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Very Preliminary

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Abstract: The purpose of this paper is to clarify whether there is a relationship between the labor productivity and the spread of five-day work week system in Japan by applying Data Envelope Analysis (DEA). Thus this paper gives another research field where we can use DEA to analyze the policy evaluation of local authorities. Our main findings are twofold: the five day system is more popular in the region where the economic activity is highly active and in such area the efficiency measured by DEA is also high, which means there is a negative correlation between the labor productivity and the number of annual working days.

JEL classification: J31, J81, J82, R10
Keywords: Data Envelope Analysis, five-day work week system, labor productivity, regional gap

A five-day work week system and labor productivity/efficiency

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1. Introduction

In 2012, Municipal Office of Nagasaki published the report that discussed about the work-life balance in Nagasaki area. It emphasized that shortening of working hours is necessary to improve the workers' welfare in Nagasaki area. According to the data released from Ministry of Internal Affairs and Communications quoted in that report, annual working hours of Nagasaki are about 1,400 hours, the longest across all prefectures in Japan.

There is the huge difference of approximately 200 hours between Nagasaki and Nara, where the working hours are shortest in Japan, and this is equivalent to 25 days (eight hours / day) a year, or one month in the labor days of Nagasaki. The report did not give the reasons in detail, but it implicitly suggested that the spread of five-day working week system is very behind in Nagasaki. In addition, in many prefectures in the metropolis area, a wage level is generally higher than Nagasaki, although working hours are relatively shorter (Fukaura (2012)). If so, workers in Nagasaki are to be inferior in quality as work force, in other words, their performance and productivity is low. However, judging from the general understanding that there are many cutting-edge companies and workers having an advanced technique mainly on manufacturing industry in Nagasaki, such reasoning seems to be strange. At all events, we can imagine that there are some kind of relation between labor productivity and the length of working hours. Furthermore, having taking into account the a wage in the metropolis and degree of the spread of five-day working week, we may assume the positive correlation between labor productivity and a five-day working week.

In this paper, we are going to confirm whether the significant relations exist between degree of the spread of five-day working week and the labor productivity. The paper is organized as follows. At first we state the current situation of a five-day working week system and confirm the more a five-day working week system spreads the more active the regional economy activity is. In other words, we try to know if the small working days are the necessary condition of the active economy in a region. Next, with that in mind, in order to have an index for labor efficiency, we conduct Data Envelope Analysis (DEA). Finally we examine the relation between the index of the labor efficiency and a five-day working week system.

2. A five-day work week system

A five-day work week system is one of the employment customs with five days on duty and 2 days off a week, normally on Saturday and Sunday. When this system was first introduced by Ford Corporation in the 1920s, by limiting working hours per week up to 40 hours, nevertheless 48 hours a week were common at that time. Originally it was intended to reduce production scale, with maintaining the employment under the global recession in those days. However, it became clear it improved the labor productivity because of the self-culture of the worker who took advantage of a holiday and security of the rest time. In addition, as the negotiation power of the labor union improved, the five days system spread more and more, which also contribute to improve the working conditions.

Introduction to Japan advanced in 1980s, when Japanese economy turned from a high growth era into the steady growth period, and toward the start of 21 century, workers, including a public servant or a public school teacher, who works under a five-day working week, grew very rapidly.

However, while the big companies having a lot of management skill could introduce the system easily, there were a lot of medium and small business that are forced to introduce it by a need for putting together for the shift of the big companies, or by a need for the compliance with laws and ordinances observance (because the legal working hours in the Labor Standards Law are 40 hours, then all forms have to set 5 days week if we assume labor for eight hours for five days on weekdays). In these cases, so-called "unpaid overtime" was caused in many occasions.

Generally speaking, there are some merits the five-day work week system has. Primarily and most importantly, an effect to the productivity is expected, by the rest days devoted to recover the work force. For example, (1) the morale improvement of workers, (2) improvement of efficiency of personnel management policy, (3) improving the fixation rate of workers, are expected. Second, there is an indication that suggests the improvement of the working situation/environment and this attracts the talented workers more easily. If this is the case, the labor productivity should rise as workers under five-day work week system are increased. On the contrary, one of the reasons of the less productivity could include a delay of the introduction of a five-day working week system.

Appended Table1 shows the ratio of worker working under five-day working week which is estimated from various sources about the working days for all prefectures but Okinawa. Here we define workers under complete five-day working week system as those whose annual working days are less than 250 days (19 a month day on average); therefore, workers who take 3 off-days in every two weeks are counted as workers more than 250 days. And, we calculated the difference between the ratio of workers with 250-300 days and those of less than 250days, and, for the analytical reason, and standardized and prioritized them.

The reason we set a cut-off line at 250days is we can observe a remarkable feature at that point. Figure 1 and Figure 2 below show high rank 10 areas (with a standardization index less than -1.2) and the low rank 11 areas (a standardization index greater than 1). Because each area's values are resembles closely, it is hard to tell individually, but we can say the distribution of workers less than 200 days does not change among all areas. Similarly, the ratios over 300 days are approximately equal.

Major difference occurs at the point of 200 days and 300 days. The shape of line is nearly flat in Figure 1, but in Figure 2 a clear peak exists at 250days. In addition, the prefectures shown in Figure 1 are areas where local economies are relatively active, on the other hand, the prefectures in Figure 2 are suffering a depressed regional economy. The degree of the regional economic activity should be understand multifactorial, but these two figures are enough to cause doubt that long working hours may not necessary bring about positive outcomes to the region. Kochi and Nagasaki are examples.

