A Computing Model for Marketable Quality and Profitability of Corporations: Model Evaluation Based on a New Source Data

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Abstract

In this paper, we introduce and evaluate a computing model for marketable quality and profitability of corporations. We discuss the model prediction of the turning and transition period based on a new source data. By applying the real data of some leading manufacturing corporations in Japan we analyze the model accuracy. From the analysis, we conclude that the proposed model give a good approximation and prediction of the turning and transition period of Japanese economy.

1. Introduction

The achieved standard profitability of corporations depends on the free competition between corporations. This is a very important concept that should be considered to evaluate the corporation profitability. The corporation profitability is conceptually considered to be a function of two variables: the qualitative and quantitative aspects. However, most of the profitability functions that have been proposed so far fall in two categories. In the first category, the quantitative aspect is considered variable, while the qualitative aspect is considered constant. In the second category, both aspects are unified as a variable. In fact, the quality and quantity are independent variables. But, when we consider the profitability, there is a relation between them. In this work, we consider the qualitative aspect variable.

The Break-Even Point (BEP) ratio expressed in the following equation is used as an indicator related to profitability.

\[
\text{BEP ratio = Sales at BEP / Sales } \times \text{ Fixed costs / (Sales - Variable costs)}
\]

This indicator is based on the profit graph presented by Knoppel [1]. Another profitability indicator (relative annual profit) has been obtained from the rate of operation and the rate of operation at the BEP [2].

Relative annual profit = Rate of operation / Rate of operation at BEP = Marginal profit / Fixed costs

As can be seen, this is an inverse number of the BEP ratio. The relative annual profit is a profitability indicator that analyzes a function based on the concept of rate of operation. Therefore, we consider the relative annual profit as a profitability indicator in this study. We define the marketable quality based on the quality aspects of products and services provided by corporations. In order to define the quality, Garvin [3] considers five viewpoints, i.e., transcendent, product based, user based, manufacture based and value based as main approaches. We define the marketable quality as a qualitative aspect of profitability. That is we measure it as a relative value of the fifth viewpoint (value based). It is an important problem to be considered how to increase the profitability by enhancing marketable quality.

In our previous work, for evaluation our model, we used the data of rate of operation of the manufacturing industry in Japan estimated by the Ministry of International Trade and Industry and the Economic Planning Agency, and the Ministry of Economy, Trade and Industry [4,5]. In this work, we use new data derived from the article of Nihon Keizai Newspaper [6]. By applying these real data of some leading manufacturing corporations in Japan we analyze the model accuracy. From the analysis, we conclude that the proposed model give a good approximation and prediction of the turning and transition period of Japanese economy.

The paper is organized as follows. In the next section, we present the proposed model. In Section 3, we give an econometric methodology. In Section 4, we discuss the turning point from economies of scale to quality enhancement. In Section 5, we give some conclusions.

2. Proposed Model

2.1 Basic Variables

We consider the following basic variables for our model. If a certain corporation consists of \( m \) kinds of processes or divisions for a certain period, we consider the capacity (total available operating time) of process \( i \) be \( T_i \), and its costs (fixed costs) be \( F_i \), where \( i = 1, \ldots, m \). The costs are divided into the capacity costs and activity costs by the source of their occurrence [7]. They are classified into fixed costs and variable costs based on the rate of operation or volume of operation. The capacity costs and fixed costs, and the activity costs and variable costs are almost the same, but the classification viewpoint is different. The necessary capacity (the
total necessary time of operation) of process \(i\) is assumed to be \(T_i\) and the marginal profit which is calculated as the value of sales minus the variable costs (activity costs) is assumed to be \(M\).

On the other hand, there is a minimum required level (minimum passing level) to purchase a product considering a sacrifice (price or fee) from the customers’ side related to the quality of products or services given by a corporation. This means the minimum level to be achieved, even if the sacrifice is small. In this way, any quality level can be quantified theoretically by comparing with the minimum passing level. Therefore, we consider the minimum passing level to be \(P_0\) and the other levels are considered as \(P\).

### 2.2 Model Indicators

#### 2.2.1 Rate of Operation Indicator

The rate of operation of a corporation \(\beta\), is expressed in Eq. (1) as the average value of the rates \(\beta_i\). The capacity cost values are used as weights for each process [2].

\[
\beta = \frac{\sum_i \beta_i F_i}{\sum_i F_i} = \frac{\sum_i T_i f_i}{F}
\]  

Hence, \(\beta_i = \frac{\beta_i}{f_i}, f_i = \frac{P_0}{P_i}, F = \sum_i P_i F_i\), Eq. (1) can be seen as a degree of used capacity costs.

