Assessing the Performance of Japanese Major Universities through the Research Funding System

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Abstract

This article reports on the performance of the research funding system of 61 Japanese national universities, specifically the Japanese Grants-in-Aid for Scientific Research (GASR) system. The competitive Japanese research funding system is quantitatively investigated and measured, focusing on the GASR fund and its relationship with the Japanese Science and Technology Basic Plans by applying mathematical modeling techniques. The paper proposes future policy recommendations to improve what aspect of the Japanese competitive research funding system.

Keywords: research funding system, Japanese national university, competitive grant, grants-in-aid for scientific research, science and technology basic plan, mathematical model

1. Introduction

Japan's economic growth in the 1960s was around 5% on the average while it was much higher at around 10% in the 1970s. Throughout the 1970s, Japan's gross national product (GNP) was the world's third largest, following the United States and Soviet Union. Thereafter, in the 1980s Japan's GNP growth rate became a little lower at around 2% to 5%. After a mild economic slump in the mid-1980s, Japan's economy began a period of expansion in 1986, entering a recessionary period in 1992. In 1989 Japan's GDP was the world's second largest. However, in 2017 it became the third, following the USA and China. In the 1990s, after the "bubble economy" gradually collapsed, we call the period as "lost decade". We have been experiencing the stagnant economy since then. It is said that Japan's high literacy rate and high education standards were major reasons for Japan's success in achieving a technologically advanced economy. Also Japanese school system encouraged discipline, and another benefit in forming an effective work force.

The Japanese national budget began to increase in 1975, and by 2000 had reached around 80 TY (trillion yen), equivalent to 733.9 BUSD (billion US dollars) since 2000. The budget has recently begun increasing again, reaching around 92.4 TY and 97.5 TY in 2011 and 2017, respectively. Tax revenues account for roughly 59.2% of the total budget. The balance consists mostly of public debts (35.4% of the total), made up of specific public debts and construction debts. As for government expenditure, three items account for 73.9% of total expenditure: i) social security spending (33.8%); ii) tax allocation grants and the like (16.0%); and iii) national debt service costs which comprise a combination of interest and principal payments with debt redemption (24.1%). Figure 1 below reports the value of the education and science-technology promotion fund (ESTPF) during the period 1975−2017. Dividing the 42 year period from 1975 to 2017 into five sub periods: I:1975−1982, II:1982−1989, III:1989−2002, IV:2002−2006 and V:2006−2017, reveals some interesting trends. During period I, the ESTPF increased in value from 2.64 TY to 4.86 TY, almost doubling in seven years in line with the high annual growth rate 9.1% − period I can be considered a high growth period. During the eight years of period II, the ESTPF remained stable at 4.8−5.0 TY. Period II can be considered a stable period. In period III the value of the ESTPF began to increase again from 5.11 TY in 1990 to 6.10 TY in 2002, corresponding to an annual growth rate of 2.3%. Period III can be considered a low growth period. In period IV the ESTPF began to decrease, falling from 6.10 TY in 2002 to 5.36 TY in 2006, an average annual decrease of 0.9% − making period IV a period of decline. During the period V the ESTPF has been almost constant at around 5.36 TY until 2017 since 2006. Under such circumstances where a sharp rise in the social security spending and a drastic decrease of the public works spending were seen, the total budget and the share of the ESTPF have changed between 1975 and 2013. Both figures have risen significantly from 1985 to 2015.

Regarding the education related budget, the Koizumi Administration of Japanese government cut the share of compulsory education expenses from approximately 1/2 to 1/3, and transferred the tax revenue resources to the prefectures. A series of discussions preceded the slashing of the government's share of compulsory education expenses, which made up the largest part of government subsidies. The reform resulted in a 1 TY reduction of the Ministry of Education, Culture, Sports, Science and Technology (MEXT)'s total budget. In the most recent period V the ESTPF had risen gradually from 5.27 TY in 2006 to 5.44 TY in 2014 (an annual growth rate of 0.5%), which characterizes a stagnant period. The ratio of the ESTPF to the total general account budget declined steadily from 12.5% in 1975 aside from period III when it increased slightly, then in 2013 it decreased to 5.7% and continued to decrease throughout that period.