Figure 1 : distribution of the working days(high ranked prefecture)

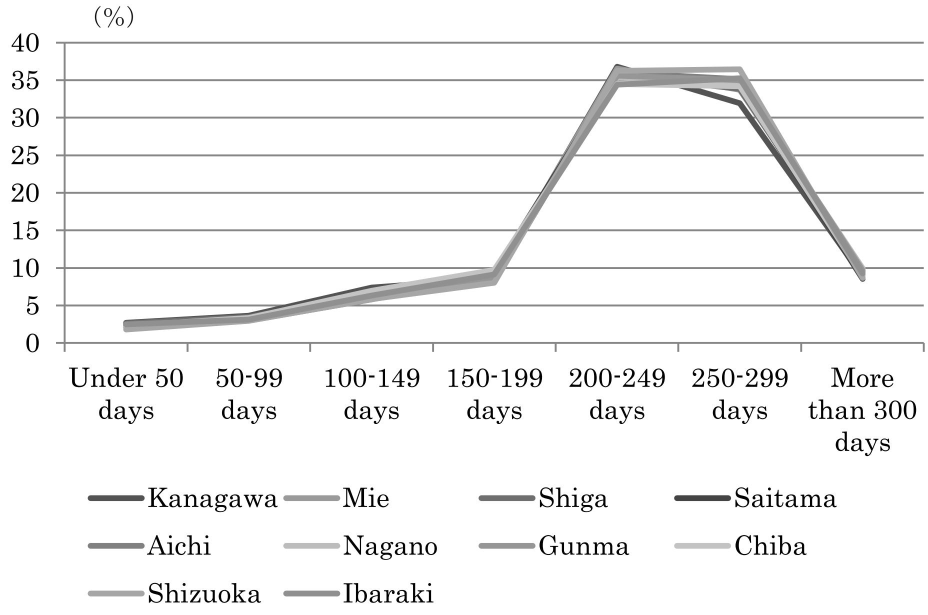
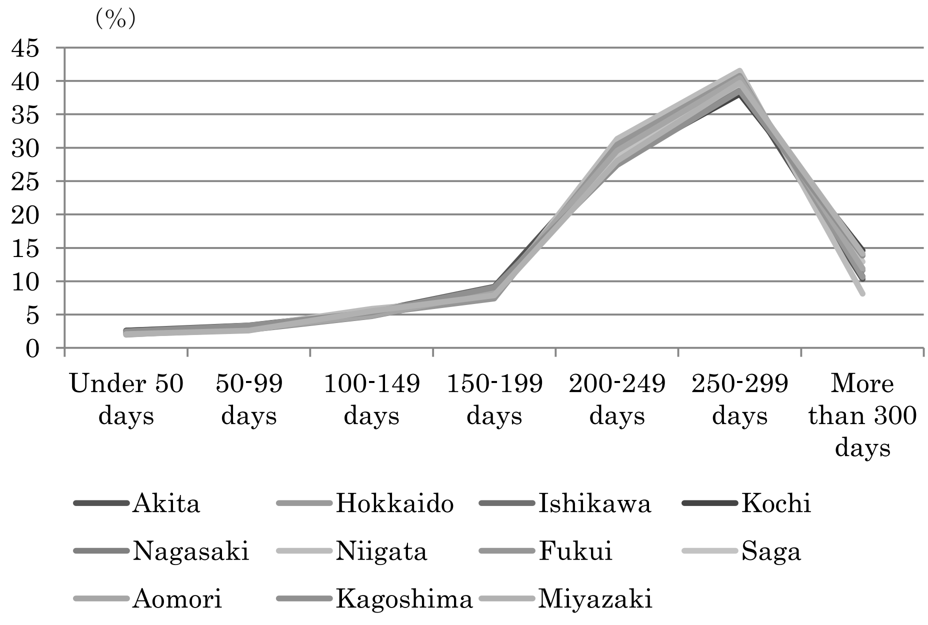


Figure 2: distribution of the working days (low ranked prefecture)



This fact induces us to assume, in the high ranked prefectures, labor input is materialized effectively and this enables the firms to accept a five-day working week system easily. As the results, it can be expected that the performance of labor input is inversely correlated with the numbers of working days, in other words, positively correlated with the degree of the introduction of a five-day working week system.

Under this hypothesis, we follow the next two steps in order to verify the relation between the labor efficiency and a five-day working week system. We will (1) derive the proper variables which reflect labor-input and its performance, and (2) apply DEA for those variables in order to measure the labor efficiency of each prefecture.

3. Variables

In DEA, we define the performance of the decision making units (DMU) just on a production-frontier as effectiveness = 1 and evaluate relative efficiency of other DMU by measuring how much they locate away from a frontier. In the case of single input, only one DMU exists on a production-frontier, but several DMUs may be located on the frontier when multiple-inputs are considered. In other words, in the case of a single input, the efficiency is defined quantitatively (size of the production for the input), but in the two input DEA, it can take into account the qualitative aspect, that is, the *combination* of inputs[1].

We chose the input and output variables as follows. At first, we applied the cluster analysis for the various kinds of variables and removed unsuitable variables for analysis sequentially. Needless to say, we removed the variables that depended linearly with each other (for example, per capita income and total income of the prefecture). Such procedures yielded three groups of the variables: (1) "wage & salary" "amount of deposits&savings" (demand deposit +time deposit) ,(2) "commuting time" "overtime working hours",(3) "vocational training costs" "prescribed working hours" . Furthermore, the second and the third groups can be integrated. Finally, variables were classified roughly in "wage & salary" "amount of deposits&savings" as the first group, and "commuting time" "overtime working hours" "vocational training costs" "prescribed working hours" as the second group.

