Corporate Social Responsibility and Technical Efficiency: A Stochastic Frontier Analysis of Japanese Automobile Manufacturing Firms

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Abstract

This study aims to empirically investigate the effect of corporate social responsibility on technical efficiency of 19 Japanese automobile manufacturing firms throughout 2010-2017, using a two-stage Stochastic Frontier Analysis. The results of the first stage show that the efficiency levels of all reported firms increase over the 8 years. In detail, the overall mean technical efficiency of car manufacturers and parts suppliers is 0.7 and 0.61, which implies that they have the potential to increase their profit by 30% and 39% respectively, given the same level of inputs and technology. In addition, the results of technical efficiency effect model indicate the negative effects of carbon dioxide (CO_2) intensity and Keiretsu on efficiency. Furthermore, positive coefficients of the interaction terms between Keiretsu and CO_2 intensity suggest that the reduction of CO_2 intensity of Keiretsu suppliers is less likely to benefit their technical efficiency than that of the independent suppliers. In terms of workforce-oriented factors, female manager rate, wage and overtime hours have a positive relationship with technical efficiency of both groups, while paid leave use rate and disability employment rate exert positive effects on the efficiency of only car manufacturers. Finally, this study provides policy implications to increase corporate technical efficiencies such as investing in environmentally-friendly technological progress and R&D innovation, restructuring Keiretsu systems and wage systems, as well as improving the employment of women in management, persons with disabilities, and the use of paid leave.

Key words: Corporate social responsibility, technical efficiency, automobile manufacturing industry, stochastic frontier analysis, panel regression analysis

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1. Introduction

According to the definition by Paul et al. (2006), corporate social responsibility (CSR) is the way an organization addresses and achieves economic, environmental, and social imperatives while at the same time fulfilling its obligations to shareholders and stakeholders.

Since the beginning of the publication of a KPMG report up to the present, Japan has always been the leader in CSR compliance not only in the Asian area but also worldwide. According to KPMG, 99% of Japanese companies reported on their impact and performance on the environment, governance, and society. Based on research data from 2010-2015 by the Global Reporting Initiative, although the number of shared reports did not rise significantly, Japan has been a pioneer and maintained a satisfactory share of reports (around 22%). Meanwhile, other Asian countries have only begun to engage in this area recently.

Environmental issues have always been a source of concern in Japan, especially for the Japanese manufacturing industry. Under the Paris Agreement adopted at the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21), Japan has committed to a reduction of greenhouse gas emissions by 26% by 2030 and 80% by 2050 from the level in 2013. Additionally, there is an increasing trend to regard corporate environmental efforts as crucial criteria for investment decisions, such as Environmental, Social, and Governance (ESG) investment. Specifically, global ESG investment grew by approximately 2,000 trillion yen from 2012 to 2018, and ESG investment in Japan increased more than four times from 2016 to 2018 (The Government of Japan, 2019). Under this background, addressing environmental issues within corporate strategies and core business has been perceived as not only corporate social responsibility but also an approach to strengthening corporate structures and leads to consistent corporate growth.

In addition, under the backdrop of a rapidly aging population, with increasing longevity, it is imperative to accelerate the employment of women, the elderly, and people with disabilities in the Japanese labor market to achieve sustainable economic growth. However, Japan still faces many considerable obstacles.

Despite the implementation of laws on gender equality and the improvement in female education, their share of managerial positions in Japan has remained at a low level, with only 13% reported in 2019. It is the second-lowest among OECD countries, implying a severe misallocation of Japanese human resources.

Regarding the employment of people with disabilities, Japan has undergone drastic efforts to promote the actual employment rate in recent years. However, the percentage of enterprises fulfilling the employment quota was as low as 48.8% in 2016 and particularly at small and medium-sized enterprises.

Other alarming problems faced by Japanese companies are the long working hours and low rates of paid leave use. Japan is the country with the highest and increasing number of cases of death from overwork. Besides, Japanese employees are currently eligible for an average of 18.5 paid holidays a year, which is only two days fewer than the global average number. However, employees often use only half of the total privilege, and very few of them utilize the full quota (Ming, 2019). Furthermore, Japan's labor productivity is lower than the average OECD level, implying that the use and allocation of labor and capital in Japan are inefficient (Ono, 2018). Therefore, Japanese firms must tackle the problem of how to improve the productivity of their human capital.

The automobile industry is an industry composed of a wide range of industrial and related activities. This dominant industry plays a vital role in the country as it not only creates value-added and then contributes to employment but also generates huge achievements in technological development activities. As one of the Japanese economy's core industrial sectors, the automotive industry makes up the largest ratio of shipments of total manufacturing sectors. In 2017, Japanese automotive shipments valued 60.7 trillion yen, an increase of 5.1% from the previous year, which accounted for 19.0% of the total value of manufacturing shipments and 41.2% of the value of the machinery industries' combined shipments in Japan (Japan Automobile Manufacturers Association, Inc, 2019).

One of the popular characteristics of the Japanese automotive industry is the Keiretsu system, the relationship between parts suppliers and automakers of an industry, which is unique to Japan. In this model, a number of companies are created in order to benefit a single, greater manufacturer, with a number of tiers. The Keiretsu relationship in the Japanese automotive industry has been regarded as a source of competitive advantage. This alliance leads to a stable and lean supply chain with well-established and trustful supplier relations under long-term contracts and high commitments. It not only enables Japanese automakers to reduce manufacturing costs and lead times and to obtain high volumes of production but also protects suppliers from market failure and financial risks with a high level of sales and demand stability. Under this system, both the Keiretsu leader and its suppliers can also achieve more effective communication and coordination in product development as well as long term investment goals and sustainable growth. Moreover, parts suppliers can upgrade technical capabilities and managerial know-how under the guidance of the automaker (Kawai, 2007).

Traditionally, because of the possibility of know-how and technologies leakage through multiple transactions, Keiretsu suppliers are only allowed to deal with one automaker exclusively, with very limited business transactions with competing companies that are members of other Keiretsu. In addition, almost all of the R&D processes are performed at Japanese car manufacturers, after which production specifications will be provided to lower-tier suppliers. Therefore, most Japanese suppliers are less independent, innovative, and flexible to adapt to market change. By missing the chance to learn the most cutting-edge technologies from their global competitors, they stay farther from the innovation and productivity frontier. After the collapse of the bubble economy, it was argued that the Japanese Keiretsu system had become a weakness and had lost its role in the Japanese automotive industry (Takeishi et. al., 2017). The limitations of the Keiretsu system were evidenced by the dismantling of the Keiretsu system by Nissan and Mazda; meanwhile, Toyota and Honda have maintained their Keiretsu system until now.

