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Estimating the Optimal Intra-Company Wage Gaps for Improving Productivity -Evidence from Japanese Listed Company-

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Abstract

This study examined the contribution on the productivity of the companies by the intra-company wage gaps as a measure of the performance-based wage systems and got some significant results and implications for management. In order to remove reverse effect by productivity on wage gap, instrumental variable methods are applied. Analyses on all industries implied that larger wage gaps do not motivate employees of Japanese companies. Analyses by nonlinear models to confirm the existence of the optimal wage gaps implied the existence of the optimal wage gaps in a few industries, but aggregately worst wage gaps are recognized. Concretely, effects by wage gaps on the productivity decrease, as wage gaps expand. These findings are contrary to those by Cirillo et al.(2017) in Europe, Dai et al.(2017) in China and Park et al.(2017) in Korea as most recent previous researches.

Keywords: Corporate finance; working condition; human capital;

1. Introduction

Performance-based wage systems have gradually become widespread among Japanese companies, replacing the seniority-based wage systems that had been the norm during Japan's period of high economic growth. Performance-based wage systems have been criticized because they base job performance only on the results and overlook the processes leading to those results, frequently making it difficult to share the technology necessary to conduct business. Nevertheless, performance-based wage systems are acknowledged as being rational in that they are based on employees' level of contribution to the company as measured by their achievements rather than being based merely on their length of service at the company. Furthermore, performance-based wage systems serve to differentiate wages among employees within a company. From a company's perspective, such wage gaps among a company's employees have been a way for the human resources department to motivate each employee to contribute to the company's performance. Meanwhile, from the employees' perspective, the increased differentiation in their wages brought on by the introduction of performance-based wage systems could induce them to improve their job skills and enhance their efficiency, thereby leading to greater productivity and efficiency throughout the company. Conversely, it could also generate somewhat negative effects that are likely to reduce the performance of the entire company because employees tend to focus on their own accomplishments; this could hamper the sharing of technology within the organization, making them more averse to taking on new challenges due to the fear of damaging their performance assessment. Focusing on these two aspects of performance-based wage systems, this paper investigates how performance reviews used to differentiate employees' wages within a company affect employee productivity as measured by sales per capita and operating profit per capita.

2.Prior researches on Japanese company

To analyze the impact of wage gaps within corporations on job satisfaction among union members and on each corporation's financial performance, Sannabe et al. (2008) used financial data from securities reports and data from questionnaires administered by the International Economy and Work Research Institute to labor union members at major Japanese corporations. Sannabe et al. (2008) ran an ordered logit estimate using intra-company wage gap and its square as independent variables and the level of union members' job satisfaction obtained from the union members'

questionnaire data as dependent variables. The result indicated that the first-order term for wage gap had positive significance, while its square had negative significance, thereby confirming that an optimal wage gap maximizes job satisfaction. Next, Sannabe et al. (2008) ran both ordinary least squares (OLS) and two-stage least squares (2SLS) estimates using wage gap and its square as independent variables and corporate performance as derived from each company's financial data (operating profit per capita) as the dependent variable. They found that the value of the first-order term for wage gap was positive and significant and that the value of its square was negative and significant. This result confirmed that an optimal wage gap maximizes corporate performance. As a result, the establishment of a pay scale that has a distribution with a 19% standard deviation in wages according to age, gender, job type, and other factors was found to be optimal for corporations and employees alike. This indicates that there is an optimal level for the implementation of performance-based wage systems. Further, it indicates that too much emphasis on results-based reviews not only reduces workers' job satisfaction but also adversely impacts corporate performance.

