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Efficiency Analysis of Retail Chain Stores in Korea

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Abstract: In today's low-growth business environment, efficiency management is becoming more important to improve corporate sustainability. In a chain store, the efficiency of individual stores must be well managed to improve the efficiency of the entire enterprise. To do this, it is important to measure the efficiency of individual stores and to find factors that affect efficiency. The main purpose of this study is to find out the factors affecting the efficiency of chain stores and to analyze the results to find out the implications that contribute to an improvement in efficiency. We measured the relative efficiency of individual stores using data envelopment analysis (DEA) and analyzed the factors that affect efficiency with the Tobit regression model. As a result, we found that the number of items per employee and a competitive environment influence the efficiency of stores. An excessive number of items may cause efficiency to be lowered. Therefore, it is necessary to manage the life cycle of the product, considering the trade-off between assortment and efficiency. Competition helps to improve efficiency to some extent, but too much competition can reduce efficiency.

Keywords: efficiency analysis; chain stores; data envelopment analysis (DEA); Tobit regression

1. Introduction

According to Statistics Korea, the Korean retail market grew at a GAGR(Compound Annual Growth Rate) of 3.2% from 2012 to 2016. In particular, department stores and supermarkets posted annual average growth of 0.7% and 2.7%, respectively, while specialty retailers recorded negative growth. These traditional offline-based retailers' low growth is attributable to the following reasons: (1) a fall in consumer confidence due to the prolonged domestic recession; (2) changes in consumption patterns due to changes in population structure (e.g., low birth rate, aging, increase in single person households); and (3) rapid growth in online shopping and mobile shopping. The slow growth of the Korean retail market is expected to continue for the time being, and it is difficult to expect the high growth rate of the past. In such a business environment, it is difficult to expand sales, so pursuing profitability through cost reduction is a common way to improve the sustainability of a company. This cost reduction is achieved through efficient operations, so the importance of efficiency management is emphasized.

In chain stores, one of the representative forms of retailing, it is essential to improve the efficiency of individual stores in order to improve the efficiency of the entire enterprise. This is because the global profitability of any chain enterprise depends on the profitability of its constituent parts [1]. To improve the efficiency of individual stores, we must first measure the efficiency of individual stores, and, if there are differences among stores, we need to figure out the cause. Since chain stores are operated based on standardized processes, IT systems, and employee training programs, theoretically, there should be little or no difference in efficiency among stores. However, if there are differences in efficiency among stores, it means that other factors are affecting the efficiency, and understanding these factors will be a starting point for improving efficiency. Therefore, this study aims to analyze the factors affecting the efficiency of individual stores and to provide managerial implications for the improvement of efficiency.

In this study, data envelopment analysis (DEA) is used to measure the efficiency of individual stores. DEA is a non-parametric productive efficiency measurement method for operations with multiple inputs and multiple outputs. It combines and transforms multiple inputs and outputs into a single efficiency index. Today, various DEA efficiency models are available for different types of measurement requirements. It also has been applied to various industrial and non-industrial contexts such as banking, education, hospitals, etc., [2]. There have been several studies on efficiency in the retail industry using DEA, which can be divided into two types. One is measuring efficiency using DEA and discussing the results [1,3–9], and the other is measuring efficiency using DEA and then analyzing factors that affect the results [10–15]. Previous studies on intra-chain comparative store efficiency mostly follow the former case [1,3,5–9] and only a few studies have analyzed the factors of efficiency [4,14]. Therefore, it is necessary to study the factors affecting efficiency at the store level.

The research questions of this study are as follows: (1) What is the efficiency of individual stores in a chain store, taking into account multiple inputs and multiple outputs? (2) Is the efficiency of the store different depending on the local characteristics? (3) What are the factors that affect the efficiency of individual stores?

2. Literature Reviews

In early stage studies, the efficiency of the retailers was measured using DEA and the results were discussed. Donthu and Yoo [3] analyzed 24 outlets of a fast-food restaurant chain in the United States. Thomas et al. [4] evaluated the efficiency of 520 outlets of a leading specialist retailer in the United States and examined 16 variables used as input variables to determine the variables affecting efficiency. Keh and Chu [5] compared the efficiency of inputs, intermediate output, and final output for 13 outlets of a grocery store chain in the Unites States. Barros and Alves [1] measured the efficiency of 47 chain stores in Portuguese hypermarkets. There have been other efficiency studies for retailers in Spain, the US, and India [6–9]. Table 1 shows early stage studies that used DEA to measure chain store efficiency and analyze the results.