2. Literature review

In the last two decades, there have been increasingly more studies focusing on the relationship between CSR and corporate performance. However, theoretical studies describing this effect show a wide variety of nexus. Inconclusive results were found for the relationship between CSR and profitability when using specific financial indicators such as value-added, net sales, market value, and return on equity (Preston et al., 1997; Stanwick et al., 1998; Verschoor, 1998; Becchetti, 2007). Besides, Paul et al. (2006) suggested that a crucial direction in exploring the relationship between CSR and corporate performance is to focus on this important measure of performance - efficiency, which is independent from how corporate value created is attributed to the different production inputs, and also independent from the way it is divided among different stakeholders (Becchetti et al., 2011). There are only a few existing contributions on the specific effects of CSR on efficiency, which also find mixed results. Shadbegian et al. (2006) concluded that the implementation of environmentally friendly techniques results in significant deviations from the efficiency frontier, especially for older firms. On the other hand, Pinheiro et.al. (2019) showed that there is a negative relationship between CSR practices and firm inefficiency, and environmental scores, workforce diversity, and workforce employment quality have an apparent positive effect on technical efficiency.

The effect of each subfactor of the CSR performance on corporate financial performance has been another source of interest in academic literature. According to Mandl et al. (2007), CSR activities can be classified into four categories, which are environment-oriented CSR, workforce-oriented CSR, market-oriented CSR, and society-oriented CSR. This study focuses on environmental-oriented and workforce-oriented CSR activities, taking into consideration the great importance of finding solutions to the alarming environmental and social issues in Japan.

Since the 1980s, the effect of environmental performance on corporate value has remained a widely discussed topic. The empirical work of McGuire et al. (1988) distinguishes three theoretical concepts covering all arguments for different relationships. First, the firms that invest in environmental performance are facing an economic disadvantage as a trade-off between economic and environmental performance. Second, the costs that corporations spend on environmental activities are not significant and can instead generate other managerial advantages such as an increase in morale, commitment or productivity. Third, the costs to enhance environmental performance are outweighed by an increase in revenues or a reduction of other costs such as turnover costs.

According to Mandl et al. (2007), workforce-oriented CSR activities are identified as the CSR practices dealing with better working conditions, flexible working hours, workplace diversity, work and life balance, workplace health and safety, training and development, etc. In empirical studies, several benefits of CSR on firm performance were reported as attracting capable employees, boosting employee commitment and morale within a firm (Godfrey, 2005), and retaining skilled staff (Eweje et al., 2006). Mandl et al. (2007) surveyed European SMEs and revealed that providing equal treatment, a fair salary structure, and honest contracts to employees is a crucial workforce-oriented CSR function.

Another point of interest is the difference in the CSR and corporate financial performance relationship across regions. According to Krukowska (2014), the Japanese CSR system is made up of five determinants: religious and philosophical beliefs; cultural and social determinants; historical and economic events; legal systems; investors and public opinions. Japanese companies are not in agreement with the universal tendency for CSR, but they are gradually adopting Western-oriented models to gain competitive advantages in the global market. However, there are still significant differences in the perception of corporate responsibility. Japanese workers may understand CSR as longer paid holidays and life-long employment, while in Western countries, CSR means work-life balance or promotion of the disabled in leadership positions.

3. Methodology

3.1 Efficiency measurement

There are several ways to examine corporate performance. Economic analyses have favored the measures of productivity or efficiency more than profitability over the last decades. Knight (1921) claimed that profit was a residual between revenues and costs, which was exposed to various uncertain or risky factors beyond the reach of the firms.

According to Farrell (1957), technical efficiency is the firm's ability to utilize given inputs in the most technological way to produce a maximum level of output. The assumption of efficiency measurement is that efficient production function is well-known; however, in reality, this function is hardly defined. Therefore, he proposed two techniques to estimate the frontier function and technical efficiency by applying non-parametric or parametric approaches. Regarding the non-parametric approaches, the most common method is Data Envelopment Analysis (DEA). The DEA does not require a specific functional form for the frontier or large sample size, however, it cannot identify the differences between technical inefficiency and random error, as well as does not provide the impact of individual inputs and exogenous factors on the outputs. The DEA assumes measurement errors are unlikely; therefore, it may produce biased efficiency estimates in the presence of measurement errors (Ruggiero, 2004).

On the other hand, the parametric approach using Stochastic Frontier Analysis (SFA) employs an econometric technique to measure efficiency by specifying a stochastic production function which assumes that the error term is composed of two elements, the inefficiency term and the noise term representing randomness. The key advantage is that it determines the exogenous factors and shocks influencing the level of technical inefficiency of each firm besides firm-specific factors, as well as estimates the marginal effect of each input and exogenous factor on the output. It is also the most suitable approach to efficiency measurement with panel data, especially in investigating the factors that influence the efficiency of a private firm or a specific period (Grosskopf, 1993). Therefore, this study adopted an SFA approach that, to a certain extent, overcomes the disadvantages of the DEA approach.

3.2 Stochastic frontier approach

The study estimates a profit frontier with inefficiency effects using a panel data version of the Aigner et al. (1977) approach and following the Battese et al. (1995) specification for panel data with a time-varying effect.

The stochastic profit frontier for panel data can be written as

$$Y_{it} = f(X_{it}, \beta)\exp(V_{it} - U_{it}) \quad i = 1,2,\ldots,n;\ t = 1,2,\ldots,T \tag{1}$$

where, Y_{it} represents the profit and X_it is the input vector of the i^{th} firm in the t^{th} year. β represents unknown parameters vector that needs to be estimated. f (X_{it}) is normally assumed as either the Cobb-Douglass function or Translog function. The study aims at choosing the Cobb-Douglass function to be more convenient in interpreting the effect of input factors to output factors. The error term is composed of a random error component, V_it, and an inefficiency component, U_{it}. V_{it} is assumed to be a standard symmetric, an independent and identically distributed N $(0,\ \sigma_v^2)$ random error term, while U_{it} is assumed to be an independent and identically exponentially distributed N $(0,\ \sigma_v^2)$ technical inefficiency effect.

The maximum likelihood method is used to estimate the coefficients of the profit function. The likelihood function is expressed in terms of the variance parameters of the frontier function

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \text{ and } \gamma = \frac{\sigma_u^2}{\sigma^2} \tag{2}$$

where, σ_v^2 is variance of noise, σ_u^2 is variance of inefficiency effects, γ is the ratio of the variance of inefficiency effects u, to total variance due to both error terms u and v.