The data from the article of Nihon Keizai Newspaper [6] are shown in Table 1. The weighted average values are calculated by using added values of the rate of operation for each item which are considered as indicator of the rate of operation. In Table 1 are shown also the estimated values of the rate (\(\beta\)) of operation for each year.

The weighted average using the capacity costs of the rate of operation for each process in a corporation and the weighted average using added value of the rate of operation for each item in the industry are both suitable from the viewpoints of the corporations and industry, respectively. However, there is a difference between them, because the weighted value is obtained by the added value and capacity costs. Therefore, it is necessary to check the correlation between them considering the changes in added value and capacity costs for each year by applying these data to our model from the industrial and corporate viewpoints. The corporation Average Gross Added Value (AGAV) and Average Fixed Costs (AFC) for each year in Table 2 [8] show that there is a high positive correlation (Correlation Coefficient (CC) = 0.72) between them. For this reason, we can apply the data of the rate of operation in Table 1 to the corporation rate of operation.

#### 2.2.2 Profitability Indicator

The ratio of marginal profit to necessary capacity costs is defined as the following marginal profit rate.

\[
\gamma = \frac{M}{\sum_i \gamma_i f_i}
\]

The inverse number of \(\gamma\) is \(\alpha\), which is the minimum utilization rate of the capacity costs required to cover capacity costs \(F\) at the marginal profit rate \(\gamma\). If the minimum cost required to cover \(F\) is considered to be \(P_0\), then

\[
\alpha = \frac{P_0}{F} = \frac{\sum_i T_i f_i}{M}.
\]

This equation can be obtained by using this relation: \(F_0 \sum_i \frac{T_i f_i}{M} = F\). Therefore, the general relative profitability \(r\) can be measured by the ratio of \(\beta\) to \(\alpha\):

\[
r = \frac{\beta}{\alpha} = \frac{M}{F}.
\]

This parameter is considered as the relative annual profit.

#### 2.2.3 Marketable Quality Indicator

The marginal profit \(V(P_0, \beta)\) when the rate of operation differs from \(B\) in the minimum passage level \(P = P_0\) can be obtained by \(V(P_0, \beta) = \frac{P_0}{B} \beta\). The parameter \(B\) is the rate of operation of the BEP, when the production is made at the minimum passage level \(P = P_0\).

If marginal profit increases in proportion to the evaluated level \(P\), the marginal profit \(V(P, \beta)\) at the evaluated level \(P\) and the rate \(\beta\) of operation is computed by the following equation:

\[
V(P, \beta) = \frac{P}{P_0} \beta \frac{P_0}{B}.
\]

By considering the input (costs) indicator corresponding to output of the evaluated point in Eq. (5), we obtain Eq. (6).

\[
\text{Input(Cost)Indicator} = \frac{F}{B} \beta
\]

Therefore, the relative value of \(P\) can be obtained by the ratio of output indicator Eq. (5) to the conditional input indicator Eq. (6) under the rate of \(B\) operation.

\[
\text{Conditional relative value} = \frac{P}{P_0}
\]

In this case, the input indicator is equal with the necessary capacity costs \(F\) multiplied by \(1/B\). When \(B\) is the same for all corporations, the input indicator is equal with the necessary capacity cost indicator. Generally, \(B\) varies from corporation to corporation. Thus, it is impossible to
make a relative evaluation by Eq. (7), because of different comparison conditions.

Because it is very difficult to obtain a common qualitative indicator for all corporations, it is necessary to carry out a more general comparable evaluation for the qualitative aspects of corporations. We deal with this problem as follows [9]. For a certain corporation and for a certain period, a point \( (\beta, r) \) for each value of \( \beta \) and \( r \) is considered. There exists a function \( r(\beta) \) of \( \beta \), that is, a point-set where the marketable quality is the same. Therefore, we treat such a point-set in the following way. The set of points \( (\beta, r) \) which can theoretically exist is considered to be \( R \), and we consider also another set which is assumed to be \( Q \) (\( Q \) is a subset of \( R \)). If the price function is expressed as \( u(\beta) \), all points in the set \( Q \) are included in the following equation:

\[
r(\beta) = u(\beta) \beta. \tag{8}
\]