Because the latter four variables express the hours devoted to work and the social investment for work force improvement, we do these with the input variable in DEA. On the other hand, output variables are "wage & salary" "amount of deposits&savings". They reflect respectively the flow and stock factor of the distributed value to labor input[2].

4. Results of DEA

4-1 D-efficiency

Appended Table 2 summarized the results. D-efficiency values are shown in a descending order and surplus, weight and reference DMU are also displayed. For reference, the five-day working week introduction index is also added[3]。9 prefectures are located on the production-frontier (D-efficiency=1). Three major urban areas, Tokyo,

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[1] Because DEA does not need any specific assumptions about the form of the production function it is effective when it is hard to assume the production function including the specific section in the firm analysis. But the assumption on the scale effect is needed. On the other hand, it is said that the probabilistic frontier analyses including the estimate of the parameter of the production function are suitable in the effectiveness evaluation for the whole industry. We performed the parametric analysis with the assumption of decreasing return.

[2] The source of data is as follows.
"wage & salary": Ministry of Health, Labor and Welfare *wage structure basics statistics survey*).
"Deposits&savings": Bank of Japan *"finance economic statistics monthly report."*
"commuting time", "prescribed working hour", "overtime working hours": Ministry of Internal Affairs and Communications *"basic survey of social living practices."*
"Vocational training costs": Ministry of Internal Affairs and Communications *"local finance statistical yearbook."*

[3] Because DMU'S economic activities is very large, so here we applied the Decreasing Return to Scale Model.

Osaka, and Nagoya are included here, and this would be a straightforward result because output is measured by the nominal value distributed to workers.

In addition, we can classify these prefectures in two groups about weight. The first includes Kanagawa, Tokyo, Aichi, Osaka, Nara, and Gifu, whose weights of the "wage & salary" are large, that is; the output in the sense of "flow" is significant. These areas are the advanced areas in applying 5-days work week system and strongly affected by the three major economic zone mentioned above. On the other hand, the second group is the group which the contribution of the "stock" is large (Mie, Nara, Tottori, Kagawa). Among this group, a five-day work week system is not so common, except Mie. It is worth to note that Tottori, Kagawa are peculiar.

On the result that Kagawa, Tottori are efficient, we have strong sense of incongruity when we consider the economic condition/environment of these two prefectures. It is thought that in Kagawa the amount of deposits&savings acted to raise an efficiency (Kagawa is the top prefecture as to the deposit&savings) and Overtime working hours does the same in Tottori where it is shortest. The effect of these variables appeared in excessively in DEA and strongly influenced the result[4]。

D-efficiency expresses how much the potential productivity of the input is realized, and we can know the cause of low efficiency by examining surplus. If surplus is big, then the production must be small, compare to the input level (or input is excess). For example, in Chiba, if all inputs are multiplied by 0.994 uniformly and decrease Overtime working hours by 2.53 hours, prescribed working hours by 22.9 hours and commuting time by 0.65 hours, then its D-efficiency rises to 1. Here we can say D-efficiency of the local prefectures is generally low, and the lowness of each Kyushu prefectures is outstanding (the 24th place of Fukuoka is the best in Kyusyu area, and three last are all Kyushu prefectures). Tohoku tends to be approximately similar.

4-2 Input and output

Next, we examine the character of input and output variables.

(1) Prescribed working hours

Prescribed working hours tend to be spent excessively in all prefectures, but especially in the high-ranked prefectures, it is longer than the low-ranked ones. In other words, we can maintain a present efficiency, with decreasing the working hours, that is, prescribed working hours works on the reduction of the efficiency. If the working hours are the disutility for workers and we assume the decreasing return of scale, this is a natural result.

However, weight of prescribed working hours is very high in Kanagawa, Aichi, and Mie. This means that prescribed working hours can give an effect to improve efficiency. This contradicts the above implication. It is unknown why it improves the efficiency in Kanagawa etc. One possible explanation is here; if the firms carry out the well-designed personnel management and the process control, the working hours may help improve the efficiency, even if they are long. Thus, an active introduction of such management know-how is helpful in the low ranked prefectures.

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[4] Weight is calculated as the optimal weight for each variable. The bigger weight is the higher the variable is evaluated for giving the output. It is not necessary for DEA to put a specific assumption about a form of production function, and it also has the advantage that analysis can be done with a few samples, but, on the other hand, there is the difficult point that a result depends on an abnormal value. Kagawa and Tottori may correspond here.

(2) Vocational training costs

The weight of vocational training costs is high in the metropolis prefectures with high efficiency, so it implies the employment policy works effectively in these prefectures. Generally, they are the high-density area and the job opportunity is abundant. Therefore, it can be expected that the "Hello Work Office" (job placement service office) functions well, that, in other words, economy of scale acts in the job placement or the vocational training.

There are four prefectures of Nagano, Hokkaido, Ehime, Kyoto that a relatively big surplus occurs as to vocational training costs (therefore, its weight is 0), and this suggests there is a room to reduce vocational training costs of these areas.

(3) Commuting time

The surplus of commuting time is observed in Chiba, Saitama, Shiga, and Tochigi. These prefectures are included in the commutable area to Tokyo, Osaka, and it very often needs over two hours to commute. Intuitively, the long commuting time is considered to exhaust the labor power and brings the less efficiency. However, the labor of these prefectures is very efficient in itself. That means a long commuting time and high efficiency are positively correlated with each other, and this contradicts our intuition.

