

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

Valbona Barolli[†], Heihachiro Fukuda[‡], Leonard Barolli[‡], Makoto Takizawa[†]

[†]Tokyo Denki University

E-mail: {valbona, taki}@takilab.k.dendai.ac.jp

[‡]Fukuoka Institute of Technology

E-mail: {fukuda, barolli}@fit.ac.jp

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.

企業の品質力と収益性モデル: 最新の企業データに基づいたモデルの評価

バロリ バルボナ[†], 福田 平八郎[‡], バロリ レオナルド[‡], 滝沢 誠[†]

[†]東京電機大学

[‡]福岡工業大学

本稿では、第一に、企業の品質力と収益性モデルを実際の企業データを用いて評価している。データとしては日本の代表的製造企業約千社の1986年から2005年までの年度別の損益分岐点比率と稼働率の実績値(平均)を用いている。第二に、これらの実績値により、規模の経済から品質力向上による収益性増大への転換と推移に関する検討が行われる。その結果、次のような結論が得られた。規模の経済から品質力向上への転換期は1986年から1998年までのあたりであり、その後2005年までに後者への推移が認められる。

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.

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

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

$$\text{Relative annual profit} = \text{Rate of operation} / \text{Rate of operation at BEP} = \text{Marginal profit} / \text{Fixed costs}$$

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^c , and its costs (fixed costs) be F_i , where $i = 1, \dots, m$. 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

Table 1. Annual relevant indicator values from Nihon Keizai Newspaper (1986-1998).

Item	Year													
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	
r	1.127	1.148	1.200	1.224	1.206	1.165	1.101	1.081	1.101	1.132	1.153	1.148	1.119	
Estimated β	77.09	76.59	81.77	83.82	85.55	83.62	76.49	72.92	72.06	73.77	74.20	77.34	71.34	
β_0	0.607	0.581	0.568	0.559	0.588	0.616	0.631	0.624	0.594	0.576	0.558	0.587	0.570	
$E(\beta)$	79.54	78.11	77.39	76.89	78.49	80.03	80.85	80.46	78.82	77.83	76.83	78.44	77.50	

Table 2. AGAV and AFC values for each year.

Item	Year													
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	
AGAV	28.373	29.407	32.784	35.186	37.489	33.580	32.451	31.302	32.115	33.564	35.077	34.512	31.151	
AFC	37.488	38.928	41.729	45.075	49.144	45.922	46.381	45.301	47.821	48.404	50.096	50.631	48.633	

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 β , is expressed in Eq. (1) as the average value of the rates β_i . The capacity cost values are used as weights for each process [2].

$$\beta = \frac{\sum_i \beta_i F_i}{\sum_i F_i} = \frac{\sum_i T_i f_i}{F} \quad (1)$$

Hence, $\beta_i = \frac{T_i}{T_0}$, $f_i = \frac{F_i}{F_0}$, $F = \sum_{i=1}^M F_i$. 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 (β) 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 of added values 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)= 0.721) 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.

$$\gamma = \frac{M}{\sum_i T_i f_i} \quad (2)$$

The inverse number of γ is α , which is the minimum utilization rate of the capacity costs required to cover capacity costs F at the marginal profit rate γ . If the minimum capacity cost required to cover F is considered to be F_0 , then

$$\alpha = \frac{F_0}{F} = \frac{\sum_i T_i f_i}{M} \quad (3)$$

This equation can be obtained by using this relation: $F_0 \sum_i \frac{M}{T_i f_i} = F$.

