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Regulation, Competition, Diversification, Governance and Costs:
An Empirical Analysis of Public Utility and Manufacturing Firms in Japan

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[Abstract]: The main purpose of this study is to investigate how regulation, competition, governance structure, and business diversification strategy affect the cost structure of firms. By using 358 observations comprised of public utility firms and manufacturing firms from 1989 to 2002, we estimate the translog cost function. From our empirical analysis, the following results are obtained: (i) The regulation factor does not affect the cost structure. (ii) Compared with the regulation factor, the competition factor shows a quite clear effect on a firm's cost reduction. (iii) As a company diversifies further from its core industry into other industries, all of the firm's business costs increase, indicating an apparent lack of economies of scope. (iv) The governance factor has an important effect on a firm's cost structure. As the ratio of foreign shareholders increases and there is more dependence on one main bank, the costs of a firm decrease.

[Key Words]: Regulation, Competition, Governance, Diversification Strategy, Japanese Firms

[JEL Classification]: L5, L6, L9, M2

1. Introduction

Public utility industries such as electricity, gas, transportation, trucking, telecommunications and so on have traditionally been heavily regulated. The advent of extensive deregulation in the late 1990s introduced competition and changed industries across the board, not only in public utilities but in other areas as well, such as manufacturing. In addition to the external forces influencing firms' behavior, such as regulation and competition, internal factors like governance structure and business diversification strategy also play an important role. Most public utility firms are privately owned, with a myriad of management options available to each. Making the correct choices has become more difficult and important than ever. Recent developments in corporate governance studies indicate that effective governance could induce efficient management of firms, with business diversification strategy another important factor necessary for better management. Thus, regulation and competition as outside factors and governance structure and business diversification strategy as inside factors are all important to consider when determining how managerial efficiency can be attained.

The main purpose of this study is to investigate how four factors—regulation, competition, governance structure, and business diversification strategy—affect the cost structure of firms. Firms taken in this study are public utility firms and manufacturing firms.

This study makes several main contributions to the literature. First, this is the only study

so far to consider together the four important factors mentioned above (i.e. regulation by government, competition among firms, governance structure, and business diversification strategy) and to investigate which are most effective in reducing the costs of a firm.

Second, this study uses the quantity rather than the quality variable of regulation. In previous studies (e.g. Berg and Jeong (1991), Antel et al. (1995), Ai and Sappington (2002), Schneider (2003), Fabrizio et al. (2007), Ter-Martirosyan and Kwoka (2010)), regulation is commonly represented as a dummy variable, whether regulation is applied or not, or whether it has been enacted or not. On the other hand, in this study, we use "the degree of regulation" as a quantity variable. The measure of the degree of regulation refers to how many laws and regulations are applied to each specified industry. If a firm in a certain industry is almost completely regulated, then the measure becomes 1.0. But for an industry with no regulation, then the measure is 0.0.

Third, we introduce the factor of governance structure in the cost function. Most studies on governance are comparative analyses between governance and a firm's performance. However, in this study, by looking closely at previous research (e.g. Berger and Hannan (1998), Fries and Taci (2005), Jeng and Lai (2005), Zelenyuk and Zheka (2006) and Berger et al. (2009)), we investigate to what degree the governance structure improves costs.

Fourth, we include a variable for the strategic behavior of a firm. Many firms operate in more than two industries. In this study, the effect of a diversified strategy (i.e. a multi-segment strategy) is investigated. We define the number of segments, that is, the number of industries, in which each individual firm is involved. If a firm diversifies into several industries, the cost structure of the firm is different from that of the non-diversified firm. Therefore, it is necessary to include this variable. If there exist scope economies as Ottoz and Di Giacomo (2012) indicate, this factor has negative effects on costs.

Last, as for regulation issues, unlike in previous studies, we try to obtain more general results in both public utility and manufacturing industries. Heretofore, analysis has focused either only on specific types of regulation: environmental regulation (e.g. Nowell and Shogren (1994)), incentive regulation (e.g. Berg and Jeong (1991), Vogelsang (2002), Mizutani et al. (2009), Ter-Martirosyan and Kwoka (2010)), and price regulation (e.g. Cabral and Riordan (1989), Bös and Peters (1995), Vogelsang (2002)); or on specific industries: the energy industry (e.g. Nelson and Wohar (1983) and Majumdar and Marcus (2001)), rail (e.g. Mizutani et al. (2009)), and postal service (e.g. Mizutani and Uranishi (2003)). It cannot be assumed that, when the focus shifts to general regulation or to other industries, the results will be the same as in the specific cases listed here.

This paper consists of five parts after the introduction. In the second section, we summarize previous studies, focusing especially on the relationship between costs and the four factors (i.e. regulation, competition, governance structure, and business diversification strategy). In

the third section, the empirical model is specified. We employ the translog cost function for the analysis. The fourth section presents an explanation of the data used in this study. There are a total of 358 observations here, from the years between 1989 and 2002, obtained from public utility and manufacturing firms. The definitions of variables are also given in this section. In the fifth section, the empirical results are summarized. An explanation of the regression results is followed by an evaluation of the effects of the four factors on cost. The last section contains concluding remarks.