In this model, the inefficiency effects are expressed as

$$U_{it} = \eta_{it} U_i \tag{3}$$

where, η is an unknown scalar parameter.

The technical efficiency of profit for the i^{th} plant at the time t^{th} is defined as the ratio of the actual observed output and the frontier output (maximum feasible output obtainable from a given quantity of inputs when there is no inefficiency) and is written as

$$TE_{it} = exp(-U_{it}) \tag{4}$$

Since U_{it} is a non-negative random variable, TE_{it} must lie between 0 and 1. If TE_{it} is equal to 1 (the firm has an inefficiency effect equal to 0), the firm is considered as operating at the maximum output with the technology embodied in the profit frontier.

Assuming that there are k inputs and that the profit function is linear in logs, the natural logarithm of the profit function in equation (1) becomes:

$$\ln Y_{it} = \beta_0 + \sum_{k=1}^{N} \beta_k \ln X_{itk} + V_{it} + \ln TE_{it} \quad (5)$$

In this study, technical efficiency effects, TE_{it} depends on exogenous factors, which are firm-specific, industry-specific, and time-varying. Assuming a linear functional relationship that allows a comparison of the dynamic performance of firms, technical efficiencies are explained as follows:

$$TE_{it} = \alpha_0 + \sum_{j=1}^{N} \alpha_j Z_{ijt} + \omega_{it} + e_i + \varphi_t \quad (6)$$

where, Z_{ijt} is exogenous factors affecting technical efficiency of the firm, α are parameter estimates, ω_{it} is a random variable, e_i is heterogeneity of identity, and φ_t is error term of time.

4. Data and model selection

4.1 Data selection

The study used panel data of 19 firms regarding their financial performance and corporate social responsibility index for the 2010-2017 fiscal year. The data was acquired from the CSR TOYO KEIZAI Database, the EOL, and Nikkei NEEDS database. Analysis of the sample separated parts suppliers from car manufacturers to interpret the differences between CSR performance and the impact of CSR sub-factors on the firm's technical efficiency of the two groups.

4.2 Variables for the efficiency measurement by stochastic profit frontier model

Description and descriptive statistics for output and input variables for parts supplier group and car manufacturer group are described in Tables 1, 2, and 3, respectively. It can be observed from the tables that the average value-added, tangible asset, intangible asset, and the number of employees of car manufacturers are significantly higher than those of Parts Suppliers.

Table 1. Description of variables in the profit frontier model

Variables	Description
Output	
Value added	Total value added of firm per year (million yen) (Value added = Net sales - Cost of goods – Depreciation)
Inputs	
Tangible asset	Total tangible asset of firm per year (million yen)
Intangible asset	Total intangible asset of firm per year (million yen)
Labor	Total employee number of firm per year (person)

Table 2. Descriptive statistics of variables in the profit frontier model (Parts suppliers)

Variables	Obs.	Mean	S.D.	Min	Max
Output					
Value added	96	16,403	13,585	1,736	61,415
Inputs					
Tangible asset	96	49,672	42,860	6,195	178,187
Intangible asset	96	1,861	2,332	23	9,783
Labor	96	4,267	3,772	399	14,979

Table 3. Descriptive statistics of variables in the profit frontier model (Car manufacturers)

Variables	Obs.	Mean	S.D.	Min	Max
Output					
Value added	56	294,422	302,512	36,064	1,116,844
Inputs					
Tangible asset	56	414,325	261,735	98,663	863,152
Intangible asset	56	22,135	21,810	629	77,502
Labor	56	15,867	6,237	7,769	28,491

4.3 Variables for the technical efficiency effects model

To explain the level of technical efficiency, exogenous variables involving firm characteristics in the efficiency effects model are described in Tables 4, 5, and 6.

The mean value of age, wage, retention rate, taking paid leave rate, female manager rate, taking childcare leave rate, disability employment rate of car manufacturer group is higher than that of parts supplier. Meanwhile, the mean value of turnover rate, overtime hours, carbon emission intensity of parts supplier group is higher than that of car manufacturer group. This implies that car manufacturers tend to have better working conditions and environmental performance than their counterparts, which is equivalent to their higher capital and labor resource compared to parts suppliers.

Table 4. Description of exogenous variables in the technical efficiency effects model

Variables	Description
CSR Workforce-oriented characteristics	
Age	Average employee age (year-old)
Wage	Average employee wage (JPY)
Overtime hours	Average overtime hours per month (hour)
Retention rate	Retention rate of newly graduate employee after 3 years of working (%)
Turnover rate	Average annual turnover rate (%)
Taking paid leave rate	Average annual taking paid leave rate (%)
Female manager rate	Average annual female manager rate (%)
Disability employment rate	Average annual disability employment rate (%)
Childcare leave rate	Childcare leave rate of both women and men (%)
CSR Environmental characteristics	
CO_2 intensity	Ratio of CO_2 emission and value added (tons/ million yen)
Industrial characteristics	
Toyota Keiretsu	Toyota Group Supplier: 1; Others: 0
Honda Keiretsu	Honda Group Supplier: 1; Others: 0

Table 5. Descriptive statistics of exogenous variables in the technical efficiency effects model (Parts suppliers)

Variables	Obs.	Mean	S.D.	Min	Max
CSR Workforce-oriented characteristics					
Age	96	39.16	1.93	35.2	43.1
Wage	96	6,326,562	452,636	5,387,200	7,389,737
Overtime hours	96	22.11	6.67	8.3	38.4
Retention rate	96	91.25	8.42	60	100
Turnover rate	96	1.7	1.48	0.2	11.87
Paid leave use rate	96	80.44	15.44	51.3	110.4
Female manager rate	96	1.67	1.4	0	6
Disability employment rate	96	2.01	0.22	1.51	2.45
Childcare leave rate	96	0.77	0.5	0	2.49
CSR Environmental characteristics					
CO_2 intensity	96	6.78	6.18	0.49	31.77
Industrial characteristics					
Toyota Keiretsu	96			0	1
Honda Keiretsu	96			0	1

Table 6. Descriptive statistics of exogenous variables in the technical efficiency effects model (Car manufacturers)

Variables	Obs.	Mean	S.D.	Min	Max
CSR Workforce-oriented characteristics					
Age	56	40.94	2.34	36.2	45
Wage	56	6,957,065	672,137	5,587,000	8,184,466
Overtime hours	56	21.26	6.35	3.2	30.7
Retention rate	56	92.42	4.29	82	100
Turnover rate	56	1.63	1.02	0	7.46
Paid leave use rate	56	84.74	9.78	62.1	106.1
Female manager rate	56	2.86	2.57	0.5	11.2
Disability employment rate	56	2.04	0.17	1.81	2.47
Childcare leave rate	56	1.25	1.59	0.24	5.83
CSR Environmental characteristics					
CO_2 intensity	56	2.44	3.08	0.36	18.54

4.4 Model selection

In this paper, two empirical analyses using panel data are conducted. First is the profit frontier analysis under a time-varying decay effect, and second is the technical efficiency effect analysis. In the technical efficiency effect analysis, several regression models are used to find out the effect of each CSR factor on technical efficiency.

