Administrative efficiency of National University Corporations in Japan

A DEA and SFA analysis

1 Introduction

In 2004 the Japanese higher education system experienced the biggest transformation since the Second World War. The government decided to relinquish direct control over national universities by incorporating them, resulting in significant administrative independence and increased flexibility. This was marketed as a significant step towards institution independence but expert opinion was mixed to say the least (see for example (Chan-Tiberghien 2006) or (Yamamoto 2004)).

The main goal of this paper is to see whether administrative efficiency improved after the reform. The initial expectation is increased efficiency since one of the tools of the reform had been an increased autonomy in matters relating to personnel. Based on data published by the universities from 2004 to 2009, I use DEA, stochastic frontier (SFA) estimation and a method that is a mix of the two to examine the public higher education sector as a whole (86 institutions). These performance estimations can be used for three purposes: to provide an estimation of the relative inefficiency of the institutions, to observe the changes in average efficiency year by year and to provide ranking between the universities. Accordingly, performance estimations are used to estimate general relative yearly efficiency and with the help of OLS estimation the efficiency scores are regressed for environmental factors. Second, a ranking is made based on each estimation method and the 10 best and the 10 worst performing institutions are selected and examined with the help of a number of indicators.

All three DEA estimation results indicate that there was indeed an efficiency increase although the magnitude of the change varies from 4% to 21% depending on different DEA models used. The average yearly value for inefficiency was similarly ranging from 11% to almost 50%. According to the BCC DEA results the ratio of institutions that managed a positive change in efficiency were 70% from 2004 to 2005 and after dropping close to 50% it steadily climbs back to more than 90%. This suggests yearly improvement and also the fact that 'learning by doing' is happening while admittedly it does not account for external factors. The two staged DEA results, where the indicators were stripped of certain environmental factors, consistently show much lower performance. The results for the SFA estimations are even less favorable for the universities. Out of the 3 regressions, in one case the average efficiency for the last year was below the starting value, one had minor improvement while only in one case did it increase significantly. In the two latter cases most of the increase happened in the first two years followed by stagnation or even a slight decline. OLS regression shows that institution type has a high impact on efficiency. The same can be told to a lesser degree about the size of the university.

In the following, I give a brief outline about university efficiency and the 2004 Japanese higher education reform. In chapter 2 there is a brief introduction to the methodology behind this paper's analysis while chapter 3 summarizes previous research for the topics in this paper. Chapter 4 is where I define the data used later on and chapter 5 shows the results of the frontier estimations. Individual universities get a closer look in chapter 6 and the paper ends with a conclusion in chapter 7.

1.1 Performance measurement at universities

Performance evaluation is not easy when talking about institutions with qualitative inputs and/or outputs. Higher Education Institutions (HEI) are a good example since they are usually grouped together as 'universities' even though they have different goals and different outputs that make most performance comparisons of little value or of debatable accuracy. Obviously there is great difference between institutions producing doctors or economists. Just because the output in both cases is an individual who is (hopefully) ready for the labor market, the equipment, the processes and the costs of training are much different. Or we might think about research output; how to decide which publication is worth more? In some fields, publications are relevant for a longer time; do these worth more?. Multiple methods have been tried to quantify outputs such as these, for example by using cost differentials for different trainings or using the impact factor of scientific journals. This does not change the fact that there are certain things that are not necessarily statistically comparable. Regarding policy work, another problem we encounter (if we ignore the above and say reach a meaningful conclusion) is that most universities are traditionally autonomous places when it comes to teaching and research. Any sweeping changes based on performance measurements will face opposition and resistance from the research and the teaching staff. that. In my personal experience, professors do not take kindly to supposedly performance enhancing interference to their work[1] thus making any changes slow and time consuming.

There is however one aspect of the university sector where I believe comparisons can prove meaningful and might also have a positive effect: administrative and management costs. All universities share certain functions that are performed by the administrative staff: student

[1] A personal example to illustrate the above: While participating in an audit of a veterinary university the dean said that it had proven impossible to close labs. You cannot argue with a professor that a certain laboratory is superfluous. Being the foremost experts, if they say that the lab in question is different, then it is. The professor in question was a member of the Hungarian Academy of Sciences, not exactly a person you might challenge on his field of expertise.

assistance, international relations, secretarial functions, security, maintenance etc. These services are provided by people I will refer to here on as administrative staff (admin staff or employees). Using this dimension of HEI performance as basis for comparison has multiple advantages: administrative staff are arguably not directly responsible for the qualitative outputs that a HEI produces, they share the same tasks across all institution types and as an added advantage they are easier targets for performance increasing reforms because they represent a much less powerful inter-institutional lobby than the teaching and the research staff. This last point is not something new, most universities start every belt-tightening program with the administrative staff so it can be argued that in most universities that must improve efficiency (narrowly defined in this case as financial efficiency) these functions are already on a shoestring[2]. I however do not think that this is the case in Japan, at least not yet.

The above makes administrative efficiency a possible candidate for quantitative analysis. Since absolute efficiency measurement is a mirage we are interested in the best relative performers. Frontier methods could be used to define them and rank the HEIs. A possible next step that is beyond the scope of this work, but would prove an extremely useful practical research is to define the best-practices of the industry; providing a framework of reference regarding institutional performance.

1.2 The Japanese Reform of 2004

In Japan, the biggest change in the higher education sector for a long time has been the university incorporation reform of 2004. This reform had the following goals (NIAD-UE Website n.d.):

- Quality Improvement of Education and Reforms
- Increasing Contributions to Society
- Creating World Class Universities

To be reached through (NIAD-UE Website n.d.):

- Greater Authority over Operation
- Flexible Personnel Systems
- Unique Practices in Education and Research
- Cooperation with Private Companies

The most important effect of the reform regarding the topic of this paper is the fact that the universities were separated from the Ministry of Education and received considerable autonomy in fiscal and personnel matters. For example, before the reform, administrative staff of

[2] Real life experience underlines this reasoning in Hungary. The same reasoning is also true for the health care sector in Hungary. Constantly funding starved, the number of nurses are very low.

universities were public employees delegated by the ministry and selected through central examinations. The reform canceled the public status of these employees and provided bigger flexibility for HR managers.

Regarding this research topic I would expect the above to have 2 separate effects on the administrative costs and efficiency of the National Universities:

- The increased flexibility of HR management will probably have a beneficial effect on efficiency. This is reached through wage negotiations and decentralized employee selection.
- Increased administrative workload will probably reduce efficiency by increasing costs. Also new processes are implemented, making the administration work on previously unnecessary things.

Since these effect are in opposite, it is difficult to tell in advance which effect will dominate the other. However I expect the second to diminish over time as HEIs become familiar with the new processes and implement the necessary protocols to handle them. This means that in the end I expect increasing average efficiency.

2 Efficiency measurement through DEA and SFA

Efficiency measurement is different from general estimation because instead of average change we are interested in the performance of the best performer and the relative performance of other institutions that are less efficient. This is done through projecting a so-called efficiency frontier, a set of points that contains the maximum amount of possible outputs for a certain amount of inputs (or vice versa, this can be turned on its head to mean the least amount of inputs for given output). This way we get a surface that defines the best performer, "enveloping" the others. Therefore the names: frontier methods and data envelopment analysis.

Frontier methods can be classified into two big groups: parametric (stochastic frontier analysis: SFA) and non-parametric (data envelopment analysis: DEA). The difference lies in the fact that non-parametric methods do not need a functional form to be set in advance for estimation. Both approaches have advantages and disadvantages. DEA is calculated through linear programming, it natively handles multiple outputs, can be used when the sample size is small and it weights the variables automatically. At the same time it does not take statistical “noise” into account (all deviations from the efficiency frontier are because of inefficiency) and does not work with panel data very well (although there are certain ways to examine improvement over time, one that is used in this paper). SFA is an econometric method that is estimated based on a predefined functional form that accounts for statistical inaccuracies. The problem is that it generally takes only one output and a larger sample is needed to reach a statistically reliable estimation. Since we have 6 years of data for 86 universities, this is not a problem in this case.

In this paper I will perform analysis using both of these methods, a combination of them, compare the results and then try to define the factors that contribute to administrative efficiency improvement or deterioration. First however I would like to introduce the mathematical and statistical basis behind the two techniques.

2.1 DEA

Data Envelopment Analysis defines efficiency in (Cooper, Seiford & Tone 2007) as

$$\frac{\text{Output}}{\text{Input}}$$

namely for university i,

$$U_i = \frac{\sum_{r=1}^{n} u_r * y_{ri}}{\sum_{p=1}^{m} v_p * x_{pi}}$$

since we are looking for a measure that is between 0 and 1, we make the above subject to

$$\frac{\sum_{r=1}^{n} u_r * y_{ri}}{\sum_{p=1}^{m} v_p * x_{pi}} \leq 1 \qquad i = 1, \ldots, k$$

where,

- y_{ri} is the quantity for output r for university i
- u_r is the attached weight to output r , r > 0, r = 1, …., n
- x_{ri} is the quantity for input p for university i
- v_r is the attached weight to input p , p > 0, p = 1, …., n

The linear program for the optimization is

$$\text{minimize: } U_i = Z$$

s.t.

$$\sum_{i=1}^{k} x_{pi} * \lambda_i \leq x_{pi} Z \qquad i = 1, \ldots., k$$

$$\sum_{i=1}^{k} y_{ri} * \lambda_i \geq y_{ri} \qquad i = 1, \ldots., k$$

where

$\lambda_i \geq 0, \; i = 1, \ldots., k$

λ_i represent weights for a composite unit that is maximally efficient.

For variable return to scale we also append the following constraint:

$$\sum_{i=0}^{k} \lambda_i = 1$$

This will provide a number between 0 and 1 that describes the distance from the origin (0) to the efficiency frontier (1). There are numerous variations on the above program but the basic idea is the same.

2.2 SFA

Stochastic frontier Analysis is a parametric econometric method that uses the production (cost) function to estimate inefficiency. The basic idea can be explained in the following way (according to Kumbhakar and Lovell (Kumbhakar & Lovell 2000) with slight modifications because of the statistical software estimation method (StataCorp 2009)):

First, the cost frontier is represented by the following equation

$$E_i \geq c(y_i, w_i; \beta)$$

where $E_i = w_i^T x_i = \sum_n w_{ni} x_{ni}$, is the total cost for producer i, since x_i is a k*1 matrix that is the amount of inputs, w_i is a matrix representing input prices, y_i is the output, and β is the technology parameter vector, making $c(y_i, w_i; \beta)$ the best achievable cost function (the cost frontier). Cost efficiency for producer i (CE_i) can be written

$$CE_i = \frac{c(y_i, w_i; \beta)}{E_i}$$

that is the minimum achievable cost divided by the actual cost. The problem with this is that all divergence from the optimal value will be attributed to inefficiency and no room is left for statistical "noise". If we add an error component, the stochastic cost frontier can be written as

$$E_i \geq c(y_i, w_i; \beta) * \exp\{v_i\}$$

where $c(y_i, w_i; \beta)$ is still a deterministic cost function that is shared by all producers and $\exp\{v_i\}$ is the term representing random shocks. Stochastic efficiency will be as follows

$$CE_i = \frac{c(y_i, w_i; \beta) * \exp\{v_i\}}{E_i}$$

Through transformation we get

$$\ln E_i \; \geq \; \beta_0 + \; \beta_y \ln y_i + \sum_n \beta_n \ln w_{ni} + v_i$$

$$= \beta_0 + \; \beta_y \ln y_i + \sum_n \beta_n \ln w_{ni} + v_i + u_i$$

Thus the error term has been deconstructed to two separate terms: v_i for the random "noise" and u_i for cost inefficiency. Unit cost efficiency will be

$$CE_i = \exp\{-u\}$$

The following conditions must hold:

$$u_i \sim \text{iid } N^+ (\mu, \sigma_u^2)$$

$$v_i \sim \text{iid } N (0, \sigma_v^2)$$

v_i and u_i are independently distributed to the regressors and to each other.

The problems of endogeneity and strong assumptions can be handled by panel data estimation (Kumbhakar & Lovell 2000).

Since there is a possibility that changes can be made to the efficiency of a certain institution, the analysis will use the time-varying decay model where (StataCorp 2009):

$$u_{it} = \exp\{-\eta(t - T_i)\}u_i$$

$$u_i \sim \text{iid } N^+(\mu, \sigma_u^2)$$

If $\eta > 0$ inefficiency has decreased, if $\eta < 0$, it has increased.

2.3 DEA and SFA combined

Cooper *et al.* in their comprehensive work propose a method built on the article by Fried *et al.* that uses a mixed DEA and SFA framework to separate external noise and effects for DEA estimation (Cooper, Seiford & Tone 2007) (Fried et al. 2002).

2.3.1 First Stage DEA

Start with a DEA analysis. Use the Slack Based Measures (SBM) approach to estimate input or output slacks. The main difference between the DEA program used in chapter 2.1 is the non-radial assumption. Radial measures are supposed to change proportionally. If this is not the case then a non-radial model is more appropriate.

The system of equations that are used are the following (Cooper, Seiford & Tone 2007)(page 101):

$$(\text{SBMt}) \qquad \max t, \lambda, s^-, s^+ \qquad \tau = t - \frac{1}{m}\sum_{i=1}^{m}\frac{ts_i^-}{x_{io}}$$

Subject to

$$1 = t + \frac{1}{s}\sum_{r=1}^{s}\frac{ts_r^+}{y_{ro}}$$

$$x_o = X\lambda + s^-$$

$$y_o = Y\lambda - s^+$$

Where $\lambda \geq 0, s^- \geq 0, s^+ \geq 0$ and $t > 0$. s are inefficiency measures and t is a positive scalar variable.

We set $S^- = ts^-, S^+ = ts^+$ and $\Lambda = t\lambda$

The linear program to be solved is the following

$$\tau = t - \frac{1}{m}\sum_{i=1}^{m}\frac{S^-}{x_{io}}$$

Subject to

$$1 = t + \frac{1}{s}\sum_{r=1}^{s}\frac{S^+}{y_{ro}}$$

$$tx_o = X\Lambda + S^-$$
$$ty_o = Y\Lambda - S^+$$

Where $\Lambda \geq 0, S^- \geq 0, S^+ \geq 0$ and $t > 0$
This is enough for finding the optimal solution.

With this method we get the slack measures for each input (or output in an outcome based model). The slack measures are the amounts of input that are unnecessary for reaching the efficiency frontier. A simple example: There are 2 firms A and B with one type of input and output each. Firm A produces 5 pieces of output with 2 pieces of inputs, while firm B produces the same output with 3 inputs. After SBM estimation the slack measure will be 1 input, meaning that firm B is using 1 more input that the best performer.

2.3.2 Second Stage SFA

We have the efficiency scores and the slacks but the random shock and noise is still unaccounted for. We use SFA analysis to separate efficiency and external effects in the regression. We write the slacks (inefficiency effect) as a combination of environmental factors, random shocks and real inefficiency:

$$\frac{s_r^{+*}}{y_{ri}} = \frac{\hat{s}_r^+}{\hat{y}_{ri}} + f(en) + v \qquad r = 1, \dots\dots, s$$

where $\frac{s_r^+}{y_{ri}}$ is the observed inefficiency measure, $\frac{\hat{s}_r^+}{\hat{y}_{ri}}$is the real inefficiency, $f(en)$is the function of environmental effects and v is the statistical noise term for each input r.
For the estimation we use the Cobb-Douglas function that will make the functional form the following

$$\frac{s_{rjt}^+}{y_{rjt}} = \beta_{ri} + \sum_{k=1}^{k} \beta_{rk} \ln Z_{kjt} + v_{rjt} + u_{rjt} \qquad r = 1, \dots\dots, s$$

where j is the cross section identifier, t is the time identifier, β_{ri} is the intercept, Z is a matrix that contains the environmental factors, v_{rjt} stands for random shocks and u_{rjt} is the actual inefficiency ($\frac{\hat{s}_r^+}{\hat{y}_{ri}}$). Thus we get the value for $\frac{\hat{s}_r^+}{\hat{y}_{ri}}$ through the SFA regression. Using this value we redefine the input variables as the following

$$y_{rjt}^a = y_{rjt}\left(1 + \beta_{ri} + \sum_{k=1}^{k} \beta_{rk} \ln Z_{kjt} + v_{rjt} \right)$$

or

$$y_{rjt}^a = y_{rjt}\left(1 + \frac{s_{rjt}^{+*}}{y_{rjt}} - u_{rjt} \right)$$

We end up with the same input variables that were cleaned of random shocks and environmental effects.

2.3.3 Third Stage DEA

Last, we rerun the DEA program of the first stage with y^{a}_{rjt} as the input variable instead of the observed y_{rjt} and this way we eliminated (hopefully) most of the environmental bias and external shocks.

3 Previous Research

3.1 Administrative costs at Universities

Cost efficiency at universities is certainly not a new topic for analysis. Since the higher education boom of the 1960s significantly raised the number of students, it was argued that the traditional structure of conservative consensual committee management style that characterized the institutions was untenable. At the same time, there always was a very significant push-back at universities that asserted the inapplicability of modern management structures for university governance. As early as 1964, people noticed the interesting ambivalence of the fact, that while universities were on the cutting edge of research and innovation, the teaching and research staff thought of themselves and the university system as an exception to the rules they investigated (Rourke & Brooks 1964). In time, with the changing fiscal and political situation the orthodoxy of university management has changed; it is no longer considered scandalous to expect universities to receive funding based on performance indicators and other quantitative measures. These factors, combined with the resurgence of neoclassical economic theory and neoliberal political economy put an ever increasing pressure on the HEIs to provide value for money and justify the public funds that were taken for granted as an extension of the times when higher education was a luxury good instead of a commodity. Even though the influence of NPM is likely to have been overstated in the last decades (Goldfinch & Wallis 2010,), there is little doubt that most higher education reforms that took place during the last twenty years were heavily influenced by it (c.f.: Australia (Winter & Sarros 2002), New Zealand (Mahoney 2003), Japan (Yamamoto 2004)). The results from the adoption of these policies are controversial to say the least (Winter & Sarros 2002) (Yamamoto 2004) (Goldfinch 2004). According to academics:

> "*economic rationalism was having a detrimental impact on the quality of education available to students"* (Winter & Sarros 2002) (page 7)

and

"(there is) value conflict with respect to policy reforms that treat universities as corporate entities created for the expressed purpose of dispensing degrees and generating large numbers of 'job-ready' graduates" (Winter & Sarros 2002)(page 8).

With this background it is no wonder that the faculty is usually not very enthusiastic when it comes to budget cuts regarding teaching and research programs.

Administrative costs on the other hand received comparatively less emphasis. There is a general consensus that administrative costs have increased disproportionately during the last few decades (see (Leslie & Rhoades 1995) or (Gornitzka & Larsen 2004)). As for the causes behind this phenomena, Leslie and Rhoades proposes the following reasons (Leslie & Rhoades 1995): 1. alternative revenues became more important, so the administrative staff connected to these services also became more numerous; 2. paradoxically the changes in the regulation framework and reporting requirements add to the expenses on the administrative side of an organization; 3. bigger institutions need bigger administrative workforce; 4. administrators slowly take over certain non-teaching and non-research functions from the faculty; 5. consensus management raises costs; 6. self-perpetuating growth of the administration; 7. adoption of best practices from the industry and 8. adhering to de-facto industry standards. Some of the above seems correct while others are debatable (especially reasons number 5, 7 and 8). Still, the fact that universities are undergoing bureaucratization is not easily refuted (Gornitzka, Larsen & Kyvik 1998).

3.2 DEA and SFA

Papers on -as well as comparing the efficiency estimates of- the DEA and SFA methods are numerous. Almost every institution can be thought of as having inputs and outputs. The fact that these institutions can be compared and ranked with a single number between 0 and 1 is very attractive.

DEA originates from the seminal paper by Charnes, Cooper and Rhodes in 1978 (Charnes, Cooper & Rhodes 1978). This was the so-called CCR model assuming constant returns to scale. This model was augmented 6 years later by Banker, Charnes and Cooper (Banker, Charnes & Cooper 1984) for the variable returns to scale BCC model. Since its inception DEA has been used for quantifying efficiency in a wide set of industries. From US Air Force bases (Bowlin 1987) (Charnes et al. 1985), through rate collection (Thanassoulis, Dyson & Foster 1987), bank efficiency (Sherman & Ladino 1995), (Cooper, Seiford & Tone 2007), dairy farms (Reinhard, Thijssen & Lovell 2000) and fisheries performance (Tingley, Pascoe & Coglan 2005) to universities (Kao & Hung 2008), (Sinuany-Stern, Mehrez & Barboy 1994), (Casu & Thanassoulis 2006). It is not without criticism however as numerous complaints have been lodged for biased results due to possible regulatory and market differences and erroneous measurements (Brown 2006).

SFA was first defined in 1977 by Aigner, Lovell, and Schmidt in the paper "Formulation and Estimation of Stochastic Frontier Production Function Models" (Aigner, Lovell & Schmidt 1977) and at the same time by Meeusen and van Den Broeck in "Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error" (Meeusen & van Dem Broeck 1977). A concise history of the method can be found in the Introduction chapter of Kumbhakar and Lovell (Kumbhakar & Lovell 2000).

It is typical to compare the DEA and SFA results and apply expert knowledge of the topic in order to reach a meaningful result for performance. Weill compares the consistency of DEA, SFA and DFA (distribution free approach) and while he observes correlation within the results, he concludes that the lack of robustness is a problem that makes it necessary to employ multiple frontier methods for a relevant measure (Weill 2004). This is the same result reached by Bauer et al regarding the banking market of the United States in 1998 (Bauer et al. 1998). In this work they have also observed inconsistencies between result produced by parametric and non-parametric approaches. The final word seems to be that when measurement error and different environment is a concern SFA is a better way to estimate, but when the functional form to be imposed is not known DEA is more appropriate (Kalirajan & Shand 1999).

There is also extensive literature regarding mixed studies where multiple level studies utilizing a mixed DEA-SFA approach to estimate efficiency.

3.3 University Efficiency

Regarding university efficiency measurement the palette is just as wide and colorful as the above. Since universities are institutions with a lot of different activities it is no wonder that many different aspects were examined in the literature. When talking about general performance and efficiency, the problem usually is to decide what constitutes the outputs of the university. For a long time it was undergraduate output but that is not very convincing in today's world of complex higher education institutions. An example of the SFA cost analysis approach that is similar to the one used in this paper is for example (Robst 2001). His goal is to examine the change in general efficiency related to the share of state funding in universities (he does not find significant differences). A DEA approach to the same general efficiency problem is (Kuah & Wong 2011) that defines teaching and research as an output (each with 4 outputs) with numerous inputs (9). They run the linear program but they do not give the university names and they do not look for any reasons for the efficiency or lack of it. Another DEA analysis that concerns the Australian higher education sector is (Avkiran 2001). He defines 3 models with the same inputs (academic and non-academic staff) with different outputs (model 1: undergraduate enrollments, postgraduate enrollments, research grants received; model 2: student retention rate, student progress rate, employment after graduation; model 3: overseas fee paying students, domestic postgraduates). He uses a slack based measure and defines the possible movements towards the efficiency frontier by the worst performing institutions. The British higher education sector is analyzed in (Johnes 2006). 3 outputs representing graduate and undergraduate student quality and research quality are used with the usual inputs (students, staff, teachers, expenditures etc.). Since she reaches a result with lots of highly efficient institutions, she concludes that the relative performance measurement in a sector with no profit motive might not give the true production frontier. Another analysis of British institutions is (Athanassopoulos & Shale 1997). They separate cost efficiency and outcome efficiency and grade the universities according to two different sets of inputs. They separate the universities into different groups and give the average efficiency of the group. The main finding is that high efficiency does not mean low unit costs.