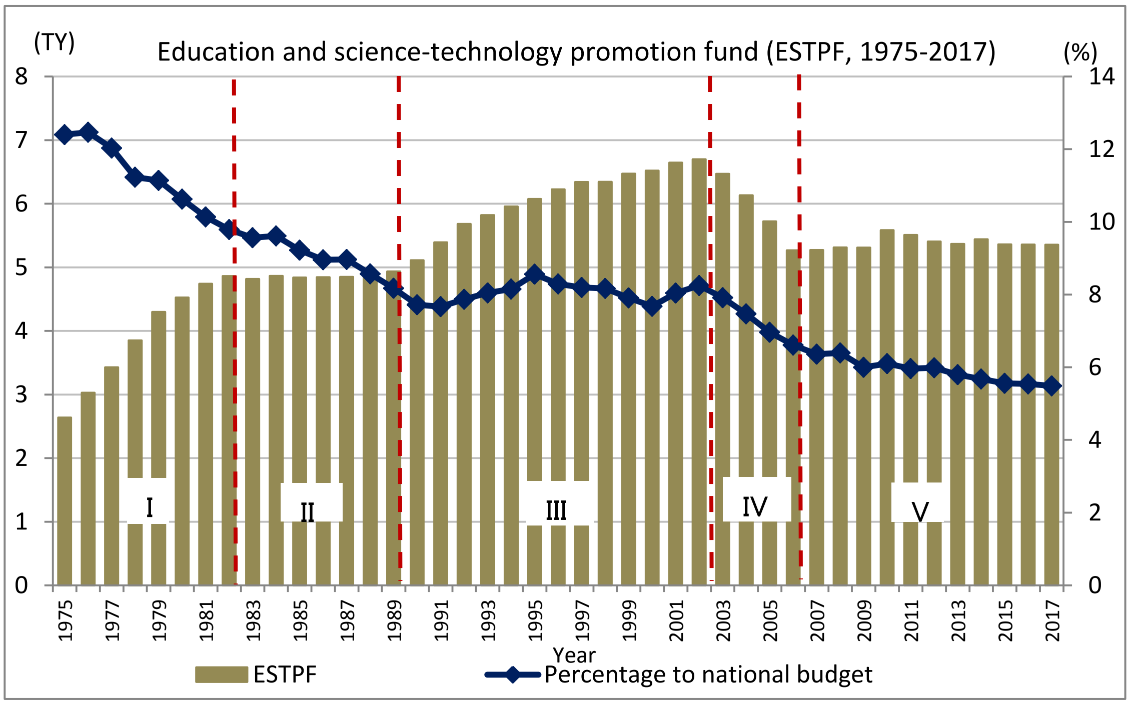


Figure 1. Education and science-technology promotion fund (1975-2017)

A review of the research for the ESTPF funding system and innovation policy showed a strong focus on how public funds are distributed in various countries. (e.g., Geuna and Martin (2003), Fandel (2007), Archibugi et al (2009), Yamashita, et al. (2018) and Psacharopoulos (2008)) Lootsma, Mensch, and Vos (1990) conducted research for designing a robust budget reallocation method by applying a multi-criteria analysis technique. They used a pairwise comparison method to rank and rate a number of European non-nuclear energy research programs in long-term research planning. Their final scores of the programs were used to calculate optimal reallocation of the research budget. Geuna and Martin (2003) compared evaluation methods used across 12 countries in Europe and the Asia-Pacific region. Focusing on the British system, they investigated the advantages and disadvantages of the performance-based funding system comparing with other approaches. They concluded that such a system seemed to produce diminishing returns over time while initial benefits outweighed the costs. Fandel (2007) used a data envelopment analysis technique to show how the results of the research fund redistribution could be justified, finding a solution for a real process of redistributing funds for teaching and research among the universities in North Rhine-Westphalia in Germany. Fandel's (2007) research showed how inefficiencies in the usage of personnel gave reasons to reallocate the staff among the universities or to reduce it correspondingly. Anwar and Oyama (2007) investigated the government subsidy system to Japanese private universities. Their research found influential factors in allocating subsidies for private universities. They explained how structural properties of the subsidy policy was influenced by applying a correlative rank analysis approaches in order to measure the "dominance power" of the top-ranking subsidy-recipient schools. Archibugi, Denni, and Filippetti (2009) reviewed the synthetic indicator uses of the technological capabilities based upon the explicit and implicit assumptions on the nature of technological change. Archibugi, et al. (2009) reported that composite synthetic indicators of the technological capabilities are based on a variety of statistical sources for multidimensional nature of technological change. Yamashita, et al. (2018) investigated the performance of the competitive Grants-in-Aid grant for Scientific Research System in Japan, which quantitatively assesses the performance of the Japanese research funding system. Psacharopoulos (2008), focusing on the public funding for universities in several European countries, showed that the size of the social returns to investment in education gave an indication regarding the most efficient use of resources, while the difference between the private and the social rates relates to issues of equity. Psacharopoulos (2008) emphasized their findings contrast higher education funding policies in several countries such as Denmark, Norway, Sweden, Hungary and the USA, regarding the efficient and equitable financing, and actual public funding of universities. Muscio, et al (2013) used a set of probit and tobit panel data models to explore whether government funding complements or substitutes private research funding to Italian universities. Muscio, et al (2013) showed that the government funding to universities complements funding from research contracts and consulting, contributing to increasing universities' collaboration with industry and activating knowledge transfer processes. Vilkkumaa et al (2015) investigated optimal funding decisions depending on evaluation accuracy. Focusing upon the policies maximizing the expected value of the project portfolio, they showed that the optimal policy for funding exceptionally excellent projects was to start a large number of projects and abandon a high proportion of them later. In general, Vilkkumaa et al (2015) emphasize that the optimal policy for maximizing the expected value of the project portfolio is to grant long-term funding to a smaller set of projects based on initial evaluation. McKinney and Hagedorn (2017) proposed a performance-based funding model for community colleges in Texas, USA.