The price function can be considered as a fair relationship when a rate of profit increases due to an increase in the rate \( \beta \) of operation \( \left(\frac{\partial u(\beta)}{\partial \beta}\right) \) (profit on the corporation's side) and the rate of reduction in the total price \( \left(-\beta \frac{\partial u(\beta)}{\partial \beta}\right) \) (profit on the customers’ side) are equal. This can be obtained by solving the following differential equation.

\[
2\beta \frac{du(\beta)}{d\beta} + u(\beta) = 0 \tag{9}
\]

\[
u(\beta) = \frac{c}{\sqrt{\beta}}, \quad c: \text{integration constant}
\]

There exist price functions when the rate of profit increase and the rate of price reduction are equal within a region where the integration constant \( c \) is a positive number. An incremental profit and a reduction in the total price on a reasonable price function at the rate \( \beta \) of operation are both expressed by the following equation.

\[
r(\beta) = \int_0^\beta \frac{dr(\beta)}{d\beta} d\beta = \int_0^\beta \frac{-\beta du(\beta)}{d\beta} d\beta = cv\sqrt{\beta} \tag{10}
\]

Eq. (10) shows a fair relationship between the relative annual profit and the rate of operation. If the rate of operation at the BEP where fixed costs can be just covered by an incremental profit is considered to be \( \beta_0 \), the integration constant \( c \) can be obtained by Eq. (10): \( cv\sqrt{\beta_0} = 1 \).

From this relation, we get: \( c = \frac{1}{\sqrt{\beta_0}} \). Therefore, from Eq. (10) of relative annual profit, we obtain the following equations:

\[
r(\beta) = \sqrt{\frac{\beta}{\beta_0}}, \tag{11}
\]

\[
0 < \beta_0 \leq 1. \tag{12}
\]

By Eq. (11), we classify the point \( (\beta, r) \) \( \in R \) by considering \( \beta_0 \) as a relative profitability of the qualitative aspect from the viewpoint of a fair relationship between \( \beta \) and \( r \) [10]. The \( \beta_0 \) is the rate of operation at the BEP. The smaller \( \beta_0 \) is, the greater the marketable quality becomes in the sense that the profitability \( r \) becomes greater for any rate of operation as shown in Fig.1. The value of \( \beta_0 \) is calculated by following equation using Eq. (4) and Eq. (11).

\[
\beta_0 = \frac{\sum r^2}{\sum r} = \frac{\beta}{r^2} \tag{13}
\]

| Table 3. Standard distribution of \( r \). |
|---------------------|-----------------|-----------------|
| \( r \) | \( \beta_0 \) | \( 1 - F(\beta_0) \) | \( P(r - 0.1 < x < r) \) |
| 1.1000 | 0.69800 | 0.41680 | 0.41680 |
| 1.2000 | 0.51900 | 0.67270 | 0.21040 |
| 1.3000 | 0.40100 | 0.74610 | 0.11800 |
| 1.4000 | 0.32100 | 0.81810 | 0.07260 |
| 1.5000 | 0.26500 | 0.88560 | 0.04780 |
| 1.6000 | 0.22300 | 0.96960 | 0.03170 |
| 1.7000 | 0.18720 | 0.99190 | 0.02230 |
| 1.8000 | 0.16100 | 0.99540 | 0.01360 |
| 1.9000 | 0.13900 | 0.99770 | 0.00750 |
| 2.0000 | 0.12320 | 0.99960 | 0.00400 |
| 2.1000 | 0.10900 | 0.99600 | 0.007100 |
| 2.2000 | 0.097000 | 0.99580 | 0.005800 |
| 2.3000 | 0.087000 | 0.99430 | 0.004500 |
| 2.4000 | 0.079000 | 0.99770 | 0.003500 |
| 2.5000 | 0.071000 | 0.99810 | 0.002800 |
| 2.6000 | 0.065000 | 0.99840 | 0.002300 |
| 2.7000 | 0.060000 | 0.99850 | 0.002100 |
| 2.8000 | 0.055000 | 0.99870 | 0.001800 |
| 2.9000 | 0.051000 | 0.99880 | 0.001400 |
| 3.0000 | 0.047000 | 0.99890 | 0.001300 |
| 3.1000 | 0.043000 | 0.99910 | 0.001300 |

The \( \beta_0 \) is related to variables: \( P, P_0, B, \beta, \) and \( \beta \). From Eq. (5) and (13), we get the following equation.

\[
\beta_0 = \frac{P_0^2 B^2}{P^2 \beta} \tag{14}
\]

In fact, it is difficult to calculate Eq. (7) and the rate \( B \) of operation, but it is possible to calculate \( r \) by ratio \( M/F \) using Eq. (4). Also, it is possible to calculate \( \beta_0 \) using Eq. (4) and the rate \( \beta \) of operation.