Regarding more targeted topics there are also quite a few papers that can be considered. A DEA analysis about the efficiency of university intellectual property licensing of US universities is (Thursby & Kemp 2002). The inputs are federal support, the number of technology transfer professionals as well as the number of faculty and the quality of the biological sciences, physical sciences and the engineering departments. The outputs are the number of executed licenses, the of industry sponsored research, the number of new patent applications etc. They then carry out a regression similar to the one in this paper but instead of setting the efficiency score as the explained variable, they use efficiency dummies (=1 if efficient, =0 if not) and employ logit regression. They uncover certain significant differences between types of universities. An analysis of the performance of departments within the same school is (Sinuany-Stern, Mehrez & Barboy 1994) in Israel or (Kao & Hung 2008) in Taiwan. A paper on the efficiency of university libraries is (Chen 1997), on university technology transfer (Anderson, Daim & Lavoie 2007), on research efficiency (Cherchye & Abeele 2005) or on university departments of accounting (Tomkins & Green 1988).

The closest of the literature to this present paper is undoubtedly (Casu & Thanassoulis 2006). They aim to investigate the efficiency of central administrations for universities in the UK. They use the same inputs (although rolled into one input variable) and three outputs: total income for students to proxy for students, total teaching staff cost to proxy for teachers and technology transfer for services provided to businesses and the community. They received a Mean score of 73.4 with a standard deviation of 17.66. From this they concluded that the UK sector displays an inefficiency of 27% regarding administrative matters.

In general we can say that higher education performance measurement is plagued by the same problems presented in part 1.1. The difficulty of setting input and output indicators in the qualitative world of higher education makes the whole outcome overly dependent on preliminary rough indicator selection.

3.4 The Japanese Reform of 2004

The effects of the Japanese reform are not yet clear, since the changes only happened in 2004. A lot of criticism could certainly be heard regarding the new system before ((Yamamoto 2004) or (Chan-Tiberghien 2006)) and after the reform (Goldfinch October 2006)

Regarding administration, the Japanese reform of 2004 had the following important impacts on university governance (Oba 2006):

- The selection of the president became easier and more flexible. But sometimes the real effect has been adverse selection because of conservative electorates.
- Managerial autonomy has increased and professional experience is more highly valued than before. The number of outside consultants used is growing.
- Resource allocation has been changing, competitive funding is increasing in importance along with external funding altogether.
- The recruitment of experienced administrators became possible
- General increase in the flexibility of HR matters.

Even though the above sounds very progressive and a step in the right direction, many people display reservations as to the real effect of these reforms ((Yamamoto 2004) (Goldfinch 2004) (Goldfinch October 2006) (Oba 2005) (Chan-Tiberghien 2006)) Some scholars note the initial opposition towards the incorporation and the effective difficulties in implementation Some universities froze hiring and the administrative workload has increased (Chan-Tiberghien 2006) just as we suspected in section 1.2.

4 Data

The data that is used for the analysis are the statistics published by the individual universities in question every year since the reform in 2004 through 2009. That provides 6 years of panel data. The input-output framework is a modified version of the one used by Casu and Thanassoulis (Casu & Thanassoulis 2006). Input side is divided to two main measures: Administrative Staff Cost (I_ASC, modified for regional average wage differences) and Other Administrative Costs (I_OAC). These two statistics are published in the yearly financial statements under roughly the same name (if we translate it from the Japanese original). These will be the input (cost) measures for DEA estimation and the natural logarithm of the sum of the two will serve as the explained variable in the SFA estimations. Also all the input indicators in the SFA estimations will be converted to the natural logarithm of their value.

Output is defined as services provided for students, services provided for the staff (teaching and administrative), services to research and to the university businesses. Services for students as an output can be considered as the as the sum of undergraduate, graduate and other kind if pupils in the institutions that are aggregated as the indicator Total Number of Students (O_TNS). Readers familiar with the topic might argue that those different types of students might represent different amount of services. In the aforementioned paper Casu and Thanassoulis have used the statistic of Total Income from Students (O_TIS) but after consultation with experts in this case it was not deemed necessary to use a proxy for the student body. It can be argued that this does not completely eliminate the differences but the paper simplifies in this regard. With the teaching staff we cannot use this simplification. The total number of faculty includes regular and non-regular employees. In this case the different administrative workload is much more obvious; therefore this number will be approximated by the Salaries of the Teaching Staff throughout the paper (O_STS, modified for regional differences). The third output measure will be the amount of Business Income received from other sources (O_BIO) to represent interactions with the businesses that the administration runs. Fourth, there is the fact that the administrative staff has to provide services to other administrators. This will be represented by the total number of administrative employees (O_TNE). Lastly, the government provides research grants to each university based on results. These grants represent research activities, the importance of outside funding and the increased administrative workload (see chapter 3.3) and as such is the last element of the administrations work. This indicator is total government grants (O_TGG).

Table 1. Input and output indicators

Input		Output	
I_ASC	Wages of the administrative staff, controlled for regional wage differences[3]	O_TNS	Total number of students (The sum of undergraduate-, graduate- and other- students)
I_OAC General administrative costs		O_STS	Total yearly salaries of the teaching staff controlled for regional wage differences[2]
		O_BIO	Total business income
		O_TNE	Total number of employees (regular and irregular)
		O_TGG	Total government grants

Table 20. in the appendix contains the correlation between the above variables, and Table 2. has the descriptive statistics.

[3] Regional wage data is taken from the Ministry of Health, Labour and Welfare's Nationwide Basic Wage Structure Survey found on page 付表 11－１（都道府県・男女計）of the Excel file http://www.mhlw.go.jp/toukei/itiran/roudou/chingin/kouzou/z2011/xls/toukeihyo.xls on the Web address http://www.mhlw.go.jp/toukei/itiran/roudou/chingin/kouzou/z2011/index.html

Table 2. Descriptive statistics of the input and output variables

Variable	Objects (n)	Mean	Std. Dev.	Min	Max
I_ASC	508	8124.699	8050.367	160.0488	35990
I_OAC	508	986.9587	1057.211	102	6025
O_STS	508	11816.55	10766.59	199.0006	52102
O_TNS	508	7169.443	5667.502	230	28071
O_BIO	508	172.2854	277.4175	0	2716
O_TGG	508	334.4291	930.2947	0	9592
O_TNE	508	1154.327	1307.961	32	8775

Source: Author calculations based on the financial statements and business reports of individual universities. Unit is person or hundred million JPY.

In addition to the above, in case of SFA estimation the following control variables will be used or not used (as shown in regressions in the Appendix (Table 22.):

- Popularity: This is represented by the proxy variable: income from entrance examinations. These fees appear in the financial statements and after modified for size they can provide an estimation of whether an institution is popular or not. Popular institutions have more people taking the entrance examinations and thus have a bigger income from entrance examinations. The actual variable used is the income from entrance examination divided by the total number of students (hundred million JPY).
- Tokyo: Dummy variable: 1 if the university is in Tokyo.
- Size dummies: Base is 0-1000 students, s1 is 1000-2000, s2 2000-3000, s3 3000-5000, s4 5000-8000, s5 8000-10000, s6 10000-15000 and s7 15000+. (in the regression results the actual sizes are shown for easier reference)
- Type dummies: The base is general university with medical school, t1 is general university with no medical school, t2 is for being a former imperial university, t3 is for universities of education, t4 is for graduate schools, t5 is for specialty universities for humanities, art or social sciences and t6 is for universities of technology (in the regression results the actual types are shown for easier reference)
- Ratio of irregular faculty members
- Ratio of irregular staff
- Ratio of graduate students

Problems that are obvious at first glance:

- The reliability of the data: Since the reporting of data has changed considerably in 2004, there is a chance that not all communicated data will be correct and complete. An example of this is the fact that in 2004 scarcely any university reported irregular teachers or employees in their report. Even so, since this data is aggregated from the actual university reports it is difficult to have more relevant version of the data and these will have to be used.

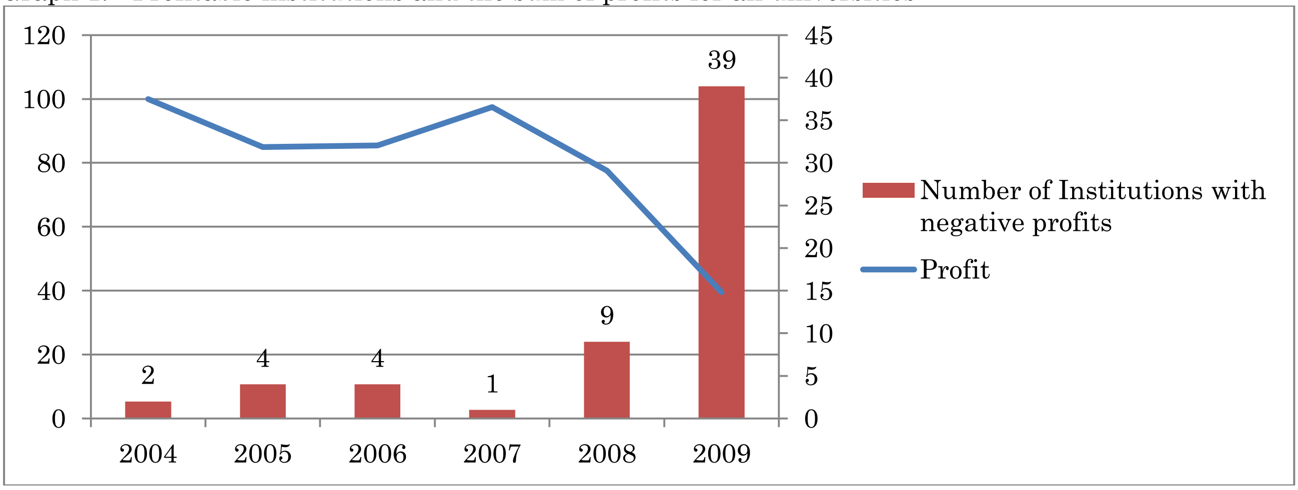
- The input and output indicators might not be exact and might vary across institutions. This is a reasonably serious problem. Everybody who knows accounting is aware that accounting practices are far from universal. Often certain expenditures can be accounted for under different headers and expenditure groups. This problem makes any statistical inquiry difficult or impossible to compare. Even so, the data still represents the best possible realistically attainable data.
- The data for Asahigawa Medical College is not available on their website, so they are not part of the analysis. The data for 2009 for the University of Fukushima and the data for 2004 for the University of Toyama is missing as well so these years are ignored as well. This is why n=508 instead of 516 (86*6=516).
- The size 15,000+ and the type imperial university is highly correlated. All 15,000+ institutions are former imperial universities and there is only one former imperial university that is not in the 15,000+ type sizewise.

5 Results

5.1 Descriptive Statistics

The Japanese national university sector has been profitable on the whole (meaning that the revenues were higher than expenditures); this can be seen on Graph 1. This does not mean that every institution turned a profit just that the sum of all profits were positive. There is however a declining trend: in 2009 the profits are only about 40% of the profits in 2004. The number of institutions that had a deficit has risen to 39. This might be because the first mid-term period was coming to a close and the institutions decided to effectuate their planned expenditures.

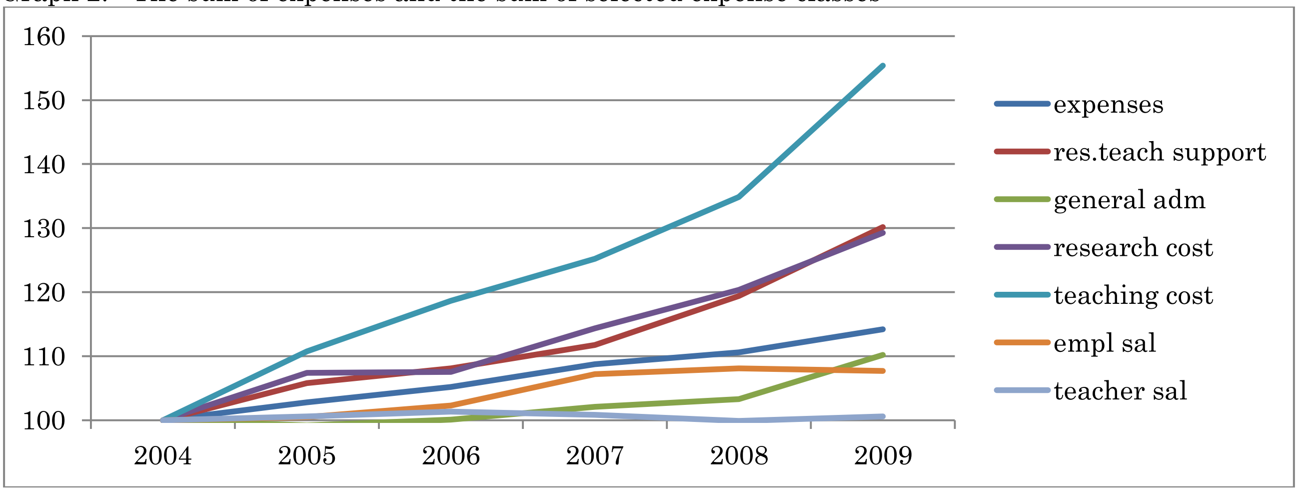
Graph 1. Profitable institutions and the sum of profits for all universities



Source: Author calculations based on the financial statements and business reports of individual universities. Profit value is on the left side in % with 2004 being 100%, while number of institutions with negative profit numbers are on the right side.

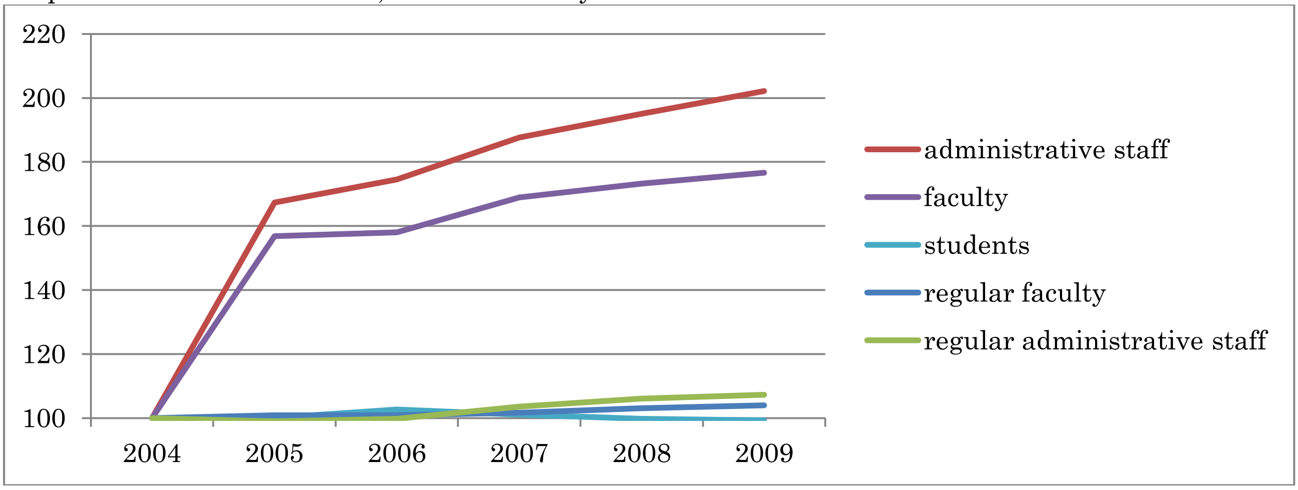
On the expenses side, we can see a constant increasing trend in Graph 2. Every kind of expenditure increases throughout with the sole exception of salaries (teacher salaries stagnate while administrative salaries increase by 9 percent and stay there. Perhaps the non reporting of irregular employees in 2004 put their salaries in a different category as well?). This seem to suggest that more flexibility in management did not improve the efficiency of these institutions. Of course this could be understandable if the output (e.g. the number of students) increased. We can see however on Graph 3 that this is not the case: the number of students stagnate around the same range. What increased heavily is the number of teachers and employees and among them mostly irregular employees. This seems to be a reaction to the increased flexibility of employment. Another possible explanation is the fact that reporting changed in 2004. It can be observed that plenty of changes took place in the 2005, so maybe there was a considerable number of irregular employees in 2004 as well they just did not get reported. An interesting addition could be the combination of this fact with the fact that the amounts expended did not change so it seems likely that these irregular employees were rather cheap for the universities.

Graph 2. The sum of expenses and the sum of selected expense classes



Source: Author calculations based on the financial statements and business reports of individual universities. Every measure is measured on the left side in % with 2004 being 100%. Expenses is the sum of all expenses. Res.teach support is the amount given for research and education on the side. General adm is general administration cost. Research cost is expenditure on research. Teaching cost is expenditure on teaching. Empl sal is administrative staff salary and teacher sal is faculty salary.

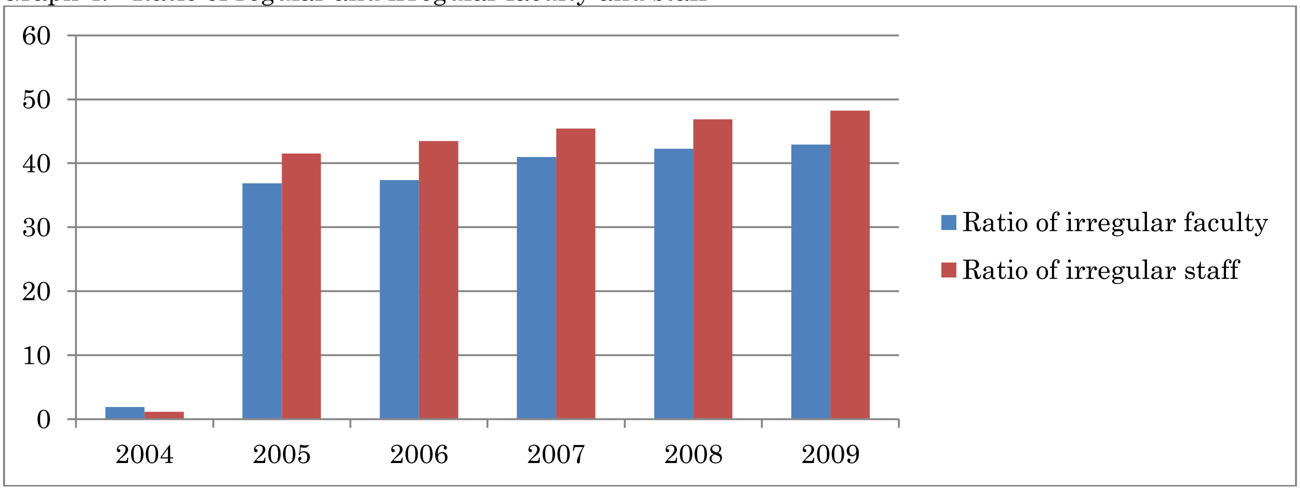
Graph 3. Number of students, staff and faculty



Source: Author calculations based on the financial statements and business reports of individual universities. Every measure is measured on the left side in % with 2004 being 100%.

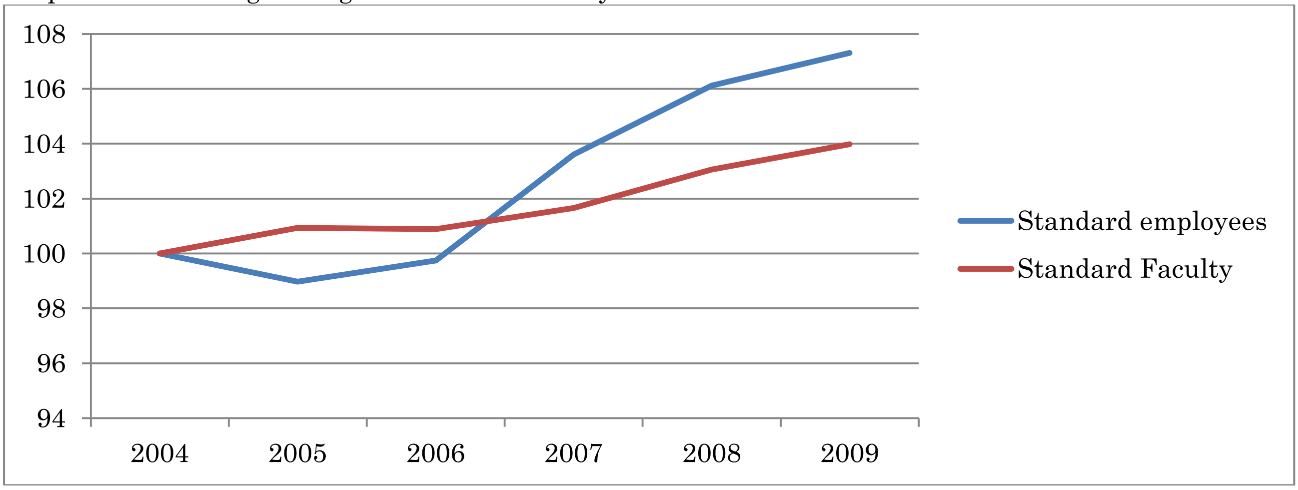
The increased use of irregular employees seems very pronounced and increasing (Graph 4) while at the same time regular staff and faculty is increasing as well but not as quickly (Graph 5).

Graph 4. Ratio of regular and irregular faculty and staff



Source: Author calculations based on the financial statements and business reports of individual universities. Every measure is measured on the left side in %.

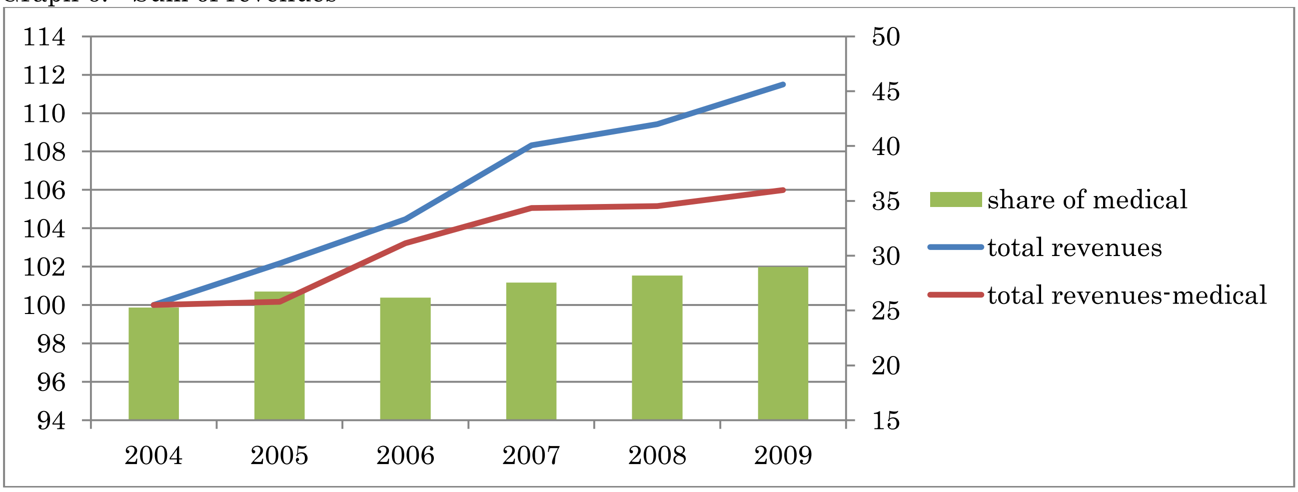
Graph 5. The change in regular staff and faculty



Source: Author calculations based on the financial statements and business reports of individual universities. Every measure is measured on the left side in % with 2004 as 100%

It can be expected from the profit measure that revenues had to keep pace with expenditures, at least on a certain level. On Graph 6 we can see the sum of revenues and it indeed increased. Much of this increase can be attributed to the fact that medical services earned a higher return and they slowly became more and more important. Of course the fact that not every university has a hospital makes this measure a little lopsided but even with the medical income excluded universities were able to increase revenues.