Later studies were extended to factors affecting efficiency, mainly using the Tobit regression model. Barros [10] measured the efficiency of 22 hypermarkets in Portugal using a DEA model and then analyzed the factors affecting the efficiency using a Tobit regression model. The independent variables examined in the Tobit regression model are the market share of the retailers, the number of outlets, ownership, regulation, and location. The results showed that the efficiency scores are positively related and statistically significant with all variables, with the exception of the regulation variables, signifying that the market share, number of outlets, national ownership, and market coverage contribute to the efficiency of retailers. Perrigot and Barros [11] used the DEA model to analyze the efficiency of 11 French retailers and identified the factors that affect their efficiency. They found that the efficiency was higher as the period increased, and the efficiency of stock market-quoted retailers, companies involved in mergers and acquisitions (M&A), retailers belonging to a group, and retailers with an international expansion strategy was high. Yu and Ramanathan [12] used the DEA model to examine the economic efficiency of 41 retail companies in the UK and analyzed the determinants of efficiency. As a result, it was found that the factors influencing efficiency are the type of ownership, legal form, and retail characteristics. Foreign retailers, private retail companies, and food retail companies seem to be more efficient. Yu and Ramanathan [13] also measured the efficiency of 61 retailers in China and analyzed the factors that affect their efficiency. They found that the only factor influencing efficiency was the retail characteristics, and department stores were the most efficient. Uyar et al. [14] assessed the operational efficiency of 79 bookshops within a bookshop chain in Turkey and identified efficiency drivers. The results revealed that shop age has a positive significant influence on bookshop efficiency, whereas manager experience, staff experience, and the education level of the shop manager do not. Gandhi and Shankar [15] studied the determinants of efficiency in 18 Indian retailers. The results showed that the number of retail outlets and M&A can be considered the driving forces influencing efficiency. Table 2 shows studies that include an analysis of the determinants of efficiency for retailers.

Table 1. List of studies on chain store efficiency using data envelopment analysis (DEA).

Studies	Units	Inputs	Outputs
Donthu and Yoo (1998)	24 outlets of a USA fast food restaurant chain	Store size, Store manager experience, Store location, Promotion expenses	Sales, Customer satisfaction
Thomas et al., (1998)	520 outlets of a USA multi-store, multi-market retailer	Full-time employees, Full-to-part-time employees, Salaries, Employee tenure, Store manager tenure, Store age, Occupancy expenses, Population, Household income, Households, Proximity, Inventory, Transactions, Employee turnover, Shrinkage	Sales, Profits
Keh and Chu (2003)	13 outlets of a USA grocery store chain	Labor (floor staff and management wages and benefits), Capital (occupancy, utilities, maintenance and general expenses)	Intermediate output: Accessibility, Assortment, Assurance of product delivery, Product information, Ambience Final output: Sales revenue
Barros and Alves (2003)	47 outlets of a Portuguese hypermarket retail company	Full-time employees, Part-time employees, Cost of labor, Absenteeism, Area of outlets, Number of points of sale (POS), Age of the outlet, Inventory, Other costs	Sales, Operational results
Sellers-Rubio and Mas-Ruiz (2006)	100 supermarket chains in Spain	Employees, Outlets, Capital	Sales, Profits
Mostafa (2009)	45 USA retailers	Employees, Assets	Revenue, Market value, Earn share
Gupta and Mittal (2010)	43 outlets of a Indian grocery retailer	Area of outlets, Number of SKU(Stock Keeping Unit)s, Number of POS machines, Labor cost of employees, Number of employees, Working hours of employees	Sales, Customer conversion ratio
Sharma and Choudhary (2010)	200 Indian retail stores	Size of retail store, Manager's experience, Location of retail store	Sales, Customer satisfaction

Table 2. List of studies on determinants of chain store's efficiency using Tobit regression model.