Using data on treatment of employees from the fiscal year ending March 2006 through the fiscal year ending March 2011 and corporate financial data for the subsequent fiscal years, Sasaki et al. (2014) conducted an empirical study of the correlation between Japanese companies' capital structures and how they treat their employees. This study also analyzed how this affected both the liability ratio and the mix of interest-bearing liabilities (whether to use bank borrowings or corporate bonds). The proxy variables for treatment of employees comprised 24 assessment items concerning employment and utilization of human resources chosen from the CSR Company Data Books published by Toyo Keizai Inc. Based on the 24 assessment items, employment conditions and human resources utilization at each company were ranked on a five-point scale. Capital structure variables comprised four liability ratios obtained from Nikkei Inc.'s Financial Quest database and the ratio of bank borrowings to liabilities. First, an OLS analysis was conducted using employee treatment as the independent variable and the liability ratio and the ratio of bank borrowings as dependent variables. Thereafter, the researchers investigated the cause and effect relationship by introducing the representative variable correlated to each hypothesis (R&D ratio). The results indicated a tendency for companies that were proactive in their treatment of employees to opt for lower leverage, and this tendency was more pronounced among companies that place importance on intangible assets and actively invest in R&D. This finding indicated that companies that are proactive in their treatment of employees choose low leverage so that they can improve employee treatment as well as lower their indirect bankruptcy costs. Furthermore, the study confirmed that the more proactive a company is in its treatment of employees, the more likely it is to raise funds by issuing bonds than by borrowing from banks and the more likely it is to opt for a low ratio of bank borrowings. This means that companies with a proactive stance toward the intangible asset of human capital prefer to raise funds by issuing unsecured bonds instead of through secured bank loans and want to hold down the indirect costs of bankruptcy by diversifying their funding methods.

Saito (2015) used financial data and data from the Recruit Works Institute's Human Resources Management Survey to conduct an empirical analysis of how merit-based compensation affects companies' performance as measured by productivity and financial results. This study also considered aspects of other human resource management systems, such as wage systems, promotion systems, performance review systems, and skills development, to analyze how both merit-based compensation and other systems would impact productivity and corporate financial performance, in addition to identifying the complementarity and substitutability between merit-based compensation and other human resource management systems. In this study, the amount of value added was a dependent variable, to which was added production coefficients encompassing independent variables that are supplementary to merit-based compensation such as discretionary labor systems, internal free agent (FA) systems, goal management systems and early decision systems. The study ran a regression analysis in which the dependent variables were labor productivity, operating profit per capita, and the employee turnover rate. The results revealed that merit-based compensation increases labor productivity, operating profit per capita, and the turnover rate. In addition, corporate performance improved when companies were using supplementary policies to merit-based compensation such as discretionary labor, internal FA systems, goal management systems, and early decision systems. However, no complementarity was observed between merit-based compensation and these other systems. Furthermore, with respect to pay based on performance, job duties, and seniority, neither the

independent term nor the cross term were significant in almost all cases; however, performance-based pay lowered the turnover rate, and when combined with merit-based compensation, both pay based on performance and pay based on job duties increased the turnover rate.

Shimizu (2008) conducted an empirical investigation of how making employees' jobs easier affected corporate performance. The metrics used to measure the ease of performing a job were derived from data on employment in Toyo Keizai's CSR Company Data Book for 2007, and it used the results of the 2007 survey on the best companies to work for (*Nikkei Sangyo Shimbun*, Aug. 27, 2007). For corporate performance and other financial data, the study used data from the DATALINK by QUICK. A regression analysis was conducted with metrics denoting the ease of working as independent variables and corporate performance as a dependent variable. Furthermore, a more in-depth analysis was conducted by analyzing the correlation between the retention rate of younger workers and other metrics denoting ease of working. The conclusion was that only the retention rate of younger workers had statistical significance among the proxy variables for ease of working. The low retention rate for new employees indicates a possible increase in hiring costs and potential problems involving the succession of technology and other know-how and could even be linked to a deterioration of corporate performance. In addition, the ease of taking vacation days and the transparency of assessment criteria and assessment results had a significant correlation with the retention rate of younger workers. Considering this, factors deemed as facilitating job performance, such as making it easy to take vacations, disclosing assessment criteria, and announcing assessment results, were positively correlated with the retention rate of younger workers. Furthermore, because the retention rate of younger workers had a positive correlation with corporate performance, measures to facilitate job performance were also correlated with corporate performance.

Our study investigates the impact of intra-company wage gap (WG) on companies' financial performance (FP) by conducting a regression analysis with FP as the dependent variable and WG as the independent variable to derive the statistical significance and the sign of the regression coefficient. In this study, FP is denoted by sales per capita, and operating profit per capita, while WG is denoted by log (wage gap for 30-year- olds/average annual compensation).