Graph 6. Sum of revenues

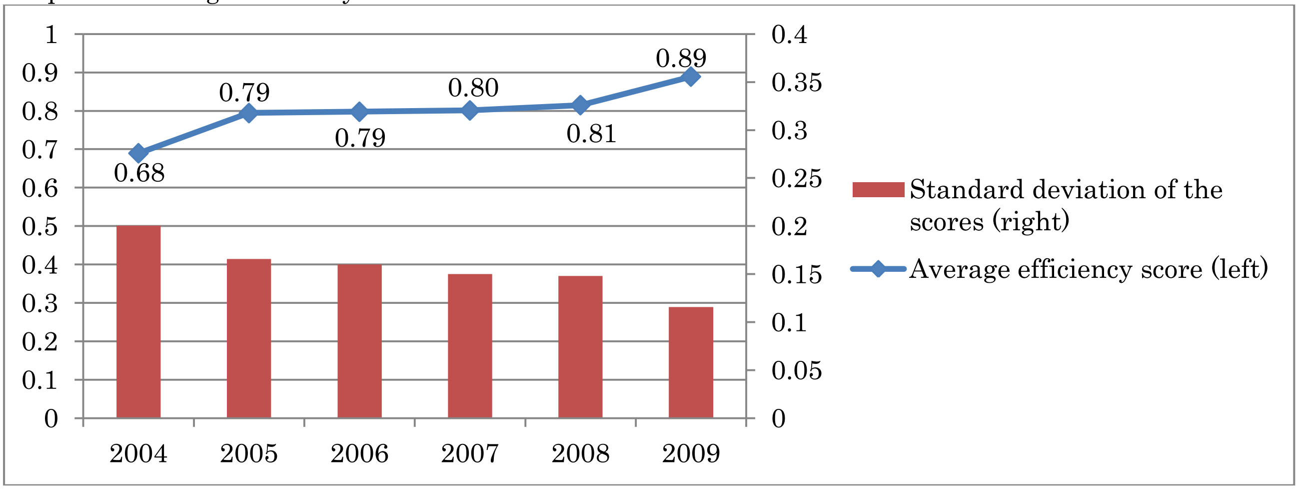


Source: Author calculations based on the financial statements and business reports of individual universities. Total revenues and total revenues-medical are measured on the left side in % with 2004 being 100%. Share of medical is measured on the right side in % for the actual year. Total revenues-medical is total revenues-revenues resulting from medical services. Share of medical is the share of income from medical services in relation to revenues.

5.2 Window DEA

The individual results for the window analysis of the Japanese national universities can be found in the Appendix (Table 21.). It can be consulted to see if individual universities have improved administrative efficiency relative to the other institutions. The general result can be seen on Graph 7 showing the average efficiency scores by year. It seems that from 2004 to 2005 there was an increase in efficiency across the board which was kept more or less constant until 2009, when there is another uptick in performance. The standard deviation of the scores are steadily decreasing from 0.2 to 0.1 suggesting that the whole sector is getting closer in terms of performance. Based on the data we can say that according to this analysis the administrative inefficiency of JNUCs have improved from 32% to 11%.

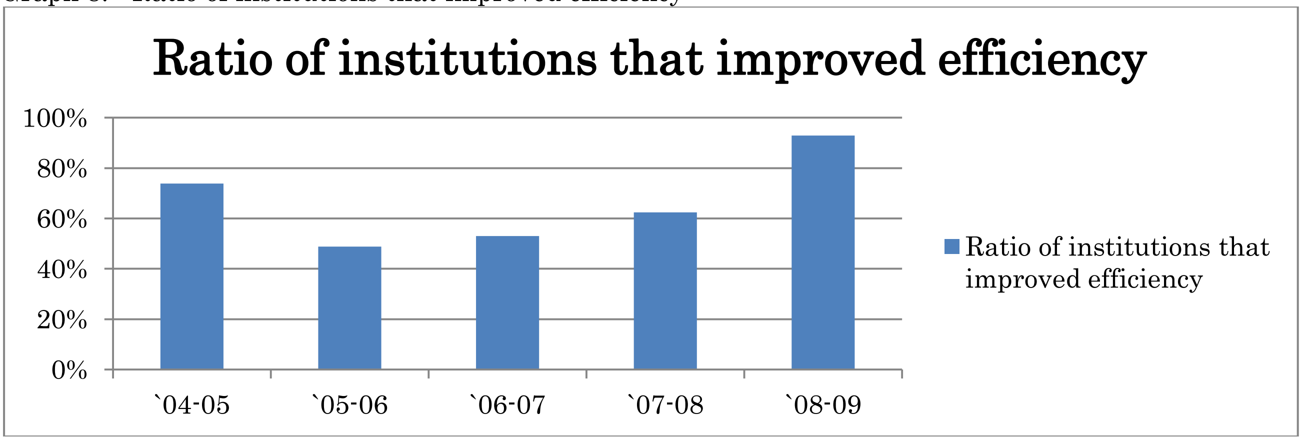
Graph 7. Average efficiency scores and standard deviation



Source: Author calculations based on the financial statements and business reports of individual universities (the software used was MAXDea). Input indicators: I_OAC and I_ASC, output indicators: O_TIS, O_STS, O_BIO, O_TNE,O_TGG. The model is input oriented, radial, variable returns to scale with 4 year windows. Average efficiency scores are on the left with standard deviation on the right.

Graph 8 shows the ratio of institutions each year that was able to improve its efficiency. After an initial improvement in 2005 when more than 70 percent of institutions improved came a drop to 50% followed by a stable climb of improvement until more than 90% in 2009.

Graph 8. Ratio of institutions that improved efficiency



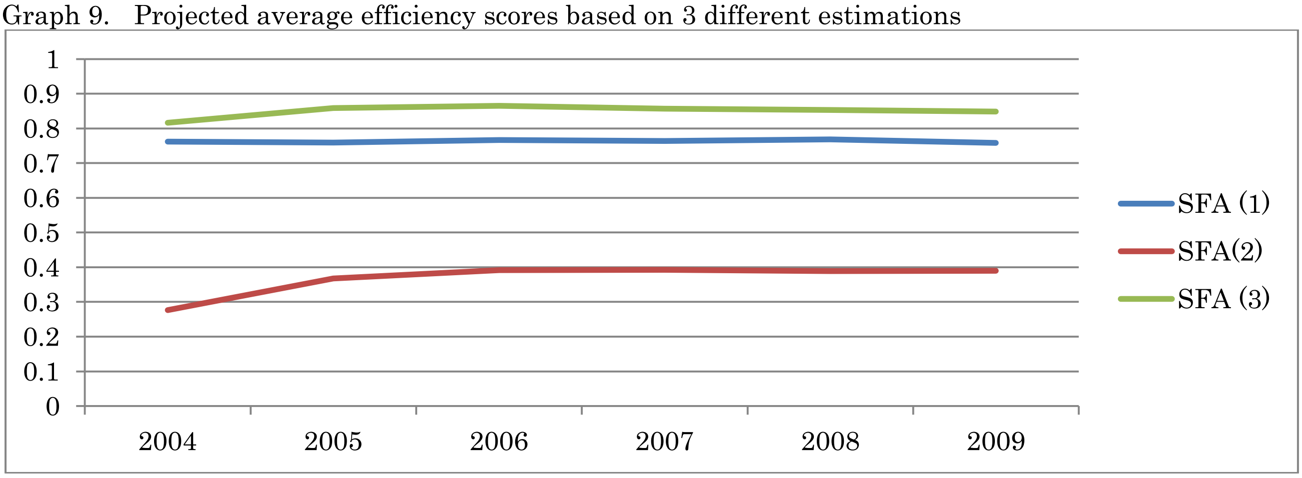
Source: Author calculations based on the financial statements and business reports of individual universities (the software used was MAXDea). Input indicators: I_OAC and I_ASC, output indicators: O_TIS, O_STS, O_BIO, O_TNE,O_TGG. The model is input oriented, radial, variable returns to scale with 4 year windows.

In general there is a discernible improvement in efficiency year by year. This is in line with the expectations put forth in the first chapter: flexibility in administrative staff management will improve efficiency countered by the unfamiliarity and increase of new administrative tasks that have a negative effect that will diminish over time.

5.3 SFA

SFA estimation results have a different magnitude depending on the estimation method and the explanatory variables used. The actual regression can be found in the Appendix (Table 22.)On Graph 9 and Table 3. we can see the average scores for every year 2004 through 2009. Since the measure of efficiency is so small, the changes relative to 2004 is shown on Graph 10 as well. Estimation (1) that contains all the explanatory variables in a panel data estimation shows decreasing efficiency throughout, with very small rises in 2006 and 2008 finishing slightly lower than the initial average value in 2009. The pooled data estimation (3) has increasing efficiency from 2004 to 2005, 2005 to 2006 with the same magnitude of deterioration in 2006 to 2007 and 2007 to 2008. The first increase is large, so in 2009 it finishes slightly above 2004. The other panel data estimation (2) has a very positive beginning and is rising throughout with a single decrease in 2008. This might suggest that efficiency in the sector depends heavily on statistical error and other noise that the DEA model does not pick up very effectively. Regarding the η, it is positive for model (2), 0.8458651 with a z value of 3.14. This suggest rising average performance just as we saw previously. Model (1) also has a positive η of 0.0747375 but this time the z is only 0.33 making it doubtful. This suggests deteriorating performance throughout the time period. The correlation of scores for the different SFA estimations can be seen in Table 4. Estimations (1) and (3) are relatively close but (2) is very different. Probably estimation 2 is not very relevant, as endogeneity is likely due to omitted variable bias. Also included are the correlations with the DEA results from the next chapter. All the correlations are quite small.

Graph 9. Projected average efficiency scores based on 3 different estimations



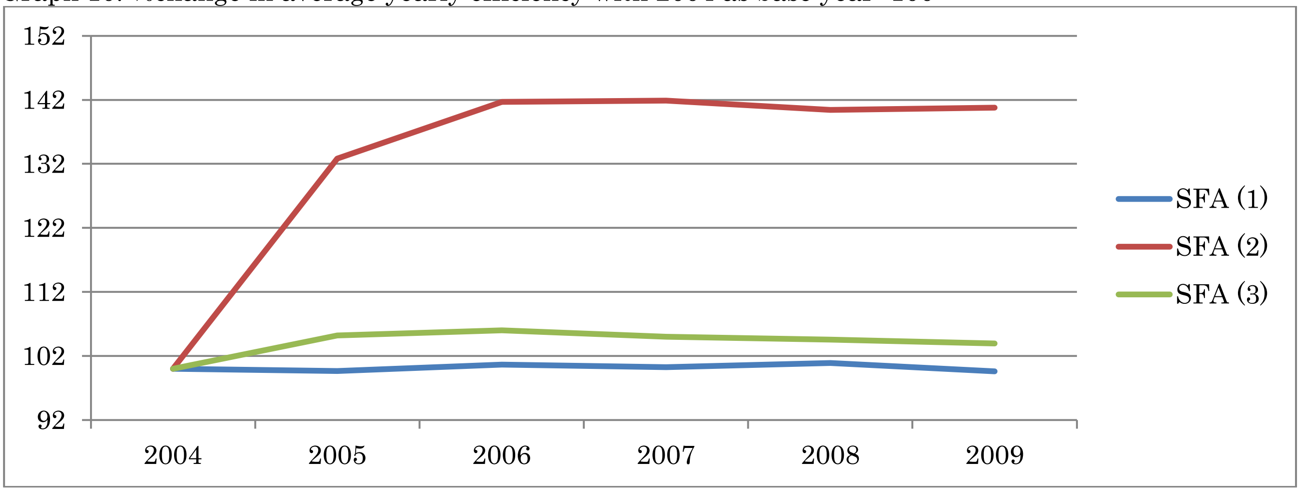
Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Cost frontier estimation: (3) is pooled OLS while (1) and (2) is panel estimation. Detailed regression results can be found in the appendix.

Table 3. Projected average efficiency scores based on 3 different estimations

	2004	2005	2006	2007	2008	2009
(1)	0.761844982	0.759124597	0.766862904	0.763920819	0.768753592	0.758767
(2)	0.276690435	0.367450134	0.391982108	0.392533162	0.388602854	0.389562
(3)	0.816237606	0.858652407	0.865328641	0.857184951	0.853406474	0.848543

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Cost frontier estimation: (3) is pooled OLS while (1) and (2) is panel estimation. Detailed regression results can be found in the appendix.

Graph 10. %change in average yearly efficiency with 2004 as base year=100



Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Cost frontier estimation: (2) is pooled OLS while (1) and (3) is panel estimation. Detailed regression results can be found in the appendix.

Table 4. Correlation of SFA and DEA results

	SFA (1)	SFA (2)	SFA(3)	SBMRawScore	SBMAdjScore
SFA (1)	1				
SFA (2)	0.1235	1			
SFA (3)	0.5906	0.0575	1		
SBMRawScore	0.0141	0.0185	0.152	1	
SBMAdjScore	-0.0279	0.0096	0.0984	0.9616	1

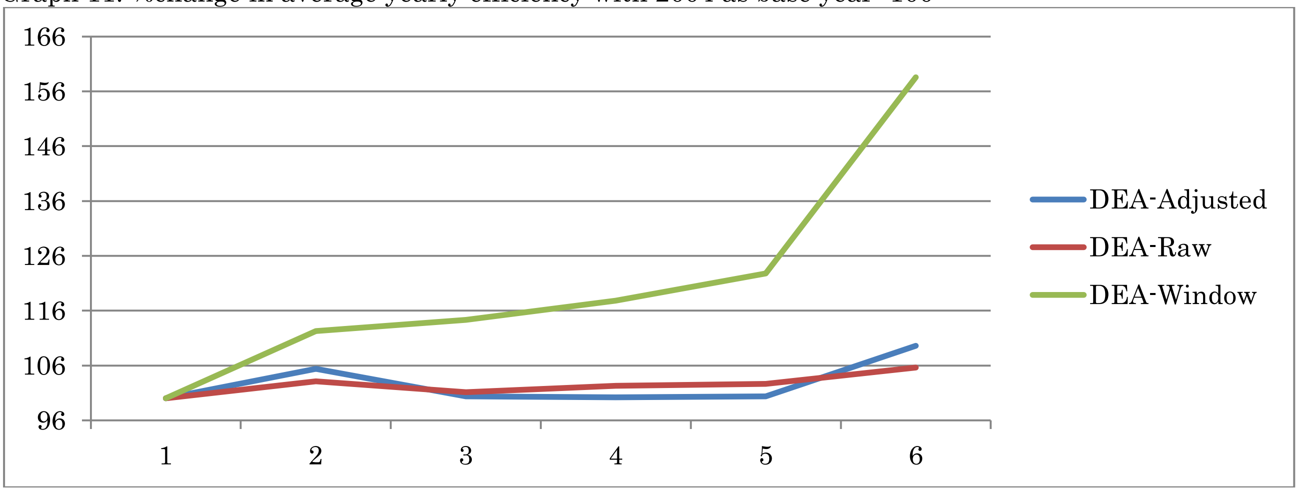
Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata and MaxDEA). Cost frontier estimation: (2) is pooled OLS while (1) and (3) is panel estimation. Detailed regression results can be found in the appendix. DEA: Input indicators: I_OAC and I_ASC, output indicators: O_TIS, O_STS, O_BIO, O_TNE,O_TGG. The model is SBM 6 years pooled.

5.4 DEA and SFA combined

In this case both DEA estimates are discussed. Since the first estimate is only a tool and an intermediate step to the final estimate this deserves and explanation. Even though it is used later as a stepping stone the first stage linear program is a full DEA estimation in its own right with the same validity as the Window DEA estimation. The only difference is that it is not analyzed in the window form but as pooled data.

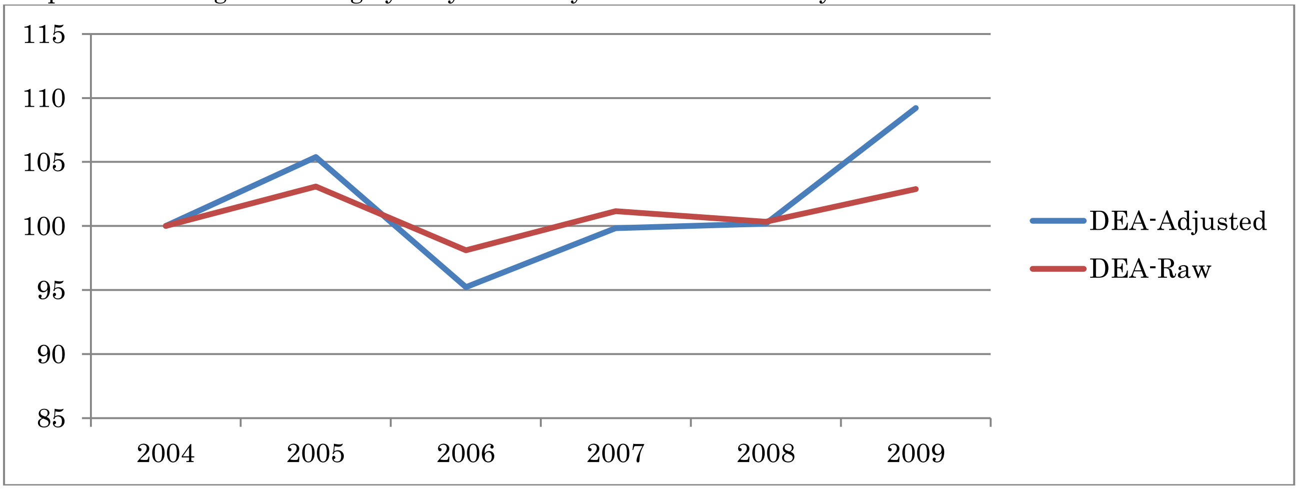
The results for yearly average efficiency change for First and Second Stage DEA regressions can be seen on Graph 12 and 13. It seems that the two results have the same trend but the SBM stage undershoots in 2005 and 2009 and overshoots in 2007 and 2008. The basic difference between this and the DEA estimation in section 5.3 is that instead of 4 year windows a pooled data is used for all 6 years, making the universities competing not only with different universities but also with themselves in different time periods. The First Stage suggests increasing efficiency with a drop in 2006, increase again in 2007 and deterioration from then on. The Second Stage DEA eliminates the drop in efficiency in 2006 making it increasing until 2007 and decreasing from there.

Graph 11. %change in average yearly efficiency with 2004 as base year=100



Source: Author calculations based on the financial statements and business reports of individual universities (the software used was MAXDea). Input indicators: I_OAC and I_ASC, output indicators: O_TIS, O_STS, O_BIO. The model is SBM 6 years pooled and radial variable returns to scale. Average efficiency scores are on the left. DEA-Adjusted is different because the input indicators are transformed by stripping them of environmental effects. DEA-Window is the DEA result from part 5.2.

Graph 12. %change in average yearly efficiency with 2004 as base year=100



Source: Author calculations based on the financial statements and business reports of individual universities (the software used was MAXDea). Input indicators: I_OAC and I_ASC, output indicators: O_TIS, O_STS, O_BIO. The model is SBM 6 years pooled. Average efficiency scores are on the left. DEA-Adjusted is different because the input indicators are transformed by stripping them of environmental effects

Graph 13. Positive change in efficiency %of the total

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was MAXDea). Input indicators: I_OAC and I_ASC, output indicators: O_TIS, O_STS, O_BIO. The model is SBM 6 years pooled. DEA-Adjusted is different because the input indicators are transformed by stripping them of environmental effects

Table 5. Average yearly values of inefficiency

	2004	2005	2006	2007	2008	2009
DEA-SBM	0.727464	0.749926	0.735768	0.744364	0.746788	0.768248
DEA-Adj	0.541767	0.570904	0.543717	0.542743	0.543672	0.593705

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was MAXDea). Input indicators: I_OAC and I_ASC, output indicators: O_TIS, O_STS, O_BIO. The model is SBM 6 years pooled. DEA-Adjusted is different because the input indicators are transformed by stripping them of environmental effects

We can say that the SFA estimation to strip the inputs from the environmental effects and statistical noise did not change the direction of the changes much but the adjusted DEA results follow the general shape of the window analysis much closer. It is telling that there is an approximately 20% drop in efficiency after the statistical noise has been cleared.

5.5 Why are the results so different?

The average sector-wide efficiency is put around 85% by Windowed DEA and SFA estimation (3), around 75% by SBM DEA and SFA estimation (1). Adjusted DEA puts it around 55% while SFA estimation (2) puts it around 40%. As we will see in chapter 6 however, the *rankings* of the measures are a different story. As we can see on Table 7. in rankings the DEA estimations are highly correlated.

The reason for the difference in the DEA results is that non-radial measures catch inefficiencies that radial DEA models might not. Whether the inputs and outputs are radial can be debated. Some of them probably are and some of them are not. General administrative costs might change proportionally with the wages of the admin staff or government support with the wages of the teaching staff. On the other hand business income will probably be a non-radial variable. Also, it is important to note that due to the nature of the windowed analysis, the yearly averages are calculated from different number of values. In 2004 and 2009 there are a single value per university, in 2005 and 2008 there are two values and in 2006 and 2007 there are three. This compared to the pooled estimation of SBM where every institution has only one value yearly. Since windowed DEA is primarily for inter-temporal change analysis in my opinion for the change year by year the windowed analysis is right, while for the actual efficiency the SBM measures might be closer to the truth. This still leaves us with two possible candidates for the actual values. There is a 20% discrepancy between the adjusted value and the base value of the SBM analysis. Since the adjusted result is reached through pooled SFA estimation, this might throw the estimation off by not considering random or fixed effects in the regression. I would say that the actual efficiency might be between the two values.

The SFA estimations are similarly ambiguous. As we will see further down it seems that this type of regression excluded most of the factors that the DEA estimation included. By controlling for types of institutions and institution sizes, most of the projected inefficiency improvement disappeared. This is in line with the conclusion of (Fiorentino, Karmann & Koetter 2006) where the authors contribute discrepancies within results to the fact that heterogeneity of institutions will make the two kinds of estimates different. This might suggest that the initial hypothesis, namely the fact that university administration is similar across all kinds of institutions is not correct. I think we can exclude the outlier SFA estimation (2) since endogeneity is probably present due to the minimal number of variables used. Panel data estimation takes into account the changing framework of the system while pooled OLS considers no changes in the external variables. As it can be seen in Table 22. in the Appendix, the effect of single variables on the cost function are greatly reduced and sometimes even change signs. I think that panel data estimation is better when it comes to general efficiency.

The differences in DEA and SFA estimation results can explained by the fact that DEA results are extremely sensitive to outliers. (Fiorentino, Karmann & Koetter 2006) reports that eliminating 1% of their sample changed DEA efficiency scores by as much as 20%, while SFA scores stayed within a range of 2%. There are certain input and output measures where outliers are present. Another possible explanation is that different institutions have different norms and practices regarding accounting and as such serious disparities might arise from basic data invalidity. Also, DEA models weight input and output indicators dynamically while in the case of SFA estimations, the output indicators were not weighted. Also, the two output indicators are summed into a single one due to the limitations of the analytic software used.

Regarding the question: Which results are correct?, unfortunately there is no easy answer. As usual with statistical inference everything depends on the initial assumptions. Is the measure radial? What is the functional form? Were random effects important? etc. The initial assumptions decide performance.