Studies	Units	Inputs	Outputs
Barros (2006)	22 hypermarket and supermarket firms in Portugal	Labor, Capital Tobit regression model variables: Share, Outlets, Ownership, Regulation, Location	Sales, Operational results
Perrigot and Barros (2008)	11 French generalist retailers	Labor, Capital, Total costs Tobit regression model variables: Trend, Square trend, Quoted, mergers and aquisitions (M&A), Group, International	Turnover, Profits
Yu and Ramanathan (2008)	41 retail companies in the UK	Total assets, Shareholders funds, Employees Tobit regression model variables: Head office location, Types of ownership, Years of incorporation, Legal form, Retail characteristic	Turnover, Profit before taxation
Yu and Ramanathan (2009)	61 retail firms in China	Total selling floor space, Employees Tobit regression model variables: Head office location, Firm nationality, Years of incorporation, Ownership type, Retail characteristic	Sales, Profit before taxation
Uyar et al., (2013)	79 bookshops within a bookshop chain in Turkey	Area, Population, Inventory, Employee, Salaries, Other costs Tobit regression model variables: Education of manager, Experience of manager, Experience of staff, Age of bookshop	Sales, Profit
Gandhi and Shankar (2014)	18 Indian retailers	Cost of labor, Capital employed Tobit regression model variables: Number of outlets, Ownership, Age since incorporation, Mergers and acquisitions	Sales, Profit

There have been many studies on the efficiency of chain stores. However, most of the studies have the unit of analysis as the entire company, so it can be seen that more studies at the store level are needed.

3. Methods

This study consists of two stages: measuring the relative efficiency of individual stores and determining the factors that affect the efficiency. In the first stage, DEA was used to measure the relative efficiency of individual stores. In the second stage, a Tobit regression model was used to analyze the factors affecting the efficiency.

3.1. DEA

DEA was developed by Charnes et al. [16] as a methodology primarily used to determine the relative efficiency when there are multiple inputs and multiple outputs. This approach first establishes an 'efficient frontier' formed by a set of decision making units (DMUs) that exhibit best practices and then assigns the efficiency level to other non-frontier units according to their distances to the efficient frontier [2].

There are several types of models used in DEA, but they can be largely classified into a constant returns-to-scale (CRS) model and a variable returns-to-scale (VRS) model, depending on the size variability. The CRS model is based on the assumption that the input and output ratios do not change with size and is called the CCR model after the first letters of the authors Charnes, Cooper, and Rhodes [16]. The VRS model is a model that applies when the ratio of input and output varies with size, also called the BCC model in the name of Banker, Charnes, and Cooper who first introduced this model [17].

A DEA model can be analyzed in two ways, with an input orientation or an output orientation, for the purpose of efficiency improvement. The input-oriented model is aimed at minimizing inputs in the direction of efficiency improvement, and the output-oriented model tries to maximize outputs in order to improve the efficiency.

Equation (1) shows the output-oriented CCR model. Assuming that there are a total of n DMUs, m inputs $x_{ij}(i = 1, \ldots, m)$, and s outputs $y_{rj}(r = 1, \ldots, s)$:

$$\begin{aligned} & max\ \phi_k + \epsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right) \\ s.t.\ & \sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = x_{ik}, \qquad i = 1, \ldots, m \\ & \sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = \phi_k y_{rk}, \qquad r = 1, \ldots, s \\ & \lambda_j,\ s_i^-,\ s_r^+ \geq 0, \qquad \forall\ i,\ j,\ r \end{aligned} \tag{1}$$

Here, $\phi_k(k = 1, \ldots, n)$ is the efficiency value of the kth DMU_k and s_i^- and s_r^+ represent the input and output slack variables, respectively.