2. Previous Studies

In this section, we will summarize previous studies concerning the relationship between the four important factors (i.e. competition, regulation, governance structure and business diversification) and firms' costs.

2.1 Regulation

Studies have been done to determine the degree to which regulation affects a firm's costs. The most common approach is to use a cost function such as the translog cost function (e.g. Berg and Jeong (1991), Antel et al. (1995), Pantalone and Platt (1997), Schneider (2003), Ter-Martirosyan and Kwoka (2010)). Some studies analyze the cost efficiency change due to regulatory reform by using the stochastic cost frontier function (e.g. Kleit and Tecrell (2001) Mizutani et al. (2009)). Also, theoretical studies have been done which construct the relationship between regulation and the costs of a firm (e.g. Cabral and Riordan (1989), Bös and Peters (1995), Vogelsang (2002)).

Second, in most previous studies, the measure of regulation is used as a dummy variable, whether or not there is regulation (e.g. Berg and Jeong (1991), Antel et al. (1995), Ai and Sappington (2002), Schneider (2003), Fabrizio et al. (2007), Ter-Martirosyan and Kwoka (2010)). Most such studies are limited to public utility industries such as electric power, gas, and transport industries. Other measures on regulation vary by individual study, with, for example, the revenue ratio of a hospital under regulation defined as a proxy variable for regulation in Antel et al. (1995). There are almost no studies in which the degree of regulation is measured as a directly obtained continuous variable.

Third, most previous studies focus on some specific regulation: environmental regulation (e.g. Nowell and Shogren (1994)), incentive regulation (e.g. Berg and Jeong (1991), Vogelsang (2002), Mizutani et al. (2009), Ter-Martirosyan and Kwoka (2010)), and price regulation (e.g. Cabral and Riordan (1989), Bös and Peters (1995), Vogelsang (2002)). There are few studies on how regulation itself in general affects the efficiency of individual firms.

Fourth, previous studies have produced conflicting results, with many studies supporting

the idea that regulation reduces costs (e.g. Cabral and Riordan (1989), Kleit and Tecrell (2001), Ai and Sappington (2002), Ter-Martirosyan and Kwoka (2010), Nakamura (2010) and Buranabunyut and Peoples (2012), and other studies showing that regulation increases productivity (e.g. Dufour et al. (1998), Berman and Bui (2001), Majumdar and Marcus (2001), Alpay et al. (2002) and Knittel (2002)). On the other hand, some studies show that regulations increase the costs of firms (e.g. Gollop and Roberts (1983), Berg et al. (2005) and Fabrizio et al. (2007)), while others suggest that regulation decreases firms' productivity (e.g. Christainsen and Haveman (1981), Gollop and Roberts (1983), Gray (1987), Majumdar and Marcus (2001) and Nicoletti et al. (2003)).

In addition to these results, some studies show that regulation does not affect cost structure. For example, studies such as Antel et al. (1995), Berg and Jeong (1991) and Bös and Peters (1995) conclude that the cost effect of regulation is not significant. Furthermore, there are two studies, Pantalone and Platt (1997) and Meyer and Leland (1980), which have different results. Pantalone and Platt (1997) conclude that effect on costs by regulation varies according to the difference in ability to respond to environmental change. Although Gutierrez' study (2003) is not a cost but a productivity study, Gutierrez concludes that regulatory governance has a positive effect on sector performance and efficiency.

Thus, empirical results have not produced a consistent conclusion. In general, regulations create extra constraints for each individual firm and could therefore increase a firm's costs. However, under the private interest theory (capture hypothesis), it is also possible that regulations reduce costs. If regulations are created under the capture hypothesis, regulatory programs could be advantageous for the regulated firms, resulting in lower costs than for unregulated firms. In fact, some studies support the private interest theory from a theoretical and empirical point of view: for example, Stigler (1971), Peltzman (1976), Primeaux Jr. et al. (1984), Nowell and Shogren (1994), Antel et al. (1995), Dnes et al. (1998), Dnes and Seaton (1999), Kroszner and Strahan (1999), Nakamura (2010) and Benmelech and Moskowitz (2010). On the other hand, Smyth and Soderberg (2010) support the public interest theory.

2.2 Competition

First, competition among firms certainly affects firms' costs. Most previous studies take cost efficiency as dependent variables: for example, Berger and Hannan (1998), Sari (2003) and Fenn et al. (2008). As a definition of competition, the Herfindahl-Hirschman index (e.g. Berger and Hannan (1998), Sari (2003)) and a concentration ratio of the top 5 firms (e.g. Fenn et al. (2008)) are often used. Most studies conclude that competition can improve cost efficiency. According to Fenn et al. (2008), competitive pressures impose the threat of bankruptcy on firm managers and thus work as an incentive to cut inefficiency. Moreover, firm owners can judge the performance of their company by comparing it to rival firms when the industry is competitive, which results in

appropriate pressure on the firm. On the other hand, Nakamura (2010) shows that competition sometimes worsens internal efficiency, since competitive pressures can drive firm managers to reduce necessary investment and costs. Sari (2003) integrates these conflicting results by pointing out that the relationship between cost inefficiency and competition is U-shaped, indicating that while a certain degree of competition improves cost efficiency, too much competition creates the opposite effect.