Therefore, the general relative profitability r can be measured by the ratio of β to α :

$$r = \frac{\beta}{\alpha} = \frac{M}{F} \quad (4)$$

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 $V(P_0, \beta) = \frac{F}{\beta} B$. 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 β of operation is computed by the following equation:

$$V(P, \beta) = F \frac{P}{P_0} \frac{\beta}{B} \quad (5)$$

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

$$\text{Input(Cost)Indicator} = \frac{F}{B} \beta \quad (6)$$

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.

$$\text{Conditional relative value} = \frac{P}{P_0} \quad (7)$$

In this case, the input indicator is equal with the necessary capacity costs $F\beta$ 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 (β, r) for each value of β and r is considered. There exists a function $r(\beta)$ of β , 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 (β, 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:

$$r(\beta) = u(\beta)\beta. \quad (8)$$

The price function can be considered as a fair relationship when a rate of profit increases due to an increase in the rate β of operation ($\frac{dr(\beta)}{d\beta}$) (profit on the corporations' side) and the rate of reduction in the total price ($-\beta \frac{du(\beta)}{d\beta}$) (profit on the customers' side) are equal. This can be obtained by solving the following differential equation.

$$2\beta \frac{du(\beta)}{d\beta} + u(\beta) = 0 \quad (9)$$

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

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 β of operation are both expressed by the following equation.

$$r(\beta) = \int_0^\beta \frac{dr(\beta)}{d\beta} d\beta = \int_0^\beta -\beta \frac{du(\beta)}{d\beta} d\beta = c\sqrt{\beta} \quad (10)$$

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 β_0 , the integration constant c can be obtained by Eq. (10); $c\sqrt{\beta_0} = 1$.

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

$$r(\beta) = \sqrt{\frac{\beta}{\beta_0}}, \quad (11)$$

$$0 < \beta_0 \leq 1. \quad (12)$$

By Eq. (11), we classify the point $(\beta, r) \in R$ by considering β_0 as a relative profitability of the qualitative aspect from the viewpoint of fair relationship between β and r [10]. The β_0 is the rate of operation at the BEP. The smaller β_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 β_0 is calculated by following equation using Eq. (4) and Eq. (11).

$$\beta_0 = \frac{\alpha^2}{\beta} = \frac{\beta}{\tau^2} \quad (13)$$

Table 3. Standard distribution of r .

r	β_0	$1 - F(\beta_0)$	$P(r - 0.1 \leq x < r)$
1.1000	0.69800	0.41680	0.41680
1.2000	0.51800	0.62720	0.21040
1.3000	0.40100	0.74610	0.11890
1.4000	0.32100	0.81810	0.072000
1.5000	0.26300	0.86510	0.047000
1.6000	0.22000	0.89680	0.031700
1.7000	0.18700	0.91910	0.022300
1.8000	0.16100	0.93540	0.016300
1.9000	0.14000	0.94760	0.012200
2.0000	0.12300	0.95690	0.0093000
2.1000	0.10900	0.96400	0.0071000
2.2000	0.097000	0.96980	0.0058000
2.3000	0.087000	0.97430	0.0045000
2.4000	0.079000	0.97780	0.0035000
2.5000	0.071000	0.98110	0.0033000
2.6000	0.065000	0.98340	0.0023000
2.7000	0.060000	0.98530	0.0019000
2.8000	0.055000	0.98710	0.0018000
2.9000	0.051000	0.98850	0.0014000
3.0000	0.047000	0.98980	0.0013000
3.1000	0.043000	0.99110	0.0013000

The β_0 is related to variables: P, P_0, B , and β . From Eq. (5) and (13), we get the following equation.

$$\beta_0 = \frac{P_0^2 B^2}{P^2 \beta} \quad (14)$$

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 β_0 using Eq. (4) and the rate β of operation.

Because point $(\beta, r) \in R$ corresponds to point (β_0, β) , it is possible to measure the following profitability function consisting of two variables: the generally comparable quality indicator β_0 and the rate β of operation.

$$r(\beta_0, \beta) = \sqrt{\frac{\beta}{\beta_0}} \quad (15)$$

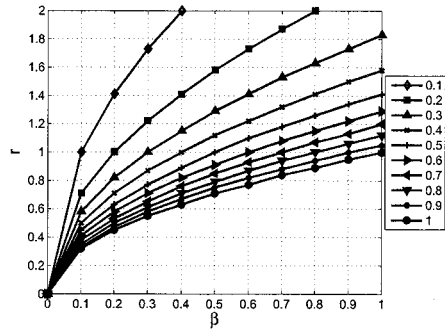


Figure 1. Relationship between r and β for different β_0 values.