Equation (2) shows the output-oriented BCC model. It has a constraint on the sum of λ in the CCR model of Equation (1) to have convexity constraints.

$$\begin{aligned}
& max\ \phi_k + \epsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right) \\
s.t.\ & \sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = x_{ik}, \qquad i = 1, \ldots, m \\
& \sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = \phi_k y_{rk}, \qquad r = 1, \ldots, s \\
& \sum_{j=1}^{n} \lambda_j = 1 \\
& \lambda_j,\ s_i^-,\ s_r^+ \geq 0, \qquad \forall\ i,\ j,\ r
\end{aligned} \tag{2}$$

3.2. Data

The focal organization for this study is the largest household goods retailer in Korea, with over 400 domestic company-owned outlets. The DMUs for this study are the individual stores. In DEA, the homogeneity of DMUs should be assumed. Therefore, to ensure homogeneity as much as possible, we selected stores through the following process. First, in order to secure regional homogeneity, we selected stores located in Seoul, the capital and most representative city of Korea. In addition, since new stores require a certain period of time to stabilize their operations, only those stores with more than one year of operation are considered. This resulted in a final sample population of 32 stores.

3.3. Input/Output Measures

In order to apply DEA successfully, the choice of input and output variables is critical. Input and output variables for DEA should be chosen such that they accurately reflect the retail firm's goals, objectives, and sales situation [3]. In this study, the input and output variables were selected with consideration of the variables used in previous studies and the key performance indicators (KPIs) used within the company. This is intended to include variables that are commonly used in retailers' efficiency analyses, as well as variables that reflect the company's strategic goals, sales situation, and performance management system. Through this process, four input variables were selected: store size, the number of items, the number of employees, and rental cost.

Store size and the number of employees were used as input variables in most of the previous studies [1,3,4,6–14], and the company manages them with a higher priority. The store size used in this study is the selling area of a store, and warehouse area is not included. The number of employees is the sum of number of full-time and part-time employees. The number of part-time employees was calculated to be 0.7 times the number of full-time employees in the same way as in the company.

The number of items, which is an important indicator of the company, means the number of stock keeping units (SKUs). This was used as an input variable for assortment in Keh and Chu [5], and Gupta and Mittal [8] said that the decision regarding the number of SKUs at one particular store played a very important role in store performance.

The rental cost was used as an input variable in the study of Thomas et al. [3]. Since rental cost varies according to the terms of the contract, we used the average rental cost in the area where the store is located.

We selected sales revenue and the number of customers as output variables. Sales revenue was used as an output variable in all previous studies [1,3–15] and is one of the most important KPIs in most companies. In this study, the daily average sales revenue was used. Finally, the number of customers was selected as the output variable to supplement the assessment results when the number of customers is high even if the sales are low. We averaged the monthly data of 2013 using proprietary data provided by the company. A table of statistics for the selected variables is shown in Table 3.

Table 3. Descriptive statistics of the variables used.

Variables	Minumum	Maximum	Mean	Standard Deviation
Inputs				
Store size	22	218	103.9	51.6
Number of items	4177.00	20,939.00	12,156.40	3460.70
Number of employees	6	23	12.9	3.9
Rental cost	1061.60	30,020.20	8603.70	5485.70
Outputs				
Sales revenue	1672.00	10,999.00	4651.20	1872.10
Number of customers	305	1636.00	831.3	287.6
Tobit model variables				
Store age	12	98	45.4	22.1
Number of items per unit area	73.1	273.1	135.4	50.9
Number of items per employee	522.1	1789.70	981.2	288.5
Trade area index	0.314	0.757	0.479	0.113
Number of competitor stores	14	57	34.8	11.9

3.4. DEA Models

As mentioned earlier, the DEA model is divided into the CCR model and the BCC model based on assumptions about the economies of scale. In this study, we used the BCC model because we could not assume that there were no economies of scale for the efficiency of stores.

The choice of input-oriented or output-oriented model was based on the general criteria proposed by Barros and Alves [1], and we applied the output-oriented model. They argued that, in competitive markets, it is desirable to apply the output-oriented DEA model because private firms operating in a competitive market environment aim to maximize their outputs rather than minimize their inputs [1].

3.5. Tobit Regression Model

To analyze the factors that affect some outcomes, we generally use a regression model. However, the general regression model cannot be used to analyze the factors that affect the efficiency calculated by DEA. Since the efficiency value calculated by DEA has a limited range of values between 0 and 1, ordinary least squares (OLS) analysis results in biased estimates or invalid inferences.