5. Empirical results and discussions

5.1 Technical efficiency of automobile manufacturing firms

Parameter estimates of the stochastic profit frontier model by the SFA approach of the two groups were presented in Table 7. For the car manufacturer group, both input variables tangible asset and labor are positively significant at the significant level of 0.01 while intangible asset appears to be insignificant in terms of the value-added of the firms. The elasticity of labor is greater than capital suggesting that the labor input is more important for the profit of the Japanese automotive industry. On the contrary, for the parts supplier group, only labor is positively significant at the significant level of 0.01 while both tangible asset and intangible asset appears to be insignificant in terms of value-added of the firms. The over-reliance on the labor of Japanese automobile manufacturing firms can lead to a low-cost labor trap and many other social issues, which makes it difficult for them to get nearer to the profit frontier and increase their competitiveness.

In this study, results show that γ of parts supplier group is 0.8511, implying that technical inefficiency explains 85.11% of the total variation from the frontier. Meanwhile, γ of the car manufacturer group is 0.2727, indicating that inefficiency only explains 27.27% of the total variation from the frontier and nearly 73% of the variation is due to the noise component that the firms cannot control（such as weather conditions, global financial crisis and economic recession）. The significant estimate of η is 0.08 and 0.308 for the parts supplier group and car manufacturer group respectively, which implies that the profit efficiency level of all reported firms in Japanese automotive industry increase over the 8 years.

Table 7. Parameter estimates of the profit frontier model

Variables	Parts suppliers	Car manufacturers
ln（Tangible asset）	-0.0786	0.4794***
ln（Intangible asset）	0.0147	0.0528
ln（Labor）	0.9328***	1.1501***
η	0.08***	0.308***
γ	0.8511	0.2727
Constant	3.261728***	-4.9693***

Note: *, **, *** significant at 10%, 5%, and 1%

The distribution of the mean profit efficiency of the parts suppliers and car manufacturers over the 8 years shown in Table 8 indicates that the mean efficiency of the car manufacturers is relatively higher than that of parts suppliers. In detail, car manufacturer group produced 70% of output and parts supplier group produced 61% of output at best at the current level of inputs and technology. Car manufacturers in overall have the potential to increase 30% of their profit given the same level of input and technology, while for parts suppliers the potential efficiency increase is 39% of their profit. Among seven car manufacturers, five firms（72%）are operating at a high efficiency level of 60—100% while no firm is operating at a low efficiency level（below 40%）; meanwhile, there are three parts suppliers（25%）operating at a low efficiency level. In details, the two firms have high

Table 8. Frequency distribution of mean efficiency of individual firms, 2010-2017

Technical efficiency	Parts suppliers		Car manufacturers	
	No. of firms	Frequency（%）	No. of firms	Frequency（%）
Less than 0.4	3	25.00	0	0.00
From 0.4 to less than 0.6	3	25.00	2	28.57
From 0.6 to less than 0.8	3	25.00	3	42.86
From 0.8 to 1.0	3	25.00	2	28.57
Mean TE	0.6118		0.6958	
Standard error	0.2379		0.1862	
Min	0.1802		0.4076	
Max	0.9374		0.9439	

technical efficiency score (90-100%), whereas the three firms are operating at low efficiency level (below 40%).

5.2 Determinants of technical efficiency

The results of the technical efficiency effect model for the parts supplier and car manufacturer groups are shown in Table 9 and Table 10.

Table 9. The technical efficiency effects model (Parts suppliers- random effect)

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
ln (Age)	1.4710***	0.9589***	0.8375***	-1.4994***	-0.7166*
	(0.2602)	(0.3080)	(0.3250)	(0.3965)	(0.3927)
ln (Wage)	0.1560	0.1532	0.1543	1.1121***	1.2197***
	(0.1290)	(0.1400)	(0.1456)	(0.2644)	(0.2639)
ln (Overtime hours)	0.0770***	0.0847***	0.0833***	0.0027	-0.0756
	(0.0270)	(0.0289)	(0.0301)	(0.0637)	(0.0584)
Retention rate	0.0006	0.0007	0.0007	0.0017	0.0004
	(0.0005)	(0.0005)	(0.0006)	(0.0019)	(0.0017)
Turnover rate	0.0062**	0.0036	0.0028	-0.0075	-0.0112
	(0.0026)	(0.0029)	(0.0031)	(0.0104)	(0.0094)
Paid leave use rate	-0.0003	-0.0007	-0.0007	0.0014	-0.0016
	(0.0007)	(0.0008)	(0.0008)	(0.0016)	(0.0015)
Female manager rate		0.0189**	0.0210**	0.0767***	0.0620***
		(0.0088)	(0.0091)	(0.0180)	(0.0161)
Disability employment rate		0.0442	0.0478	0.1274	0.1382
		(0.0318)	(0.0335)	(0.0974)	(0.0854)
Childcare leave rate		0.0060	0.0063	-0.0835**	-0.0455
		(0.0128)	(0.0134)	(0.0383)	(0.0353)
CO_2 intensity			-0.0014	-0.0062**	-0.0349***
			(0.0016)	(0.0029)	(0.0069)
Toyota Keiretsu supplier				-0.2754***	-0.4994***
				(0.0507)	(0.0628)
Honda Keiretsu supplier				-0.3115***	-0.3961***
				(0.0627)	(0.0742)
CO_2 intensity × Toyota Keiretsu					0.0393***
					(0.0079)
CO_2 intensity × Honda Keiretsu					0.0190**
					(0.0094)
Constant	-7.495***	-5.699***	-5.266***	-11.722***	-15.559***
	(1.4717)	(1.7249)	(1.8441)	(3.6848)	(3.6402)