We can explain this quiz as follows; in one aspect the long commuting time discourages workers, but we have to focus on the other side of commuting time. Actually, it is often reported that the self-study opportunity before arriving the office tends to become popular recently, for example, attending the career-up seminar, the cross industrial association and so on. This reminds us the side-effects of commuting time for improving the labor efficiency. We cannot deny the possibility that such an effect occurs.

On the other hand, in the low ranked prefectures, contributions of commuting time is large (i.e., its weight is large). By examining the original data, it can be easily found that commuting time of the low-ranked prefecture is short without exception. So we can imagine, because workers do not get tired in commuting, they can concentrate into their jobs, which buoys up the efficiency. This may be the very natural interpretation. However, commuting time is the only factor to contribute in Ehime, Yamagata, Yamanashi, Iwate, Fukushima, Aomori, Saga and Nagasaki (weight= 0). After all, advantage of the short commuting time is cancelled by other factors which jeopardies the efficiency, so it cannot help improve the total efficiency.

(4) Overtime working hours

A clear relation between Overtime working hours and the labor efficiency cannot be derived. But in many cases, in the area where weight is positive, it is the maximum weight among all inputs (e.g., Tokushima, Toyama). Because weight expresses a response to the efficiency-improvement when an input is decreased by one unit, decreasing overtime working hour will be the most effective way for efficiency improvement in Tokushima, Toyama.

All three inputs (prescribed working hour, commuting time, overtime working hours) are necessary hours for workers, but the derived results above show that length of these hours is not simply related to the efficiency. The question is how the firm manager can utilize prescribed working hour and commuting time, in other words, the personnel management and process control should be focused if we try to utilize the prescribed hours effectively, and on the same time, the manager needs to encourage workers to do a self-culture activity during commuting time.

However, such a relation was not seen in Overtime working hours. This makes us conclude a holiday attendance, for example, does not enhance workers' ability or labor will[5]。

(5) Output

As for three prefectures of Fukui, Shimane, Kochi, DEA results tell us wage&salary is low. For example in Kochi, the total wage bill can be increased to approximately 28 billion yen if inputs are used efficiently. However, in almost all prefectures, no surplus of wage&salary is detected. Therefore, to improve the labor efficiency, it should be done by the adjustment of the input, rather than the outputs.

As mentioned before, the stock side can be expressed by the deposits&savings and the flow side by the wage&salary, respectively. When we compare the both weights, they are Kanagawa, Aichi, Tokyo, Osaka, Gifu, Chiba and Saitama that weight of the wage & salary exceeds that of deposits&savings. This is the very natural result because the high wage level was evaluated substantially to improve D-efficiency[6].

4-3 Referenced prefectures

The Appended Table also shows the list of prefectures which refer the prefectures with D-efficiency=1. Kagawa is the most referred prefecture and Aichi is the next. But we have to remember Kagawa (and Tottori) strongly received huge influence of the data itself, then it is safe to say Aichi is the typical prefecture, in the sense that it is the model prefecture of the labor efficient area[7]。

When we remember there are many prefectures with surplus of vocational training costs, it follows that we should strengthen the employment policy more for Aichi. This is because the labor market is very tight in Aichi where manufacturing industry is in boom, the more intensive employment policy is needed to help the firms who demand the work force immediately. On the other hand, the employment policy helps the job applicants, too. From the view point of the job applicants, we are to devote a policy effort to the area where the labor resources have the less competitiveness. But such an implication, i.e., upbringing of long-term labor resources, does not come out of DEA directly because DEA is the method assuming the present labor market.

It is Hyogo, Tochigi, Ibaraki, Kyoto that refers Tokyo, and this is the clear evidence indicating their working condition is the metropolis type. Situation is similar about Osaka.

Kanagawa and Mie have some striking features and contrastive to Aichi. Both are top-ranked efficient prefectures but only one prefecture (Fukui) refers Kanagawa and Mie is referred by only two (Shiga, Ibaraki). That means that these are in a peculiar position among 46 prefectures. Or, graphically speaking, Kanagawa and Mie locate on

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[5] Of course Overtime working hours are paid more than prescribed hours financially. However, the increase of overtime hours may reflect the lack of the management ability of the firm. This may discourage workers in spite of higher financial compensation.

[6] All input data used in this DEA is about the men, but output data came from the local statistics which includes the female. Therefore, a notice must be paid to remember the contribution of the inputs may be overestimated. The reason we basically exclude the female labor from the analysis is because we did not take into account the difference of working types (e.g., part-time, or full-time). This is deeply related the female labor condition.

[7] Traditionally Kagawa has the strong ties with the Osaka economic zone, and, the economic/social unification with Honshu has been advancing by the Honshu-Shikoku Bridge. These factors nay contribute to the results, so the detailed examination must be done.

the production–frontier, but in the place very near of the axis of the input variables. It is not obvious from where this uniqueness comes. But, in both prefectures, because weights of prescribed working hours and vocational training costs balance relatively well, it may be able to say that the firm's effort to improve the labor-efficiency, including personnel management and the process control, and the employment policy are synchronizing relatively well.

5. Labor-efficiency and five-day working week system

Finally, we examine the relation between D-efficiency and degree of the spread of five-day working week system. If labor input is used more efficiently, it is thought that we can shorten the working days with keeping the output the same level. In order to verify this, a regression analysis was carried out, where the dependent variable is a five-day working week index (shown in Append Table 1) and the independent is D-efficiency.