The Tobit regression model proposed by Tobin [18] is suitable for cases in which the dependent variable of the regression model is limited to a certain range of values [14]. Equation (3) shows the Tobit regression model used in this study.

$$\begin{gathered} y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \ \ldots \ + \beta_5 x_{5i} + \varepsilon_i \\ if\ y_i^* \leq 0, then\ y_i = 0 \\ if\ y_i^* \geq 1, then\ y_i = 1 \\ if\ 0 < y_i^* < 1, then\ y_i = y_i^* \end{gathered} \tag{3}$$

Here, y_i is the efficiency value of DMU_i calculated by DEA, and the five explanatory factors, namely, store age (x_1), the number of items per unit area (x_2), the number of items per employee (x_3), trade area index (x_4), and the number of competitor stores (x_5), were examined.

The selection of independent variables is the most important process in designing the regression model. In this study, we selected independent variables by considering the results of the previous studies and the opinions of the company's management. As a result, the independent variables included experience and knowledge of stores, operational capabilities, and external environment factors.

The most common variables that represent the experience and knowledge of the stores are store age and employee's working period. Store age is an indicator of accumulated experience and knowledge of stores, reputation within the community, and consumers' awareness. Thomas et al. [4] found that store age is associated with high store efficiency, and Uyar et al. [14] also found that it proved to be a significant efficiency driver. Also, in the study of Assaf et al. [19], for supermarket chain stores, the age of the firm was found to affect the efficiency, but the results of Sellers-Rubio and Mas-Ruiz [20] showed that the effect of store age was not clear. Reflecting the results of previous studies, store age was considered a factor to determine whether the experience and knowledge of stores influence their efficiency. Another variable that can represent the experience of a store is the manager's or staff's working period, but this was excluded because employees are moved between two or more stores in the company.

To compare the operational capabilities among stores, we included two explanatory variables: the number of items per unit area and the number of items per employee. The number of items per unit area represents the ability to display a variety of items in a limited space and effectively display them. For this company, which handles more than 30,000 items, the capability to utilize the store's display space is considered to have an important effect on the efficiency, so it was included in the explanatory variables. The number of items per employee is the number of products sold at the store divided by the number of employees, which represents the number of the items that one employee must manage. One of the most important operational capabilities is how many items can be managed by the staff who display the goods, manage the inventory, and respond to customers.

External environmental factors are also important. The environmental variables mainly used in the previous studies were demographic variables such as population, population density, number of households, income level, store location, and distance from other stores. We used a trade area index and the number of competitor stores as variables representing external environmental factors. A trade area index is a numerical representation of how the facilities and buildings affecting the sales of the stores are distributed around the stores. It was calculated by first evaluating the distribution of 14 facilities and buildings within a radius of 500 m from the store using a five-point scale and then summing the results. Some examples of the 14 facilities and buildings are subway stations, schools, offices, hospitals, hotels, etc. As the value of the trade area index increases, the size of the trade area also increases. We included a trade area index as an explanatory variable to determine whether the size of a trade area affects efficiency as well. Competition is also an important external environmental variable that can affect the efficiency of a store. Dubelaar et al. [21] found that competition had a significant impact on productivity and that competition-related factors should be included in the assessment of productivity. In this study, we used the number of competitor stores as an explanatory variable, which is the number of similar stores located within a radius of 500 m from the store and which indicates the competitive strength of the stores.

4. Discussion of Results

4.1. *Efficiency Scores*

The distribution of the efficiency scores of 32 stores is shown in Figure 1. The efficiency score ranges from 0.511 to 1.000, with an average of 0.837 (the dotted line in Figure 1) and a standard deviation of 0.157. There is a total of 14 stores, with efficiency scores between 0.95 and 1.000 as in Figure 1. The number of efficient stores is 10, indicating that 31% of the stores are efficient. This means that 69% of the stores are inefficient, and there is an opportunity to improve efficiency for these stores. The efficiency scores of 13 stores (41%) are less than 0.75. Therefore, it is found that the efficient and ineffective stores in the company are relatively distinct.