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 β_0 approaches the real values. For the pe-

riod from 1986 to 1998, β_0 shows major fluctuations. This period includes the period of the bubble economy of leading Japanese manufacturing corporations. The average values of β_0 for 13 years is 0.589.

To find the marketable quality indicator β_0 , it is important to consider the difficulty of production on the producers' side and the sacrifice on the consumers' side. The smaller is β_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 β_0 is a value within the range of Eq. (12), its probability distribution is set independently from β in the following way. If the probability density function of β_0 is assumed to be $f(\beta_0)$, its value is obtained as Eq. (16) by using Eq. (11).

$$f(\beta_0) = \frac{\sqrt{\frac{\beta_0}{\beta}}}{\int_0^1 \sqrt{\frac{\beta_0}{\beta}} d\beta_0} = 1.5\sqrt{\beta_0} \quad (16)$$

Therefore, the expectation of the marketable quality indicator β_0 is obtained by Eq. (17).

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

By this expectation, the standard value of β_0 can be set equal to 0.6. Such theoretical standard value of β_0 nearly agrees with the average value 0.589 of β_0 in Table 1.

3.2 Relationship of Marketable Quality and Relative Annual Profit

The difficulty degree to realize the rate β of operation for each β_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 β is obtained by Eq. (18).

$$f(\beta) = \frac{\sqrt{\frac{\beta_0}{\beta}}}{\int_{\beta_0}^1 \sqrt{\frac{\beta_0}{\beta}} d\beta} = \left\{ 2 \left(1 - \sqrt{\beta_0} \right) \sqrt{\beta} \right\}^{-1} \quad (18)$$

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

$$E(\beta) = \int_{\beta_0}^1 \beta f(\beta) d\beta = \frac{1}{3} (\beta_0 + \sqrt{\beta_0} + 1) \quad (19)$$

The $E(\beta)$ can be established as the theoretical standard value of β at β_0 . Therefore, the standard relationship between the marketable quality indicator β_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).

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

The r value and its incremental rate increase with the decrease of β_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:

$$r = 1.1486. \quad (21)$$

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 β_0 in Eq. (16) [11, 12].

$$\beta_0 = \left\{ \frac{1 + \sqrt{12r^2 - 3}}{2(3r^2 - 1)} \right\}^2 \quad (22)$$

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

$$\begin{aligned} E(r) &= \int_0^1 r(\beta_0) f(\beta_0) d\beta_0 \\ &= \frac{1.5}{\sqrt{3}} \int_0^1 (1 + \sqrt{\beta_0 + \beta_0})^{0.5} d\beta_0 \\ &= 1.2649 \end{aligned} \quad (23)$$

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 economies of scale to enhancement of marketable quality.

4.1 Economies 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 γ and the rate of operation β .

Let us consider the relation between γ and β . The graph shown in Fig. 2 is based on the data of Table 1 and can be calculated by the following equation.

$$\beta = -0.739\gamma + 1.870 \quad (24)$$

In Fig. 2, the maximum relative annual profit is 1.184 when γ is 1.266 and β is 0.935. The CC between γ and β is -0.819 . Thus based on Eq. (13), the value of marketable quality indicator β_0 is calculated to be 0.668. 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 γ is small, by increasing the value of β , 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 γ and β in Fig. 2, the values of γ and β for years 1990 and 1991 are the closed values with the maximum r point. The values of γ and β for other years sometime become closer sometime go far from the maximum point of r . In this situation, the pattern of values of γ and β 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

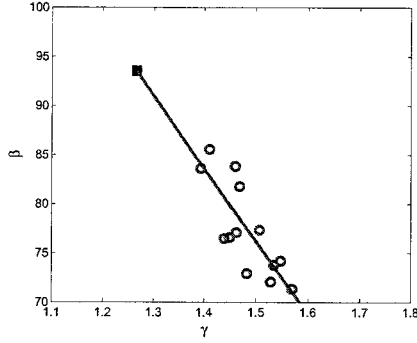


Figure 2. Relationship of γ and β .