2.3 Governance Structure

Although governance structure affects a firm's costs through the discipline of corporate management, few studies have investigated the relationship between governance structure and the costs of a firm. There are, however, a few studies, such as Berger and Hannan (1998), Fries and Taci (2005), Jeng and Lai (2005), Zelenyuk and Zheka (2006) and Berger et al. (2009), which evaluate to what degree governance structure improves cost efficiency.

As for the measures of governance structure, there are (i) insider ownership (e.g. Berger and Hannan (1998)), (ii) foreign ownership (e.g. Fries and Taci (2005), Zelenyuk and Zheka (2006), Berger et al. (2009)), (iii) large shareholders (e.g. Berger and Hannan (1998) and Berger et al. (2009)) and (iv) governmental or public ownership (e.g. Berger et al. (2009)). In addition to these measures, as characteristics of Japanese governance structure, (v) 'keiretsu' (e.g. Jeng and Lai (2005)) and (vi) main bank (e.g. Weinstain and Yafeh (1998)) are often used. 'Keiretsu' is an industrial group of firms affiliated with each other for mutual help and monitoring through shareholding, an arrangement typical of Japanese manufacturing and financial industries. Main bank is a bank that has established a close relationship with firms by providing extensive financing and consulting services through a system unique to Japanese governance.

These measures of governance structure are commonly defined as either the ratio or dummy variable. For example, some studies (e.g. Berger and Hannan (1998), Fries and Taci (2005), Zelenyuk and Zheka (2006)) take the ratio of these governance measures to total shares or total assets. On the other hand, some studies (e.g. Berger and Hannan (1998) and Weistain and Yafeh (1998)) treat the governance measure as a dummy variable. Furthermore, in addition to these methods, some studies analyze the effect of the governance structure by comparing results obtained from different observations according to type of governance structure (e.g. Berger et al. (2009) and Jeng and Lai (2005)).

Finally, we will summarize the empirical results of our study of governance structure's effect on cost efficiency as follows. First, foreign ownership improves cost efficiency, as Zelenyuk and Zheka (2006) and Berger et al. (2009) show. Second, the existence of large shareholders has differing results. Berger and Hannan (1998) analyze the banking industry and they obtain the result that large shareholders decrease cost efficiency. On the other hand, a more recent study by Berger

et al. (2009), an analysis of the banking industry in China, produced the opposite result that large shareholders increase cost efficiency. Furthermore, Berger et al. (2009) also obtain a result contradictory to what is commonly perceived as the effect of governmental ownership. According to their results, governmental ownership increases cost efficiency. As for insider ownership, an increase in the manager's ownership tends to decrease cost efficiency but the effect is not statistically significant. As for the characteristics of Japanese governance structure, 'keiretsu' increases cost efficiency, according to Jeng and Lai (2005), who argue that 'keiretsu' fosters strong relationships among firms inside the 'keiretsu,' and main bank. As a result, cost efficiency is increased by the fact that firms inside the 'keiretsu' monitor each other, the search costs for information are reduced, and firms can attain cheaper capital costs. It is worth noting that one result has shown that the main bank system has merit only for the main bank and that the main bank system causes firms to increase capital costs.

2.4 Diversification Strategy

There are few previous studies analyzing to what extent a business diversification strategy affects the costs of firms. Business diversification could propel the costs of a firm in two different directions. If there exist economies of scope among diversified businesses, the more diversified firms have smaller costs than otherwise. On the other hand, more diversified firms might have bigger costs if they are promoting excess investment and cross-subsidies among diversified divisions.

Some previous empirical studies investigate the relationship between business diversification and the cost efficiency of a firm (e.g. Ferrier et al. (1993), Rajan et al. (2000), Jeng and Lai (2005)). These studies focus on industries such as banking (e.g. Ferrier et al. (1993), Rajan et al. (2000)) and insurance (e.g. Jeng and Lai (2005)) and conclude that diversification causes cost inefficiency through the promotion of excess investing and cross-subsidizing. On the other hand, in the Italian bus industry, there exist economies of scope (e.g. Ottoz and Di Giacomo (2012)). Although his study is a productivity analysis of Italian manufacturing firms, Vannoni (2000) concludes that the degree of diversification is not significantly related to productivity.

3. Empirical Model

The main purpose of this study is to determine what factors affect public utility firms' cost structure, with a special focus on the following: regulations, governance structure, diversification strategy, and competition. As public utility firms are in general regulated and limited in terms of competition, too much regulation might lead to the over-costing of a firm. Manufacturing firms are also partly regulated but the market of the industry itself is characterized by competition among

firms. At the same time, as many public utility firms and manufacturing firms are privately owned, proper governance structure might reduce the costs of a firm. Furthermore, many firms have diversified their business. If there exist economies of scope in business diversification, a more diversified firm can attain lower costs than others. On the other hand, a diversification strategy might generate extra costs through unnecessary investment and cross-subsidies. We will analyze how these four important factors (i.e. regulations, competition, governance structure and diversification strategy) affect firms' costs.