5.6 Factors of inefficiency

It is interesting to see if there is a statistical relationship between DEA efficiency scores and properties of the universities, so in the last analysis I have regressed certain properties of universities on the efficiency scores to see if they have an effect on the efficiency score. The results can be found in the appendix. Pooled OLS, panel data, random effects and fixed effects regressions were run with the following explained variables: DEA-SBM, DEA-Adjusted, SFA (1), (2), (3) and DEA-Window. The explanatory variables were the following:

- Popularity: : This is represented by the proxy variable, income from entrance examinations. These fees appear in the financial statements and after modified for size they can provide an estimation of whether an institution is popular or not. Popular institutions having more people taking the exams and thus having a bigger income from the entrance examinations. The actual variable is the income from entrance examination divided by the total number of students.
- Tokyo: 1 if the university in Tokyo
- Size dummies: Base is 0-1000 students, s1 is 1000-2000, s2 2000-3000, s3 3000-5000, s4 5000-8000, s5 8000-10000, s6 10000-15000 and s7 15000+
- Type dummies: : The base is general university with medical school, t1 is general university with no medical school, t2 is for being a former imperial university, t3 is for universities of education, t4 is for graduate schools, t5 is for specialty universities for humanities, art or social sciences and t6 is for universities of technology (in the regression results the actual types are shown for easier reference)

- Ratio of irregular faculty members
- Ratio of irregular staff
- Ratio of graduate students

This leaves us with 17 regressions. Tokyo as a dummy is only relevant in 2 regressions, the pooled estimation for the SBM-SBM and SBM-Adj. The most important size dummy is s7 (15,000+), it is significant in 6 regressions, in a positive way 5 times in all the SBM results, once in DEA-Window, and once in a negative way in regression SFA (2). Regarding the type dummies, t3 is significant in 9 instances, 8 times in a positive 1 time in a negative way (t3 is the dummy for colleges of education). The old imperial university type dummy (t2) is significant 9 times, out of which 6 is negative and 3 is positive. Universities of type 1 (general universities without a medical school) have an advantage over general universities with medical school according to 5 results with no negative results this time The other indicators seem either unimportant or confusing with the same amount of positive and negative effects.

A caveat: the size 15,000+ and the type imperial university is highly correlated. All 15,000+ institutions are former imperial universities and there is only one former imperial university that is not in the 15,000+ type sizewise. I would say that the two indicators are probably having a smaller positive effect overall in the DEA result regressions than suggested by the size dummy and we could omit the former imperial university dummy.

We can say that based on the results size and type is the most important; the bigger the better, and different types of universities are different in efficiency.

6 The best and the worst

Having 6 different sets of efficiency estimates makes it possible to have a closer look at the best and the worst performing institutions. I have formed 4 separate orders of institutions. First on Table 8. the average position of every institution in all 6 estimations forms the list. Table 11. is limited to the DEA estimations, while Tables 14 and 17 have average SFA estimation scores with table 17 excluding estimation (3).

I have selected 17 indicator numbers for a closer look at the individual institutions. These indicators can be seen in Table 6. These more or less cover the data used in the estimations but they also add some extra information. The summary statistics and the distributions for the indicators can be found in the Appendix (Tables 30 and 31.)

Table 6. Indicators

Nr	Indicator
1	General Administrative Cost/Student (I_OAC/O_TNS)
2	General Administrative Cost/Teacher (I_OAC/Total Number of Teachers)
3	General Administrative Cost/Employees (I_OAC/O_TNE)
4	Teaching Wages /General Administrative Cost (Total Modified Teaching Wages/I_OAC)
5	Admin Wages /General Administrative Cost (I_ASC/I_OAC)
6	Government Support/General Administrative Cost (O_TGG/I_OAC)
7	Business Income/General Administrative Cost (O_BIO/I_OAC)
8	Admin Wages/Student (I_ASC/O_TNS)
9	Admin Wages/Teacher (I_ ASC/Total Number of Teachers)
10	Admin Wages/Employees (I_ ASC/O_TNE)
11	Teaching Wages/Admin Wages (Total Modified Teaching Wages/I_ ASC)
12	Government Support/Admin Wages (O_TGG/I_ ASC)
13	Business Income/Admin Wages (O_BIO/I_ ASC)
14	Ratio of irregular employees to all employees (Irregular Teachers/Total Teachers)
15	Ration of irregular teachers to all teachers (Irregular Employees/O_TNE)
16	Government Support/ Total Number of Students (O_TGG/O_TNS)
17	Government Support/Total Number of Teachers (O_TGG/Total Number of Teachers)

6.1 Correlation between the results

As mentioned before a ranking can be established based on the efficiency scores. This will create a separate measure where instead of the actual inefficiency the relative position of the institution is important. Ranking the institutions based on the 6 types of estimation we can observe high correlation between DEA and the SFA results respectively but the correlation is quite low between the two methods but it is significantly higher than the correlation in scores. The high correlation between the SBM Adjusted Score and the SBM SBM Score was noted previously. This is true for rankings as well and adding the order based on average values of the DEA-Window analysis also yields high correlation (Table 7.). The SFA estimation (1) rankings are much more highly correlated with estimation (3) ranking than the actual efficiency scores. The low correlation with estimation (2) is still present however, although a bit larger this time. This is probably due to the fact that the number of explanatory variables were greatly reduced for estimation (3) (see the appendix for details).

The big problem is the lack of correlation between any SFA and DEA result. In one university's case this ends in the DEA estimation putting it to place 6 overall, while the SFA estimations (all 3) put it 3rd from last. This is corrected when we eliminate SFA estimation (3) from the mix but then another university becomes a problem. This combination puts the 1st institution in every DEA estimation to 10th from last place in the 2 SFA estimation average order.

Regarding the differences there are numerous possibilities elaborated in Chapter 5.5

Table 7. Correlations between the orders of inefficiency

	SBMAdjScore	SBMRawScore	DEAwindow	SFA (1)	SFA (3)	SFA (2)
SBMAdjScore	1					
SBMRawScore	0.9812	1				
DEAwindow	0.8836	0.8772	1			
SFA (1)	-0.0229	-0.0167	0.0653	1		
SFA (2)	-0.0332	-0.0377	0.1383	0.2329	1	
SFA (3)	0.0875	0.0907	0.179	0.6551	0.1863	1

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata and MaxDEA). Cost frontier estimation: (2) is pooled OLS while (1) and (3) is panel estimation. Detailed regression results can be found in the appendix. DEA: Input indicators: I_OAC and I_ASC, output indicators: O_TIS, O_STS, O_BIO, O_TNE,O_TGG. The model is SBM 6 years pooled in the case of SBMAdjScore and SBMRawScore and input oriented 4 year window averages with variable returns to scale and radial measure.

6.2 All estimations

According to the averages of all 6 estimations we get the following top and bottom 10 institutions (Table 8.)

Table 8. The best and the worst performers according to the 6 efficiency estimates

Nr	Best 10	Score	Nr	Worst 10	Score
1	Kyoto University of Education	12.0	**85**	University of the Ryukyus	76.3
2	Tokyo University of Foreign Studies	13.8	**84**	Japan Advanced Institute of Science and Technology	75.3
3	Nara University of Education	15.0	**83**	Iwate University	72.8
4	Osaka University	17.3	**82**	Kanazawa University	72.8
5	Shiga University	18.3	**81**	Nagaoka University of Technology	72.5
6	Yokohama National University	20.2	**80**	Shiga University of Medical Science	70.5
7	Wakayama University	20.8	**79**	Utsunomiya University	70.0
8	Hiroshima University	21.5	**78**	Akita University	64.7
9	Ochanomizu University	24.3	**77**	Shimane University	62.8
10	Tokyo University of Marine Science and Technology	24.8	**76**	National Institute of Fitness and Sports in KANOYA	62.8

Source: Author calculation.

From the scores on the right side we can immediately see what was discussed in chapter 5.5. The estimation results correlate very poorly so the average scores are not extreme. The best performer is in the first place with 12 points on average while nr. 10 only has 24.8. The other extreme deviates to almost the same extent: 11 points for the worst and 23 for the 10 from last.

The institution mix is very varied. In the top 10 we have 3 institutions with student numbers between 3000-5000, two with student numbers 1000-2000 and 2000-3000 each, and one 8000-1000, 10000-15,000 and 15,000+. In the bottom, sizewise, there are 3 universities with 5000-8000 students, 2 each of -1000, 3000-5000 and 1000-2000 and one with student numbers 8000-10,000. Regarding the types of the universities. in the top there are 3 general universities with no medical schools, 2 each of teaching universities and specialty universities (文化大 in Japanese, not technical specialties but social sciences, fine arts, culture etc.) and 1 former imperial university, 1 university of technology and 1 general university with medical school. In the bottom we have 4 general universities with medical school, 2 general universities with no medical school and 1 each of teaching universities, medical schools, universities of technology and graduate schools (in this case a graduate school of technology).

We can conclude from the OLS estimation in chapter 5.6 that size effects are dominated by institution types, except for former imperial colleges and size 15,000+. The list underlines the results of the OLS estimation but only imperfectly. While we would expect teaching universities coming out top, we mostly see general universities in the top 10, while relative to numbers specialty colleges are the most representative (2 out of 4). Teaching universities are there but they are also present in the worst 10 list as well as number 76. The bad performance of general universities with medical schools is no surprise since they were the base dummy variables in the regressions and most university types had positive coefficients regarding efficiency. Therefore we would expect former imperial universities to be in the bottom.

On Table 9 we can see the ratio of the individual universities average indicators to every universities averages. Red cells mean that the university in question, on average, had a larger value for the given indicator than the sector wide average. Green cells mean the opposite.

Table 9. University average value divided by the average of all universities. Green cells are less than 1, red cells are larger than 1.

1	0.55	0.35	0.79	2.11	0.89	0.87	0.67	0.51	0.34	0.97	1.94	0.87	0.55	1.17	1.28	0.50	0.35
2	0.51	0.85	1.78	0.92	0.49	2.26	1.28	0.27	0.41	1.13	1.53	3.08	1.81	0.86	1.64	0.98	1.47
3	0.64	1.31	1.65	1.41	0.70	1.72	0.43	0.50	1.04	1.63	1.62	1.83	0.46	0.00	0.00	1.03	2.67
4	0.74	0.72	0.57	1.25	1.28	2.67	1.02	1.02	1.03	1.02	0.79	1.82	0.61	1.00	0.97	2.10	2.35
5	0.40	0.65	0.85	1.29	0.67	0.58	0.40	0.29	0.50	0.85	1.56	0.71	0.48	1.38	0.82	0.23	0.44
6	0.45	0.57	1.11	1.14	0.63	1.80	1.18	0.31	0.37	0.90	1.46	2.04	1.35	1.44	1.78	0.75	0.81
7	0.37	0.65	1.08	1.36	0.68	0.57	0.52	0.28	0.50	1.04	1.61	0.65	0.57	0.85	0.69	0.21	0.44
8	0.82	0.72	0.50	1.05	0.97	0.65	1.17	0.89	0.79	0.69	0.87	0.50	0.89	1.60	1.31	0.55	0.50
9	0.56	0.54	1.40	1.32	0.52	3.08	0.54	0.31	0.30	1.00	2.05	4.00	0.67	1.09	1.54	1.45	1.23
10	0.67	0.97	0.79	1.27	0.74	0.76	0.81	0.52	0.81	0.83	1.40	1.05	0.82	0.67	0.67	0.64	0.94
Rk	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
85	0.94	1.07	0.65	0.75	1.12	0.47	0.67	1.17	1.34	1.02	0.54	0.33	0.43	1.12	1.00	0.48	0.62
84	3.31	2.17	1.81	0.30	0.35	1.15	0.65	1.29	0.85	0.86	0.70	2.08	1.35	0.82	1.23	3.90	2.98
83	0.77	1.55	1.43	0.73	0.55	0.52	1.11	0.46	0.94	1.07	1.06	0.72	1.41	0.86	0.15	0.38	0.95
82	1.18	1.28	0.80	0.62	0.85	0.44	0.40	1.10	1.22	0.96	0.59	0.41	0.34	1.12	1.04	0.56	0.67
81	1.32	1.20	1.94	0.47	0.39	0.94	0.11	0.57	0.53	1.06	0.99	2.02	0.22	0.70	1.65	1.28	1.14
80	3.14	1.86	0.35	0.63	2.06	0.46	0.16	6.73	4.05	0.99	0.25	0.18	0.06	1.02	0.04	1.51	1.10
79	0.69	1.35	2.03	0.99	0.66	0.19	1.39	0.50	0.99	1.85	1.22	0.27	1.58	0.65	0.48	0.15	0.34
78	0.81	0.72	0.38	1.08	1.74	0.73	0.39	1.52	1.40	0.94	0.50	0.38	0.18	1.18	1.09	0.67	0.69
77	0.86	1.21	0.52	0.91	1.42	0.56	0.95	1.32	1.88	1.04	0.51	0.34	0.51	0.77	0.08	0.54	0.90
76	1.31	2.18	1.22	0.38	0.51	0.17	0.02	0.74	1.25	0.91	0.61	0.26	0.02	0.89	0.83	0.21	0.42

Source: Author calculation based on the financial statements and business reports of individual universities

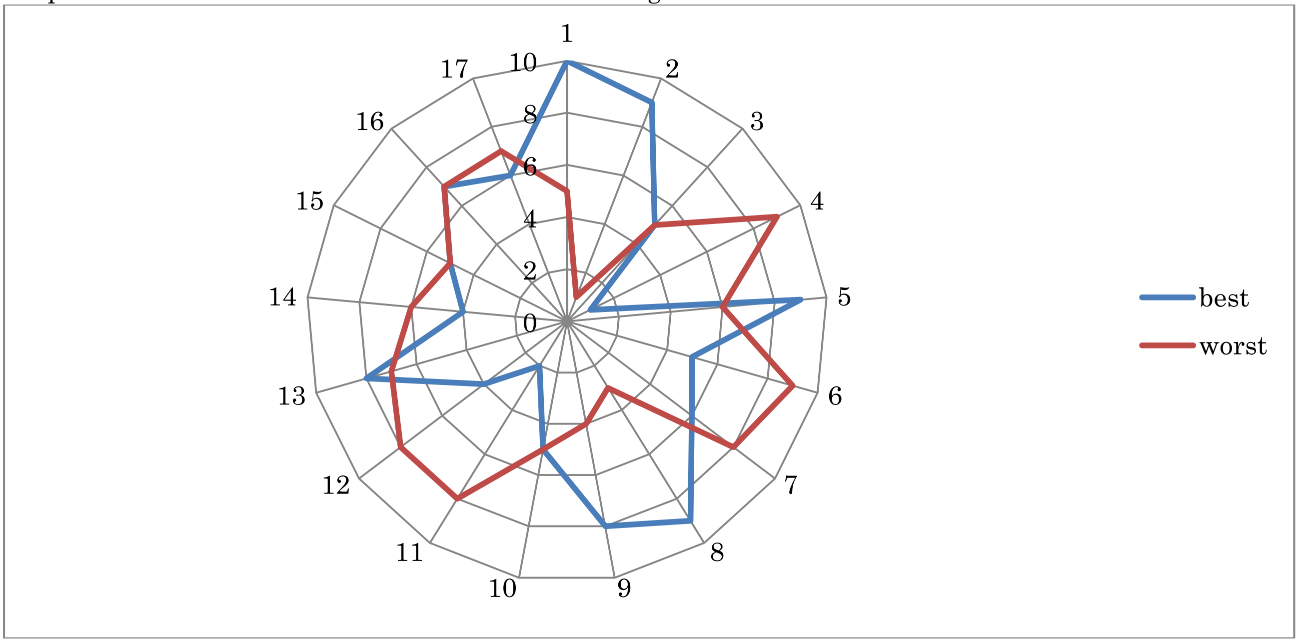
On Graph 14. there is a comparison regarding the number of under average indicators for the two groups of institutions. We can see that the biggest difference is in indicator 2 which is the general administrative cost per teacher indicator. In this case, 9 out of 10 top performers were under the average while from the worst performers we can find only 1 such institution. This correlates highly with indicator 4, that is the amount of teacher wage in JPY paid for 1 JPY of general administrative cost. As we can expect the relationship is the opposite. 1 JPY of general administrative cost pays for above average teacher wage in the best performing institutions (9 out of 10) and the opposite in case of the worst performers. What is interesting is that while for the worst performers the institutions are the mirror images in this indicator in the case of the best performers the above average in indicator 2 is university number 3 while the under average value in indicator 4 belongs to university number 2. This seems to suggest that while comparatively university number 2 has fewer teachers than the average, they pay them more.

While the same pattern can be observed regarding indicators 9 and 11, the differences are less pronounced. These are the same indicators with general administrative cost substituted by wages of the administrative staff. 2 institutions in the best performers group are below average in indicator 11 and the opposite is true for indicator 9. For the worst performers indicator 11 is similarly above average for 2 universities but in the case of indicator 9 there are 4 institutions below average.

Marked differences can also be observed with indicators 1, 6, 8 and 12. Respectively these are general administrative cost per student, government support per general administrative cost, admin wages per student and government support per admin wages. In case of indicator 1 all of the universities in the top group are below the average while in the bottom group half are. Indicator six has below average results for all institutions except one in the bottom 10 but in the top group half of the universities are only above average. Indicator 8 is very similar to indicator 1 with one university in the top group coming in above average but only with a minimal difference (2%), the bottom ten having one less institution below average than in indicator 1. Indicator 12 adds 1 institution to the above average group in the case of the worst performers raising their number to two, while in the top performers bracket one above average institution is added.

Regarding the remaining indicators the results are either mixed or skewed in the same direction.

Graph 14. The number of indicators under the average for the best and the worst 10 institutions

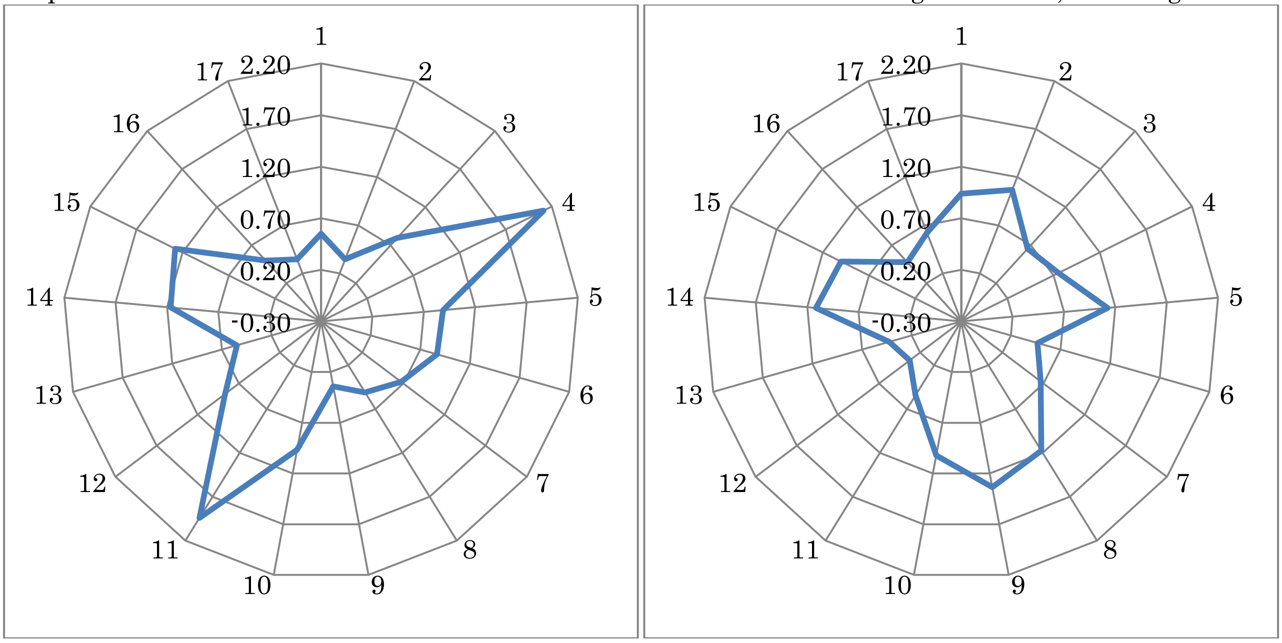


Source: Author calculation based on the financial statements and business reports of individual universities

On Graph 15. we can see a comparison of the best and the worst performer, where 1 means the sector average. The results are surprising. The best performer's values are markedly different from the average but not always in the way we would expect. For indicators 1, 2, 3, 8, 9, 10 they are under the average as we would predict but regarding the above average values of the remaining indicators we see that only 4, 11, 14 and 15 fit the bill. In case of the worst performer the situation is still stranger. Indicators 1, ,2, 5, 8, 9, 10, 14 and 15 are almost the same as the average. On Table 10. we can see the extremity of the indicators. Yellow cells stand for a difference of 1 standard deviation or more, while red cells stand for more than 2 standard deviations. The worst performer has no deviation from the mean that is at least one standard deviation large. The best performer on the other hand has an outlier value in indicators 4, 9 and 11.

It can generally be stated the standard deviation of the population is so big that large outliers are quite rare. For example in case of indicator 1 the standard deviation is more than 100%.

Graph 15. The best and the worst institution's indicator ratio to the average. Best left, worst right.



Source: Author calculation based on the financial statements and business reports of individual universities

Table 10. Deviation from the mean. Yellow background means larger than 1 standard deviation, while red background means more than 2

1	0.07	0.63	0.29	16.07	0.99	0.03	0.06	0.63	4.91	0.30	1.95	0.01	0.01	0.06	0.08	0.02	0.14
2	0.08	0.15	1.09	1.11	4.45	0.33	0.05	0.95	4.39	1.10	1.10	0.08	0.02	0.05	0.19	0.00	0.10
3	0.06	0.30	0.91	5.88	2.60	0.19	0.10	0.65	0.26	5.43	1.28	0.03	0.01	0.33	0.29	0.00	0.35
4	0.04	0.27	0.60	3.64	2.41	0.43	0.00	0.03	0.26	0.21	0.42	0.03	0.01	0.00	0.01	0.05	0.28
5	0.10	0.33	0.20	4.19	2.85	0.11	0.10	0.91	3.73	1.33	1.16	0.01	0.01	0.13	0.05	0.03	0.12
6	0.09	0.41	0.16	1.97	3.22	0.21	0.03	0.89	4.71	0.85	0.95	0.04	0.01	0.15	0.23	0.01	0.04
7	0.10	0.34	0.11	5.20	2.78	0.11	0.08	0.93	3.75	0.36	1.27	0.01	0.01	0.05	0.09	0.03	0.12
8	0.03	0.27	0.69	0.68	0.26	0.09	0.03	0.14	1.59	2.63	0.27	0.02	0.00	0.20	0.09	0.02	0.10
9	0.07	0.44	0.56	4.62	4.21	0.54	0.08	0.89	5.21	0.01	2.17	0.12	0.01	0.03	0.16	0.02	0.05
10	0.05	0.03	0.29	3.90	2.30	0.06	0.03	0.62	1.44	1.49	0.82	0.00	0.00	0.11	0.10	0.02	0.01
Rk	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
85	0.01	0.07	0.49	3.56	1.07	0.14	0.06	0.22	2.50	0.19	0.95	0.03	0.02	0.04	0.00	0.02	0.08
84	0.38	1.14	1.13	10.17	5.67	0.04	0.06	0.37	1.11	1.16	0.62	0.04	0.01	0.06	0.07	0.13	0.41
83	0.04	0.53	0.60	3.98	3.88	0.13	0.02	0.69	0.47	0.60	0.12	0.01	0.01	0.05	0.25	0.03	0.01
82	0.03	0.27	0.27	5.45	1.29	0.15	0.10	0.13	1.62	0.36	0.84	0.02	0.02	0.04	0.01	0.02	0.07
81	0.05	0.20	1.31	7.66	5.32	0.01	0.15	0.56	3.47	0.51	0.03	0.04	0.02	0.10	0.19	0.01	0.03
80	0.36	0.83	0.91	5.31	9.25	0.14	0.14	7.39	22.65	0.09	1.55	0.03	0.03	0.01	0.28	0.02	0.02
79	0.05	0.34	1.43	0.09	2.99	0.21	0.07	0.65	0.10	7.33	0.46	0.03	0.02	0.12	0.15	0.04	0.14
78	0.03	0.27	0.87	1.14	6.46	0.07	0.11	0.67	2.94	0.47	1.03	0.03	0.02	0.06	0.03	0.01	0.07
77	0.02	0.20	0.66	1.32	3.66	0.11	0.01	0.41	6.56	0.38	1.01	0.03	0.01	0.08	0.27	0.02	0.02
76	0.05	1.14	0.31	8.93	4.24	0.22	0.17	0.33	1.89	0.81	0.81	0.03	0.03	0.04	0.05	0.03	0.12

Source: Author calculation based on the financial statements and business reports of individual universities

6.3 DEA estimations

The DEA estimations are highly correlated with each other so the scores of institutions are much closer (Table 11.). The first difference in placing is in 3rd place while the estimations are equivalent in determining the last institution.