Note: Standard errors in parentheses, *, **, *** significant at 10%, 5%, and 1%

Table 10. The technical efficiency effects model (Car manufacturers- fixed effect)

Variables	Model 1	Model 2	Model 3
ln (Age)	-0.2365	-0.3071	0.0945
	(1.0822)	(0.7833)	(0.7162)
ln (Wage)	1.9952***	0.8352***	0.7822***
	(0.2705)	(0.2526)	(0.2280)
ln (Overtime hours)	0.1370***	0.0799**	0.1254***
	(0.0394)	(0.0352)	(0.0347)
Retention rate	0.0014	0.0023	0.0015
	(0.0037)	(0.0026)	(0.0024)
Turnover rate	0.0050	-0.0026	0.0053
	(0.0126)	(0.0092)	(0.0087)
Paid leave use rate	0.0065**	0.0045**	0.0061***
	(0.0030)	(0.0022)	(0.0020)
Female manager rate		0.0857***	0.0590***
		(0.0147)	(0.0156)
Disability employment rate		0.2986**	0.2769**
		(0.1190)	(0.1073)
Childcare leave rate		0.0293	0.0060
		(0.0275)	(0.0258)
CO_2 intensity			-0.0139***
			(0.0043)
Constant	-30.9510***	-13.0408***	-13.7279***
	(3.6815)	(3.7484)	(3.3815)
R-squared	0.8249	0.9217	0.9381

Note: Standard errors in parentheses, *, **, *** significant at 10%, 5%, and 1%

i. CO_2 intensity

CO_2 intensity is significantly and negatively affecting profit efficiency of both groups at a significant level of 0.01. This means that a lower level of CO_2 intensity results in higher efficiency of the Japanese automotive firms. This is in line with the previous studies of McGuire et al. (1988) and Porter et al. (1995), which found that less CO_2 emission rates result in higher morale, as well as an increase in productivity and increase in revenues can outweigh the initial cost of complying with the new environmental regulations. Taking into consideration the significance and large-scale of the Japanese automotive industry, both Japanese automotive firms and government should take actions to reduce CO_2 intensity in the manufacturing processes.

First, from corporate perspectives, technological progress and R&D innovation are effective ways to reduce emissions in manufacturing as well as increase profit efficiency. Firms can maximize environmental performance by replacing obsolete and inefficient processes with more advanced technologies and implement cross-cutting technologies, which can improve both CO_2 performance and efficiency significantly at low or even negative costs (Napp et. al., 2012). In addition, automakers and parts suppliers should cooperate and invest in the design of lighter, leaner, and environmentally- friendly products. Moreover, they should together carry out low-carbon technology research, spread knowledge and technologies to reduce emission in the whole supply chain to achieve a more efficient and sustainable growth without compromising on profit efficiency or cost competitiveness.

Second, it is apparent that many of these green technologies and research are expensive and require significant capital investment. Therefore, the Japanese government needs to accelerate the formulation of measures and policies such as R&D subsidies, tax reduction, and the exemption for corporate CO_2 reduction activities. In that way, enterprises with large carbon emissions or insufficient capital amount can be encouraged to invest in R&D innovations and research activities as well as implement emission reduction technologies into their manufacturing processes.

ii. Supplier Keiretsu system

Keiretsu and technical efficiency

The study found that belonging to a Keiretsu exerts significantly and negatively affects the technical efficiency of suppliers, which expands on previous criticisms on Keiretsu partnerships. Many studies reported that Keiretsu suppliers have less corporate financial performance or competitiveness than independent firms (Hundley et al., 1998; Kawai, 2007). Kim et al. (2004), for instance, connected Keiretsu memberships with weak power, dependence, and product diversification, especially for the less powerful members. According to the study of Nobeoka et al. (2002), independent firms that deal with more customers yield higher profitability and productivity as they can take advantage of the knowledge diversification and learning opportunities to upgrade both product quality and negotiation skills. Dekker et al. (2010) also criticized Keiretsu's affiliations in terms of their ability to effectively respond to global and rapid changes in the manufacturing landscape under increasingly higher demands for flexibility and cost reduction.

Keiretsu and CO_2 intensity – technical efficiency relationship

First, the positive coefficients of the interaction term between CO_2 intensity and Toyota Keiretsu, CO_2 intensity and Honda Keiretsu implies that the reduction of CO_2 intensity of the Keiretsu suppliers is less likely to benefit the profit efficiency than that of the independent suppliers. It can be explained that under the demanding cost reduction pressures from the automaker, Keiretsu suppliers have to spare their effort and capability on increasing short-term profits for the group leader instead of their efficiency and CO_2 performance. Besides, they have limited opportunities to engage in global transactions and competitions, which may hinder them from learning opportunities and knowledge diversification on CO_2 reduction activities from the global partners as well as lead to lower innovation capability and innovation motivation to improve their CO_2 performance. In addition, under the guidelines and trainings of car manufacturers, Keiretsu suppliers may have already reached their maximum environmental efficiency; therefore, the negligible benefits of additional reduction of CO_2 intensity cannot substantially outweigh the costs of conducting these activities.

Second, it can be observed that for parts suppliers which belong to Honda Keiretsu, the coefficient of CO_2 intensity on efficiency is negative ($-0.035 + 0.019 = -0.016 < 0$), implying that reducing CO_2 intensity still leads to an increase in profit efficiency. However, for the parts suppliers which belong to Toyota Keiretsu, the coefficient of CO_2 intensity on efficiency turns positive ($-0.035 + 0.039 = 0.004 > 0$) implying that reducing CO_2 intensity leads to a decrease in technical efficiency. The reason for the positive relationship between CO_2 intensity and technical efficiency of Toyota Keiretsu may be that its suppliers are under even greater pressures than Honda's suppliers or independent suppliers, to achieve not only cost reduction but also higher product quality and high delivery accuracy with demanding targets from Toyota. Therefore, any effort to reduce CO_2 intensity can affect the achievement of these targets and decrease overall profit efficiency. Specifically, in 2000, Toyota launched the Construction of Cost Competitiveness for the 21st Century (CCC21) program demanding an unprecedented 30% cost reduction over three years from its long-standing and excellent suppliers. Toyota's explicit request for continuously conducting *kaizen* activities to meet its demand make the suppliers' efforts and *kaizen* activities become mere exploitative and short-term profit-seeking activities (Aoki et al., 2017).