To investigate this theme, we estimate the cost function because it can reveal the current situation relatively accurately. With regard to the cost function, the following points are important. As stated in the purpose of our analysis above, in addition to output (*Q*) and input factor prices (*w*), we include the four key variables of regulation (*RG*), competition (*CMP*), governance structure (*GS*) and diversification strategy (*STR*). First, variables such as regulation and competition reflect the situation of industries in which each firm is involved. These are factors the firm cannot change, as set by the government or as the industry was created by the market. On the other hand, governance structure and diversification strategy are factors over which a firm can exercise a degree of control. Each individual firm can change its environment. If a firm can gain cost advantages from business diversification, then the firm has incentive to diversify. At the same time, it can be easily seen that governance structure affects a firm's cost structure, in that a firm with strict management discipline adopting proper governance structure would generate less cost than a firm with loose management. In addition to these four factors, it is also necessary to control for differences among industries. Some industries might be declining while others are growing. Therefore, we include an industry's characteristics variables as control variables (*EX*). As a result, with these variables, the cost function (*C*) is expressed as output (*Q*), input factor price (*w*), technology (*T*) as follows.

$$C \equiv min \sum_i w_i x_i \quad subject\ to\ Q = g(x_i; REG, CMP, GS, STR, EX, T) \tag{1}$$

$$C = f(Q, w_i, REG, CMP, GS, STR, EX, T) \tag{2}$$

where *C*: cost,
Q: output,
w_i: input factor price of input-*i*,
x_i: input-*i*,
T: technology,
RG: regulation,
CMP: competition,
GS: governance structure,
STR: diversification strategy,
EX: characteristics of industry as a control variable.

The empirical cost model in this study is the translog cost function, which has been widely used in previous cost studies. Costs for the estimation are total costs, and the cost function is specified as three-input-factor-price model of labor (w_L), material and service (w_M) and capital (w_K). Because we use panel data, we include time trend (T) to control for technology progress.

As for regulation, we take the degree of regulation (RG_{REG}). This variable is a quantity variable showing the magnitude of regulation. As for the competition factor, we consider two possible variables: the Herfindahl-Hirschman index (CMP_{HHI}) and the concentration ratio of 4 firms (CMP_{CR4}). As for the strategy variable, we define the number of industries in which each firm is involved (STR_{DIV}). As for the governance structure[1], we consider the following variables: the ratio of external auditors (GS_{XAUD}), stock ratio held by foreign shareholders (GS_{FRN}), stock ratio held by the top 10 shareholders (GS_{TOP}), and main bank variable (GS_{BANK}). Finally, as for control variables for industries in which each firm is involved, we consider the industry's bankruptcy ratio (EX_{BKT}), and the industry's profitability (EX_{PRF}).

As a result, the cost function is expressed as follows.

$$lnC = \alpha_0 + \alpha_Q lnQ + \sum_i \beta_{w_i} lnw_i + \tfrac{1}{2}\alpha_{QQ}(lnQ)^2 + \tfrac{1}{2}\sum_i \sum_j \beta_{w_{ij}} lnw_i lnw_j + \tfrac{1}{2}\sum_i \beta_{Qw_i} lnQ\ ln\, w_i + \gamma_{REG} RG_{REG} + \sum_l \gamma_{CMP_l} CMP_l + \sum_m \gamma_{GS_m} GS_m + \gamma_{DIV} STR_{DIV} + \sum_n \gamma_{EX_n} EX_n + t_T T + \delta D_{NPU} \quad (3)$$

where C: total costs,

Q: revenues,

w_i, w_j: $i, j = L$ (labor price), M (material and service price), K (capital price),

T: time trend,

RG_{REG}: degree of regulation,

CMP_l: l = *HHI* (Herfindahl-Hirschman index), *CR4* (concentration ratio of 4 firms),

GS_m: m = *XAUD* (the ratio of external auditors), *FRN* (stock ratio held by foreign shareholders), *TOP* (stock ratio held by top 10 shareholders), *BANK* (main bank index),

STR_{DIV}: number of segments,

EX_n: n = *BKT* (industry's bankruptcy ratio), *PRF* (industry's profitability),

[1] There are two reasons why our model does not include a variable for 'keiretsu.' First, our sample is comprised of large firms, which are mostly parent companies influencing the management of member firms. This means that the effect of keiretsu on our sample firms is minor. Second, main bank variable can control the effect of keiretsu in a group simultaneously because the power of keiretsu is determined by financing from the main bank (Nakamura (2010)).

D_{NPU}: non-public utility dummy (i.e. non-public utility =1, otherwise =0).