As mentioned above, Saito (2008) approached the topic of the impact of WG on FP. Saito (2008) concluded that an optimal wage gap exists and that too much gap not only reduces workers' job satisfaction but also adversely impacts corporate performance. However, the study by Saito (2008) was based on a questionnaire survey with a sample size of only 66, so it did not investigate matters such as gaps among industrial sectors, and there was certainly some sample bias (respondents). Regarding this point, our study at least has room for development in that, although it is secondary information, it uses the results of a large-scale questionnaire survey that had a high response rate and elicited the necessary information for this research. Following the methodology of Wooldridge (2010), this paper enlarges the sample size to more than 2,400 companies to facilitate a sector-by-sector analysis and conducts a multidimensional investigation by running regression analyses using both linear and non-linear models. In addition, it attempts to come up with some practical and effective suggestions based on the findings of the sector-by-sector analysis, as the analytical results projected the impact on the sector.

3. Data and analysis

3-1. Data

This study investigates the impact of WG on FP by conducting a regression analysis with FP as the dependent variable and WG as the independent variable to derive the statistical significance and the sign of the regression coefficient. Furthermore, in the study, FP is denoted by sales per-capita and operating profit per-capita, while WG is denoted by Log{(highest annual salary－lowest annual salary)/average salary} of 30-years-old full-time employees. However, we believe that FP is affected by the financial performance of the company and working conditions, so we adopted a control variable (LABOR and FIN) for labor conditions, as shown in Table 3-1. Furthermore, we employed dummy variables to eliminate the influence of fiscal years and industrial sectors. $LABOR_{ij}$ control the effects by the gap of working condition of each company and FIN_{ij} control the effects by financial performance of each company.

Table 3-1. Definition of Variables of jth-sample

Explanatory variables	Definitions
FP	Sales or Operating profit per capita
WG	Wage diversity ≡Log{(highest annual salary－lowest annual salary)/average salary} of 30-years-old full-time employees in most recent fiscal year
$LABOR_{1j}$	Log(Average monthly overtime pay/average monthly hours of overtime)
$LABOR_{2j}$	Log(Monthly average hours of overtime)
$LABOR_{3j}$	Mid-career hires Factor ≡ Average age/years of service
$LABOR_{4j}$	log(the number of employees in most recent fiscal year)
$LABOR_{5j}$	Turnover rate in most recent fiscal year
FIN_{1j}	Log(total assets in most recent fiscal year)
FIN_{2j}	Total debt/ total assets in most recent fiscal year
FIN_{3j}	Return on assets in most recent fiscal year
YD_{ij}	Dummy variables of i -th year
IND_{ij}	Dummy variables of i -th industrial sector used in the industrywide regression analysis

The sample were 2,012 from publicly listed companies for which data on WG was available from Toyo Keizai Inc. (Toyo Keizai's CSR Corporate Data Books (Employment and Human Resource Utilization editions). Holding companies, financial sector and companies with liabilities exceeding assets are excluded. Furthermore, the sample period encompassed the fiscal years ending March 31, 2007, through March 31, 2015, including the most recent reporting period. Financial data for all companies was sourced from the Nikkei NEEDS database. Industrial sector classifications conformed to the subclassifications used in Toyo Keizai's CSR Corporate Data Books.

3-2. Analytical methodology

We used the model described below to analyze and verify the impact of WG on FP. Besides analyzing the entire industrial sample, we also employed SPSS Statistics Ver.23 to analyze the aforementioned industrial categories. In our analysis of the industrywide sample, we used the sector dummy and fiscal year dummy as control variables. In the sector-by-sector analysis, we used only the fiscal year dummy because consideration of the sector effect was not necessary. We first conducted Analysis (1) using a normal OLS method. In each equation, the term Z_j denotes a dummy variable.

$$FP_j = \alpha_0 + \alpha_1 WG_j + \Sigma^5{}_i \alpha_{2ij} LABOR_{ij} + \Sigma^3{}_i \alpha_{3ij} FIN_{ij} + \alpha_4 \Sigma_i YD_{ij} + \alpha_5 \Sigma_i IND_{ij} + \varepsilon_{1j} \quad (1)$$

Furthermore, as in the case where improved corporate performance causes wage gap, we ran estimates using the instrumental variable method to eliminate endogeneity, which is the reverse causal relationship in which FP would influence WG. In other words, we used an instrumental variable that was strongly correlated with WG and weakly correlated with FP, which we refer to as IV. The OLS calculation used the estimated value of WG in Equation (2) as the independent variable in Equation (3). In this case, Rate of paid vacation days for the most recent fiscal year is assumed as IV_j

$$WG\hat{}_j = \beta_0 + \beta_1 IV_j \quad (2)$$

$$FP_j = \alpha_0 + \alpha_1 WG\hat{}_j + \alpha_2 \Sigma^5{}_i LABOR_{ij} + \Sigma^3{}_i \alpha_{3ij} FIN_{ij} + \Sigma_i \alpha_{4ij} YD_{ij} + \Sigma_i \alpha_{5ij} IND_{ij} + \varepsilon_{3j} \quad (3)$$