The result was given in Table 1. If Nagasaki's D-efficiency is improved and becomes 1, a five-day working week index is decreased by 1.55(from 1.13 to -0.43). This is almost the same level of Miyagi. Workers who work more than 250 days are 47.46% in Miyagi and 53% in Nagasaki. Then, in Nagasaki, approximately 22,000 workers can enjoy a five-day working week newly (the male's working population is approximately 410,000[8]).

Table 1: regression analysis
(a dependent variable: Five-day working week index)

variables	Partial regression coefficient	Standard error	F-value	t- value	p-value
D-efficiency	-3.3068	0.9154	13.0484	-3.6123	0.0008
Constant	2.7543	0.7574	13.2242	3.6365	0.0007

(R^2= 0.228)

The results of the regression to per capita income are given in Table 2. According to the table, if D-efficiency is improved by 0.5, per capita prefecture income will rise around 700,000 yen. This corresponds to the gap between 2,940,000 yen, the average per capita income of the prefectures with D-efficiency=1 and 2,150,000 yen of Nagasaki with D-efficiency = 0.52.

Table 2: regression analysis
(a dependent variable: per capita income)

variables	Partial regression coefficient	Standard error	F-value	t- value	p-value
D-efficiency	1397.7896	318.3704	19.2761	4.3905	0.0001
Constant	1532.2477	263.4143	33.8360	5.8169	0.0000

(R^2= 0.340)

By integrating Table1, Table2 and DEA results, at the risk of oversimplification, the

8 Of course, this does not mean Miyagi is a model prefecture of Nagasaki, but just a numerical example.

following interpretation seems a fair generalization as a background of the introduction of a five-day working week system. If the firm use prescribed working hours efficiently and workers can utilize their commuting time as a self-culture opportunity, labor input yields output more effectively. This is reflected by wages primarily, and followed by the growth of the deposits&savings. These finally improve the prefecture income per capita. On the other hand, shortening of the working days lead to improvement of the working condition, and enhance an effect of the employment policy. This kind of good circulation, income and working environment, is an important key factor to boost up the whole regional economy.

Micro-economics teaches us a labor supply curve bends backwardly, as wages rise, through an income effect. If we can understand the spread of five-day working week system as a result of an income effect, then it is explicable theoretically that introduction of a five-day working week advances as per capita income and wages rise.

From the view point of the firm manager or human resource director it is critically important to understand how they connect working hours and commuting time to the labor efficiency effectively. In this sense, it is natural to say the grass-root-like management technique such as TQC and TQM are still important and effective, and "morning activities" (asa-katsu in Japanese new word, which means the self–culture activities before the duty hours), which has been getting to popular recently, is more likely to be a trigger for shortening of working hours. In this sense, an improvement of the motivation of worker oneself is another key factor. Conversely, in prefectures of Tohoku and Kyushu, because the personnel management and the self-culture activity are not so refined, a vicious circle that disturbs the effective use of working hours occurs, that is, a poor personal management and self-culture activity lead the long working hours followed by the low productivity.

Of course, this may the exaggerated picture. However, it is necessary for Tohoku, Kyushu prefectures with having low D-efficiency to promote the precise time management, but not to utilize Commuting time of workers because it is originally short. Rather, the firm managers should try to refine their time management method, and raise workers' concentration during a prescribed working hour.

Finally, for reference, we show Table 3 showing the results of regression of the minimum wage of 2011 to D-efficiency. We know from the table the minimum wage is high in the area where D-efficiency is high, and it will rise approximately 19 yen if D-efficiency is improved by 0.1. As the facts, the difference of the minimum wage between Nagasaki and Miyagi is 29 yen and the difference of D-efficiency is about 0.1.

However, the most impressive implication from Table 3 is the high correlation between the minimum wage and D-efficiency. The minimum wage is determined by considering many social factors as well as the economic ones, but the essential determinant must be a labor productivity of the area concerned[9].

Recently, Japanese government set a policy objective to make a minimum wage 800yen nation-widely in next few years. Improvement of the effectiveness necessary to achieve this goal can be calculated as shown in Appended Table 3, by using a result of Table 3. At a glance, it is absolutely impossible to realize 800yen, as far as economic reality is concerned.

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[9] According to Minimum Wage Law, the minimum wage must be determined in consideration of cost of living of the worker and ability to pay of the employer, and the consistency with other policy measures for the public assistance, in order to maintain the minimum standards of wholesome and cultured living. It is not allowed to decide minimum wage simply only by labor productivity. However, it will be clear that a minimum wage in defiance of labor productivity cannot be sustainable.

Table 3 regression analysis
(a dependent variable: Amount of 2011 minimum wage)

variables	Partial regression coefficient	Standard error	F-value	t- value	p-value
D-efficiency	190.6981	39.4764	23.3355	4.8307	0.0000
Constant	536.7003	32.6621	270.0068	16.431	0.0000

(R^2= 0.413)

6. Conclusion

D-efficiency is one possible index to measure the efficiency. However, considering the result of 0.529, D-efficiency of Nagasaki, it can be seen that the regional economy of Kyushu is facing the severe situation, as well as Tohoku area.

The following difficulties are left in this paper. At first, there is no easy way to measure the working condition quantitatively or numerically. The cultural and social factors like "a working style" must have an important influence on the use of the local labor resources, or commuting time. It is not easy to take such elements into the analysis directly, and what we should work on is to interpret the statistical results from the wide social point of view. Such an explanation was partial in this paper, and this may cause the biased results, in Kagawa and Tottori for example.

Second concern is about the input and output variables. If this is an analysis of the business organization’s activity, then such variables are relatively easily determined. Because we had no clear assumption about the DMU as mentioned earlier, we were forced to rely on the cluster analysis to find the possible variables, and this means the theoretical base of our variables was not so sound.