We apply Shepard's lemma for the cost function. As a result, the share equations are obtained as follows.

$$S_i = \beta_i + \sum_j \beta_{w_{ij}} lnw_j + \beta_{Qw_i} lnQ \quad (4)$$

where S_i : share of input i ($i, j = K, L, M$).

The estimation method is the Seemingly Unrelated Regression (SUR) method for equations (3) and (4). We also impose restrictions in equation (3) as follows: $\sum_i \beta_{w_i} = 1$, $\sum_j \beta_{w_{Lj}} = 0, \sum_j \beta_{w_{Kj}} = 0, \sum_j \beta_{w_{Mj}} = 0, \sum_i \beta_{Qw_i} = 0, \beta_{QK} + \beta_{QL} + \beta_{QM} = 0, \beta_{w_i w_j} = \beta_{w_j w_i}$.

4 Data

4.1 Sample

As the main purpose of this study is to evaluate the effects of regulation, competition, governance structure and diversification strategy, we collected observations from both public utility industries and manufacturing industries. As other industries such as service industries (e.g. retail, finance, agriculture, and mining) are quite different in cost structure, we limited our sample to manufacturing industries only. At first, we selected a total of 300 firms, consisting of 150 firms in the public utility industry and 150 from the manufacturing industry, in Japan for the 14 years from 1989 to 2002. The public utility industries in this study are electricity supply, gas supply, water supply, transportation (i.e. air, railway, bus, and truck), telecommunications, broadcasting, and postal services. In order to avoid estimation bias by size difference, in the sample selection of manufacturing industries, we selected firms similar in size to public utility industries. Finally, the total sample size is reduced to 358, since some variables such as diversification strategy are not available for all observations.

4.2 Definition of Variables

Table 1 shows the definition of all variables used for the estimation of total cost function in this study. First, total costs (C) in this study are defined as the sum of labor, material (including energy) and capital costs. Capital costs include depreciation and interest payments.

As for output (Q), we define total sales as total output because there are many variations if we select physical output measures. Therefore, we choose output measure as monetary values.

We use three kinds of input factor prices: (i) labor, (ii) material and service, and (iii) capital. First, labor price (w_L) is obtained by dividing labor costs by the total number of employees.

Second, material and service price (w_M) is defined as *domestic Corporate Goods Price Index* (*CGPI*) weighted by divisional sales ratio. Last, capital price (w_K) is defined as the sum of depreciation rate (depreciation per fixed asset) and interest rate (interest payment per debt).

Time trend (*T*) is a proxy variable for technology progress. In this study, 1989 is defined as the starting year.

As for regulation, we choose "degree of regulation." The degree of regulation (RG_{REG}) shows to what degree each firm is subjected to regulation, or its "regulation weight," as originally defined by the Management and Coordination Agency (*Somucho*). The original data source for regulation weight is the JIP database for 2006, issued by the Research Institute of Economy, Trade and Industry (RIETI). This measure is obtained by counting the number of existing laws and regulations in each industry, by which process we can determine quantitatively the degree of industries' regulation. However, this measure does not include information regarding types of regulations (i.e. environment, safety, and price regulation). Finally, it is worth noting that while this measure is based on industry summaries, many firms provide various services in diversified industries. The degree of regulation referred to in this study is calculated by weighted revenues of the industries in which each firm is involved.

As for competition factors, we choose two kinds of measures, the Herfindahl-Hirschman index (CMP_{HHI}) and the concentration ratio of 4 firms (CMP_{CR4}). These measures are obtained on a revenues basis and again are obtained by using weights of each firm's individual industry's revenues.

As for the governance structure, we consider four kinds of measures: the stock ratio held by foreign shareholders (GS_{FRN}), the stock ratio held by the top 10 shareholders (GS_{TOP}), and the main bank (GS_{BANK}). First, the stock ratio held by foreign shareholders (GS_{FRN}) is defined as the number of shares held by non-Japanese relative to the total number of shares. Second, the stock ratio held by the top 10 shareholders (GS_{TOP}) is defined as the number of shares held by the largest ten shareholders to the total number of shares. Third, as for the characteristics of Japanese corporate governance structure, main bank index (GS_{BANK}) is chosen. Main bank index is the standard deviation of the ratios of debt loan by each financial institution. This variable expresses the pressure on a firm's management by a main bank. The main bank index is large, which means that a firm obtains its loans mainly through a certain single bank. Therefore, as this variable becomes larger, the effect of a main bank becomes larger. On the other hand, the fact that the main bank index is small means that a firm obtains a loan by diversifying financial sources among various financial institutions.

As for the diversification strategy variable (STR_{DIV}), the number of segments is defined as the number of industries in which each firm is involved. If a firm diversifies into a non-regulated business, the regulation effect on costs will be different.

As for characteristics of industry as a control variable, there are two variables: industry's bankruptcy ratio (EX_{BKT}) and industry's profitability (EX_{PRF}). First, industry's bankruptcy ratio (EX_{BKT}) is obtained by dividing the number of bankrupt firms by existing firms. Last, industry's profitability (EX_{PRF}) is defined as the weighted average profitability of the industries to which each firm belongs. For example, if a firm is involved in four industries, this variable is obtained by the weighted average profitability of the four industries. The weight is used by the firm's revenues from each industry.