Table 11.The best and the worst performers according to the 3 DEA efficiency estimates

Nr	Best 10	Score	Nr	Worst 10	Score
1	Shizuoka University	1.0	85	Nagaoka University of Technology	85
2	TOHOKU UNIVERSITY	2.0	84	Japan Advanced Institute of Science and Technology	83.67
3	Osaka University	3.7	83	Kitami Institute of Technology	83.3
4	The University of Tokyo	4.3	82	Kanazawa University	82
5	Yokohama National University	5.3	81	University of the Ryukyus	80.67
6	Hamamatsu University School of Medicine	7.7	80	Kochi University	77.3
7	Hiroshima University	8.3	79	Iwate University	76.3
8	Kyoto University	9.3	78	Hyogo University of Teacher Education	76.3
9	Tokyo Gakugei University	12.0	77	Kyoto Institute of Technology	76
10	Kyoto University of Education	12.3	76	The University of Tokushima	75.7

Source: Author calculation.

Regarding the types and sizes of each university in the two groups the results are a bit more cohesive than in the above chapter. The top group has 4 former imperial universities, Two general universities with no medical school, two teaching universities and one medical school and one general university with medical school. The four former imperial universities all have sizes of 15,000+, two has size 8000-10,000 and 1000-2000, and one each of 10,000-15,000 and 3000-5000. The last 10 has 4 general universities with medical schools, three universities of technology, one graduate school, one teaching university and one general university with medical school.

In this result the problem with the multicolinearity of the OLS regression dummies former imperial university and size 15,000+ is quite obvious. According to the OLS estimation, being a former imperial universities should have a negative effect on efficiency but the size of these institutions are dominating this result by a lot. Teaching universities are still doing quite well, just like general universities with no medical school. In the bottom 10 we have the same number of general universities with medical school as before and three universities of technology. Universities of technology are not statistically significant as a type dummy when regressed on efficiency scores, so this suggests that they do not markedly differ from the worst performers (that is the baseline general university with medical school type).

On Table 12 we can again see the ratio of the individual universities average indicators to every universities averages. Red cells mean that the university in question, on average, had a larger value for the given indicator than the sector wide average. Green cells mean the opposite.

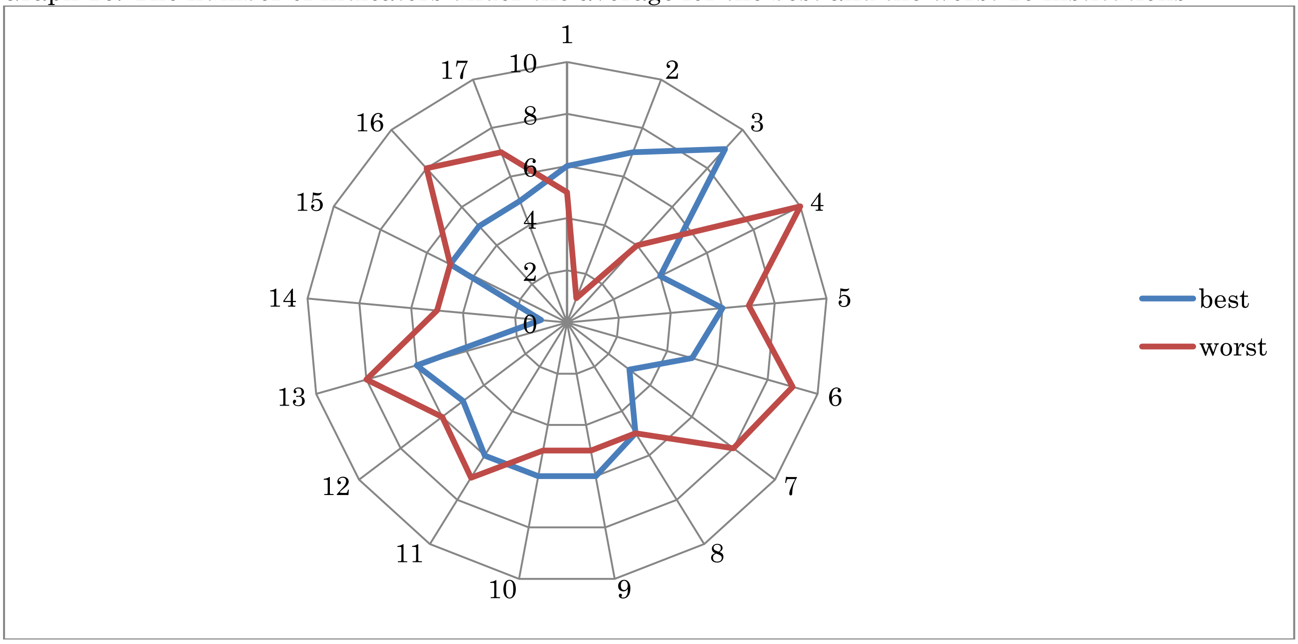
Table 12. University average value divided by the average of all universities. Green cells are less than 1, red cells are larger than 1

1	0.30	0.57	0.87	1.86	1.03	0.82	2.74	0.33	0.66	1.29	1.46	0.71	2.02	0.50	0.31	0.27	0.59
2	1.58	1.38	0.86	0.66	0.86	2.42	2.58	1.48	1.28	1.01	0.63	1.84	2.29	1.03	0.86	3.23	2.80
3	0.74	0.72	0.57	1.25	1.28	2.67	1.02	1.02	1.03	1.02	0.79	1.82	0.61	1.00	0.97	2.10	2.35
4	1.21	1.13	0.63	0.87	1.03	2.12	0.73	1.39	1.31	0.92	0.69	1.49	0.52	1.28	0.54	2.51	2.54
5	0.45	0.57	1.11	1.14	0.63	1.80	1.18	0.31	0.37	0.90	1.46	2.04	1.35	1.44	1.78	0.75	0.81
6	1.75	1.04	0.20	0.97	3.18	0.75	1.07	6.07	3.67	0.90	0.24	0.21	0.27	1.11	0.12	1.59	1.05
7	0.82	0.72	0.50	1.05	0.97	0.65	1.17	0.89	0.79	0.69	0.87	0.50	0.89	1.60	1.31	0.55	0.50
8	1.20	0.85	0.77	0.83	0.92	2.50	0.83	1.22	0.84	0.95	0.73	1.90	0.63	1.19	1.47	2.79	1.91
9	0.41	0.67	0.80	1.97	0.92	0.72	1.55	0.41	0.70	1.03	1.74	0.67	1.28	1.07	1.38	0.32	0.57
10	0.55	0.35	0.79	2.11	0.89	0.87	0.67	0.51	0.34	0.97	1.94	0.87	0.55	1.17	1.28	0.50	0.35
Rk	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
85	1.32	1.20	1.94	0.47	0.39	0.94	0.11	0.57	0.53	1.06	0.99	2.02	0.22	0.70	1.65	1.28	1.14
84	3.31	2.17	1.81	0.30	0.35	1.15	0.65	1.29	0.85	0.86	0.70	2.08	1.35	0.82	1.23	3.90	2.98
83	0.95	2.04	1.75	0.53	0.48	0.22	0.43	0.48	1.05	1.13	0.92	0.39	0.75	0.50	0.31	0.20	0.55
82	1.18	1.28	0.80	0.62	0.85	0.44	0.40	1.10	1.22	0.96	0.59	0.41	0.34	1.12	1.04	0.56	0.67
81	0.94	1.07	0.65	0.75	1.12	0.47	0.67	1.17	1.34	1.02	0.54	0.33	0.43	1.12	1.00	0.48	0.62
80	0.98	1.04	0.52	0.81	1.30	0.33	1.15	1.42	1.52	0.95	0.50	0.18	0.63	1.10	0.78	0.32	0.39
79	0.77	1.55	1.43	0.73	0.55	0.52	1.11	0.46	0.94	1.07	1.06	0.72	1.41	0.86	0.15	0.38	0.95
78	1.07	1.06	1.39	0.90	0.53	0.77	0.41	0.61	0.63	1.03	1.39	1.30	0.63	0.73	0.64	0.87	0.99
77	0.70	0.84	1.50	0.77	0.46	0.84	0.10	0.36	0.43	0.96	1.36	1.41	0.15	1.12	1.75	0.64	0.58
76	1.05	1.54	0.70	0.82	1.12	0.71	0.55	1.20	1.76	0.92	0.59	0.45	0.35	1.25	0.11	0.65	1.18

Source: Author calculation.

On Graph 16. we can see the number of institutions that are below the average value in each group. Mixed indicators in this case are indicators 1, 5, 8, 9, 10, 11, 12 and 15. The biggest difference is in indicator 2 and 4, general administrative cost per teacher and teacher's wages per general administrative cost just like in the previous chapter. However in this case both groups have one institution that has the 'wrong' deviation in one of the indicators. In the top group this is institution nr. 8 and in the bottom group it is nr. 77. In the top group, except for Osaka University and Tokyo University two of the three above average institutions are former imperial universities. In indicator 4 Osaka University is the one switching to below average wages per general administrative costs making it likely that the university might pay above average wages to its teaching staff. the same is true for nr. 77 The Kyoto Institute of Technology. Accordingly we would expect indicator 9 and 11 to be largely different for the two groups but it is not so. The next biggest difference is in indicators 3 and 7 that are general administrative cost per employee and business income per administrative cost respectively. We can see that 9 out of the ten top institutions have below average values in indicator 3 with the only exception being reasonably close to the average. In the bottom group the results are mixed and deviating from the average to a larger extent. In the case of indicator 7 the worst group is very much underperforming although due to the large standard deviation of the measure only two institutions reach the standard deviation range. The top group is pretty close to the average with a few positive and negative outliers. The next two indicators are indicators 6 and 14, government support per general administrative cost and the ratio of irregular employees respectively. In the case of the bottom group they underperform in measure 6 for all institutions but one while the top group result is mixed but the above average gains are well above 200% of the average (resulting in two institutions that are above standard deviation difference). Indicator 14 seems to be important since this is the ratio of irregular employees but a closer look at the results show near average values for both groups with no institutions reaching standard deviation range of differences. Last, indicators 13, 16 and 17 or business income per admin wages, government support per number of students and government support per number of teachers respectively. In the case of indicator 13 we see pattern as in indicator 5; underperforming institutions in the worst group and mixed performance in the top. Indicators 16 and 17 are similar to indicator 6, the worst group is under the average while the top group is mixed in this case as well. It is interesting to note that two institutions are above average in measures 16 and 17 with greater than standard deviation but they are not from the same group.

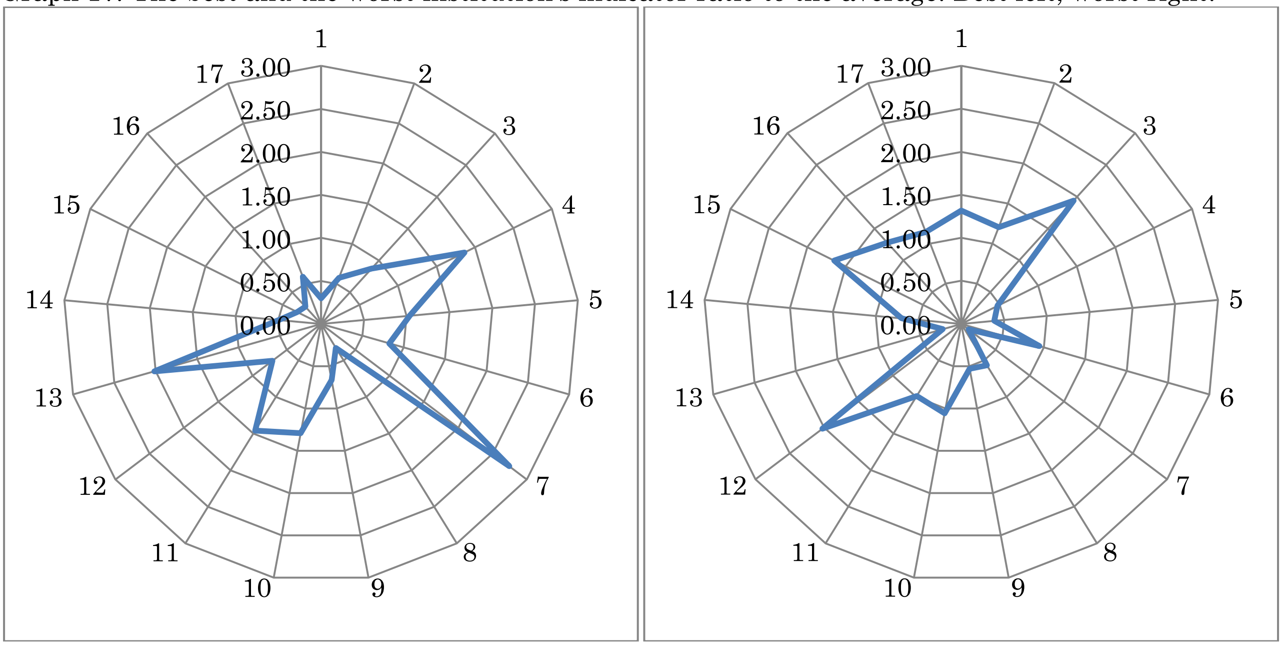
Graph 16. The number of indicators under the average for the best and the worst 10 institutions



Source: Author calculation.

In this case the unequivocal best and last performer of the three estimations are compared on graph 17 with nr.1 being on the left side and nr. 85 being on the right. As before the average value is 1. We have two standard deviation range differences in the case of nr.1 and 3 in the case of nr. 85. These are all in opposite directions with indicator 4 and 7 being common. the last institutions also adds indicator 3 to the list. The best performer has 'wrong' values in indicators 6, 12, 14, 15, 16 and 17 being under the average while the worst performer outperforms the average on indicators 10, 12, 15, 16 and 17.

Graph 17. The best and the worst institution's indicator ratio to the average. Best left, worst right.



Source: Author calculation.

Table 13. Deviation from the mean. Yellow cells mean larger than 1 standard deviation, while red cells means more than 2

1	0.12	0.41	0.18	12.48	0.30	0.05	0.30	0.87	2.51	2.50	0.94	0.01	0.03	0.17	0.20	0.03	0.09
2	0.10	0.36	0.20	4.85	1.25	0.37	0.27	0.62	2.08	0.11	0.77	0.03	0.04	0.01	0.04	0.10	0.38
3	0.04	0.27	0.60	3.64	2.41	0.43	0.00	0.03	0.26	0.21	0.42	0.03	0.01	0.00	0.01	0.05	0.28
4	0.04	0.12	0.52	1.81	0.25	0.29	0.05	0.51	2.30	0.65	0.65	0.02	0.01	0.09	0.13	0.07	0.32
5	0.09	0.41	0.16	1.97	3.22	0.21	0.03	0.89	4.71	0.85	0.95	0.04	0.01	0.15	0.23	0.01	0.04
6	0.13	0.04	1.12	0.49	18.95	0.07	0.01	6.55	19.82	0.82	1.56	0.03	0.02	0.04	0.26	0.03	0.01
7	0.03	0.27	0.69	0.68	0.26	0.09	0.03	0.14	1.59	2.63	0.27	0.02	0.00	0.20	0.09	0.02	0.10
8	0.03	0.14	0.32	2.48	0.71	0.39	0.03	0.28	1.17	0.46	0.56	0.04	0.01	0.06	0.14	0.08	0.19
9	0.10	0.32	0.28	14.03	0.73	0.07	0.10	0.76	2.26	0.28	1.53	0.01	0.01	0.02	0.11	0.03	0.09
10	0.07	0.63	0.29	16.07	0.99	0.03	0.06	0.63	4.91	0.30	1.95	0.01	0.01	0.06	0.08	0.02	0.14
Rk	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
85	0.05	0.20	1.31	7.66	5.32	0.01	0.15	0.56	3.47	0.51	0.03	0.04	0.02	0.10	0.19	0.01	0.03
84	0.38	1.14	1.13	10.17	5.67	0.04	0.06	0.37	1.11	1.16	0.62	0.04	0.01	0.06	0.07	0.13	0.41
83	0.01	1.01	1.04	6.74	4.54	0.20	0.10	0.67	0.39	1.14	0.16	0.02	0.01	0.17	0.20	0.04	0.09
82	0.03	0.27	0.27	5.45	1.29	0.15	0.10	0.13	1.62	0.36	0.84	0.02	0.02	0.04	0.01	0.02	0.07
81	0.01	0.07	0.49	3.56	1.07	0.14	0.06	0.22	2.50	0.19	0.95	0.03	0.02	0.04	0.00	0.02	0.08
80	0.00	0.04	0.67	2.68	2.65	0.17	0.03	0.54	3.89	0.45	1.02	0.03	0.01	0.03	0.06	0.03	0.13
79	0.04	0.53	0.60	3.98	3.88	0.13	0.02	0.69	0.47	0.60	0.12	0.01	0.01	0.05	0.25	0.03	0.01
78	0.01	0.06	0.55	1.45	4.11	0.06	0.10	0.51	2.74	0.26	0.81	0.01	0.01	0.09	0.10	0.01	0.00
77	0.05	0.15	0.70	3.37	4.72	0.04	0.16	0.83	4.27	0.37	0.74	0.02	0.02	0.04	0.22	0.02	0.09
76	0.01	0.52	0.42	2.66	1.05	0.07	0.08	0.25	5.68	0.72	0.85	0.02	0.02	0.08	0.26	0.02	0.04

Source: Author calculation.

6.4 All 3 SFA estimations

The averages of the scores in this case are less consistent than in case of the DEA results. The first get 4.7 points on average and the last has 81.7. There is a tie for places 76 and 78.

Table 14.The best and the worst performers according to the 3 SFA efficiency estimates

Nr	Best 10	Score	Nr	Worst 10	Score
1	Ochanomizu University	4.7	83	Tokyo Medical and Dental University	81.7
2	Nara Women's University	6.3	82	Shiga University of Medical Science	80.3
3	Tokyo University of Foreign Studies	7.7	81	Hamamatsu University School of Medicine	73.7
4	Nagoya Institute of Technology	11.0	80	University of the Ryukyus	72.0
5	Nara University of Education	11.3	79	Kagoshima University	69.7
6	Kyoto University of Education	11.7	78	Tokyo Institute of Technology	69.3
7	Shiga University	12.7	78	Iwate University	69.3
8	Wakayama University	14.7	77	Nagasaki University	69.0
9	Tokyo University of Marine Science and Technology	18.3	76	Japan Advanced Institute of Science and Technology	67.0
10	Miyagi University of Education	19.0	76	Utsunomiya University	67.0

Source: Author calculation.

In the top group we have 3 teaching universities, 3 general universities with no medical school, two specialty universities and two universities of technology. In the bottom group we have 3 general universities with medical school, three medical schools, two general universities with no medical school, one graduate school and one university of technology. Sizewise, both the top and the bottom group has mainly smaller institutions: three 1000-2000, 2000-3000 and 3000-5000 and one 5000-8000 institutions in the top group, while three 8000-10,000, two 5000-8000, two 1000-2000, and one -1000 and 3000-5000 each. According to the OLS estimation, SFA regression (2) contributes a considerable negative effect to the size dummy 8000-10000 and that is what we see on the list. In the next chapter this might vanish since this result is significant only in estimation SFA (2). The same is true with the opposite effect of the type dummy general university with no medical school; significant positive effect based on SFA estimation (3). Regarding teaching universities, graduate schools, specialty universities and universities of technology the results are strongly positive in the case of SFA (3) but insignificant mostly in the other two instances. The positive effect of (3) is sometimes also turned on its head. This positive effect for all type dummies is probably responsible for the bad performance of general universities with medical school types.

On Table 15. we can again see the ratio of the individual universities average indicators to every universities averages. Red cells mean that the university in question, on average, had a larger value for the given indicator than the sector wide average. Green cells mean the opposite.