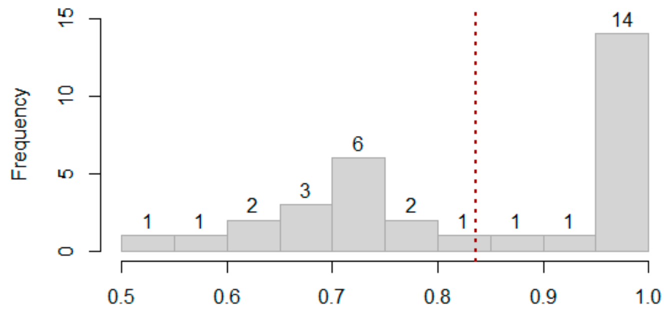

Figure 1. Histogram of efficiency scores.

4.2. Comparison of Efficiency

Is the efficiency of the store different depending on the local characteristics? For example, is the store in the residential area more efficient than the store in the commercial area? Or is it the opposite? To answer this question, we first divided the stores into two groups based on the location of the stores. As a result, all stores were divided into two groups, those in residential areas (four stores) and those in commercial areas (27 stores). The classification of the land is designated by the government into four areas based on usage: residential, commercial, industrial, and green. Therefore, residential areas cannot be designated as commercial areas and are independent. Residential areas are more restrictive in permitting business facilities compared to commercial areas. For example, some permitted facilities in residential areas are houses, schools, facilities providing basic necessities, etc. One store was excluded from the classification because it does not belong to either a residential or a commercial area.

We then tested whether there is a difference in the mean of the two groups. The efficiency scores obtained using DEA are calculated values, so it cannot be assumed that these data are normally distributed. It can be easily known by a histogram of efficiency scores, as shown in Figure 1. Therefore, when testing the difference between two means, we cannot use a *t*-test that assumes normality. So, we used the non-parametric Wilcoxon Rank Sum Test [22] to test whether the efficiency of the two groups is different. As a result of the test, the *p*-value was 0.048, indicating that there is a difference in efficiency between the two groups at significance level of 0.05.

The average efficiency score of the stores in the residential area was 0.681, and it was 0.864 for residential and commercial area stores. This result shows that the stores in the residential and commercial areas are more efficient than those in the residential areas.

4.3. Tobit Regression Model

The results of the Tobit regression model are shown in Table 4. The number of items per employee and the number of competitor stores were statistically significant at the significance level of 1%. Moreover, the number of items per employee has a negative effect, while the number of competing stores has a positive effect on efficiency.

Table 4. The results of the Tobit regression model (1).

Variables	Estimate	Std. Error	z Value	*p*-Values
Store age	0.0011525	0.0015299	0.753	0.45128
Number of items per unit area	0.001473	0.0007993	1.843	0.06536
Number of items per employee	−0.0004210	0.0001429	−2.945	0.00322 **
Trade area index	−0.3490104	0.3113706	−1.121	0.26234
Number of competitor stores	0.0067086	0.0025178	2.664	0.00771 **
R-Squared = 0.6469811, Adjusted R-Squared = 0.5790929				

Note: *p*-values followed by ** are significant at a level of 1%.

The number of items per employee has a negative effect on the efficiency of retail stores. It can be understood that managing the appropriate number of items that can be afforded by store staff helps to improve efficiency. In terms of customer satisfaction, it is good to have a large assortment of products. However, efficiency may be deteriorated if product displays or customer responses are not performed properly due to excessive amounts of items. Broniarczyk and Hoyer [23] showed similar results. They found that large assortments increase choice difficulty, increase negative affect and regret, and decrease the likelihood of product purchase. Thus, they concluded that having an optimal rather than simply a large assortment is critical for retailers [23]. The fact that the number of competitor stores affects efficiency in a positive way means that some competitive environments can have a positive impact on efficiency. It can be understood that the more intense the competitive environment, the higher the work tensions of the employees, as is the case with a store in the central commercial district of the big city, which can improve the efficiency of the store.

4.4. In-Depth Analysis of Significant Variables

More detailed analysis is needed to understand the characteristics of the two factors that have been found to affect the efficiency of the store.