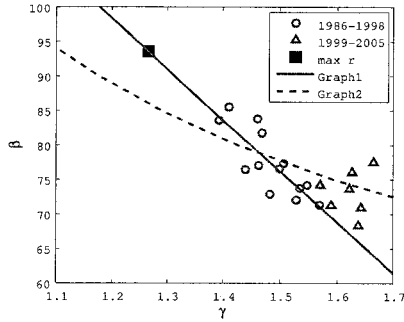


Figure 3. Turning point period.

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 β_0 and the theoretical standard value of the rate of operation β in Eq.(19) is transformed to the relation between β and γ by using Eq.(13) ($\gamma = 1/\alpha$) and Eq.(19) as follows.

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

Eq.(25) is a standard relationship between β and γ , where β 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:

$$\beta = 0.789, \gamma = 1.468. \quad (26)$$

Based on these values the values of β_0 and r are calculated as follows:

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

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 (β, γ) 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 γ and β 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 $\beta \rightarrow 1/3$, thus $\gamma \rightarrow \infty$.
- The turning point in Eq.(26) and Eq.(27) are almost the same to the theoretical standard value (0.6) of β_0 and the theoretical standard value (0.79) of β (β is a function of β_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 β_0 (marketable quality enhancement), but by increasing β . On the other hand, the profitability of the quality enhancement can not be achieved by increasing β , but by decreasing β_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 $\beta = 0.6889$.

For 1986 to 1998 and from 1986 to 2001, if we compare with their average values, the β_0 and β values are bigger. While for 1986 to 2005 are smaller. It should be noted that when β_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 γ and β 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 β from 0.838 is decrease to 0.775, the value of marketable quality indicator β_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 β_0 are shown in Fig. 4. From 1986 to 1998 for 13 years, the $\max r$ value is indicated with \blacksquare mark, while the average value is shown by the \blacktriangle mark. From 1999 to 2005, the average value is shown by the \bullet mark. Looking to Fig. 4, we conclude that the value of marketable quality is increased considering two periods 1986 to 1989 and 1999 to 2005. 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

Table 4. Annual relevant indicator values from Nihon Keizai Newspaper (1999-2005).

Item	Year						
	1999	2000	2001	2002	2003	2004	2005
r	1.132	1.165	1.119	1.165	1.194	1.237	1.290
Estimated β	71.20	74.20	68.35	70.92	73.64	76.06	77.50
β_0	0.556	0.547	0.546	0.523	0.517	0.534	0.466
$E(\beta)$	76.72	76.22	76.18	74.87	74.53	75.49	71.62

Table 5. Pattern changes from 1986 to 2005.

Period	Value Types	Indicators			
		β_0	β	γ	r
1986	Average	0.589	0.7734	1.4831	1.1470
~	<i>t.p.</i>	0.589	0.7888	1.4675	1.1576
1998	max r	0.668	0.9352	1.2655	1.1835
1986	Average	0.582	0.7620	1.5048	1.1454
~	<i>t.p.</i>	0.591	0.7888	1.4650	1.1556
2001	max r	0.639	0.8670	1.3431	1.1645
1986	Average	0.567	0.7590	1.6210	1.1860
~	<i>t.p.</i>	0.603	0.7938	1.4450	1.1470
2005	max r	0.499	0.6889	1.7059	1.1752

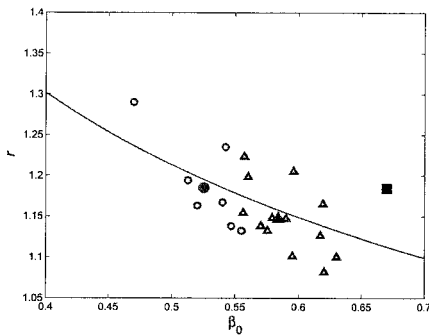


Figure 4. Transition period considering relation of β_0 and r .

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.

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