Furthermore, the physical productivity of the labor was not reflected. For example, it will be natural to suppose that the amount of factory shipment reflects the efficiency of labor input.

When some problems are left about the analysis technique, the overestimated results are provided or otherwise the underestimated. If our results are underestimated, it is expected that there would be a larger difference between areas. On the contrary, the difference is smaller if a result is emphasized excessively.

A problem may be settled by using more general DEA, but probably a more important point is to consider whether DEA is appropriate method as the analytical technique to meet an object of this paper. The prefectures we assumed as DMU here are the abstract units and do not mean the concrete decision making institutes such as a local authority or the central government office and so on. In this sense our prefectures are the *virtual* organizations. If we focus on the effectiveness of an employment policy, we should have referred the concrete decision making institutes such as the local labor bureau. In such a case, the meaning of the analysis could be clearer.

However, even if so, the labor productivity difference of Nagasaki and Tokyo is not a small so as to disappear in the short term. In this sense, this paper roughly supports the tough situation that a low-ranked prefectures face.

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Appended Table 1

Working days (per month)	~ 50 (4)	～ 99 (6)	～ 149 (10)	～ 199 (15)	～ 249 (19) *	～ 299 (23) **	300 ~ (25)	Weighted average	(**)－(*)	(**)－(*) Standardized index
Kanagawa	2.72	3.64	7.4	8.59	36.8	31.95	8.89	226	-4.85	-2.2631
Mie	2.3	3.18	5.94	8.79	36.55	33.73	9.5	230	-2.82	-1.8038
Shiga	2.64	3.47	6.52	8.23	35.65	33.85	9.64	229	-1.8	-1.5730
Saitama	2.39	3.27	6.51	9.4	35.68	34.2	8.55	228	-1.48	-1.5006
Aichi	2.25	3.03	6.03	8.56	36.01	35.12	9	231	-0.89	-1.3671
Nagano	2.25	3	5.87	9.04	35.34	34.55	9.94	231	-0.79	-1.3445
Gunma	2.07	3	5.83	8.85	35.61	34.99	9.65	231	-0.62	-1.3061
Chiba	2.33	3.36	6.98	9.75	34.48	34.19	8.91	228	-0.29	-1.2314
Shizuoka	1.81	2.94	5.85	8.04	36.23	36.45	8.69	232	0.22	-1.1160
Ibaraki	2.48	3.14	6.31	9.16	34.41	35.24	9.25	230	0.83	-0.9780
Tokyo	2.76	3.63	6.73	8.67	33.45	34.41	10.34	229	0.96	-0.9486
Hyogo	2.77	3.31	6.52	9.14	34.06	35.03	9.18	228	0.97	-0.9463
Tochigi	2.3	3.08	5.67	8.7	34.85	36.05	9.34	231	1.2	-0.8943
Yamanashi	2.48	3.52	6.25	8.91	32.69	34.57	11.57	231	1.88	-0.7404
Miyagi	2.28	2.77	5.62	8.25	33.62	36.98	10.48	233	3.36	-0.4056
Osaka	2.68	3.2	6.35	8.94	32.25	35.71	10.89	231	3.46	-0.3830
Kyoto	3.08	3.97	6.91	9.07	30.44	35.1	11.43	228	4.66	-0.1115
Nara	2.88	3.44	6.5	8.9	31.18	36.01	11.09	230	4.83	-0.0730
Yamaguchi	2.38	3.87	6.1	8.64	31.84	36.81	10.36	231	4.97	-0.0413
Shimane	2.99	3.52	5.99	7.71	32.36	37.53	9.9	231	5.17	0.0039
Hiroshima	2.73	3.32	6.27	8.15	31.85	37.58	10.1	231	5.73	0.1306
Gifu	2.24	3.03	6.06	8.6	31.78	37.86	10.43	233	6.08	0.2098
Toyama	2.25	3.16	4.97	7.28	32.98	39.41	9.94	235	6.43	0.2890
Oita	2.53	3.09	5.85	8.47	30.18	37.1	12.77	234	6.92	0.3999
Wakayama	2.11	3.03	5.9	8.45	30.74	37.81	11.94	234	7.07	0.4338
Fukuoka	2.28	3.16	6.18	8.44	30.9	38.03	11.02	233	7.13	0.4474
Fukushima	2.06	3.01	5.41	7.89	31.4	38.87	11.37	235	7.47	0.5243
Kumamoto	2.38	2.95	5.22	8.32	29.44	37.58	14.11	236	8.14	0.6759
Okayama	2.68	3.05	5.6	7.95	31.21	39.4	10.11	233	8.19	0.6872
Yamagata	2.07	2.88	5.1	7.35	31.46	39.73	11.41	237	8.27	0.7053
Tottori	2.3	3.31	5.51	6.89	31.24	39.6	11.16	235	8.36	0.7257
Tokushima	2.76	3.31	5.69	8.17	29.08	37.7	13.3	234	8.62	0.7845
Iwate	2.52	3.6	5.61	8.21	30.15	39.13	10.77	233	8.98	0.8659
Ehime	2.15	3.08	5.55	7.96	29.91	39.07	12.29	236	9.16	0.9066