Regarding the technology and innovation aspects of the funding system, Kuwahara (1999) concluded that applying the Japanese Delphi process to the data obtained from every five years survey, Japanese technology policies were less consistent than commonly believed and involved an assortment of policy measures and actors/agencies. Zhao, et al (2015) described regional collaborations and indigenous innovation capabilities in China by applying a multivariate method for analyzing regional innovation systems. Zhao, et al (2015) reported that regional collaborations amongst organizations could be categorized by means of eight dimensions including public versus private organizational mindset and resources; innovation capacity versus available infrastructures; innovation's input versus output; production versus dissemination for knowledge; and collaborative capacity versus collaboration output. Collaborations fell into four categories, those related to highly specialized public research institutions, public universities, private firms and governmental intervention. Paredes-Frigolett (2016) built a multi-criteria decision analysis model of responsible research and innovation (RRI) designed to generate science, technology, and innovation strategy and guide processes of technology innovation and technology road mapping by firms that drive substantial and radical innovation. The model addressed how innovative firms could functionally and organically incorporate broader deliberation processes associated with responsible research and innovation involving actors of the public and private sectors as well as civil society organizations along the precepts of the quadruple-helix innovation framework. Staphorst, et al (2016) developed a framework for the structural equation modeling based context sensitive data fusion of technology indicators in order to produce technology forecasting output metrics in the National Research and Education Network. Jeffrey, et al. (2014) presented a detailed analysis of the activities in which ocean energy public funding in the UK and the U.S. has been spent. Their research reported that UK investment in the sector had been relatively sustained and had increased since 2002 while U.S. spending began with the establishment of the Marine Hydrokinetic division of the DoE Water Power Programme in 2008.

The next section provides an overview of the research funding system in Japan, focusing upon the Science and Technology Promotion Fund (STPF), Grants-in-Aid for Scientific Research (GASR) program, and Strategic Creative Research Program (SCRP) and their relations to the Science and Technology Basic Plans (STBP).

2. Research Funding System in Japan

In Figure 2 we show the STPF in the general account budget allocated to the MEXT in Japan during the period 1985−2017. The STPF can be divided into two groups of competitive grants and noncompetitive ones. The present year (2018) has witnessed an increasing share for the competitive grants. Likewise, Figure 2 presents the total value for the period 1985−2017 of STPF, GASR and SCRP, respectively, from the MEXT.