Because point \( (\beta, r) \in R \) corresponds to point \( (\beta_0, \beta) \), it is possible to measure the following profitability function consisting of two variables: the generally comparable quality indicator \( \beta_0 \) and the rate \( \beta \) of operation.

\[
r(\beta_0, \beta) = \sqrt{\frac{\beta}{\beta_0}} \tag{15}
\]

![Figure 1. Relationship between \( r \) and \( \beta \) for different \( \beta_0 \) values.](image)

3 Econometric Methodology

3.1 Actual and Theoretical Standard Values of Marketable Quality

Let us look at Table 1 to see how our proposed marketable quality indicator \( \beta_0 \) approaches the real values. For the pe-
period from 1986 to 1998, \( \beta_0 \) shows major fluctuations. This period includes the period of the bubble economy of leading Japanese manufacturing corporations. The average values of \( \beta_0 \) for 13 years is 0.589.

To find the marketable quality indicator \( \beta_0 \), it is important to consider the difficulty of production on the producers' side and the sacrifice on the consumers' side. The smaller is \( \beta_0 \) value (from 1 to 0) in Eq. (12), the greater is the incremental profit in Eq. (11) (which is equal to a reduction in the total price for any rate of operation). In the case when \( \beta_0 \) is a value within the range of Eq. (12), its probability distribution is set independently from \( \beta \) in the following way. If the probability density function of \( \beta_0 \) is assumed to be \( f(\beta_0) \), its value is obtained as Eq. (16) by using Eq. (11).

\[
f(\beta_0) = \sqrt{\frac{\beta_0}{\beta_0}} = 1.5\sqrt{\beta_0}
\] (16)

Therefore, the expectation of the marketable quality indicator \( \beta_0 \) is obtained by Eq. (17).

\[
E(\beta_0) = \int_0^1 \beta_0 f(\beta_0) d\beta_0 = \int_0^1 \beta_0 (1.5\sqrt{\beta_0}) d\beta_0 = 0.6
\] (17)

By this expectation, the standard value of \( \beta_0 \) can be set equal to 0.6. Such theoretical standard value of \( \beta_0 \) nearly agrees with the average value 0.589 of \( \beta_0 \) in Table 1.

3.2 Relationship of Marketable Quality and Relative Annual Profit

The difficulty degree to realize the rate \( \beta \) of operation for each \( \beta_0 \) in Eq. (11) exceeding the BEP (within the range of \( \beta_0 \leq \beta \leq 1 \)) is in proportional relation to the size of the incremental profit in Eq. (11). The probability density function of \( \beta \) is obtained by Eq. (18).

\[
f(\beta) = \frac{\sqrt{3}}{\int_0^1 \sqrt{\beta} d\beta} = \frac{1}{\sqrt{3}} \left( 2 - \sqrt{\beta_0} \right) \sqrt{\beta}
\] (18)

Therefore, the expectation of \( \beta \) is obtained by Eq. (19).

\[
E(\beta) = \int_0^1 \beta f(\beta) d\beta = \frac{1}{3} (\beta_0 + \sqrt{\beta_0} + 1)
\] (19)

The \( E(\beta) \) can be established as the theoretical standard value of \( \beta \) at \( \beta_0 \). Therefore, the standard relationship between the marketable quality indicator \( \beta_0 \) and relative annual profit \( r \) is derived by Eq. (20), where \( E(\beta) \) is considered as a parameter. The \( r \) value can be obtained by putting Eq. (19) into Eq. (11).

\[
r = \left\{ \frac{1 - \beta_0 \sqrt{\beta_0}}{3(1 - \sqrt{\beta_0})} \right\}^{0.5}
\] (20)

The \( r \) value and its incremental rate increase with the decrease of \( \beta_0 \). This represents a gradual increase in profitability (returns) by improvement of marketable quality.