Furthermore, we saw that a linear relationship between FP and WG could not be verified for some industries. In such cases, we considered the possibility of a non-linear relationship. To verify such a correlation, we conducted an analysis using the instrumental variable method and a non-linear OLS that included the square of WG as the independent variable. We used the same method for selecting the instrumental variable as we did for the linear analysis. In this case, we followed Wooldridge (2010), and if the coefficient of FP was not significant when we regressed FP with WG, we calculated our estimates using 2SLS with only the square of WG as an endogenous variable. In other words, if β_1 in

$$WG_j = \gamma_0 + \gamma_1 FP_j + \gamma_2 EV_j + \varepsilon_{4j} \quad (4)$$

was not significant, we ran our estimates using the 2SLS method, with WG_j^2 as the endogenous variable and EV_{ij}^2 as the instrumental variable. In this case, Return on equity in most recent fiscal year is assumed as EV_j.

$$FP_j = \lambda_0 + \lambda_1 WG_j + \lambda_2 WG\hat{}_j^2 + \lambda_3 \Sigma^5_i LABOR_{ij} + \Sigma^3_i \lambda_{4ij} FIN_{ij} + \Sigma_i \lambda_{5ij} YD_{ij} + \Sigma_i \lambda_{6ij} IND_{ij} + \varepsilon_{5j} \quad (5)$$

$$WG\hat{}_j^2 = \omega_0 + \omega_1 EV_j^2 \quad (6)$$

Analysis that posits a non-linear relationship not only verifies a non-linear relationship but also confirms the optimal wage gap when productivity is maximized (or minimized).

4.Results and Discussion

In this chapter, implications are derived mainly from results by 2SLS. Results by OLS are used only for comparison between results by OLS and 2SLS to guess at reverse effect by productivity on WG.

Table 4.1 depicts Significance of WG on FP examined by Linear OLS (1) and 2SLS (3).

Table4.1 Analysis on all industries by linear model (1):OLS, (3):2SLS (exposure(p-value), n=2012)

FP	Sales per capita		Operating profit per capita	
Model	(1) : OLS	(3) : 2SLS	(1) : OLS	(3) : 2SLS
WG	-213.990 (0.138)	-85.833 (0.117)	-0.596 (0.143)	-0.317 (0.118)
$LABOR_{1j}$	-0.959 (0.216)	-1.079 (0.341)	0.018 (0.422)	0.034 (0.222)
$LABOR_{2j}$	0.003 (0.141)	0.006 (0.045)	-0.000 (0.097)	-0.001 (0.073)
$LABOR_{3j}$	0.679 (0.453)	0.439 (0.451)	0.013 (0.733)	0.048 (0.848)
$LABOR_{4j}$	69.338 (0.205)	47.747 (0.229)	1.295 (0.214)	4.391 (0.281)
$LABOR_{5j}$	22.024 (0.588)	30.943 (0.644)	-1.432 (0.346)	-2.711 (0.166)
FIN_{1j}	25.135 (0.812)	34.467 (0.226)	-0.232 (0.873)	-1.570 (0.748)
FIN_{2j}	12.854 (0.858)	20.697 (0.917)	-2.508 (0.086)	-3.632 (0.025)
FIN_{3j}	21.475 (0.004)	31.685 (0.101)	-0.543 (0.707)	-2.006 (0.573)
Adj R^2	0.272	0.398	0.252	0.400

WG insignificantly contribute on both productivity but slight negative contribute on sales and positive contribute on operating profit can be presumed. These facts give several possible implication below:

(a) Performance-based wage systems measured by wage gap can disappoint employees and don't enhance productivity.

It is conjectured that corporations with smaller WG achieved high productivity and employees in Japanese company tend to prefer small WG.

(b) non-linearity between WG and productivity

(c) inconsistent industry effects

(d) As the reverse effect, both sales and profits have negative effects on WG. This can be conjectured by comparison between OLS results and 2SLS results.

Based on (c) , industry effects are examined by linear model. As is expected, some industries show significant results and others show insignificant results. And in significant results, some industries show positive results and others show negative results. Some of significant results are shown in Table 4.2.