Kagawa	2.27	2.65	4.84	7.72	31.08	40.46	10.98	237	9.38	0.9564
Akita	2.6	3.36	5.43	9.19	29.67	39.4	10.35	233	9.73	1.0356
Hokkaido	2.01	2.95	5.71	8.07	29.92	39.72	11.63	236	9.8	1.0514
Ishikawa	2.34	2.99	5.28	7.53	30.65	40.5	10.7	236	9.85	1.0628
Kochi	2.59	3.2	5.39	8.25	27.91	38.05	14.61	236	10.14	1.1284
Nagasaki	2.26	2.72	4.77	8.38	28.87	39.05	13.95	238	10.18	1.1374
Niigata	2.41	3.19	5.85	7.55	31.31	41.54	8.14	233	10.23	1.1487
Fukui	2.23	3.39	5.12	7.4	30.44	40.78	10.63	236	10.34	1.1736
Saga	2.04	2.72	5.23	8.66	28.88	39.55	12.93	237	10.67	1.2483
Aomori	2.04	2.82	4.8	8.43	29.56	40.45	11.89	237	10.89	1.2981
Kagoshima	2.5	3.35	5.34	9.06	27.39	38.54	13.82	235	11.15	1.3569
Miyazaki	2.08	2.62	5.54	7.87	28.03	39.73	14.14	238	11.7	1.4813
All	2.48	3.29	6.22	8.71	32.97	35.95	10.38	231	2.98	0

Note 1: Data from the Employment Status Survey(2007)

Note 2: an average of the working days in parenthesis

Note 3: The ratio(%) of the worker who work in each annual working days

Note 4: "(**)-(*)" is a difference of "... 299 days" and "~249 day"

Appended Table 2（result s of DEA）

prefecture	D-efficiency	Index of (**)－(*)	slacks					
			Prescribed working hours	Vocational training cost	Commuting time	Excess working hours	Deposit & savings	Wage & salary
Kanagawa	1	-2.2631	0	0	0	0	0	0
Mie	1	-1.8038	0	0	0	0	0	0
Aichi	1	-1.3671	0	0	0	0	0	0
Tokyo	1	-0.9485	0	0	0	0	0	0
Osaka	1	-0.3829	0	0	0	0	0	0
Nara	1	-0.0730	0	0	0	0	0	0
Gifu	1	-0.2098	0	0	0	0	0	0
Tottori	1	0.7256	0	0	0	0	0	0
Kagawa	1	0.9564	0	0	0	0	0	0
Chiba	0.994	-1.2314	22.97422	0	0.658555	2.530304	0	0
Shizuoka	0.979	-1.1160	17.40502	0.596316	0	1.775696	0	0
Fukui	0.959	1.1735	23.95509	0.06402	0	0.933971	0	0.02101
Tokushima	0.955	0.7844	0	0.150423	0	0	0	0
Saitama	0.944	-1.5006	0.39395	0	0.552599	0.790293	0.867849	0

Nagano	0.921	-1.3445	17.99719	1.008675	0	0.301422	0	0
Niigata	0.901	1.1487	21.93064	0.430165	0	0	0	0
Hokkaido	0.889	1.0514	41.25623	3.05774	0	0.507024	0	0
Ishikawa	0.865	1.0627	17.12201	0.254748	0	0	0	0
Shiga	0.854	-1.5730	0	0	0.034296	1.695182	0	0
Okayama	0.848	0.6871	10.03752	0	0	1.332303	0	0
Shimane	0.828	0.0039	22.66179	0.470058	0	1.133089	0	0.065822
Toyama	0.827	0.2889	9.089782	0	0	0	0	0
Hyogo	0.821	-0.9463	0	0	0	0.579107	0	0
Hiroshima	0.819	0.1306	0	0.512545	0	0.963068	0	0
Ehime	0.81	0.9066	29.05415	8.053482	0	2.404048	0	0
Yamagata	0.809	0.7052	39.53737	0.693478	0	2.543331	0	0
Yamanashi	0.786	-0.7404	7.88032	0.339149	0	0.668951	0	0
Tochigi	0.775	-0.8942	0	0	0.000559	0	0	0
Kochi	0.765	1.1283	24.29512	0.159769	0	2.113494	0	0.028159
Gunma	0.764	-1.3066	3.113853	0	0	2.921303	0	0
Ibaraki	0.764	-0.9779	0	0	0	0.559086	0	0
Fukuoka	0.731	0.4473	1.077987	0.627738	0	0	0	0
Kyoto	0.726	-0.1114	0	7.497135	0	0	0	0
Yamaguchi	0.72	-0.0413	1.147684	0.154405	0	0	0	0
Wakayama	0.719	0.4337	0	0	0	0	0	0
Oita	0.673	0.3998	8.905946	0.31647	0	0	0	0
Iwate	0.672	0.8659	13.28332	0.619057	0	0.983537	0	0
Fukushima	0.659	0.5242	12.83927	0.272323	0	1.383823	0	0
Miyagi	0.622	-0.4055	13.35974	0.269886	0	0	0	0
Akita	0.601	1.0356	7.643447	0.127162	0	0	0	0
Kumamoto	0.6	0.6758	10.0236	0.307963	0	1.175888	0	0
Saga	0.592	1.2482	11.72803	0	0	0.867869	0	0
Aomori	0.586	1.2980	21.2377	0.275197	0	0.446087	0	0
Kagoshima	0.583	1.3568	18.4754	0.142688	0	0	0	0
Miyazaki	0.566	1.4813	19.98472	0.053634	0	1.480189	0	0
Nagasaki	0.529	1.1378	1.121641	0.209052	0	0.320418	0	0

Appended Table 2(continued)

prefecture	weights					
	Prescribed working hours	Vocational training cost	Commuting time	Excess working hours	Deposit & savings	Wage & salary
Kanagawa	0.3373	0.662689	0	0	0	1