The standard value of marketable quality \( \beta = 0.6 \) based on the standard operation rate gives a profitability value \( r \). This value can be calculated from Eq. (20) and is will be:

\[
r = 1.1486.
\] (21)

In following, the distribution of \( r \) can be obtained as shown in Table 3, by transforming Eq. (20) to Eq. (22) and applying this value to the distribution of \( \beta_0 \) in Eq. (16) [11, 12].

\[
\beta_0 = \left\{ \frac{1 + \sqrt{12\gamma^2 - 3}}{2(3\gamma^2 - 1)} \right\}^2
\] (22)

Then, the expectation of \( r \) is theoretically calculated as follows.

\[
E(r) = \int_0^1 r(\beta_0) f(\beta_0) d\beta_0
\] (23)

\[
= \frac{1.5}{\sqrt{3}} \int_0^1 (1 + \sqrt{\beta_0} + \beta_0)^{0.5} d\beta_0
\]

\[
= 1.2649
\]

Therefore, the effect in the standard value of the gradual increase of profitability due to improvement of marketable quality can be measured by the profitability of Eq. (23) minus profitability of Eq. (21), i.e. 0.116. The target value of marketable quality for this effect is \( \beta_0 = 0.437 \).

4 Turning Point to Quality Enhancement and Transition Period

In this section, we extract the turning point from economics of scale to enhancement of marketable quality.

4.1 Economics of Scale Model

We discuss the improvement of marketable quality for Japanese manufacturing corporations for 13 years by considering the values shown in Table. The relative annual profit \( r \) as can be expressed by the production of marginal profit rate \( \gamma \) and the rate of operation \( \beta \).

Let us consider the relation between \( \gamma \) and \( \beta \). The graph shown in Fig. 2 is based on the data of Table 1 and can be calculated by the following equation.

\[
\beta = -0.739\gamma + 1.870
\] (24)

In Fig. 2, the maximum relative annual profit is 1.184 when \( \gamma = 1.266 \) and \( \beta = 0.935 \). The CC between \( \gamma \) and \( \beta \) is -0.819. Thus based on Eq. (13), the value of marketable quality indicator \( \beta_0 \) is calculated to be 0.686. These are the lowest levels of marketable quality compared with the marketable quality for each year shown in Table 1. So, even if the value of \( \gamma \) is small, by increasing the value of \( \beta \), the \( r \) value can be increased. This shows that for increasing the profitability, the marketable quality should be decreased. But, the maximum point of \( r \) is far from other points of \( r \) for each year. If we see the values of \( \gamma \) and \( \beta \) in Fig. 2, the values of \( \gamma \) and \( \beta \) for years 1990 and 1991 are the closed values with the maximum \( r \) point. The values of \( \gamma \) and \( \beta \) for other years sometime become closer sometime go far from the maximum point of \( r \). In this situation, the pattern of values of \( \gamma \) and \( \beta \) should be changed, because the marketable quality is decreased. Therefore, it is necessary that the corporations should increase the rate of operation by reducing the capacity while maintaining or improving the marketable quality. From this analysis, we conclude that the corporation management reform from 1986 to 1998 was needed from the
viewpoint of maximum profitability. Therefore, Eq.(24) is considered economies of scale models for 13 years period in Japanese manufacturing corporations.

### 4.2 Turning Point to Marketable Quality Enhancement

The relation between the marketable quality indicator $\beta_0$ and the theoretical standard value of the rate of operation $\beta$ in Eq.(19) is transformed to the relation between $\beta$ and $\gamma$ by using Eq.(13) ($\gamma = 1/\alpha$) and Eq.(19) as follows:

$$
\gamma = \frac{1 + \sqrt{3(4\beta - 1)}}{2(3\beta - 1)\sqrt{\beta}} \tag{25}
$$

Eq.(25) is a standard relationship between $\beta$ and $\gamma$, where $\beta$ corresponds to Eq.(18). Then, the turning point from economies of scale to enhancement of marketable quality is obtained by using Eq.(24) as follows:

$$
\beta = 0.789, \quad \gamma = 1.468. \tag{26}
$$

Based on these values the values of $\beta_0$ and $r$ are calculated as follows:

$$
\beta_0 = \frac{1}{\beta\gamma^2} = 0.589, \quad r = \gamma\beta = 1.158. \tag{27}
$$

In Fig. 3 are shown the results for data in Table 1 and Table 4. In this figure are shown: the Graph 1 (Eq.(24)) and Graph 2 (Eq.(25)), the intersection point ($\beta$, $\gamma$) in Eq.(26), $\max r$, and the data from 1986 to 2005. From Fig. 3 results, we conclude as follows.