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Table 1

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5. Empirical Results

We estimate the total cost function shown in equation-(3) with equation-(4). For our estimation, we use the seemingly unrelated regression (SUR) method according to the total cost function and input share equations. The estimation results of the total cost function are summarized in Table 2. We show four cases in Table 2: (i) Case 1, regulation only; (ii) Case 2 and Case 3, with regulation and competition; (iii) Case 4 and Case 5, with regulation, competition, governance and diversification strategy; (iv) Case 6, Case 7 and Case 8, with regulation, competition, governance, diversification strategy and external environments.

The goodness-of-fit in the regressions is acceptably high for these cases because pseudo R^2 is very high at over 0.96. As for the required properties in the cost function, first, symmetry and homogeneity conditions in input factor prices are satisfied, because we imposed restrictions on the cost model. Second, as for monotonicity conditions, it is necessary that the cost function be a non-monotone decreasing function in both output and input factor prices. Whether or not the monotonicity conditions are satisfied was evaluated by checking that the partial derivative of the cost function with respect to output and input factor prices is not negative (i.e. $\partial lnC/\partial lnQ \geq 0$, $\partial lnC/\partial lnw_j \geq 0$). Around the sample mean, these conditions are satisfied. Determining whether or not the Hessian matrix holds negative semi-definite can test for the concavity condition in input factor prices. In our test results, 12.6% to 20.7% of observations satisfy the concavity condition.

Among these cases, Case 4 is the best because the log of likelihood statistics and R^2 are large, the concavity condition is relatively high, and key variables such as competition factor show the correct sign. If we consider the external environment, Case 6 seems to be second. Therefore, we discuss our findings based mainly on these results.

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Table 2

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First, the regulation factor (RG_{REG}) does not affect the cost structure. Although it shows the negative sign, which means that regulation does reduce the cost, the regulation factor is not statistically significant. These results are consistent with previous studies such as Antel et al. (1995), Berg and Jeong (1991) and Bös and Peters (1995). Our empirical results do not support either the public or private interest theory. We think that regulation itself does not affect costs.

Compared with the regulation factor, the competition factor is quite clear and consistent with previous results. As the empirical results show, competition (CMP_{HHI}, CMP_{CR4}) has the effect of reducing the costs of a firm. The market becomes more competitive, which means that as CMP_{HHI} or CMP_{CR4} decreases, the cost becomes smaller.

Third, governance factors are also important in the cost structure. Among three governance variables, both the stock ratio held by foreign shareholders (GS_{FRN}) and main bank (GS_{BANK}) are statistically significant. As the foreign shareholders' ratio becomes larger and more concentrated in a single main bank, the costs of a firm become smaller. As for foreign shareholders' effect, our result is consistent with Zelenyuk and Zheka (2006) and Berger et al. (2009). The result that firms under main bank influence have smaller costs needs to be discussed, since main bank has both positive and negative effects on firm management. While Weinstain and Yafeh (1998) state that the main bank system increases the cost of capital, Jeng and Lai (2005) argue that the close relationship with main bank results in better monitoring and reduced information costs. Our result is consistent with Jeng and Lai (2005).

Fourth, the fact that all empirical diversification strategy (STR_{DIV}) shows the positive sign with a statistical significance of 1% means that as a company diversifies more from its core industry to other industries, the costs of all the firm's business increase. Our results are consistent with previous studies, which are analyses of the financial industry, such as Ferrier et al. (1993), Rajan et al. (2000) and Jeng and Lai (2005). This result shows that there are no economies of scope.

Fifth, the non-public utility dummy (D_{NPU}) shows the correct sign (i.e. the negative sign) in case 4 but with a statistical significance of at most 10%. However, results in other cases are not statistically significant. Presumably, as we include many factors in order to explain the cost difference, the non-public utility dummy does not affect the costs.

Last, as for characteristics of industry as a control variable, as industry's bankruptcy ratio

(EX_{BKT}) increases and industry's profitability (EX_{PRF}) decrease, the cost of a firm becomes large.

6. Conclusion

The main purpose of this study is to investigate how the four factors of regulation, competition, governance structure, and business diversification strategy affect the cost structure of firms. Among the four factors, regulation and competition are considered as outside factors that are beyond a firm's control, factors it must accept while striving to attain efficiency under the given conditions. On the other hand, governance structure and business diversification strategy are considered as internal factors amenable to change at the will of a firm seeking to achieve managerial efficiency. Our main research question is this: which, among these four factors, is the most influential? Furthermore, although the regulation factor in most previous studies is treated as a dummy variable, the regulation factor in this study is treated as a continuous variable representing the degree of regulation affecting a firm's cost structure. To analyze these questions, we estimate translog cost functions by using 358 observations obtained from public utility firms and manufacturing firms from 1989 to 2001. In order to avoid estimation bias by size difference, in the sample selection of manufacturing industries, we selected firms similar in size to public utility industries.