Another difference between Toyota Keiretsu and Honda Keiretsu is that Toyota relies on tight relations with fewer but larger suppliers, while Honda relies on a loosely related group of a larger number of smaller suppliers

(Kim et al., 1999). According to this study, the ratio of the first-tier suppliers over the first and second-tier combined is much higher in Toyota (29.3%) than in Honda (9.2%) in 1996. Toyota even strengthened financial control over its affiliated companies, while Honda Keiretsu showed only subtle changes between 1993 and 2006 (Kawai, 2007). In addition, Toyota is found to traditionally expand their production only through a small number of permanent first-tier suppliers and to procure a very limited number of parts from other automakers' Keiretsu. All of these findings also imply that Toyota Keiretsu suppliers have to focus extensively on the short-term profit maximization and product development of Toyota that they have no chance to invest in their performance, especially on CO_2 reduction.

iii. Female manager rate

Female manager rate is significant and positively affecting profit efficiency of both groups. This is in line with several supporting arguments on the diversity of board members such as Bantel et al. (1989).

According to Smith et al. (2006), one benefit of a diverse board of managers is that it is possible to make decisions based on the evaluation of more alternatives compared to a homogenous board. A heterogenous board can have a better understanding of the marketplace of the firm and increases creativity and innovation. In addition, if the candidates for the executive boards are selected from among the best from the distribution of both men and women, or other minority groups such as persons with disabilities, the quality of the selection will increase.

To promote women in management in the Japanese workforce, Prime Minister Shinzo Abe has announced the target of reaching 30% women in leadership roles in Japan by 2020. In addition, a law was passed to require large companies to set explicit goals for promoting women to leadership positions. Despite these efforts of the Japanese government and policy makers, Japanese culture and traditional beliefs regarding gender roles still pose certain obstacles for Japanese women to achieve higher positions in their careers. In reality, the female manager rate in Japan is still very low compared to other countries and much below the goal rate of 30%, implying that Japan is still in the transitional period to successfully promote women in management in the workplace.

iv. Disability employment rate

Disability employment rate has a significantly positive effect on the efficiency of the car manufacturer group but shows no significant relationship with the parts supplier group. Various studies show that the benefits of employing disabled workers may offset the costs. First, disabled workers are proved to have better attendance records (Chomka, 2004), lower turnover rates (Hull, 2007), more loyalty and commitment (Fraser et al., 2011), and capable and productive (Houtenville et al., 2012) when compared to their counterparts. Besides, disability employment can increase work ethic and retention of existing employees (Goldstone et al., 2002), not to mention its contribution to increase corporate diversity and hiring pools.

On the other hand, the insignificant relationship between disability employment and profit efficiency of Parts suppliers in this study can be explained by the fact that the proportion of costs needed for disability employment within general costs is relatively larger for small and medium-sized enterprises, which do not have as much resource allocation when compared to larger companies (Nagae, 2015).

v. Paid leave use rate

Paid leave use rate has a significantly positive effect on the efficiency of the car manufacturer groups but shows no significant relationship with the parts supplier group. A large number of studies bring out the merits of employees' taking paid leave on firm performance as it leads to an increase in employees' productivity and morale as well as to improve the retention rate of skilled workers.

According to Ogura (2004), there are several reasons why Japanese workers did not take more of their annual paid leave. The answers include "Taking holidays leads to negative personnel evaluations especially by their leaders or superiors" and "Having too much work to do and no one can replace them". These respondents are mainly workers of both men and women with ages ranging from their 20s to 40s who have a strong tendency to work in small companies and for comparatively long hours and be dissatisfied with their wage (Ogura, 2004). Therefore, the fact that employees of parts suppliers have a lower paid leave use rate and higher overtime hours on average than car manufacturers. This implies that there is too much work at parts suppliers, which also explains the insignificant effect of paid leave use rate on firm efficiency of parts suppliers.

With only 51.1% rate of paid holidays taken by employees of private companies in 2017, the Japanese government has set a 70% target for average use of paid vacation days by 2020. In addition, from April 2019, companies in Japan will be fined up to ¥300,000 if their employees do not use at least five paid holidays. Despite these efforts, many employees seem reluctant to take days off work; therefore, there is still a long way to go for Japanese companies to reach the 70% target set by the government.

vi. Wage

Wage has significant and positive effects on the efficiency of both groups, which means that a higher wage leads to higher profit efficiency. This result is in line with the study of Khalifah (2013) that the average wage of workers positively affects corporate profit efficiency.

First, higher average wages can promote higher effort levels and greater commitment and productivity of existing employees (Akerlof, 1982) can improve corporate performance by attracting and retaining capable employees as well as motivating employees (Larkin et. al., 2012). Employees who get higher wages are less inclined to leave their employers, which helps reduce costs associated with employee turnover, in industries where the costs of replacing labor are high (Akerlof, 1982). This increased labor productivity or decreased costs may compensate for the higher wages.

In Japan, there is a traditional long-term employment contract for regular workers that offers seniority-based wages for those with long years of service. However, in order to survive the global competition in artificial intelligence and other advanced fields, Japanese companies need to secure excellent manpower from around the world from overseas rivals that attract excellent talent with generous and fair compensation. Therefore, it is recommended that Japanese businesses shift from the traditional seniority-based wage system to a more flexible system that properly rewards individual employees based on their expertise and performance.

vii. Overtime hours

Overtime hours significantly and positively affect profit efficiency of both groups, which means that longer overtime hours lead to higher firm efficiency.

Overtime work has been perceived as a way to avoid employment adjustment and to reduce the cost of hiring additional personnel (Takami, 2019). In addition, in Japanese companies, not only the employees' performance and achievements are assessed, but also the levels of their motivation and diligence are also of crucial criteria, which encourages workers to put themselves into highly challenging tasks and demanding work schedules from a young age. The higher commitment and performance level associated with overtime helps increase firm efficiency.

The situation of workplaces and characteristics of work are thought to be the reasons for employees' increasing overtime on a regular basis. Especially, in the manufacturing sector, factors that lead to excessive workloads for employees are noted to be overly high-performance quotas and targets along with great pressure to meet tight deadlines for customers or relating departments (Takami, 2019). Therefore, in order to maintain profit efficiency while reducing the negative effects of overtime hours, measures such as the adoption of a flexible working time or changes in the way employees work are necessary. In recent years, the policies related to overwork in Japan have undergone significant developments. The Work Style Reform Act enacted in 2018 (and put into effect in 2019) placed clear upper limits on overtime hours, for example, 45 hours a month and 360 hours a year, and these are expected to have a significant impact in the coming years. The Japanese government and authorities need to monitor and provide sufficient guidance to the companies to ensure that these regulations are effective in practice.