Table4.2 Analysis on some industries by linear model (1):OLS, (2)+(3):2SLS
–significant cases-

α_1 (p-value)
Adj R^2

FP	Sales per capita		Operating profit per capita	
Model	(1) : OLS	(2)+(3):2SLS	(1) : OLS	(2)+(3):2SLS
Utility	-356.180 (0.046)	-227.424 (0.038)	-22.402 (0.380)	-9.745 (0.094)

(n=58)	0.424	0.542	0.464	0.488
Precision Machinery (n=75)	23.644 (0.085)	47.342 (0.012)	11.796 (0.020)	13.243 (0.030)
	0.416	0.532	0.454	0.501
Wholesale Trade (n=277)	-310.123 (0.061)	-139.970 (0.005)	0.773 (0.063)	3.791 (0.088)
	0.352	0.411	0.393	0.466

(e) In precision machinery sector, WG enhance productivities both on sales and operating profit, but, in utility sector, exactly opposite results are recognized.

Sales per capita can regarded as a measure of employee's motivation, but operating profit doesn`t include wage. If a sign about operating profit is same as the sales, wage and profit of the enterprise are consistent. In utility sector, small WG motivate employees and enhance operational profit, so that small WG is optimal management policy. On the contrary, in machinery sector, large WG motivate employees and enhance operational profit, so that large WG is optimal management policy.

(f) In wholesale trade sector, WG reduce productivities on sales, but improve the profit.

It's possible to guess at influence to the amount of the wages by the wage gaps by comparing results about operating profit and the sales. If a sign about operating profit is different from that about sales, wage and profit of the enterprise are inconsistent and there is no WG policy beneficial for both employees and the enterprise. In wholesale trade sector, larger WG disappoint employees and enhance profit of the enterprise. One possible interpretation of this fact is that expansion of the WP and decrease of the total amount of wages have occurred at the same time. The sector where a sign about sales is plus and that about operating profit is minus could not be found in this analyses.

(g) As the reverse effect, both sales and profits have negative effects on WG. This can be conjectured by comparison between OLS results and 2SLS results.

This implies that improve of productivity reduces WG.

Table 4.3 shows insignificant results by linear model.

Table4.3 Analysis on some industries by linear model (1):OLS, (2)+ (3):2SLS (α_1 (p-value))
–insignificant cases-

α_1 (p-value)
Adj R^2

FP	Sales per capita		Operating profit per capita	
Model	(1) : OLS	(3)+(6):2SLS	(5) : OLS	(5)+(6):2SLS
IT (n=149)	-11.479 (0.381)	0.533 (0.761)	1.596 (0.107)	0.007 (0.212)
	0.342	0.394	0.355	0.392
Oil company (n=77)	-190.675 (0.645)	-28.079 (0.164)	1.863 (0.426)	0.577 (0.307)
	0.416	0.431	0.369	0.422
Electronic device (n=319)	0.113 (0.595)	-0.016 (0.628)	0.203 (0.757)	-0.101 (0.217)
	0.342	0.401	0.376	0.426
Food industry (n=98)	-261.306 (0.382)	-69.113 (0.201)	-7.989 (0.453)	-3.001 (0.451)
	0.390	0.402	0.402	0.441

Insignificant α_1 implies

(h) homogeneity of business of companies in each sector

(i) non-linearity between WG and productivity

From the viewpoint of (i), existence of optimal WG is examined by non-linear model analyses on insignificant sectors above and all industries depicted in table 4.1. Significant results in some sectors are shown in table 4.4. Estimated WG can be optimal point or worst point depending on sign of λ_2. If sign of λ_2 is minus, estimated WG maximizes productivity and can be interpreted as optimal WG. If

sign of λ_2 is plus, estimated WG minimizes productivity and can be interpreted as worst WG. Optimal or worst WG are calculated by

$\exp(-\lambda_1/(2\lambda_2))$

=(highest annual salary－lowest annual salary)/average salary(%) at the optimal WG

for easiness to interpret.