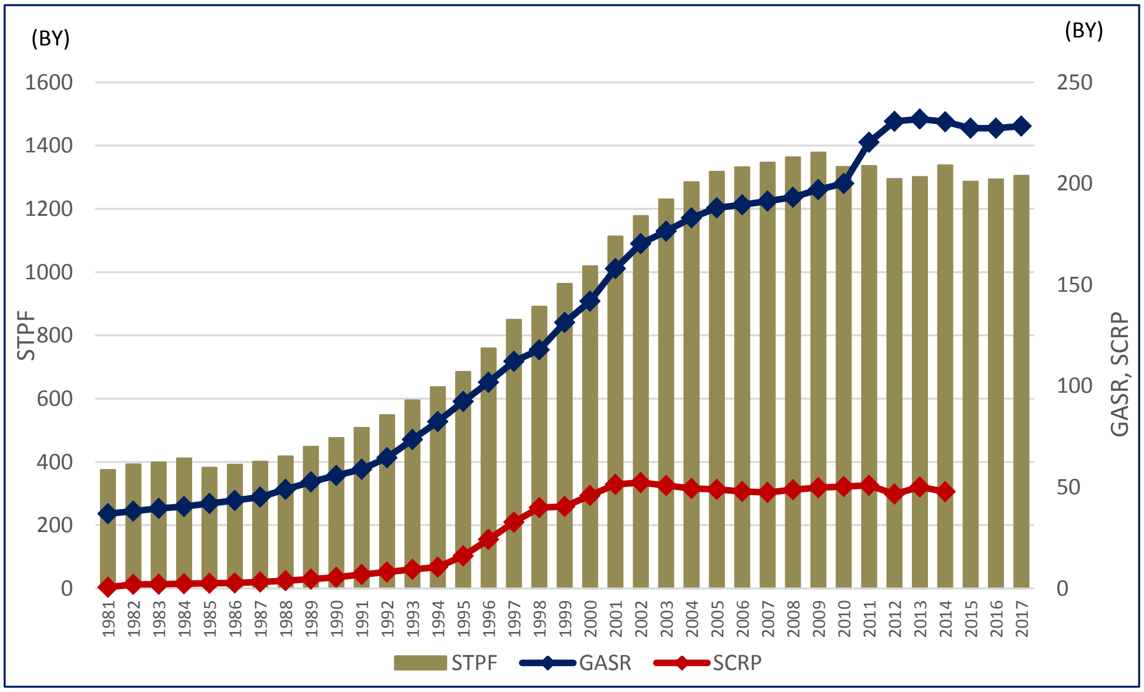


Figure 2. STPF, GASR and SBRP

In Japan basic science and technology policy has been announced by the STBP. The first STBP (1996–2000) was approved by the cabinet in July 1996, in which a "competitive grant" was defined for the first time. The STBP clearly stated a large expansion of various competitive grant programs offered by respective ministries. During the first STBP basic research was added as a research item to set the program apart with the new basic research promotion program for promoting scientific research with a view to creating intellectual resources in the Ministry of Education. The second STBP (2001–2005), which was approved by the cabinet in March 2001 and stated the expansion of competitive grants clearly along with a target of doubling the funds granted in the second period. "Indirect expenses", whose proportion was tentatively set to around 30% of the budget, were also defined as the necessary administrative expenditure of the research institutes. In Figure 2 we can see that during the period of those two STBPs, there was a significant rise in the budget allocations for the STPF, and GASR. A particularly sharp rise of competitive grants can be seen from 296.8 billion yen (BY) in FY2000 to 467.2 BY in FY2005, as the second STBP set the target of doubling the amount of funds by FY2005. During the second STBP Grants-in-Aid clearly took on the character of support for bottom-up basic research. The continued expansion of the total amount of GASR was accompanied by the introduction of the 30% allowance for indirect expenses..

The cabinet approved the third STBP (2006–2010) in March 2006, in which expanding competitive grants and available indirect expenses fund were clearly stated again. The plan stressed the reform of competitive grant programs such as fair and transparent reviewing system, feedback of review results, securing program officer and post doctoral, and other measures to reinforce agencies. Then expansion and reform of competitive grant programs pointed out necessary challenges to these such as piecemeal size of available funds, poor continuity of projects, increased number of applications, poor environment for younger and female researchers, and so on. Necessary reforms included measures to ensure diversity and continuity of basic research, creation of a seamless system, development of an attractive research environment for younger and female researchers, boosting high-risk but impressive and original research, reinforcement of the evaluation system, and development of a fair, transparent, and efficient system for allocating and using the fund. The fourth STBP (2011–2015) was approved by the cabinet in August 2011, after the Great East Japan Earthquake, in which the title was changed from "expansion" to "improvement and enrichment" of the competitive grant programs. During the third STBP (2006–2010) and thereafter, competitive grants and the STPF remained at the same level or slightly decreased, in contrast to the significant increase of the GASR. One possible factor was the push to develop basic research, as encouraged by the awarding of the Nobel Prize to two Japanese scholars in chemistry Akira Suzuki and Ei-ichi Negishi. Even in comparison with various socio-economic indicators and other indicators related to science and technology, the budget for GASR is visibly surging. In the fourth STBP it emphasized that the science and technology policy should be determined more comprehensively and also more systematically, promoting the science, technology and innovation policy. The plan advocated the importance of the organizational institution to cultivate and train young human resources. From the policy aspects discipline oriented approach was shifted to problem solving one. In addition, promoting green innovation and life innovation was emphasized. The Council for Science, Technology and Innovation (CSTI) was established in May, 2014 following the Council for Sciences and Technology. Then the current fifth STBP (2016–2021) was approved by the cabinet in 2016, in which policy challenges for creating future industry and reforming the society, i.e., for the so-called super smart society or "society 5.0" were advocated. Also the fifth STBP emphasized cooperation by industry, academics and public administration in addition to human resources, knowledge and budgetary support were necessary and indispensable in order to attain the innovation.