Table 15. University average value divided by the average of all universities. Green cells are less than 1, red cells are larger than 1

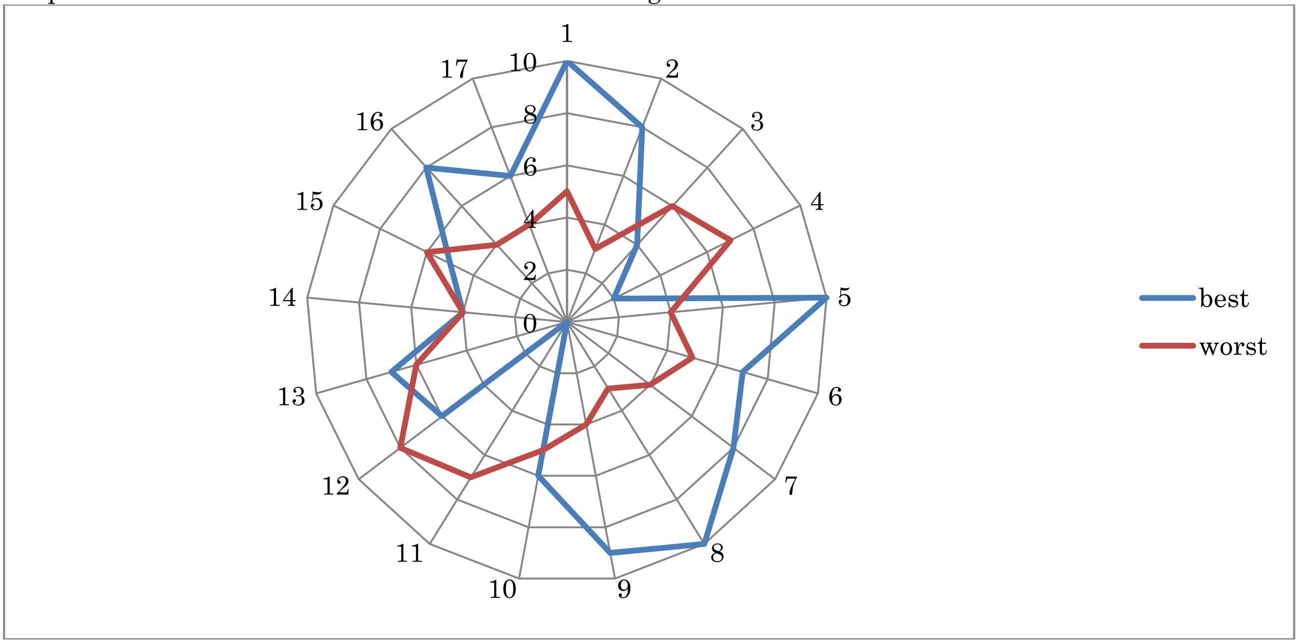
1	0.56	0.54	1.40	1.32	0.52	3.08	0.54	0.31	0.30	1.00	2.05	4.00	0.67	1.09	1.54	1.45	1.23
2	0.69	0.68	0.79	1.02	0.47	0.49	0.89	0.36	0.36	0.53	1.76	0.78	1.38	2.03	1.45	0.33	0.33
3	0.51	0.85	1.78	0.92	0.49	2.26	1.28	0.27	0.41	1.13	1.53	3.08	1.81	0.86	1.64	0.98	1.47
4	0.64	1.48	1.03	0.69	0.44	0.58	0.42	0.31	0.73	0.66	1.26	0.94	0.69	1.76	0.67	0.37	1.02
5	0.64	1.31	1.65	1.41	0.70	1.72	0.43	0.50	1.04	1.63	1.62	1.83	0.46	0.00	0.00	1.03	2.67
6	0.55	0.35	0.79	2.11	0.89	0.87	0.67	0.51	0.34	0.97	1.94	0.87	0.55	1.17	1.28	0.50	0.35
7	0.40	0.65	0.85	1.29	0.67	0.58	0.40	0.29	0.50	0.85	1.56	0.71	0.48	1.38	0.82	0.23	0.44
8	0.37	0.65	1.08	1.36	0.68	0.57	0.52	0.28	0.50	1.04	1.61	0.65	0.57	0.85	0.69	0.21	0.44
9	0.67	0.97	0.79	1.27	0.74	0.76	0.81	0.52	0.81	0.83	1.40	1.05	0.82	0.67	0.67	0.64	0.94
10	0.68	0.43	1.10	1.23	0.64	0.58	1.40	0.47	0.30	0.96	1.56	0.67	1.64	1.13	1.82	0.36	0.28
Rk	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
83	1.66	0.60	0.27	1.20	2.73	2.21	1.03	4.74	1.77	1.03	0.35	0.71	0.27	1.33	1.47	4.11	1.63
82	3.14	1.86	0.35	0.63	2.06	0.46	0.16	6.73	4.05	0.99	0.25	0.18	0.06	1.02	0.04	1.51	1.10
81	1.75	1.04	0.20	0.97	3.18	0.75	1.07	6.07	3.67	0.90	0.24	0.21	0.27	1.11	0.12	1.59	1.05
80	0.94	1.07	0.65	0.75	1.12	0.47	0.67	1.17	1.34	1.02	0.54	0.33	0.43	1.12	1.00	0.48	0.62
79	0.53	0.87	0.31	1.76	2.58	1.57	1.64	1.11	1.85	0.93	0.54	0.64	0.56	1.20	0.03	0.84	1.70
78	0.77	1.55	1.43	0.73	0.55	0.52	1.11	0.46	0.94	1.07	1.06	0.72	1.41	0.86	0.15	0.38	0.95
78	1.42	1.74	1.46	0.59	0.41	2.12	0.84	0.65	0.81	0.85	1.15	3.83	1.48	1.51	0.50	3.30	4.51
77	0.65	0.49	0.39	1.30	1.81	1.45	1.55	1.28	1.02	1.01	0.58	0.68	0.67	0.88	1.61	1.04	0.83
76	0.69	1.35	2.03	0.99	0.66	0.19	1.39	0.50	0.99	1.85	1.22	0.27	1.58	0.65	0.48	0.15	0.34
76	3.31	2.17	1.81	0.30	0.35	1.15	0.65	1.29	0.85	0.86	0.70	2.08	1.35	0.82	1.23	3.90	2.98

Source: Author calculation.

Checking Graph 18. we can see that the biggest discrepancy is in indicators 8 and 11 that are admin wages per student and teaching wages per admin wages respectively. In the top group all of the institutions are either under or over the average value in these indicators. In case of indicator 8 we do not see larger than standard deviation in the top group but we see two in case of indicator 11. On the other hand, in the bottom group, out of the seven institutions over the average, the worst three are over the average with more than two standard deviations. By now it is obvious that 2 standard deviations are quite rare in the sample so this might not be a coincidence. In indicator 11 there is no deviation over standard deviation for the bottom group. The next is indicator 5, admin wages per general administrative cost. In this case all of the institutions in the top group are *below* average. This is surprising since this indicator is the higher the better. We can say that the bottom group has better performance in this case, with even positive outlier values of up to 2 standard deviation in 3 cases. Indicators 1, 2, 4 and 9 are less confusing. In all instances the direction of the difference is right on average, and the bottom group has large deviations in the negative direction in all of them, but especially indicators 1, 5 and 9. Indicators 7 and 16, business income per general administrative cost and government support per student the deviation directions re wrong again in the case of the top group: they are under the average for most part in these measures with the bottom group coming out on top.

The remaining indicators are mixed. From the data we might conclude that SFA estimation puts a large emphasis on hue outlier values but from the next chapter we will see that this is not the case.

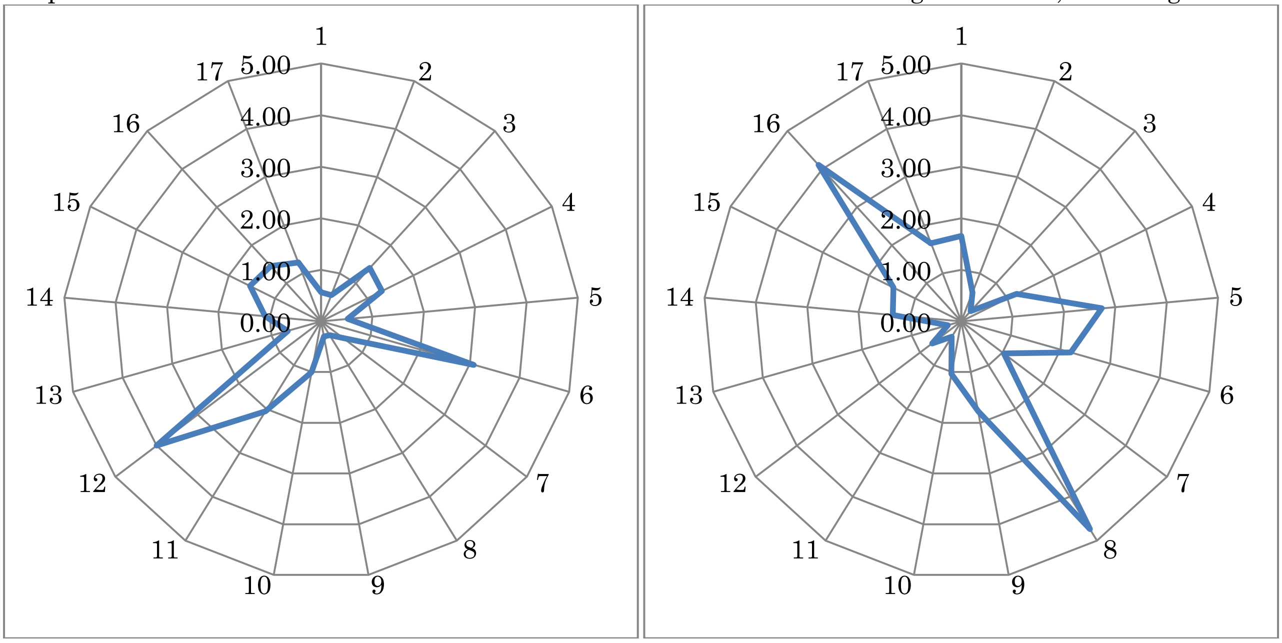
Graph 18. The number of indicators under the average for the best and the worst 10 institutions



Source: Author calculation.

We can see the best and the worst institution on Graph 19. it is an interesting comparison, since the top institution has a bad sign in indicators 3, 5, 11, 12, 14, 15, 16 and 17 and 11 and 12 out of these is larger than standard deviation. In case of the other indicators the signs are correct and 6 and 9 is greater than standard deviation. In the case of the last institution the results are the same mixed bag. Indicators 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13 have the wrong sign. 5 and 8 has higher than 2 standard deviation and 9 is higher than standard deviation. We cannot even say that the outliers in the remaining indicators threw the results off since there is only a single higher than standard deviation value in case of indicator 16.

Graph 19. The best and the worst institution's indicator ratio to the average. Best left, worst right.



Source: Author calculation.

Table 16. Deviation from the mean. Yellow cells mean larger than 1 standard deviation, while red cells means more than 2

1	0.07	0.44	0.56	4.62	4.21	0.54	0.08	0.89	5.21	0.01	2.17	0.12	0.01	0.03	0.16	0.02	0.05
2	0.05	0.31	0.30	0.35	4.60	0.13	0.02	0.83	4.75	4.06	1.57	0.01	0.01	0.34	0.13	0.03	0.14
3	0.08	0.15	1.09	1.11	4.45	0.33	0.05	0.95	4.39	1.10	1.10	0.08	0.02	0.05	0.19	0.00	0.10
4	0.06	0.46	0.04	4.56	4.87	0.11	0.10	0.89	1.99	2.96	0.54	0.00	0.01	0.25	0.10	0.03	0.00
5	0.06	0.30	0.91	5.88	2.60	0.19	0.10	0.65	0.26	5.43	1.28	0.03	0.01	0.33	0.29	0.00	0.35
6	0.07	0.63	0.29	16.07	0.99	0.03	0.06	0.63	4.91	0.30	1.95	0.01	0.01	0.06	0.08	0.02	0.14
7	0.10	0.33	0.20	4.19	2.85	0.11	0.10	0.91	3.73	1.33	1.16	0.01	0.01	0.13	0.05	0.03	0.12
8	0.10	0.34	0.11	5.20	2.78	0.11	0.08	0.93	3.75	0.36	1.27	0.01	0.01	0.05	0.09	0.03	0.12
9	0.05	0.03	0.29	3.90	2.30	0.06	0.03	0.62	1.44	1.49	0.82	0.00	0.00	0.11	0.10	0.02	0.01
10	0.05	0.56	0.14	3.39	3.11	0.11	0.07	0.69	5.24	0.34	1.16	0.01	0.02	0.04	0.24	0.03	0.15
Rk	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
83	0.11	0.39	1.02	2.85	15.06	0.31	0.01	4.83	5.76	0.29	1.34	0.01	0.02	0.11	0.14	0.14	0.13
82	0.36	0.83	0.91	5.31	9.25	0.14	0.14	7.39	22.65	0.09	1.55	0.03	0.03	0.01	0.28	0.02	0.02
81	0.13	0.04	1.12	0.49	18.95	0.07	0.01	6.55	19.82	0.82	1.56	0.03	0.02	0.04	0.26	0.03	0.01
80	0.01	0.07	0.49	3.56	1.07	0.14	0.06	0.22	2.50	0.19	0.95	0.03	0.02	0.04	0.00	0.02	0.08
79	0.08	0.12	0.97	10.94	13.76	0.15	0.11	0.14	6.30	0.61	0.95	0.01	0.01	0.07	0.29	0.01	0.15
78	0.04	0.53	0.60	3.98	3.88	0.13	0.02	0.69	0.47	0.60	0.12	0.01	0.01	0.05	0.25	0.03	0.01
78	0.07	0.71	0.65	5.98	5.10	0.29	0.03	0.45	1.43	1.31	0.31	0.11	0.01	0.17	0.15	0.10	0.73
77	0.06	0.49	0.85	4.33	7.03	0.12	0.10	0.36	0.18	0.08	0.87	0.01	0.01	0.04	0.18	0.00	0.04
76	0.05	0.34	1.43	0.09	2.99	0.21	0.07	0.65	0.10	7.33	0.46	0.03	0.02	0.12	0.15	0.04	0.14
76	0.38	1.14	1.13	10.17	5.67	0.04	0.06	0.37	1.11	1.16	0.62	0.04	0.01	0.06	0.07	0.13	0.41

Source: Author calculation.

6.5 2 SFA estimations

The previous analysis has strengthened the grounds for excluding the result of SFA estimation (3) from the results. In this case only the results that included a large number of explanatory variables for the initial frontier estimation remain (namely SFA estimations (1) and (2)). We can see that in line with the greater correlation in the scores we get less widely ranging scores for the top and bottom institutions.

Table 17. The best and the worst performers according to SFA efficiency estimates (1) and (2)

Nr	Best 10	Score	Nr	Worst 10	Score
1	Nagoya Institute of Technology	5	85	Tokyo Medical and Dental University	83.5
2	Kagawa University	5	84	Iwate University	82.5
3	Ochanomizu University	5	83	Tokyo Institute of Technology	82
4	Nara Women's University	6.5	82	Fukuoka University of education	80.5
5	Osaka University	8	81	Shiga University of Medical Science	80.5
6	Gifu University	8.5	80	Utsunomiya University	80
7	University of Toyama	10.5	79	Japan Advanced Institute of Science and Technology	79.5
8	Tokyo University of Foreign Studies	11	78	National Institute of Fitness and Sports in KANOYA	74
9	Kyoto University of Education	13	77	Hokkaido University of Education	73.5
10	Nara University of Education	13.5	76	Shizuoka University	72.5

Source: Author calculation.

The distribution of types and sizes in the two groups are as follows: We have three general universities with medical school, two teaching universities, two general universities without medical school, one specialty college, one university of technology and one former imperial university in the top 10; while there are three teaching universities, three general universities with no medical school, two medical schools, one graduate school and one university of technology in the bottom 10. The sizes in the top 10 and the bottom 10 are mixed with 5000-8000 being the most common in the top with 3 institutions and no more than two of each type in the bottom.

This is the first time that general universities with medical school are in the top 10, also the mixed performance of teaching universities are interesting. It is worth mentioning that on this list nr. 76 is the same university that was the winner in every DEA estimation.

On Table 18. we can again see the ratio of the individual universities average indicators to every universities averages. Red cells mean that the university in question on average had a larger value for the given indicator than the sector wide average. Green cells mean the opposite.

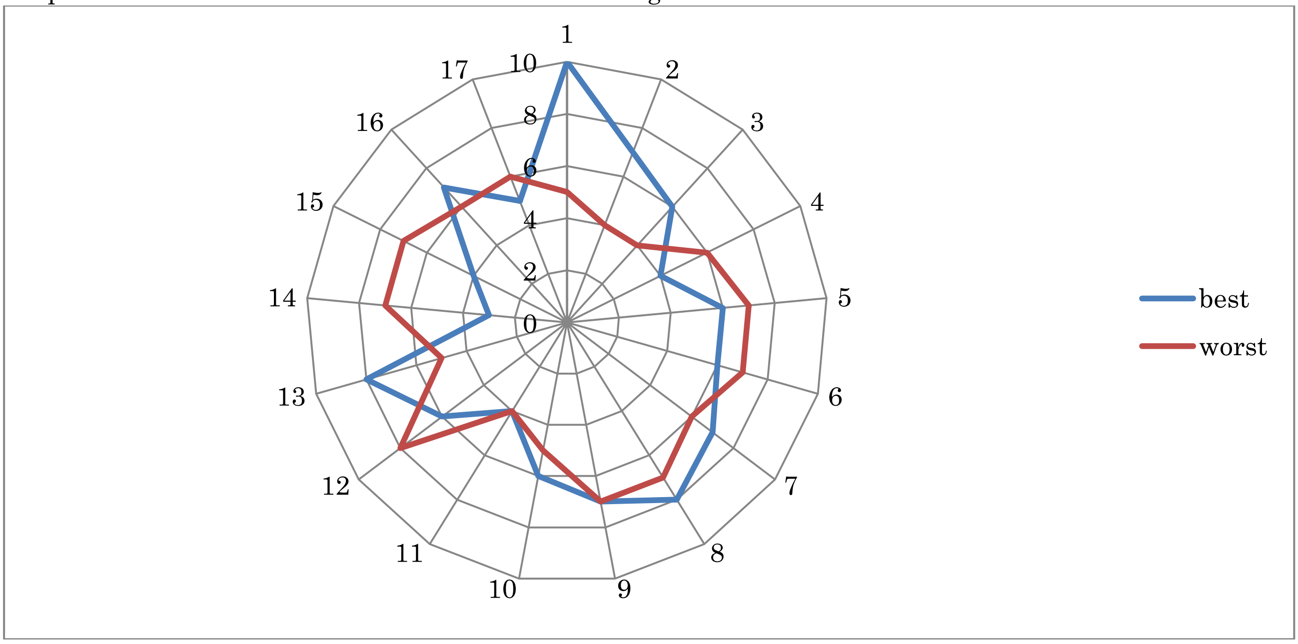
Table 18. University average value divided by the average of all universities. Green cells are less than 1, red cells are larger than 1

1	0.64	1.48	1.03	0.69	0.44	0.58	0.42	0.31	0.73	0.66	1.26	0.94	0.69	1.76	0.67	0.37	1.02
2	0.73	0.85	0.45	1.04	1.36	0.54	1.25	1.11	1.31	0.88	0.62	0.30	0.66	0.88	0.76	0.41	0.54
3	0.56	0.54	1.40	1.32	0.52	3.08	0.54	0.31	0.30	1.00	2.05	4.00	0.67	1.09	1.54	1.45	1.23
4	0.69	0.68	0.79	1.02	0.47	0.49	0.89	0.36	0.36	0.53	1.76	0.78	1.38	2.03	1.45	0.33	0.33
5	0.74	0.72	0.57	1.25	1.28	2.67	1.02	1.02	1.03	1.02	0.79	1.82	0.61	1.00	0.97	2.10	2.35
6	0.95	1.14	0.68	0.86	1.02	0.45	0.49	1.00	1.14	0.83	0.68	0.30	0.31	1.12	1.06	0.36	0.45
7	0.69	0.71	0.51	0.90	1.24	0.72	0.83	0.94	0.96	0.86	0.59	0.41	0.48	1.03	1.27	0.48	0.57
8	0.51	0.85	1.78	0.92	0.49	2.26	1.28	0.27	0.41	1.13	1.53	3.08	1.81	0.86	1.64	0.98	1.47
9	0.55	0.35	0.79	2.11	0.89	0.87	0.67	0.51	0.34	0.97	1.94	0.87	0.55	1.17	1.28	0.50	0.35
10	0.64	1.31	1.65	1.41	0.70	1.72	0.43	0.50	1.04	1.63	1.62	1.83	0.46	0.00	0.00	1.03	2.67
Rk	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
85	1.66	0.60	0.27	1.20	2.73	2.21	1.03	4.74	1.77	1.03	0.35	0.71	0.27	1.33	1.47	4.11	1.63
84	0.77	1.55	1.43	0.73	0.55	0.52	1.11	0.46	0.94	1.07	1.06	0.72	1.41	0.86	0.15	0.38	0.95
83	1.42	1.74	1.46	0.59	0.41	2.12	0.84	0.65	0.81	0.85	1.15	3.83	1.48	1.51	0.50	3.30	4.51
82	3.14	1.86	0.35	0.63	2.06	0.46	0.16	6.73	4.05	0.99	0.25	0.18	0.06	1.02	0.04	1.51	1.10
81	0.51	0.69	1.09	1.26	0.60	0.29	0.35	0.34	0.40	0.80	3.62	0.37	0.54	0.79	1.15	0.17	0.22
80	0.69	1.35	2.03	0.99	0.66	0.19	1.39	0.50	0.99	1.85	1.22	0.27	1.58	0.65	0.48	0.15	0.34
79	3.31	2.17	1.81	0.30	0.35	1.15	0.65	1.29	0.85	0.86	0.70	2.08	1.35	0.82	1.23	3.90	2.98
78	1.31	2.18	1.22	0.38	0.51	0.17	0.02	0.74	1.25	0.91	0.61	0.26	0.02	0.89	0.83	0.21	0.42
77	0.42	0.58	0.95	1.60	0.77	0.71	0.38	0.36	0.49	1.04	1.66	0.65	0.36	0.57	0.83	0.26	0.35
76	0.30	0.57	0.87	1.86	1.03	0.82	2.74	0.33	0.66	1.29	1.46	0.71	2.02	0.50	0.31	0.27	0.59

Source: Author calculation.

We have much less extreme results in the case of the indicator numbers in this batch of institution grouping. Indicators 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16 and 17 are mixed and close to each other regarding the group distribution in deviation from the average. About half of these groups have the right sign of deviation. Indicator 1 has the biggest difference. In this case all the top group performers are below average but not by much while the bottom group is mixed but it has two outliers in the right direction. In case of indicator 14, the signs are in the right direction and the top group has 3 outlying values out of which one should be ignored, since it is a 0, because the university in question did not report irregular teacher and irregular employee numbers. Indicators 2, 13 and 15 are also markedly different. In case of indicators 2 and 15, the signs are right but in the case of 13 the signs of the top group are 'wrong'.

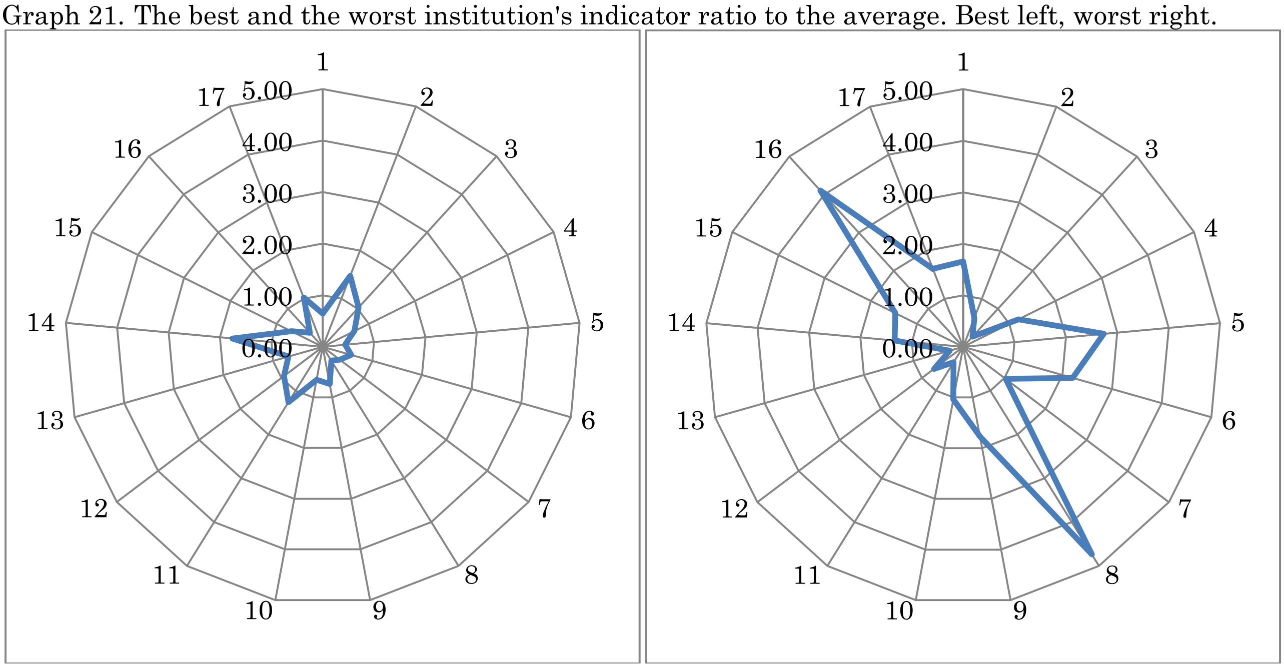
Graph 20. The number of indicators under the average for the best and the worst 10 institutions



Source: Author calculation.

The best institution has a bad sing in indicators 2, 3, 12, 13, 15 and 16, with outlier values in 10 and 14. The worst institution has 'wrong' sign in indicators 2, 3, 4, 5, 6 7, 14, 15, 16 and 17 with a value over the standard deviation range in case of indicators 10 and 14.

Graph 21. The best and the worst institution's indicator ratio to the average. Best left, worst right.



Source: Author calculation.

