., Ojasalo,K., (2004). Service Productivity: Towards a conceptualization of the transformation of input into economic result in services, *Journal of Business Research*, 57, 414-423.

Hair, J. Black, w. Babin, B. Anderson, R. Tatham, R (2006). Multivariate Data Analysis (6th edition). Prentice Hall, Upper Saddle River, New Jersey 07458.

Hwang S, N Chang T.Y (2003). Using data envelopment analysis to measure managerial efficiency changes in Taiwan. *Tourism Management*, 24(4),359-369.

Hean Tat Keh, Singfat Chu, Jiye Xu. (2006). Efficiency, effectiveness and productivity of marketing in services. *European Journal of Operational Research*. 170 (1), 265-276.

Heide, J. & Weiss, A., (1995). Vender Consideration and Switching Behavior for Buyers in High-Technology Markets, *Journal of Marketing*, 59,30-43.

Ingene,C.,(1984). Productivity and Functional Shifting in Spatial Retailing: Private and Social Perspectives, *Journal of retailing*, 60(3).15-36.

Johnston, R. & Jones, P.(2003). Service productivity: Towards understading the relationship between operational and customer productivity, International Journal of Productivity and Performance Management. 53(3), 201-213.

Kasavana, M & Smith, D.(1982). Menu Engineering: A practical Guide, Lansing, MI: Educational Institute of American Hotel & Motel Association.

Keh,H., Chu,S., Xu,J.,(2006). Efficiency, effectiveness and productivity of marketing in Services, *European Journal of Operational research*, 170(1), 265-276.

Lozano, S., &Villa, G., Andenso-Diaz,B.,(2004). Centalised target setting for regional recycling operations using DEA, *International Journal of Management Science*, 32 (2), 101-110.

Luo, X., Donthu, N. (2001) Benchmarking advertising efficiency. *Journal of Advertising Research*, November-December, 7-18.

Mahajan, J. (1991). Data envelopment analytic model for assessing the relative efficiency of the selling function. European *Journal of Operational Research* 53, 189-20.

Malhotra, D. K Lafond, A. Garritt, F., (2006). Ratio Analysis and Its Use in Portfolio Diversification Using RMA's Annual Statement Studies, The RMA Journal, 88(9), 64-69.

McLanghlin, P, Coffey, S.(1990). Measuring Productivity in Services, *International Journal of Service Industry Management*, 1, 46-64.

Morey, R.C., Dittman, D.A., (1995) . Evaluating a hotel GM's performance: a case study in benchmarking. *Cornell H Hotel and Restaurant Administration Quarterly,* 36 (5), 30-36.

Muller, C (1999). A Simple Measure of Restaurant Efficiency, *Cornell Hotel and Restaurant Administration Quarterly,* 40 (3) 31-37.

Neter, J. Wasserman, W, Kuter, M.(1989) Applied Linear Regression Models, Irwin, Boston, MA.

Norton, S. W.(1988). An empirical look at franchising as an organizational form. *Journal of Business,* 61(2), pp. 197-218.

Parsons, L.J, (1997). Productivity versus relative efficiency in marketing: past and future, Research Traditions in Marketing, *Kluwer Academic Publishers*, Boston, MA

Pavesic, D. (1983). Cost-Margin Analysis: A third approach to menu pricing and design, *International Journal of Hospitality Management*, 2(3).127-134.

Reynolds, D., Thomson, G.M.,(2007). Multiunit restaurant productivity assessment using three-phase data envelopment analysis. *International Journal of Hospitality Management* 26 (1), 20-32.

Reynolds, D., (2004). An exploratory investigation of multiunit restaurant productivity assessment using data envelopment analysis. *Management Science Applications in Tourism and Hospitality*, 16 (2), 19-26.

Reynolds, D., (2003) Hospitality productivity assessment using data envelopment analysis. *Cornell Hotel and Restaurant Administration Quarterly,* 44 (2), 130-138.

Roh, Y.,(2002). Size, Growth rate risk sharing as the determinants of propensity to franchise in chain restaurants, *International Journal of Hospitality Management*,21,43-56.

Schmidgall, R (2006). Hospitality Industry Managerial Accounting, Educational Institute, Lansing, MI

Torgerson, A.M., FØrsund, F.R., Kittelsen, S.A.C.(1996). Slack-adjusted efficiency measures and ranking of efficient unit. *Journal of Productivity Analysis* 7, 379-398.

Yoo B. N Pilling B.K (1998) Channel Efficiency: Franchise versus Non-franchise System, *Journal of Marketing Channels*, 6(3/4), 1-15.

Wober, K.W., Fesenmaier, D.R, (2004). A multi-criteria approach to destination benchmarking: a case study of state tourism advertising programs in the united states. *Management Science Applications in Tourism and Hospitality,* 16 (2), 1-18.

Zhu, J.(2000). Multi-factor performance measure model with an application to Fortune 500 companies. *European Journal of Operation Research,* 123, 205-124.

ABOUT THE AUTHORS:

Dr. Kyuwan Choi is a visiting scholar of the Department of Hospitality and Tourism at Purdue University. He earned his Ph.D. from the College of Business Administration at Seoul National University in Korea. He published extensively in many Hospitality and Tourism journals in Korea.

Dr. Yae Sock Roh is an Associate Professor of Marketing and Hospitality Administration at Central Michigan University, His research interests include franchising, real estate, and hotel operations and management. His works appeared in many prestigious hospitality journals.

Dr Jihwan Yoon is an Associate Professor of School of Hospitality Management at Kyung Hee University, Soul, Korea. He received his Ph. D from Pennsylvania State University and his area of research interests include Hospitality and Tourism management, and franchising. His research appeared in many Hospitality and Tourism journals.