From this empirical analysis, we found the following results.

(i) The regulation factor does not affect the cost structure. Our results are consistent with previous studies such as Antel et al. (1995), Berg and Jeong (1991) and Bös and Peters (1995).

(ii) Compared with the regulation factor, the competition factor shows a quite clear effect in reducing a firm's costs. This result is consistent with theory and supports previous literature.

(iii) The governance factor has an important impact on firms' cost structure. Empirical results show that as the ratio of foreign shareholders becomes larger and there is more concentration on a single bank, a firm's costs decrease. As for foreign shareholders' effect, our result is consistent with Zelenyuk and Zheka (2006) and Berger et al. (2009).

(iv) As a company diversifies more from its core industry into other industries, the costs of all a firm's business increases. Our results are consistent with previous studies such as Ferrier et al. (1993), Rajan et al. (2000) and Jeng and Lai (2005). There are apparently no economies of scope.

(v) Another important finding is that as an industry's bankruptcy ratio increases and its profitability decreases, the costs of a firm increase.

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Table 1 Definition and Statistics of Variables

Variable	Unit	Mean	Standard Deviation	Minimum	Maximum
TC (total cost)	Million yen	408,031	543,665	1,843	3,042,338
Q (output)	Million yen	415,140	554,060	1,926	3,000,000
w_L (labor price)	Thousand yen	6,260	2,375	1,068	15,907
w_M (material price)	-	95.7899	26.4882	7.3416	249.9917
w_K (capital price)	-	0.1131	0.0357	0.0258	0.2802
T (time trend)	-	8.4916	3.7817	1.0000	15.0000
RG_{REG} (degree of regulation)	-	0.4585	0.3920	0.0000	1.0000
CMP_{HHI} (Herfindahl-Hirschman index)	-	0.4677	0.2505	0.0161	1.0000
CMP_{CR4} (concentration ratio of 4 firms)		0.7154	0.2936	0.0119	1.0000
STR_{DIV} (numbers of industries which a firm involves)		3.4330	1.3698	2.0000	12.0000
GS_{FRN} (stock ratio held by foreign shareholders)		0.0584	0.0591	0.0000	0.4024
GS_{TOP} (stock ratio held by top 10 shareholders)		0.3813	0.1230	0.0837	0.7876
GS_{BANK} (main bank dummy)		0.0908	0.0645	0.0198	0.6566
EX_{BKT} (industry's bankruptcy ratio)		0.2032	0.3622	0.0008	0.9828
EX_{PRF} (industry's profitability)	-	0.8731	0.3884	0.2510	5.9841
D_{NPU} (non-public utility dummy)	-	0.5000	0.5007	0.0000	1.0000
S_L (share of labor)	-	0.1657	0.0763	0.0393	0.5384
S_M (share of material and service)	-	0.7293	0.0868	0.4158	0.9067
S_K (share of capital)	-	0.1050	0.0662	0.0177	0.3374