Table 19. Deviation from the mean. Yellow cells mean larger than 1 standard deviation, while red cells means more than 2

1	0.06	0.46	0.04	4.56	4.87	0.11	0.10	0.89	1.99	2.96	0.54	0.00	0.01	0.25	0.10	0.03	0.00
2	0.04	0.14	0.76	0.56	3.15	0.12	0.04	0.14	2.32	1.05	0.79	0.03	0.01	0.04	0.07	0.03	0.10
3	0.07	0.44	0.56	4.62	4.21	0.54	0.08	0.89	5.21	0.01	2.17	0.12	0.01	0.03	0.16	0.02	0.05
4	0.05	0.31	0.30	0.35	4.60	0.13	0.02	0.83	4.75	4.06	1.57	0.01	0.01	0.34	0.13	0.03	0.14
5	0.04	0.27	0.60	3.64	2.41	0.43	0.00	0.03	0.26	0.21	0.42	0.03	0.01	0.00	0.01	0.05	0.28
6	0.01	0.14	0.45	2.05	0.19	0.14	0.09	0.00	1.04	1.49	0.67	0.03	0.02	0.04	0.02	0.03	0.12
7	0.05	0.28	0.69	1.49	2.07	0.07	0.03	0.08	0.31	1.20	0.85	0.02	0.01	0.01	0.08	0.02	0.09
8	0.08	0.15	1.09	1.11	4.45	0.33	0.05	0.95	4.39	1.10	1.10	0.08	0.02	0.05	0.19	0.00	0.10
9	0.07	0.63	0.29	16.07	0.99	0.03	0.06	0.63	4.91	0.30	1.95	0.01	0.01	0.06	0.08	0.02	0.14
10	0.06	0.30	0.91	5.88	2.60	0.19	0.10	0.65	0.26	5.43	1.28	0.03	0.01	0.33	0.29	0.00	0.35
Rk	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
85	0.11	0.39	1.02	2.85	15.06	0.31	0.01	4.83	5.76	0.29	1.34	0.01	0.02	0.11	0.14	0.14	0.13
84	0.04	0.53	0.60	3.98	3.88	0.13	0.02	0.69	0.47	0.60	0.12	0.01	0.01	0.05	0.25	0.03	0.01
83	0.07	0.71	0.65	5.98	5.10	0.29	0.03	0.45	1.43	1.31	0.31	0.11	0.01	0.17	0.15	0.10	0.73
82	0.36	0.83	0.91	5.31	9.25	0.14	0.14	7.39	22.65	0.09	1.55	0.03	0.03	0.01	0.28	0.02	0.02
81	0.08	0.30	0.12	3.70	3.50	0.19	0.11	0.86	4.49	1.73	5.42	0.03	0.01	0.07	0.05	0.04	0.16
80	0.05	0.34	1.43	0.09	2.99	0.21	0.07	0.65	0.10	7.33	0.46	0.03	0.02	0.12	0.15	0.04	0.14
79	0.38	1.14	1.13	10.17	5.67	0.04	0.06	0.37	1.11	1.16	0.62	0.04	0.01	0.06	0.07	0.13	0.41
78	0.05	1.14	0.31	8.93	4.24	0.22	0.17	0.33	1.89	0.81	0.81	0.03	0.03	0.04	0.05	0.03	0.12
77	0.10	0.40	0.06	8.74	1.95	0.07	0.11	0.83	3.77	0.31	1.37	0.01	0.02	0.14	0.05	0.03	0.14
76	0.12	0.41	0.18	12.48	0.30	0.05	0.30	0.87	2.51	2.50	0.94	0.01	0.03	0.17	0.20	0.03	0.09

Source: Author calculation.

7 Implications and conclusion

The main goal of this paper is to see whether administrative efficiency improved after the reform. Based on data published by the universities from 2004 to 2009 I think we can conclude that the results are mixed and dependent on the estimation method.

The three DEA estimation results indicate that there was indeed an efficiency increase although the magnitude of the change varies from 4% to 21% depending on different DEA models used. The average yearly value for inefficiency was similarly ranging from 11% to almost 50%. According to the pure DEA results the ratio of institutions that managed a positive change in efficiency were 70% from 2004 to 2005 and after dropping close to 50% it steadily climbs back to more than 90%. This suggests yearly improvement and also the fact that 'learning by doing' is happening while admittedly it does not account for external factors. The two staged DEA results, where the indicators were stripped of certain environmental factors, consistently show much lower performance. The results for the SFA estimations are not so favorable for the universities. Out of the 3 regressions, in one case the average efficiency for the last year was below the starting value, one had minor improvement while only in one case did it increase significantly.

In the two latter cases most of the increase happened in the first two years followed by stagnation or even a slight decline.

In general it can be said that there is little efficiency of scale except for the biggest of universities. The most important factor of efficiency seems to be the type of university. It should warrant further examination as to the reasons behind this. I suspect that those universities have extra expenses that show up under the same accounting category. The presence of general universities with medical schools on the list is probably due to the administrative costs taht are connected to healthcare functions. The location of the university seems unimportant as well as the popularity of the institution. It seems true that for institutions that have no profit motive basic expectations behave differently than in the for profit sector.

Regarding the initial assumptions, namely that universities will have an increase in efficiency that is more and more pronounced the more time passes we can say that all three DEA estimations support this conclusion. The magnitudes vary but there is a visible improvement. The SFA estimations do not support the prediction.

As for the future, it is difficult to make predictions based on the results. With the relative decrease of funding that is almost sure to come, I expect bigger and bigger administrative efficiency since my previous knowledge suggests that this is the area where they will start cost cutting when push comes to shove. All predictions leave ample room for improvement even for catching up to the best performers, let alone an absolute efficient institution. A possible next step based on this paper could be the closer analysis of the best performers. The level of detail of the data that was available in this paper this is as deep as one can go but it is obvious that there are other interesting aspects. Since institution types and size were important but definitely not everything, it would be worthwhile to see what other factors are significant in deciding efficiency. For example I would like to know the answers to such questions as: How much of the administrative functions are outsourced? Is there a meritocratic system for advancement regarding the employees? How are the salaries determined? What are the differences in accounting practices, regarding different institutions?

In closing I have to say that I expected robust results based on the two methods. Some shortcomings of both estimation techniques came to light in this paper. I have provided so many different estimation results because I did not want to cherry-pick the result that supports my conclusion the most. At the moment I can only pinpoint the possible reasons for the differences. In the future after a closer look, a decisive conclusion might be reached.

8 References

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9 Appendix

Table 20. Correlation of main variables

	I_ASC	I_OAC	O_STS	O_TNS	O_BIO	O_TGG	O_TNE
I_ASC	1						
I_OAC	0.8809	1					
O_STS	0.9568	0.924	1				
O_TNS	0.8796	0.8762	0.952	1			
O_BIO	0.656	0.706	0.6563	0.5961	1		
O_TGG	0.5181	0.5771	0.541	0.5077	0.5446	1	
O_TNE	0.921	0.8734	0.907	0.8467	0.6637	0.6229	1

Source: Author calculations based on the financial statements and business reports of individual universities.

Table 21. DEA Window analysis

Name of University	2004	2005	2006	2007	2008	2009	Average	Variance
Hokkaido University	0.9059	0.8634	0.8606	0.7945			0.8561	0.0021
		0.8725	0.8655	0.8033	0.7648		0.8265	0.0027
			0.8657	0.8038	0.7650	0.8754	0.8275	0.0027
TOHOKU UNIVERSITY	0.9829	1.0000	1.0000	1.0000			0.9957	0.0001
		1.0000	1.0000	1.0000	1.0000		1.0000	0
			1.0000	1.0000	0.9619	1.0000	0.9905	0.0004
The University of Tokyo	1.0000	0.9888	1.0000	1.0000			0.9972	0.0000
		0.9888	1.0000	0.9590	1.0000		0.9870	0.0004
			1.0000	0.9266	0.9406	1.0000	0.9668	0.0015
Nagoya University	0.6287	0.7156	0.7776	0.7671			0.7222	0.0046
		0.7170	0.7795	0.7648	0.7692		0.7576	0.0008
			0.7805	0.7540	0.6898	0.7898	0.7535	0.0020
Kyoto University	1.0000	0.8836	1.0000	1.0000			0.9709	0.0034
		0.8563	0.9587	0.9323	1.0000		0.9368	0.0037
			0.9274	0.8883	0.9284	0.9491	0.9233	0.0006
Osaka University	1.0000	0.9370	0.9735	1.0000			0.9776	0.0009
		0.9388	0.9756	1.0000	1.0000		0.9786	0.0008
			0.9763	1.0000	1.0000	1.0000	0.9941	0.0001
Kyushu University	0.7430	0.7096	0.8688	0.8193			0.7852	0.0052
		0.7120	0.8690	0.8122	0.8551		0.8121	0.0050
			0.8690	0.8063	0.8445	0.9073	0.8568	0.0018
Hokkaido University of Education	0.7395	0.8328	1.0000	0.9512			0.8809	0.0138
		0.8297	1.0000	0.9540	1.0000		0.9459	0.0065
			1.0000	0.9352	1.0000	1.0000	0.9838	0.0010
Miyagi University of Education	0.5432	0.7930	0.7958	0.8553			0.7469	0.0193
		0.8209	0.8194	0.8707	0.8688		0.8449	0.0008
			0.8354	0.8743	0.8751	0.9145	0.8748	0.0010
Tokyo Gakugei University	0.9161	0.9868	0.9928	1.0000			0.9739	0.0015
		1.0000	0.9985	1.0000	0.9730		0.9929	0.0002
			1.0000	1.0000	0.9177	1.0000	0.9794	0.0017

Name of University	2004	2005	2006	2007	2008	2009	Average	Variance
Joetsu University of Education	0.4329	0.6310	0.7668	0.7455			0.6441	0.0234
		0.6296	0.7668	0.7455	0.7293		0.7178	0.0037
			0.7832	0.7618	0.7296	0.8444	0.7798	0.0023
Aichi University of Education	0.8044	0.9332	0.8335	0.8518			0.8557	0.0031
		0.9829	0.9334	0.9142	0.9703		0.9502	0.0010
			0.9332	0.9183	0.9684	0.8671	0.9217	0.0018
Kyoto University of Education	1.0000	0.8959	1.0000	1.0000			0.9740	0.0027
		0.9074	1.0000	1.0000	0.9339		0.9603	0.0022
			1.0000	1.0000	0.9339	0.9542	0.9720	0.0011
Osaka Kyoiku University	0.8736	0.8127	1.0000	0.9007			0.8967	0.0061
		0.8245	1.0000	0.9126	1.0000		0.9343	0.0071
			1.0000	0.9112	1.0000	1.0000	0.9778	0.0020
Hyogo University of Teacher Education	0.5942	0.5607	0.5724	0.6364			0.5909	0.0011
		0.6328	0.6498	0.6657	0.6779		0.6565	0.0004
			0.6778	0.6935	0.6963	0.7156	0.6958	0.0002
Nara University of Education	0.7669	0.8747	0.8024	1.0000			0.8610	0.0106
		0.9399	0.8605	1.0000	1.0000		0.9501	0.0044
			0.8601	1.0000	0.9357	1.0000	0.9490	0.0044
Naruto University of Education	0.7557	0.8408	0.8561	1.0000			0.8632	0.0103
		0.8408	0.8595	1.0000	0.9354		0.9089	0.0054
			0.8595	1.0000	0.8875	1.0000	0.9367	0.0055
Fukuoka University of education	1.0000	0.8479	0.6387	0.6937			0.7951	0.0265
		0.8638	0.7535	0.7922	0.7267		0.7841	0.0035
			0.7625	0.7995	0.7379	0.7471	0.7618	0.0007
National Institute of Fitness and Sports in KANOYA	0.5643	0.6200	0.5826	0.6658			0.6082	0.0020
		0.6503	0.6203	0.6811	0.6848		0.6591	0.0009
			0.8030	0.8674	0.8678	0.8946	0.8582	0.0015
Muroran Institute of Technology	0.4531	0.8742	0.7048	0.7323			0.6911	0.0307
		0.8874	0.8052	0.7646	0.8538		0.8277	0.0029
			0.8159	0.7763	0.8454	0.7799	0.8044	0.0011
Obihiro University of Agriculture and Veterinary Medicine	0.6214	0.5987	0.7479	0.7653			0.6833	0.0073
		0.5987	0.7479	0.7653	1.0000		0.7780	0.0275
			0.7407	0.7628	0.8942	1.0000	0.8494	0.0147
Kitami Institute of Technology	0.5195	0.4836	0.3731	0.4536			0.4575	0.0039
		0.5751	0.4880	0.5241	0.5492		0.5341	0.0014
			0.5017	0.5342	0.5646	0.6962	0.5742	0.0073
Tsukuba University of Technology	0.5800	1.0000	0.5449	0.6567			0.6954	0.0434
		1.0000	0.5980	0.6826	0.6867		0.7418	0.0313
			0.7673	0.8376	0.8385	0.8712	0.8287	0.0019
Tokyo University of Agriculture and Technology	0.6016	0.6791	0.8428	1.0000			0.7809	0.0315
		0.7124	0.8470	1.0000	1.0000		0.8898	0.0192
			0.8478	1.0000	1.0000	1.0000	0.9619	0.0058
Tokyo Institute of Technology	1.0000	0.6887	0.8631	1.0000			0.8879	0.0218
		0.6552	0.8495	1.0000	1.0000		0.8762	0.0267
			0.8961	1.0000	0.7563	1.0000	0.9131	0.0133

Name of University	2004	2005	2006	2007	2008	2009	Average	Variance
Tokyo University of Marine Science and Technology	0.7005	0.7423	0.7302	0.7576			0.7326	0.0006
		0.8116	0.7974	0.8038	0.7737		0.7966	0.0003
			0.7988	0.7944	0.7697	1.0000	0.8407	0.0114
University of Electro-Communications	0.6997	0.8240	0.8165	0.9426			0.8207	0.0098
		0.9429	0.8664	1.0000	0.5643		0.8434	0.0376
			0.8972	1.0000	0.5684	1.0000	0.8664	0.0418
Nagaoka University of Technology	0.3073	0.3787	0.4093	0.3954			0.3727	0.0021
		0.4478	0.4665	0.4645	0.4547		0.4584	0.0001
			0.4668	0.4641	0.4545	0.5607	0.4865	0.0025
Nagoya Institute of Technology	0.7508	1.0000	0.6695	0.7753			0.7989	0.0200
		1.0000	0.7255	0.8097	0.8564		0.8479	0.0132
			0.7306	0.8274	0.9027	1.0000	0.8652	0.0130
Toyohashi University of Technology	0.4424	0.5285	0.4728	0.6856			0.5323	0.0117
		0.5908	0.5297	0.6677	0.7142		0.6256	0.0067
			0.5323	0.6108	0.6025	0.7041	0.6124	0.0050
Kyoto Institute of Technology	0.5101	0.5794	0.5823	0.6102			0.5705	0.0018
		0.6901	0.7006	0.6988	0.6481		0.6844	0.0006
			0.7006	0.6993	0.6481	0.7155	0.6909	0.0009
Kyushu Institute of Technology	0.5295	0.5060	0.7364	0.7904			0.6406	0.0207
		0.5620	0.7312	0.7721	0.8313		0.7241	0.0134
			0.7656	0.7860	0.8343	0.8468	0.8082	0.0015
Otaru University of Commerce	1.0000	1.0000	0.9359	0.9395			0.9688	0.0013
		1.0000	0.9661	0.9051	1.0000		0.9678	0.0020
			1.0000	0.9056	1.0000	0.7406	0.9116	0.0150
Tokyo University of Foreign Studies	0.6028	0.8450	0.8780	1.0000			0.8314	0.0277
		0.9462	1.0000	0.9774	1.0000		0.9809	0.0006
			1.0000	0.9777	1.0000	1.0000	0.9944	0.0001
Tokyo National University of Fine Arts and Muzic	0.4606	0.5898	0.6377	0.5772			0.5663	0.0056
		0.7950	0.8336	0.7646	0.7879		0.7952	0.0008
			0.7814	0.7306	0.7229	0.9404	0.7938	0.0102
Hitotsubashi University	0.6988	0.8692	0.8023	0.8342			0.8011	0.0054
		1.0000	0.8593	0.8373	1.0000		0.9241	0.0078
			0.8619	0.8385	0.7836	1.0000	0.8710	0.0085
Shiga University	0.7726	1.0000	1.0000	1.0000			0.9432	0.0129
		1.0000	0.9989	1.0000	0.9617		0.9902	0.0004
			1.0000	1.0000	0.9611	0.9608	0.9805	0.0005
Asahikawa Medical College								
Tokyo Medical and Dental University	0.5655	1.0000	0.9434	0.7987			0.8269	0.0376
		1.0000	0.9321	0.7907	1.0000		0.9307	0.0097
			1.0000	0.8649	0.9747	1.0000	0.9599	0.0042
Hamamatsu University School of Medicine	0.6925	1.0000	0.9922	0.8926			0.8943	0.0205
		1.0000	1.0000	0.8926	0.9090		0.9504	0.0033
			1.0000	0.9758	1.0000	1.0000	0.9940	0.0001

Name of University	2004	2005	2006	2007	2008	2009	Average	Variance
Shiga University of Medical Science	0.5388	0.9025	0.5886	0.6242			0.6635	0.0266
		0.9025	0.5886	0.6242	0.6313		0.6866	0.0211
			0.6529	0.6795	0.6819	0.8539	0.7171	0.0085
Hirosaki University	0.5439	0.7139	0.6901	0.6513			0.6498	0.0057
		0.7415	0.7079	0.6652	0.6142		0.6822	0.0030
			0.7229	0.6842	0.6255	0.6695	0.6755	0.0016
Akita University	0.5795	0.7660	0.6698	0.6892			0.6761	0.0059
		0.7870	0.6775	0.6929	0.6800		0.7094	0.0027
			0.7115	0.7313	0.7076	0.8204	0.7427	0.0028
Yamagata University	0.4417	0.7109	0.6848	0.6639			0.6253	0.0154
		0.7353	0.7028	0.6760	0.5855		0.6749	0.0041
			0.7364	0.7140	0.5813	0.7627	0.6986	0.0065
University of Tsukuba	1.0000	1.0000	0.8619	0.8751			0.9342	0.0058
		1.0000	0.8630	0.8686	0.8622		0.8984	0.0046
			0.8630	0.8611	0.8504	0.9611	0.8839	0.0027
Gunma University	0.7074	0.7156	0.8491	1.0000			0.8180	0.0189
		0.7156	0.8845	0.9108	1.0000		0.8777	0.0141
			1.0000	1.0000	1.0000	1.0000	1.0000	
Chiba University	1.0000	0.7733	0.8038	0.7323			0.8274	0.0141
		0.7798	0.8115	0.7323	0.7689		0.7731	0.0011
			0.8240	0.7428	0.7403	0.9748	0.8205	0.0121
Niigata University	0.7734	0.8566	0.7811	0.8544			0.8164	0.0021
		0.9650	0.8116	0.8601	0.8458		0.8706	0.0044
			0.8212	0.9247	0.8635	0.9045	0.8785	0.0021
University of Toyama		1.0000	0.5189	0.6255			0.7148	0.1120
		1.0000	0.5228	0.6325	0.6817		0.7092	0.0420
			0.5366	0.6796	0.7047	0.8491	0.6925	0.0164
Kanazawa University	0.5124	0.5793	0.5294	0.5236			0.5362	0.0009
		0.5818	0.5288	0.5204	0.6217		0.5632	0.0023
			0.5331	0.5185	0.6281	0.6640	0.5859	0.0051
University of Fukui	0.6087	0.8600	0.8554	0.7685			0.7732	0.0138
		0.8582	0.8534	0.7689	0.8075		0.8220	0.0018
			1.0000	0.8249	0.8826	1.0000	0.9269	0.0077
University of Yamanashi	0.7238	0.8220	0.7719	0.6888			0.7516	0.0034
		0.8738	0.7755	0.6930	0.6911		0.7583	0.0075
			0.8655	0.7482	0.6835	0.8029	0.7750	0.0060
Shinshu University	0.6299	0.7661	0.7820	0.7677			0.7364	0.0051
		0.7748	0.7890	0.7689	0.7341		0.7667	0.0005
			0.8607	0.8214	0.7778	0.8400	0.8250	0.0012
Gifu University	0.4053	0.5421	0.7524	0.7510			0.6127	0.0289
		0.5417	0.7588	0.7553	0.7399		0.6990	0.0111
			0.7852	0.7833	0.7759	0.8637	0.8020	0.0017
MIE University	0.4785	0.5686	1.0000	0.5755			0.6556	0.0547
		0.5700	1.0000	0.5727	0.5638		0.6767	0.0465
			1.0000	0.5832	0.5732	0.8068	0.7408	0.0415

Name of University	2004	2005	2006	2007	2008	2009	Average	Variance
Kobe University	0.9794	0.9485	0.9587	0.8516			0.9346	0.0032
		1.0000	1.0000	0.8516	0.8827		0.9336	0.0060
			1.0000	0.8516	0.8675	1.0000	0.9298	0.0066
Tottori University	0.5561	0.6980	0.6426	0.5964			0.6233	0.0037
		0.7065	0.6498	0.5964	0.7188		0.6679	0.0032
			0.6841	0.6089	0.6891	0.8542	0.7091	0.0107
Shimane University	0.5576	0.6730	0.6206	0.5411			0.5981	0.0037
		0.6879	0.6254	0.5411	0.6190		0.6184	0.0036
			0.6518	0.5519	0.5991	0.7179	0.6302	0.0051
Okayama University	0.9353	0.9807	0.8498	0.8076			0.8934	0.0062
		1.0000	0.8498	0.8115	0.7803		0.8604	0.0095
			0.8502	0.8168	0.7783	0.9517	0.8492	0.0055
Hiroshima University	1.0000	1.0000	1.0000	0.8550			0.9638	0.0053
		1.0000	1.0000	0.8521	0.9266		0.9447	0.0050
			1.0000	0.8471	0.9173	1.0000	0.9411	0.0054
Yamaguchi University	0.5767	0.6583	0.6272	0.7082			0.6426	0.0030
		0.6773	0.6279	0.7077	0.6473		0.6650	0.0012
			0.6297	0.7008	0.6376	0.7779	0.6865	0.0047
The University of Tokushima	0.3732	0.5976	0.7348	0.6932			0.5997	0.0261
		0.6029	0.7349	0.6936	0.6726		0.6760	0.0030
			0.7405	0.7251	0.6989	0.7745	0.7348	0.0010
Kagawa University	0.6026	0.6722	0.6653	0.7192			0.6648	0.0023
		0.6764	0.6653	0.7192	0.7761		0.7092	0.0025
			0.7001	0.7463	0.7762	0.9080	0.7826	0.0080
Ehime University	0.6747	0.6668	0.6056	0.7217			0.6672	0.0023
		0.6828	0.6127	0.7288	0.8559		0.7201	0.0105
			0.6178	0.7026	0.7956	0.9038	0.7550	0.0151
Kochi University	0.4838	0.7347	0.5763	0.5559			0.5877	0.0112
		0.7347	0.5781	0.5588	0.6052		0.6192	0.0063
			0.6113	0.5957	0.6225	0.7941	0.6559	0.0086
Saga University	0.7212	0.7449	0.6453	0.7544			0.7164	0.0024
		0.7449	0.6453	0.7544	0.7699		0.7286	0.0032
			0.6546	0.7709	0.7724	0.8634	0.7653	0.0073
Nagasaki University	0.7355	0.8365	0.7995	0.7637			0.7838	0.0019
		1.0000	0.8550	0.7637	1.0000		0.9047	0.0135
			1.0000	0.7398	1.0000	0.9205	0.9151	0.0151
Kumamoto University	0.7316	1.0000	0.8728	0.9525			0.8892	0.0138
		1.0000	0.8721	0.9499	0.9746		0.9491	0.0031
			0.9177	1.0000	0.9600	1.0000	0.9694	0.0015
Oita University	0.6068	0.7760	0.7315	0.7068			0.7053	0.0051
		0.8174	0.7591	0.7232	0.7218		0.7554	0.0020
			1.0000	0.7508	0.7633	0.9202	0.8586	0.0148
University of Miyazaki	0.6811	0.6773	0.7573	0.7650			0.7202	0.0023
		0.6773	0.7572	0.7766	0.6997		0.7277	0.0022
			0.8725	1.0000	0.7461	0.8579	0.8691	0.0108