- There is a trade-off relation between $\gamma$ and $\beta$ in each case of the economies of scale model or the marketable quality enhancement model.
- The maximum profitability $r$ is 1.165 when $\gamma = 1.3431$ and $\beta = 0.867$. The maximum profitability point in Eq.(25) is when $\beta \to 1/3$, thus $\gamma \to \infty$.
- The turning point in Eq.(26) and Eq.(27) are almost the same to the theoretical standard value (0.6) of $\beta_0$ and the theoretical standard value (0.79) of $\beta$ ($\beta$ is a function of $\beta_0$). That is, these standard values are at the equilibrium point of the economies of scale model and the quality enhancement model.
- The line of enhancement of marketable quality goes along the line of Eq.(24) until the turning point and then shifts to the line of Eq.(25).
- The profitability of economies of scale can not be achieved by decreasing $\beta_0$ (marketable quality enhancement), but by increasing $\beta$. On the other hand, the profitability of the quality enhancement can not be achieved by increasing $\beta$, but by decreasing $\beta_0$. In this way, a gradual increase in profitability by improvement of marketable quality is achieved.

### 4.3 Transition Period

In order to infer the transition period, we present Table 4. The pattern changes from 1986 to 2005 are shown in Table 5. From 1986 to 2001, the max $r$ is when $\gamma = 1.3431$ ($\beta_0 = 0.639$) and $\beta = 0.867$. This maximum value is $r = 1.1645$. While, from 1986 to 2005, the max $r$ is $r = 1.1752$, when $\gamma = 1.7059$ ($\beta_0 = 0.499$) and $\beta = 0.6898$.

For 1986 to 1998 and from 1986 to 2001, if we compare with their average values, the $\beta_0$ and $\beta$ values are bigger. While for 1986 to 2005 are smaller. It should be noted that when $\beta_0$ (marketable quality indicator) is smaller, the marketable quality is higher.

In Table 5, if we look at the data from 1986 to 2001 and from 1986 to 2005, the relation between $\gamma$ and $\beta$ has the $\max r$ in the reverse direction with the turning point as shown in Fig. 3. If we compare these data with data from 1988 to 1991 (bubble economy), by using Eq.(24) and Eq.(25), we can derive the transition period.

Comparing year 2005 with 1989 which has the higher profitability value during the bubble economy, even the value of $\beta$ from 0.538 is decrease to 0.775, the value of marketable quality indicator $\beta_0$ is decrease from 0.559 to 0.466 (increase of marketable quality). The value of profitability $r$ is increase from 1.224 to 1.290.

The theoretical and real relation of $r$ and $\beta_0$ are shown in Fig. 4. From 1986 to 1998 for 13 years, the $\max r$ value is indicated with ■ mark, while the average value is shown by the ▲ mark. From 1999 to 2005, the average value is shown by the ● mark. Looking to Fig. 4, we conclude that the value of marketable quality is increased considering two periods 1986 to 1989 and 1999 to 2003. The period from 1986 to 1989 is considered turning point period, while the period from 1999 to 2005 is considered the transition period.

### 5 Conclusions

In this paper, we evaluated the proposed marketable quality and profitability model for corporations using a new
source data. We defined the rate of operation of corporations and based on that the profitability. Then, we presented a model to identify a profitability function by the marketable quality indicator. We applied the proposed model to real data of leading Japanese manufacturing corporations and carried out analysis of the marketable quality indicator and the profitability. Based on our study, we got the following results.

- The proposed model give a good approximation of turning and transition period of Japanese economy.
- The general average value of the marketable quality indicator is very close to the theoretical standard value 0.6 (60%).
- We considered the theoretical standard value of the rate of operation as a function of marketable quality indicator in the range more than the marketable quality indicator and obtained a profitability function where the profitability gradually increases due to the increase in marketable quality.
- From our analysis, we extracted the turning point from economies of scale to enhancement of marketable quality. The turning point is almost the same with the theoretical standard values of marketable quality and the rate of operation.

The period between 1986 to 1989 is considered as the turning point period, while the period from 1999 to 2005 is considered the transition period.

In the future, we want to broaden the range of application of the proposed model.

References