Mie	0.4526	0.547389	0	0	0.710092	0.289908
Aichi	0.452	0.548048	0	0	0	1
Tokyo	1	0	0	0	0	1
Osaka	0	0.659098	0	0.340902	0	1
Nara	0	0.515996	0	0.484004	0.714466	0.285534
Gifu	0	1	0	0	0.17282	0.82718
Tottori	0	0	0	1	1	0
Kagawa	0	1	0	0	0.862583	0.137417
Chiba	0	1	0	0	0.053994	0.939906
Shizuoka	0	0	1	0	0.744801	0.234058
Fukui	0	0	1	0	0.959213	0
Tokushima	0.182	0	0.006825	0.811176	0.951091	0.003903
Saitama	0	1	0	0	0	0.944284
Nagano	0	0	1	0	0.788725	0.131948
Niigata	0	0	0.384784	0.615216	0.790832	0.109755
Hokkaido	0	0	1	0	0.578434	0.310588
Ishikawa	0	0	0.339615	0.660385	0.817778	0.047358
Shiga	0.9639	0.036105	0	0	0.817866	0.036224
Okayama	0	0.620088	0.379912	0	0.494734	0.353253
Shimane	0	0	1	0	0.828027	0
Toyama	0	0.420402	0.030914	0.548684	0.6424	0.184944
Hyogo	0.9385	0.035792	0.025742	0	0.718193	0.102431
Hiroshima	0.8845	0	0.115451	0	0.757571	0.061109
Ehime	0	0	1	0	0.733693	0.075959
Yamagata	0	0	1	0	0.731693	0.077539
Yamanashi	0	0	1	0	0.734908	0.050621
Tochigi	0.3257	0.055077	0	0.619233	0.696353	0.078489
Kochi	0	0	1	0	0.764884	0
Gunma	0	0.649202	0.350798	0	0.430817	0.332762
Ibaraki	0.9578	0.019495	0.022728	0	0.711062	0.053354
Fukuoka	0	0	0.436417	0.563583	0.535795	0.195365
Kyoto	0.1598	0	0.009245	0.830952	0.711995	0.014342
Yamaguchi	0	0	0.369969	0.630031	0.661878	0.05815
Wakayama	0.11	0.024042	0.015719	0.850259	0.69337	0.025435
Oita	0	0	0.373788	0.626212	0.6239	0.048647
Iwate	0	0	1	0	0.604016	0.068345
Fukushima	0	0	1	0	0.548872	0.110559
Miyagi	0	0	0.380051	0.619949	0.522529	0.099906
Akita	0	0	0.367397	0.632603	0.566598	0.034775

Kumamoto	0	0	1	0	0.512524	0.087216
Saga	0	0.558586	0.441414	0	0.420169	0.171542
Aomori	0	0	1	0	0.511823	0.074651
Kagoshima	0	0	0.390215	0.609785	0.516733	0.065861
Miyazaki	0	0	1	0	0.509067	0.056759
Nagasaki	0	0	1	0	0.468848	0.059824

Appended Table2(continued, reference sets)

prefecture	Kana-gawa	Mie	Aichi	Tokyo	Nara	Osaka	Gifu	Tottori	Kagawa
Chiba			■				■		
Shizuoka			■						■
Fukui		■							■
Tokushima								■	■
Saitama			■						
Nagano			■						■
Niigata			■						■
Hokkaido			■						
Ishikawa									■
Shiga	■								■
Okayama			■				■		
Shimane									■
Toyama					■		■		■
Hyogo				■	■			■	
Hiroshima			■						■
Ehime									■
Yamagata									■
Yamanashi									■
Tochigi				■		■			
Kochi									■
Gunma			■						■
Ibaraki	■			■					
Fukuoka			■			■			
Kyoto				■	■				
Yamaguchi						■			■
Wakayama						■		■	
Oita						■			■
Iwate									■
Fukushima			■						■

Miyagi									
Akita									
Kumamoto									
Saga									
Aomori									
Kagoshima									
Miyazaki									
Nagasaki									
total	2	1	13	4	3	6	4	3	27

AppendenTable3　Efficiency improvement required to realize 800 yen

prefecture	Minimum wage(2011)	Improvement required	prefecture	Minimum wage(2011)	Improvement required
Hokkaido	705	0.500	Mie	717	0.437
Aomori	647	0.805	Shiga	709	0.479
Iwate	645	0.816	Kyoto	751	0.258
Miyagi	675	0.658	Osaka	786	0.074
Akita	647	0.805	Hyogo	739	0.321
Yamagata	647	0.805	Nara	693	0.563
Fukushima	658	0.747	Wakayama	685	0.605
Ibaraki	692	0.568	Tottori	646	0.811
Tochigi	700	0.526	Shimane	646	0.811
Gunma	690	0.579	Okayama	685	0.605
Saitama	759	0.216	Hiroshima	710	0.474
Chiba	748	0.274	Yamaguchi	684	0.611
Tokyo	837	－0.195	Tokushima	647	0.805
Kanagawa	836	－0.189	Kagawa	667	0.700
Niigata	683	0.616	Ehime	647	0.805
Toyama	692	0.568	Kochi	645	0.816
Ishikawa	687	0.595	Fukuoka	695	0.553
Fukui	684	0.611	Saga	646	0.811
Yamanashi	690	0.579	Nagasaki	646	0.811
Nagano	694	0.558	Kumamoto	647	0.805
Gifu	707	0.489	Oita	647	0.805
Shizuoka	728	0.379	Miyazaki	646	0.811
Aichi	750	0.263	Kagoshima	647	0.805