6. Conclusion and policy implications

The main objective of this study was to measure the technical efficiency of Japanese automobile manufacturing firms in the period 2010-2017 and determine key factors affecting the level of technical efficiency using a stochastic frontier approach.

The results from the stochastic frontier model indicate that Japanese automotive firms rely heavily on labor to improve their profit. Therefore, it suggests that they should invest in upgrading their technology and manufacturing process to achieve high profit as well as profit efficiency while diminishing labor-related issues such as overwork or low wages. In addition, the overall mean technical efficiency of car manufacturers and parts suppliers is 0.7 and 0.61, which implies that they have the potential to increase their profit by 30% and 39%, respectively, given the same level of inputs and technology within the reported period.

The results from technical efficiency effect models indicate that technical efficiency of automotive firms can be improved by a reduction of CO_2 intensity. Especially, independent suppliers are found to be associated with higher technical efficiency and higher effect of CO_2 reductions on technical efficiency compared with Keiretsu suppliers. In addition, the promotion of women in management, employees' wage rise, and overtime hours also lead to higher efficiency of both parts suppliers and car manufacturers. Meanwhile, the increase of paid leave use rate and disability employment benefits, only car manufacturers. On the other hand, the inconsistent and/or insignificant coefficients of age, turnover rate, childcare leave rate show that there are no conclusive findings regarding their effects on firm efficiency of both groups. Based on the findings, several recommendations were made to help firms increase their technical efficiency.

First, firms should invest in technological progress and R&D innovation as well as incorporate environmental-friendly techniques into their manufacturing processes, which will lead to an increase in both environmental performance as well as technical efficiency. Besides, it is imperative that both automakers and parts suppliers cooperate in the design of lighter and leaner products and manufacturing processes, as well as spread knowledge and technologies to reduce emissions in the whole supply chain.

Second, taking into consideration the significant benefits of Keiretsu systems such as establishing stable supply chains under long-term commitment as well as a high level of communication and product development capabilities, it is recommended that the Japanese Keiretsu system should be restructured towards a more liberalized outward Keiretsu. This will allow suppliers to actively engage in transactions with other automakers and global competitions, which give them more chance to obtain diverse knowledge and innovate their manufacturing process to achieve higher efficiency.

Third, firms should promote women in management and disability employment as well as the use of paid leave rate, in order to achieve the goal quota set by the government. From then, we will be able to observe more consistent effects of disability employment and taking paid leave rate on firm efficiency.

Fourth, Japanese automotive firms should shift from a traditional seniority-based wage system to a more flexible system that properly rewards individual employees for their expertise and performance, which should, in turn, enable workers to give full play to their potential and increase firm efficiency.

Moreover, in order to maintain high-profit efficiency while reducing overtime hours' negative effects, firms need to promote more flexible working styles and change the ways Japanese employees work.

Last but not least, in order to facilitate these above activities, the Japanese government and policymakers should establish long-term measures and policies such as providing incentives, subsidies, or penalties as well as strict regulations that will stimulate companies to achieve the quota and standards relating to CSR and conduct sufficient research and innovation to continuously improve their performance. Besides, to ensure that these policies are effective in practice, the Japanese government also needs to monitor and provide guidance to companies.

Due to the data limitations, these results are based on a relatively small panel data sample, under a short period from 2010 to 2017 with only 19 firms. Besides, this study focuses only on the companies in the Japanese automobile manufacturing industry and thus does not examine how the relationship between CSR and technical efficiency differs across industries or countries. Therefore, it will be interesting to see if the results of this study hold when more firms across various industries or countries for a longer period of time are studied. Moreover, future research should also examine the effect of other sub-drivers of CSR such as society-oriented or governance scores on corporate technical efficiency.

References

Aigner, D., Lovell, C. K., & Schmidt, P. (1977). *Formulation and estimation of stochastic frontier production function models.* Journal of Econometrics, 6 (1), 21-37.

Akerlof, G. A. (1982). *Labor contracts as partial gift exchange.* The Quarterly Journal of Economics, 97 (4), 543-569.

Aoki, K., & Wilhelm, M. (2017). *The role of ambidexterity in managing buyer–supplier relationships: The Toyota case.* Organization Science, 28 (6), 1080-1097.

Bantel, K. A., & Jackson, S. E. (1989). *Top management and innovations in banking: Does the composition of the top team make a difference?* Strategic Management Journal, 10 (S1), 107-124.

Battese, G. E., & Coelli, T. J. (1995). *A model for technical inefficiency effects in a stochastic frontier production function for panel data.* Empirical Economics, 20 (2), 325-332.

Becchetti, L. (2007). *Corporate Social Responsibility: Not Only Economic and Financial Performance.* Finance Bien Commun, (3), 152-158.

Becchetti, L., & Trovato, G. (2011). *Corporate social responsibility and firm efficiency: A latent class stochastic frontier analysis.* Journal of Productivity Analysis, 36 (3), 231-246.

Chomka, S. (2004). *Disabled workers help solve recruitment issues.* Food Manufacture, 79 (8), 56-57.

Dekkers, R., & Bennett, D. (2010). *A Review of Research and Practice for the Industrial Networks of the Future.* Enterprise Networks and Logistics for Agile Manufacturing, (28), 11-38. Springer, London.

Eweje, G. & Bentley, T. (2006). *CSR and staff retention in New Zealand companies: a literature review.* Research Working Paper Series, No. 6. Department and International Business, Massey University, Auckland, New Zealand.

Farrell, M. J. (1957). *The measurement of productive efficiency.* Journal of Royal Statistical Society, 120, 11-37.

Fraser, R., Ajzen, I., Johnson, K., Hebert, J., & Chan, F. (2011). *Understanding employers' hiring intention in relation to qualified workers with disabilities.* Journal of Vocational Rehabilitation, 35 (1), 1-11.

Godfrey, P. C. (2005). *The relationship between corporate philanthropy and shareholder wealth: A risk management perspective.* Academy of Management Review, 30 (4), 777- 798.

Goldstone, C. & Meager, N. (2002). *Barriers to employment for disabled people.* In: Great Britain, Analytical Services Division.

Grosskopf, S. (1993). *Efficiency and productivity.* In Fried HO and SS Schmidt (eds.): The measurement of productive efficiency: techniques and applications. Oxford U.K.: 160-194.