Name of University	2004	2005	2006	2007	2008	2009	Average	Variance
Kagoshima University	1.0000	0.8738	0.9222	0.7359			0.8830	0.0123
		1.0000	1.0000	0.7358	0.8141		0.8875	0.0179
			1.0000	0.7499	0.8363	0.9186	0.8762	0.0116
University of the Ryukyus	0.4944	0.5868	0.5931	0.5809			0.5638	0.0022
		0.5985	0.6095	0.5964	0.6062		0.6026	0.0000
			0.6198	0.6061	0.6129	0.6800	0.6297	0.0012
Iwate University	0.4619	0.5937	0.6020	0.6453			0.5757	0.0063
		0.5899	0.5947	0.6453	0.6994		0.6323	0.0026
			0.5545	0.6476	0.6994	0.6549	0.6391	0.0037
Fukushima University	0.6564	0.7771	0.6603	0.5765			0.6676	0.0068
		0.8817	0.7892	0.6795	0.8161		0.7916	0.0071
			0.7911	0.6833	0.8172		0.7639	0.0050
Ibaraki University	0.9246	0.9455	0.8589	0.7208			0.8624	0.0103
		0.9510	0.8654	0.7358	0.8079		0.8400	0.0083
			0.8723	0.7454	0.8165	0.9625	0.8492	0.0084
Utsunomiya University	0.5303	0.6075	0.5617	0.6332			0.5832	0.0021
		0.6384	0.5868	0.6466	0.6647		0.6341	0.0011
			0.5932	0.6490	0.6668	0.7540	0.6658	0.0044
Saitama University	0.9112	1.0000	0.8753	0.8469			0.9083	0.0044
		1.0000	0.8870	0.8556	0.8619		0.9011	0.0045
			0.9148	0.8823	0.8815	1.0000	0.9196	0.0031
Ochanomizu University	0.5814	0.5533	0.6999	1.0000			0.7086	0.0418
		0.7613	0.8623	1.0000	1.0000		0.9059	0.0135
			0.8378	1.0000	0.9607	1.0000	0.9496	0.0059
Yokohama National University	1.0000	0.9183	1.0000	1.0000			0.9796	0.0017
		0.9183	1.0000	1.0000	1.0000		0.9796	0.0017
			1.0000	1.0000	1.0000	1.0000	1.0000	
Shizuoka University	1.0000	1.0000	1.0000	1.0000			1.0000	
		1.0000	1.0000	1.0000	1.0000		1.0000	
			1.0000	1.0000	1.0000	1.0000	1.0000	
Nara Women's University	0.4512	0.9270	0.8722	1.0000			0.8126	0.0608
		1.0000	1.0000	1.0000	1.0000		1.0000	
			1.0000	1.0000	1.0000	1.0000	1.0000	
Wakayama University	0.8600	0.9085	0.8166	0.9121			0.8743	0.0020
		0.9456	0.8974	0.9513	0.9021		0.9241	0.0008
			0.9114	0.9682	0.9163	0.9275	0.9309	0.0007
National Graduate Institute for Policy Studies (GRIPS)	0.6691	0.6664	1.0000	0.9349			0.8176	0.0306
		0.7508	1.0000	0.9412	1.0000		0.9230	0.0139
			1.0000	0.9702	1.0000	1.0000	0.9925	0.0002
The Graduate University for Advanced Studies	0.8308	0.7909	0.8165	0.9804			0.8546	0.0073
		0.9155	0.9561	1.0000	1.0000		0.9679	0.0016
			0.9606	1.0000	1.0000	1.0000	0.9901	0.0004
Japan Advanced Institute of Science and Technology	0.3185	0.3562	0.3813	0.4927			0.3871	0.0056
		0.3681	0.3922	0.4927	0.4996		0.4381	0.0046
			0.4344	0.4957	0.4983	0.6303	0.5147	0.0068

Name of University	2004	2005	2006	2007	2008	2009	Average	Variance
Nara Institute of Science and Technology	0.3297	0.4983	0.5831	1.0000			0.6028	0.0812
		0.4979	0.5929	1.0000	1.0000		0.7727	0.0704
			0.5765	0.7675	0.7051	0.8740	0.7308	0.0154
Average	0.6897	0.7943	0.7977	0.8012	0.8150	0.8892	0.7994	0.0089
Variance	0.0401	0.0274	0.0256	0.0225	0.0219	0.0134		
Standard deviation	0.2003	0.1656	0.1601	0.1500	0.1481	0.1157		

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was MAXDea). Input indicators: I_OAC and I_ASC, output indicators: O_TIS, O_STS, O_BIO. The model is radial input oriented 4 year window.

Table 22.Regression results for frontier estimation

Explained var.: lnCost	(1)	(2)	(3)
lnO_TNS	-0.1485	-0.05	0.4358
	-2.39*	-1.05	9.83*
lnO_STS	0.8578	0.4296	0.1209
	1.17	7.52*	2.5*
lnO_BIO	0.0056	-0.0078	-0.0097
	1.12	-1.4	-1.56
lnO_TNE	0.1098	0.1114	0.22
	4.46*	4.08*	9.13*
lnO_TGG	0.0031	-0.0001	0.0254
	0.4	-0.01	2.88*
Tokyo	-0.0047		0.0549
	-0.07		2.1*
Popular	0.0001		-0.0001
	1.46		-1.45
1000-2000	0.5232		-0.1197
	2.87*		-1.52
2000-3000	0.4606		-0.4157
	2*		-4.02*
3000-5000	0.8478		-0.2534
	3.4*		-2.09*
5000-8000	1.0409		-0.1804
	3.7*		-1.33
8000-10,000	1.1279		-0.1714
	3.73*		-1.15
10,000-15,000	1.3167		-0.2087
	4.048*		-1.26
15,000+	1.5083		-0.0326
	3.64*		-0.17
医無総大	-1.3253		-0.8459
	-12.94*		-20.28*
旧帝大	0.3137		0.0539
	1.66		0.77
教育大	-1.5789		-1.029
	-11.4*		-22.48*
大	-1.7166		-0.7339
	-7.68*		-10.79*
文化大	-1.7253		-0.9593
	-12.92*		-17.26*
理工大	-1.2857		-0.7575
	-16.51*		-18.54*
constant	7.9046	3.4707	2.6531
	11.12*	10.79*	6.12*

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Cost frontier estimation: (3) is pooled OLS while (1) and (2) is panel estimation.). Underneath the coefficients is the z value. * means at least 95% significance. N=508

Table 23.Regression results. Explained variable DEA-SBM

OLS type	Pooled	Fixed Effects	Random Effects
Tokyo	0.121	0	0.0903233
	4.58*	0	1.82
1000-2000	0.007	0	-0.0230116
	0.15	0	-0.23
2000-3000	-0.028	0	-0.0411698
	0.6	0	-0.46
3000-5000	0.019	0	0.0258796
	0.48	0	0.32
5000-8000	0.005	0	-0.0032045
	0.013	0	-0.04
8000-10,000	0.075	0	0.0556047
	1.7	0	0.63
10,000-15,000	0.188	0	0.1493478
	4.1*	0	1.62
15,000+	0.363	0	0.3221752
	7.13*	0	3.37*
医無総大	0.058	0	0.064169
	2.4*	0	1.21
旧帝大	-0.106	0	-0.1459769
	-3.94*	0	-3.59*
教育大	0.119	0	0.1255355
	4.16*	0	1.98*
大	0.049	0	-0.1739233
	0.52	0	-0.96
文化大	0.066	0	0.0977621
	1.77	0	1.49
理工大	-0.021	0	-0.048015
	-0.81	0	-0.96
Entrance EF	0	-0.000465	-0.0005332
	-0.6	-1.17	-1.7
R/O irreg T	0.016	0.0677183	0.0501708
	0.46	1.3	1.24
R/O irreg S	-0.013	-0.0593626	-0.0425051
	-0.33	-1.21	-1.07
R/O Grad S	-0.097	0.731291	0.2076808
	-1.01	4.93*	0.98
C	0.699	0.6499506	0.731964
	11.94*	6.53*	7.43*
R2	0.2632	0.0023	0.2337

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Underneath the coefficients is the t or z value. * means at least 95% significance. N=508

Table 24.Regression results. Explained variable DEA-Adjusted

OLS type	Pooled	Fixed Effects	Random Effects
Tokyo	0.1611507	0	0.1275753
	4.28*	0	1.87
1000-2000	0.0431647	0	0.0084882
	0.67	0	0.06
2000-3000	0.0223907	0	0.0114806
	0.35	0	0.11
3000-5000	0.0568476	0	0.0669356
	1.02	0	0.66
5000-8000	0.0577614	0	0.0473686
	1.02	0	0.45
8000-10,000	0.1627024	0	0.1373494
	2.59*	0	1.21
10,000-15,000	0.3479308	0	0.3014484
	5.17*	0	2.39*
15,000+	0.6611572	0	0.6179921
	8.86*	0	4.54*
医無総大	0.1306892	0	0.1389834
	3.51*	0	1.7
旧帝大	-0.1791388	0	-0.2342148
	-4.32*	0	-3.27*
教育大	0.1917739	0	0.2022146
	4.31*	0	2.15*
大	0.0775393	0	-0.1896216
	0.57	0	-0.71
文化大	0.0997588	0	0.1444637
	1.87	0	1.7
理工大	0.0107785	0	-0.0232658
	0.27	0	-0.33
Entrance EF	-0.0001667	-0.0007292	-0.0007404
	-0.54	-1.19	-1.68
R/O irreg T	0.017971	0.0239198	0.0186273
	0.33	0.31	0.3
R/O irreg S	-0.0179496	-0.0483714	-0.0365267
	-0.32	-0.69	-0.63
R/O Grad S	-0.1358454	1.000955	0.2456259
	-0.92	3.53*	0.76
C	0.4214863	0.4518016	0.4796719
	5.08*	2.87*	3.75*
R2	0.2885	0.001	0.2672

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Underneath the coefficients is the t or z value. * means at least 95% significance. N=500

Table 25.Regression results. Explained variable SFA (1)

	Pooled	Fixed Effects	Random Effects
Tokyo	-0.0298631	0	-0.0723054
	-1.2	0	-1.29
1000-2000	0.1042027	0	0.0233546
	1.74	0	0.22
2000-3000	0.0600035	0	0.0364164
	0.93	0	0.28
3000-5000	0.1004673	0	0.0905293
	1.74	0	0.77
5000-8000	0.0631736	0	0.0411094
	1.06	0	0.32
8000-10,000	0.0096937	0	-0.0136162
	0.16	0	-0.1
10,000-15,000	0.1157437	0	0.0749482
	1.84	0	0.55
15,000+	-0.014569	0	-0.0272373
	-0.22	0	-0.19
医無総大	-0.0542385	0	-0.0296467
	-1.86	0	-0.46
旧帝大	0.1371204	0	0.0934501
	8.18*	0	3.11*
教育大	-0.0759097	0	-0.0606142
	-2.73*	0	-0.93
大	0.02894	0	-0.0515508
	0.36	0	-0.34
文化大	-0.0207678	0	0.0088884
	-0.68	0	0.12
理工大	0.0075109	0	0.0273496
	0.26	0	0.43
Entrance EF	-0.0003111	0.0000148	0.0000106
	-1.63	0.458	0.7
R/O irreg T	0.1397009	-0.0018376	-0.0017828
	3.54*	-0.88	-0.83
R/O irreg S	-0.078316	-0.0122564	-0.0122887
	-1.76	-6.23*	-6.12*
R/O Grad S	-0.2697563	-0.0000103	-0.0004441
	-3.71*	0	-0.08
C	0.813436	0.7668176	0.7475561
	12.81*	209.45*	5.7*
R2	0.2459	0.0019	0.1629

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Underneath the coefficients is the t or z value. * means at least 95% significance. N=420

Table 26. Regression results. Explained variable SFA (2)

	Pooled	Fixed Effects	Random Effects
Tokyo	0.0026066	0	-0.0269195
	0.15	0	-0.66
1000-2000	-0.0354718	0	-0.0808198
	-0.78	0	-1.02
2000-3000	0.0937614	0	0.0942096
	1.97*	0	1.08
3000-5000	-0.0296852	0	-0.0158453
	-0.69	0	-0.21
5000-8000	-0.1034282	0	-0.101614
	-2.45*	0	-1.34
8000-10,000	-0.1123436	0	-0.114995
	-2.57*	0	-1.42
10,000-15,000	-0.0727924	0	-0.0872637
	-1.7	0	-1.14
15,000+	-0.1171442	0	-0.1147221
	-2.49*	0	-1.48
医無総大	0.3794402	0	0.3959453
	19.14*	0	8.8*
旧帝大	0.0137977	0	-0.0214281
	1.54	0	-5.45*
教育大	0.4693212	0	0.4793788
	24.39*	0	11.1*
大	0.4797462	0	0.3981417
	8.53*	0	3.69*
文化大	0.597568	0	0.6235722
	25.81*	0	11.25*
理工大	0.3616371	0	0.3677808
	17.44*	0	8.39*
Entrance EF	-0.0001566	0.0000193	-0.00000216
	-1.16	0.977	-0.11
R/O irreg T	0.1042125	-0.0019794	-0.0017476
	3.8*	-0.56	-0.48
R/O irreg S	-0.0312815	-0.0210707	-0.0211698
	-0.98	-7.12*	-7*
R/O Grad S	-0.2331274	0.0052915	0.00359
	-4.31*	0.69	0.45
C	0.2912359	0.3903367	0.2493644
	5.21*	77.69*	3.29*
R2	0.9075	0.0015	0.8943

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Underneath the coefficients is the t or z value. * means at least 95% significance. N=420

Table 27. Regression results. Explained variable SFA (3)

	Pooled	Fixed Effects	Random Effects
Tokyo	-0.0159178	0	-0.0155342
	-0.89	0	-0.52
1000-2000	0.0316929	0	0.0237641
	0.98	0	0.4
2000-3000	-0.0231742	0	-0.0189387
	-0.62	0	-0.27
3000-5000	0.0149704	0	0.0207849
	0.44	0	0.35
5000-8000	0.0284958	0	0.0281443
	0.88	0	0.47
8000-10,000	0.0396608	0	0.0321285
	1.19	0	0.51
10,000-15,000	0.0431941	0	0.036286
	1.29	0	0.6
15,000+	0.0415426	0	0.0426389
	1.15	0	0.68
医無総大	-0.0245662	0	-0.0143863
	-1.51	0	-0.41
旧帝大	0.0274405	0	0.0080111
	1.8	0	0.55
教育大	-0.0002638	0	-0.0000429
	-0.02	0	0
大	0.0646519	0	0.0323641
	1.39	0	0.41
文化大	-0.0009528	0	0.0162441
	-0.04	0	0.37
理工大	0.0008047	0	0.0009217
	0.04	0	0.03
Entrance EF	0.0002517	0.0001889	0.00004
	2.44*	0.652	0.29
R/O irreg T	0.0908277	0.0002697	0.0324236
	4.32*	0.01	1.03
R/O irreg S	0.0733798	0.110956	0.091821
	2.87*	2.73*	2.64*
R/O Grad S	-0.1163464	0.0344088	-0.0281078
	-2.53*	0.62	-0.42
C	0.7531155	0.8191923	0.7851635
	19.39*	15.7*	11.59*
R2	0.1474	0.0216	0.1153

Table 28. Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Underneath the coefficients is the t or z value. * means at least 95% significance. N=420

Table 29.Regression results. Explained DEA-Window.

	OLS	OLS	Significant +	Significant -
Tokyo	0.0668891	0.0641004	2	0
	1.63	1.8		
1000-2000	-0.0811136	0.0279279	0	0
	-0.79	0.2		
2000-3000	-0.030508	0.1474529	1	0
	-0.33	1		
3000-5000	-0.035267	0.1589886	0	0
	-0.41	1.11		
5000-8000	-0.0732079	0.1403666	0	1
	-0.84	0.9		
8000-10,000	-0.0179129	0.2091741	1	1
	-0.19	1.28		
10,000-15,000	0.0442037	0.3072253	3	0
	0.43	1.84		
15,000+	0.1597167	0.4788831	5	1
	0.97	2.81*		
医無総大	0.0959622	0.1060316	5	0
	1.93	2*		
旧帝大	-0.1205233	-0.1260803	2	7
	-4.74*	-5.11*		
教育大	0.1716298	0.2060401	8	1
	2.94*	2.69*		
大	0.1468496	0.1239694	2	0
	0.81	0.76		
文化大	0.1198357	0.1355903	2	0
	1.79	1.93		
理工大	0.001039	0.0393622	2	0
	0.02	0.59		
Entrance EF	0.0000343	0	1	0
	1.05	0		
R/O irreg T	-0.0181025	0	3	0
	-0.2	0		
R/O irreg S	0.2825854	0	4	4
	2.94*	0		
R/O Grad S	-0.1808915	0	2	3
	-1.12	0		
C	0.6784284	0.5633247	17	0
	8.6*	3.41*		
R2	0.4576	0.3705		

Source: Author calculations based on the financial statements and business reports of individual universities (the software used was Stata). Underneath the coefficients is the t or z value. * means at least 95% significance. N=86

Table 30. Indicator Distributions; 2004-2009, n varies as 0 values are excluded from the sample of 508

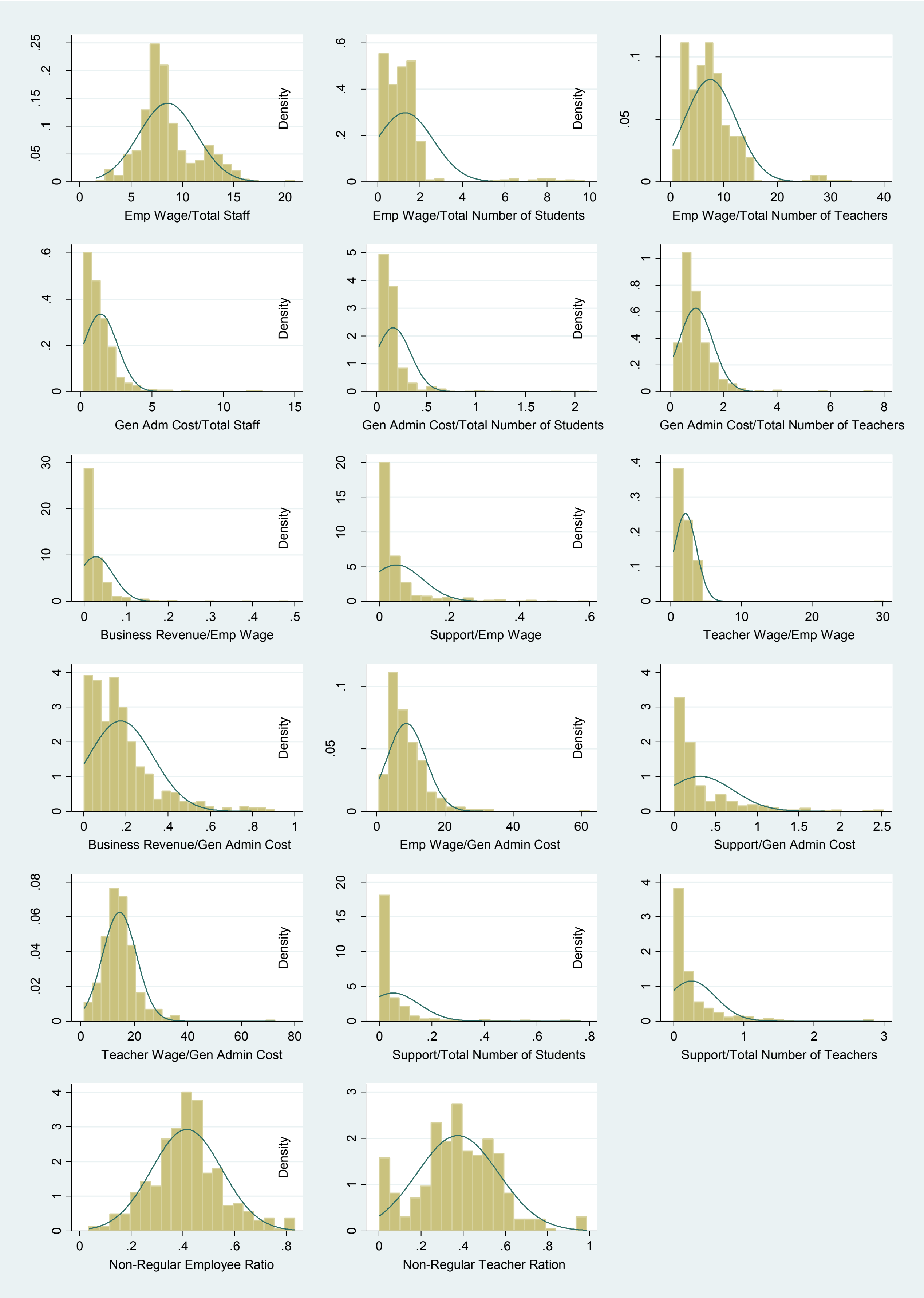

Table 31. Descriptive statistics of the indicators.

Ind Nr.	Obs	Mean	Std. Dev.	Min	Max	Indicator Name
1	508	0.166264	0.173289	0.021358	2.143478	General Administrative Cost/Student (I_OAC/O_TNS)
2	508	0.967263	0.635652	0.124792	7.584615	General Administrative Cost/Teacher (I_OAC/Total Number of Teachers)
3	508	1.397876	1.185613	0.220628	12.75	General Administrative Cost/Employees (I_OAC/O_TNE)
4	508	14.47366	6.372924	1.171356	72.53507	Teaching Wages /General Administrative Cost (Total Modified Teaching Wages/I_OAC)
5	508	8.686634	5.654339	0.654941	62.40149	Admin Wages /General Administrative Cost (I_ASC/I_OAC)
6	508	0.260144	0.380033	0	2.526667	Government Support/General Administrative Cost (O_TGG/I_OAC)
7	508	0.173164	0.15374	0	0.904459	Business Income/General Administrative Cost (O_BIO/I_OAC)
8	508	1.291172	1.336277	0.053003	9.753494	Admin Wages/Student (I_ASC/O_TNS)
9	508	7.436258	4.869467	0.430372	33.905	Admin Wages/Teacher (I_ ASC/Total Number of Teachers)
10	508	8.572296	2.81603	1.594102	20.95669	Admin Wages/Employees (I_ ASC/O_TNE)
11	508	2.064406	1.574626	0.377571	30.16239	Teaching Wages/Admin Wages (Total Modified Teaching Wages/I_ ASC)
12	508	0.040123	0.071371	0	0.598927	Government Support/Admin Wages (O_TGG/I_ ASC)
13	508	0.027304	0.041025	0	0.484688	Business Income/Admin Wages (O_BIO/I_ ASC)
14	508	0.33271	0.205953	0	0.833632	Ratio of irregular employees to all employees (Irregular Teachers/Total Teachers)
15	508	0.294937	0.230534	0	0.986908	Ration of irregular teachers to all teachers (Irregular Employees/O_TNE)
16	508	0.044089	0.09204	0	0.766187	Government Support/ Total Number of Students (O_TGG/O_TNS)
17	508	0.209044	0.328543	0	2.850254	Government Support/Total Number of Teachers (O_TGG/Total Number of Teachers)

Source: Author calculations based on the financial statements and business reports of individual universities. Unit is hundred million JPY where applicable