Table 2 Estimation Results

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
ln Q	0.9670***	0.9690***	0.9653***	0.9661***	0.9632***	0.9637***	0.9611***	0.9611***
	(0.0100)	(0.0100)	(0.0099)	(0.0123)	(0.0121)	(0.0121)	(0.0120)	(0.0121)
ln w_L	0.1974***	0.1973***	0.1975***	0.1944***	0.1947***	0.1930***	0.1932***	0.1932***
	(0.0050)	(0.0050)	(0.0050)	(0.0049)	(0.0049)	(0.0049)	(0.0049)	(0.0049)
ln w_M	0.6386***	0.6399***	0.6390***	0.6461***	0.6447***	0.6443***	0.6429***	0.6430***
	(0.0076)	(0.0076)	(0.0076)	(0.0074)	(0.0074)	(0.0075)	(0.0074)	(0.0075)
ln w_K	0.1640***	0.1628***	0.1635***	0.1595***	0.1607***	0.1628***	0.1639***	0.1638***
	(0.0057)	(0.0057)	(0.0057)	(0.0058)	(0.0059)	(0.0060)	(0.0060)	(0.0060)
$(\ln Q)^2$	-0.0038**	-0.0038**	-0.0038**	-0.0043**	-0.0044***	-0.0048***	-0.0048***	-0.0048***
	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0016)	(0.0016)	(0.0016)
$(\ln w_L)^2$	0.0358***	0.0361***	0.0363***	0.0359***	0.0362***	0.0354***	0.0356***	0.0356***
	(0.0073)	(0.0073)	(0.0073)	(0.0073)	(0.0073)	(0.0073)	(0.0073)	(0.0073)
$\ln w_L \cdot \ln w_M$	-0.0698***	-0.0699***	-0.0703***	-0.0635***	-0.0639***	-0.0607***	-0.0611***	-0.0611***
	(0.0077)	(0.0077)	(0.0077)	(0.0076)	(0.0075)	(0.0075)	(0.0075)	(0.0075)
$\ln w_L \cdot \ln w_K$	0.0340***	0.0339***	0.0340***	0.0275***	0.0277***	0.0253***	0.0255***	0.0255***
	(0.0068)	(0.0067)	(0.0068)	(0.0069)	(0.0070)	(0.0071)	(0.0071)	(0.0071)
$(\ln w_M)^2$	0.2088***	0.2064***	0.2079***	0.1862***	0.1886***	0.1906***	0.1929***	0.1927***
	(0.0119)	(0.0118)	(0.0118)	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0121)
$\ln w_M \cdot \ln w_K$	-0.1390***	-0.1364***	-0.1376***	-0.1227***	-0.1248***	-0.1299***	-0.1319***	-0.1316***
	(0.0092)	(0.0092)	(0.0092)	(0.0097)	(0.0098)	(0.0099)	(0.0099)	(0.0099)
$(\ln w_K)^2$	0.1051***	0.1025***	0.1036***	0.0952***	0.0971***	0.1047***	0.1064***	0.1061***
	(0.0108)	(0.0107)	(0.0108)	(0.0113)	(0.0114)	(0.0116)	(0.0117)	(0.0117)
$\ln Q \cdot \ln w_L$	-0.0228	-0.0219	-0.0257*	-0.0114	-0.0155	-0.0191	-0.0226	-0.0227
	(0.0154)	(0.0153)	(0.0153)	(0.0157)	(0.0155)	(0.0154)	(0.0153)	(0.0154)
$\ln Q \cdot \ln w_K$	0.0162	0.0148	0.0134	-0.0012	-0.0028	-0.0052	-0.0068	-0.0068
	(0.0186)	(0.0186)	(0.0185)	(0.0188)	(0.0187)	(0.0189)	(0.0188)	(0.0188)
$\ln Q \cdot \ln w_M$	0.0066	0.0071	0.0123	0.0125	0.0183	0.0243	0.0294*	0.0296*
	(0.0164)	(0.0164)	(0.0164)	(0.0165)	(0.0164)	(0.0167)	(0.0166)	(0.0168)
T	0.0224***	0.0225***	0.0217***	0.0233***	0.0222***	0.0281***	0.0271***	0.0271***
	(0.0029)	(0.0029)	(0.0029)	(0.0030)	(0.0030)	(0.0034)	(0.0034)	(0.0034)
ln RG_{REG}	-0.0007	-0.0006	-0.0001	-0.0014	-0.0007	-0.0007	-0.0001	-0.0001
	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)
ln CMP_{HHI}	-	0.0292*	-	0.0472***	-	0.0426***	-	-0.0014
		(0.0153)		(0.0156)		(0.0153)		(0.0257)
ln CMP_{CR4}	-		0.0428***	-	0.0559***	-	0.0510***	0.0521**

			(0.0144)		(0.0148)		(0.0146)	(0.0247)
ln GS_{FRN}	-		-	-0.0214*** (0.0085)	-0.0210** (0.0084)	-0.0238*** (0.0083)	-0.0234*** (0.0082)	-0.0234*** (0.0082)
ln GS_{TOP}	-		-	-0.0079 (0.0359)	0.0047 (0.0360)	-0.0092 (0.0356)	0.0022 (0.0357)	0.0024 (0.0359)
ln GS_{BANK}	-		-	-0.0815*** (0.0232)	-0.0748*** (0.0230)	-0.0780*** (0.0229)	-0.0719*** (0.0227)	-0.0717*** (0.0229)
ln STR_{DIV}	-		-	0.1455*** (0.0302)	0.1503*** (0.0300)	0.1781*** (0.0306)	0.1817*** (0.0304)	0.1817*** (0.0305)
ln EX_{BKT}	-		-	-	-	0.0154** (0.0062)	0.0152** (0.0061)	0.0152** (0.0061)
ln EX_{PRF}	-		-	-	-	-0.1512*** (0.0348)	-0.1472*** (0.0346)	-0.1473*** (0.0346)
D_{NPU}	-0.0467* (0.0252)	-0.0373 (0.0256)	-0.0259 (0.0259)	-0.0483* (0.0271)	-0.0347 (0.0274)	0.0255 (0.0337)	0.0365 (0.0337)	0.0366 (0.0338)
Constant	12.2528*** (0.0303)	12.2398*** (0.0310)	12.2359*** (0.0307)	12.2052*** (0.0323)	12.2080*** (0.0316)	12.1651*** (0.0327)	12.1684*** (0.0321)	12.1686*** (0.0325)
Log-likelihood	894.485	897.344	900.112	901.368	902.790	915.185	916.358	916.544
R^2	0.9676	0.9678	0.9681	0.9709	0.9713	0.9719	0.9722	0.9722
Concavity Condition	12.6%	13.1%	12.8%	20.7%	19.6%	17.9%	15.4%	15.9%

(Note):
(1) Numbers in parentheses are standard errors.
(2) Sample size is 358.
(3) Statistically significant at 1% (***), 5% (**) and 10% (*).

[2013.6.13 1134]