Houtenville, A., & Kalargyrou, V. (2012). *People with disabilities: Employers' perspectives on recruitment practices, strategies, and challenges in leisure and hospitality.* Cornell Hospitality Quarterly, 53 (1), 40-52.

Hull, R. (2007a). *Dow Chemical Company.* In Hidden talent, ed. Lengnick-Hall, Mark, 47-53. Westport, CT: Praeger Publishers.

Hundley, G., & Jacobson, C. K. (1998). *The effects of the keiretsu on the export performance of Japanese companies: help or hindrance?* Strategic Management Journal, 19 (10), 927-937.

Kawai, N. (2007). *Does keiretsu ownership improve or undermine corporate performance? The case of the automobile sector.* Japan aktuell-

Journal of Current Japanese Affairs, 15（6), 5-36.

Khalifah, N. A. (2013). *Ownership and technical efficiency in Malaysia's automotive industry: A stochastic frontier production function analysis.* The Journal of International Trade & Economic Development, 22（4), 509-535.

Kim, H., Hoskisson, R. E., & Wan, W. P. (2004). *Power dependence, diversification strategy, and performance in keiretsu member firms.* Strategic Management Journal, 25（7), 613-636.

Kim, J. B. & Michell, P. (1999). *Relationship marketing in Japan: the buyer-supplier relationships of four automakers.* Journal of Business and Industrial Marketing, 14（2), 118-129.

Knight, Frank H. (1921). *Risk, Uncertainty and Profit.* Hart, Schaffner & Marx; Boston: Houghton Mifflin Company, The Riverside Press, Cambridge.

Krukowska, M. (2014). *Determinants of corporate social responsibility in Japanese companies.* Management and Business Administration. Central Europe, 127（4), 39-57.

Larkin, I., Pierce, L., & Gino, F. (2012). *The psychological costs of pay - for - performance: Implications for the strategic compensation of employees.* Strategic Management Journal, 33（10), 1194-1214.

Mandl, I. & Dorr, A., (2007). *CSR and competitiveness: European SMEs' good practice.* National Report Austria. KMU Forschung Austria, Autrian Institute for SME Research (KMU), Vienna.

McGuire, J. B., Sundgren, A., & Schneeweis, T. (1988). *Corporate social responsibility and firm financial performance.* Academy of Management Journal, 31（4), 854–872.

Ming, L. C. (2019). *Female Managers in Japan: How to Set the Goal of Increasing Women in Leadership Roles.* Business and Management Studies, 5（2), 85-102.

Nagae, A. (2015). *Disability employment and productivity.* Japan Labor Review, 12（1), 56-75.

Napp, T., Gambhir, A., Florin, N., & Fennell, P. S. (2012). *Reducing CO_2 emissions from heavy industry: a review of technologies and considerations for policy makers.* Grantham Briefing Paper No. 7. Grantham Institute for Climate Change, Imperial College London, London.

Nobeoka, K., Dyer, J. H., & Madhok, A. (2002). *The influence of customer scope on supplier learning and performance in the Japanese automobile industry.* Journal of International Business Studies, 33（4), 717-736.

Ogura, K. (2004). *Annual paid leave in Japan.* Management, 34（6.7), 21-1.

Ono, H. (2018). *Why do the Japanese work long hours? Sociological perspectives on long working hours in Japan.* Japan labor issues, 2（5), 35-49.

Paul, C. J., & Siegel, D. S. (2006). *Corporate social responsibility and economic performance.* Journal of Productivity Analysis, 26（3), 207-211.

Pinheiro, C. and Silva, P. P. (2019). *Corporate Social Responsibility and Firm Efficiency: A Stochastic Frontier Analysis.* IFABS 2018 Chile Conference.

Porter, M. E., & Van der Linde, C. (1995). *Toward a new conception of the environment-competitiveness relationship.* Journal of Economic Perspectives, 9（4), 97-118.

Preston, L. E., & O'bannon, D. P. (1997). *The corporate social-financial performance relationship: A typology and analysis.* Business & Society, 36（4), 419-429.

Ruggiero, J. (2004). *Data envelopment analysis with stochastic data.* Journal of the Operational Research Society, 55（9), 1008-1012.

Shadbegian, R. J., & Gray, W. B. (2006). *Assessing multi-dimensional performance: environmental and economic outcomes.* Journal of Productivity Analysis, 26（3), 213.

Smith, N., Smith, V., & Verner, M. (2006). *Do women in top management affect firm performance? A panel study of 2,500 Danish firms.* International Journal of Productivity and Performance Management, 55（7), 563-599.

Stanwick, P. A., & Stanwick, S. D. (1998). *The relationship between corporate social performance, and organizational size, financial performance, and environmental performance: An empirical examination.* Journal of Business Ethics, 17（2), 195-204.

Takami, T. (2019). *Current State of Working Hours and Overwork in Japan Part II: Why do the Japanese Work Long Hours?* Japan Labor Issues, 3（18), 15-19.

Takeishi, A., & Noro, Y. (2017). *Keiretsu Divergence in the Japanese Automotive Industry: Why Have Some, But Not All, Gone.* CEAFJP Discussion Paper Series 17–04, CEAFJPDP.

The Government of Japan (2019). *The Long-term Strategy under the Paris Agreement.* The Long-term Strategy under the Paris

Agreement.pdf (unfccc.int)（Accessed by December 14, 2020）
Japan Automobile Manufacturers Association, Inc（2019）. *The motor industry of Japan 2019*, available online: http://www.jama.or.jp/industry/ebook/bookdata_e/book.pdf
Verschoor, C. C.（1998）. *A study of the link between a corporation's financial performance and its commitment to ethics*. Journal of Business ethics, 17（13）, 1509-1516.

Database
CSR Companies Handbook 2010（Toyo Keizai, Tokyo）.
CSR Companies Handbook 2011（Toyo Keizai, Tokyo）.
CSR Companies Handbook 2012（Toyo Keizai, Tokyo）.
CSR Companies Handbook 2013（Toyo Keizai, Tokyo）.
CSR Companies Handbook 2014（Toyo Keizai, Tokyo）.
CSR Companies Handbook 2015（Toyo Keizai, Tokyo）.
CSR Companies Handbook 2016（Toyo Keizai, Tokyo）.
CSR Companies Handbook 2017（Toyo Keizai, Tokyo）.
EOL, available online: http://eoldb.jp/EolDb/CompanySearch.php
The Nikkei Economic Electronic Databank System（NEEDS）, available online: https://needs.ritsumei.ac.jp/ssi/page/nfsi

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