4.4.1. Number of Items per Employee

We divided the stores into four groups based on efficiency scores and sales and then compared the number of items per employee for each group. The stores with an efficiency score above average are in the high-efficiency stores group, and the rest of the stores are in the low-efficiency stores group. In the same way, if sales are above average, the store belongs to the high-sales stores group, and if they are below average, the store belongs to the low-sales stores group. The averages of the number of items per employee for the four groups are shown in Figure 2a. This figure shows the following facts. First, regardless of whether sales are high or low, high-efficiency stores have a fewer items per employee. This shows, as the result of Tobit regression model, that the number of items per employee affects efficiency in the negative direction. Second, there are a fewer items per employee in high-sales stores regardless of efficiency. Finally, the difference in the number of items per employee between high-efficiency stores and low-efficiency stores is greater in low-sales stores.

Similar results can be obtained by using store size instead of sales in the same way. That is, the difference in the number of items per employee between high-efficiency stores and low-efficiency stores is greater in small stores. Figure 2b shows this relationship.

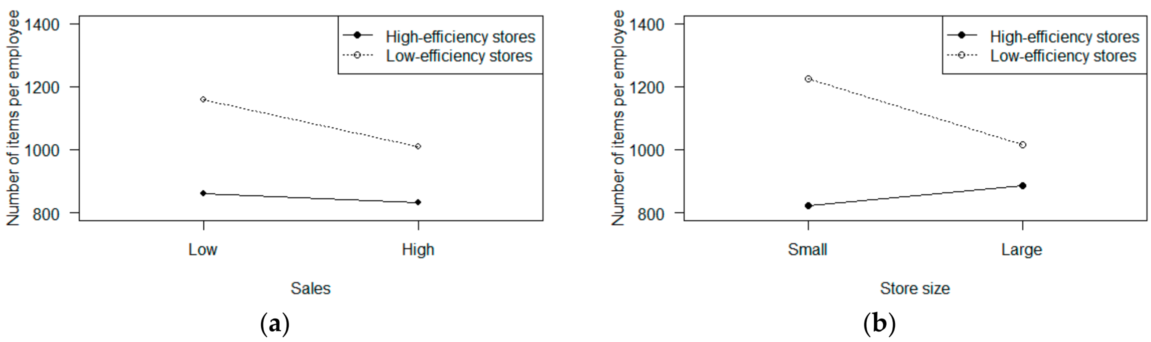

Figure 2. The number of items per employee in high-efficiency and low-efficiency stores: (**a**) Comparison of high-sales stores and low-sales stores; (**b**) Comparison of large stores and small stores.

In sum, it can be deduced that the number of items per employee is high in stores where sales are low or stores are small in size. This is because, even if it is a small-size store, it is necessary to have a product assortment of a certain size, and the number of items increases with time, but the number of employees cannot be increased proportionally.

We can derive two important managerial implications from these results. First, in estimating an appropriate number of employees, it is necessary to consider the number of items, not just the size of the store. Currently, this company estimates the number of employees by considering the sales and external characteristics of the store such as if the store has several floors. Second, it is important to manage the life cycle of the product. As a new product is sourced, the number of items continues to increase, while the number of employees is not constantly increasing, so the number of items per employee increases. Since it is practically difficult to increase the number of employees, managing the life cycle of a product and discontinuing it at a proper time will be a way to improve efficiency by keeping the number of items at an appropriate level. This is especially important for small stores.

4.4.2. Number of Competitor Stores

The results of the Tobit regression model showed that the number of competitor stores has a positive effect on efficiency. If so, does the efficiency continue to improve as the intensity of competition increases? Or will the efficiency decrease after it reaches a certain level? We added a square number of competitor stores to the model to see if efficiency has a linear or nonlinear relationship with the number of competitor stores. The results are shown in Table 5.

Table 5. The results of the Tobit regression model (2).

Variables	**Estimate**	**Std. Error**	**z value**	***p*-values**
Store age	0.0008127	0.0014315	0.568	0.57024
Number of items per unit area	0.0014026	0.0007522	1.865	0.06224
Number of items per employee	−0.0004082	0.0001345	−3.036	0.00240 **
Trade area index	−0.3134973	0.2904058	−1.080	0.28036
Number of competitor stores	0.0325403	0.012631	2.576	0.00999 **
Square number of competitor stores	−0.0003695	0.0001767	−2.091	0.03655 *
R-Squared = 0.6469811, Adjusted R-Squared = 0.5790929				

Note: *p*-values followed by ** are significant at a level of 1% and those followed by * are significant at a level of 5%.