Table4.4 Analysis on some industries by non-linear model (5):OLS, (5)+(6):2SLS (λ_1 λ_2 (p-value)) –significant cases-

FP		Sales per capita		Operating profit per capita	
Model		(5):OLS	(5)+(6):2SLS	(5):OLS	(5)+(6):2SLS
All	λ_1	-25.280 (0.014)	-8.847 (0.000)	-1.080 (0.386)	-0.272 (0.095)
	λ_2	-3.296 (0.260)	46.405 (0.000)	-0.145 (0.532)	1.799 (0.014)
	Adj R^2	0.332	0.378	0.347	0.402
Optimal WG		2.160%		2.413%	
Worst WG			110.001%		107.853%
IT	λ_1	-18.57 (0.340)	-2.900 (0.076)	6.138 (0.042)	0.653 (0.092)
	λ_2	-5.69 (0.270)	-10.821 (0.102)	1.159 (0.154)	-6.288 (0.049)
	Adj R^2	0.382	0.424	0.375	0.452
Optimal WG		19.560%	87.459%		105.330%
Worst WG				7.079%	
Oil company	λ_1	-27.528 (0.068)	-1.18 (0.068)	-2.598 (0.098)	0.234 (0.098)
	λ_2	-4.287 (0.072)	-266.86 (0.072)	-0.477 (0.063)	-38.706 (0.000)
	Adj R^2	0.406	0.421	0.333	0.367
Optimal WG		4.033%	99.779%	6.566%	100.303%
Worst WG					

Based on results by 2SLS,

(j)Aggregately, existence of worst WG are confirmed.

Worst WG are larger than maximum WG as shown in table 4.5.

Table 4.5 Distribution of WG

Average	1.891%	Minimum	0.007%
Standard Deviation	3.861%	Maximum	78.453%

So it should be interpreted that down-sloping convex function by WG is confirmed on sales and profit. This gives almost the same implication as (a) from table 4.1. It is conjectured that corporations with smaller WG achieved high productivity and employees in Japanese company tend to prefer small WG on the average.

(k)In IT and Oil company industry, optimal WG exists around 100%. That is, Maximum – minimum wage should be around average wage of 30 years employees.

In a few industries like IT and Oil company, optimal WG are confirmed. But in these cases optimal WG is larger than maximum WG, so it should be interpreted that up-sloping concave function by WG are confirmed on sales and profit (diminishing returns).

(l) As the reverse effect, both sales and profits have negative effects on optimal (or worst) WG. This can be conjectured by comparison between OLS results and 2SLS results.

Table4.6 Analysis on some industries by non-linear model (5):OLS, (5)+(6):2SLS (λ_1 λ_2 (p-value)) –insignificant cases-

FP		Sales per capita		Operating profit per capita	
Model		(5):OLS	(5)+(6):2SLS	(5):OLS	(5)+(6):2SLS
Electronic	λ_1	-9.777 (0.138)	1.803 (0.117)	-0.776 (0.445)	-0.657 (0.168)

device	λ_2	-2.080 (0.525)	18.477 (0.103)	-0.009 (0.935)	0.878 (0.428)
	Adj R^2	0.382	0.446	0.416	0.476
Food industry	λ_1	-56.010 (0.343)	27.56 (0.121)	-3.201 (0.002)	-0.134 (0.682)
	λ_2	-9.23 (0.378)	27.44 (0.206)	-0.568 (0.013)	0.145 (0.786)
	Adj R^2	0.488	0.532	0.560	0.567

Insignificant λ_1 λ_2 implies

(m)homogeneity of business of companies in each sector

Electronic device (n=319) should be devided into more small and homogeneous groups

(n)Existence of other factors or other types of nonlinear model

5. Conclusion

This study examined the contribution on the productivity of the enterprise by the intra-company wage gaps as a measure of the performance-based wage systems and got some significant results and implications for management. In order to remove reverse effect by productivity on wage gap, instrumental variable methods are applied.

Analyses by linear model on all industries implied larger wage gaps do not motivate employees of Japanese companies. As different interpretation, expansion of wage cap caused by decrease of minimum wages disappoint employees. But this hypothesis will be examined in future research.

Existence of the optimal wage gap was examined by nonlinear models. As a result, the existence of the optimal wage gaps in IT and OIL industry and worst wage gaps in all industry are confirmed. But maximum wage gap are higher than optimal or worst wage gaps,this result should be interpreted as the reconfirmation of non-significant result by linear models. Concretely, effects by wage gaps on the productivity decrease, as wage gaps expand.

Discussion in this study assumes wage gaps can be adjusted flexibly, but actually, range of wage gaps that manager can adjust is not so wide. This point should be considered in future tasks in order to make effective proposal for managers.

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