Compared with the results of the previous model (see Table 3), the significant variable is the same, and the newly added variable, the square number of competitor stores, is also statistically significant. The square number of competitor stores affects the negative direction, which is the opposite effect of the number of competitor stores, which has an effect in the positive direction. In other words, the effect of the number of competitor stores on efficiency scores is an inverted-U shape, which means that efficiency increases when the intensity of competition increases to a certain level but that efficiency decreases if the threshold is exceeded. This regression function is converted into a quadratic function by replacing the remaining variables, except for the number of competitor stores, with an average value and then shown as a graph in Figure 3. The efficiency scores increase as the number of competitor stores increases, but when the number of competitor stores exceeds 44, the efficiency scores decrease from that point.

In many previous studies, it is known that competition has a positive effect on productivity growth at the firm level [24–27]. In this study, however, competition appears to have an inverted-U shape rather than a simple positive effect on efficiency, which is the same as the result of Aghion et al.'s study [28] of the relationship between competition and innovation.

This result implies that it is necessary to consider the competitive environment of the store when evaluating the performance of the store. It can also be used when evaluating a possible location for a new store [29–31].

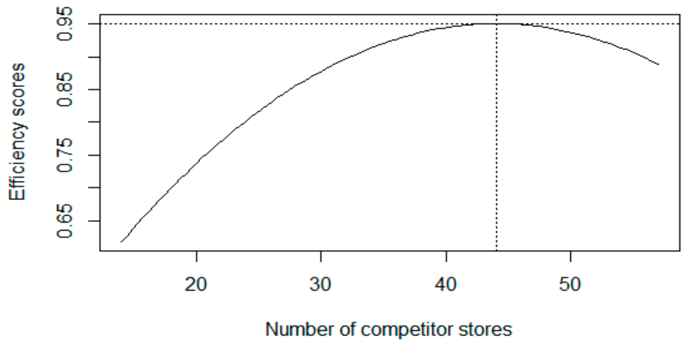

Figure 3. The changes in efficiency scores as the number of competitor stores changes.

5. Conclusions

In this study, we measured the relative efficiency of 32 stores of a household goods retailer in Korea. We found that about 70% of the stores are inefficient, which means that there is room for improvement in performance without additional resources. In addition, the efficiency score of the least efficient store was 0.511, which is about half of those of the efficient stores, and there were many differences in efficiency among the stores. Therefore, it is necessary to analyze what is causing these differences in chain stores operating according to standard operating procedures.

To identify the cause of these differences in efficiency, we used the Tobit regression model. As a result, we found that the number of items per employee and the number of competitor stores influence the efficiency of the stores. These results provide the following managerial implications.

First, large product assortments are required for customer satisfaction, but the excessive number of items may lead to lower efficiency. Therefore, it is important to have an optimal assortment of products suitable for the sales situation of the store. To do this, it is necessary to manage the life cycle of the product by considering the trade-off between assortment and efficiency. In particular, these issues are clearly seen in low-sales stores and small-size stores, so it is necessary to focus on these stores in order to improve the efficiency of the entire enterprise [32,33].

Second, understanding the impact of competitive environment on efficiency is important. Competition affects efficiency with an inverted-U shape. In other words, competition helps to improve efficiency to some extent, but too much competition can reduce efficiency. Therefore, it is necessary to consider the influence of this competitive environment in making decisions such as evaluating the performance of a store or determining the location of a new store.

The main contribution of this paper is to find out two factors that affect efficiency at the individual store level of chain stores. We expect that understanding the characteristics of these factors will help improve efficiency. However, this study is limited to one household goods retailer, so the results may not be applied to other industries. It was also conducted as a cross-sectional study based on data at a specific point in time, so it would be meaningful to conduct a longitudinal study in the future. Furthermore, studies should investigate a 'tipping point' at which product line depth or breadth becomes inefficient and recommend which products should be cut to solve the inefficiency. Another possible future contribution is the implementation of advanced methodologies of DEA to further develop this proposed area of research.

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