The term "competitive grant" appeared in the first STBP for the first time in July, 1996. Still, the GASR and other funding programs were already in place. Subsequently other noteworthy funding programs were launched. The first such program, Special Coordination Funds for Promoting Science and Technology, was established in FY1981 to mobilize the research institutes of respective ministries for accelerating basic research on important cross-cutting issues that transcend the scope of research performed by each ministry. In FY2011, the program was reorganized as Strategic Funds for the Promotion of Science and Technology after a budget screening and other discussions under the Democratic Party of Japan administration. A second noteworthy program was Exploratory Research for Advanced Technology (ERATO) aimed at stimulating basic research in a planned and efficient manner by organizing research groups under the leadership of creative and innovative researchers, regardless of the sector in which the researcher works (industry, academia, or the public sector) to effectively identify seeds of innovative technologies.

The GASR program is defined as "a program intended to facilitate marked progress in "academic research," or research inspired by researchers with original ideas, in the full range of fields from the arts and humanities, social sciences, and natural sciences in every stage from basic to applied research, in which funding is granted to original and pioneering research projects that build the foundations for a wealthier society after due screening by peer review." Meanwhile, limitations on funding programs and on the research items eligible for funding have been modified or abolished for improving and keeping with the changing times and the social situation since the 1980s. In the 1990s, the government drew up the Basic Act on Science and Technology and developed the notion of STBP. In the early 2000s, a doubling of the value of competitive grants was planned in the second STBP. In 2010, the programs were subject to evaluation for the government's budget screening.

The GASR program is a major competitive grant program in Japan. The budget for FY2013 amounted to 238.1 BY (almost a 60% share of all the competitive grants offered by all ministries). In addition to the GASR, strategic funds for the promotion of science and technology and health and labor sciences research grants are also major elements of the national competitive grant program. The budget of these programs amounted to 238.1 BY, 62.5 BY, and 31.2 BY, respectively for FY2013, which accounted for nearly 80% of the total competitive grants (408.5 BY) offered by all ministries.

3. Mathematical Modeling Analysis for the Research Fund Allocation

In Figure 2 we have shown the historical trend of major competitive research funds in Japan, which are provided by STPF (2081–2017) and GASR (1981–2017) from MEXT, and by SCRP (1981–2014) from the Japan Science and Technology Agency (JSTA), respectively. In this section we show that all those trends can be expressed approximately using the so-called logistic curve. Thus, we explain that these trends show clear correspondences with Japanese basic science and technology policy represented by the STBP. The GASR fund is the largest research fund of all competitive research funds in Japan. The next largest competitive research funds in Japan is SCRP provided by JSTA. Trends of those two major research funds as well as the SCRP can be expressed by using the logistic curve.

Approximations are made with logistic curves for the respective data corresponding to the period FY1981–FY2017 shown in Figure 3 for each of STPF, GASR and SCRP, respectively We apply the logistic model whose mathematical formula is given as follows.

$$y = \frac{c}{1+ae^{-bx}} + d, \tag{1}$$

where

y: budgeted amount of STPF (BY), GASR (BY), and SCRP (BY)

x: values denoting years such as 1 for 1981, 2 for 1982, and so forth

a,b,c,d: parameters.

According to the above equation, the parameters can be estimated as

$$\frac{c}{y} - 1 = ae^{-bx} \quad (2)$$

Taking the logarithm of both sides of (2), we obtain

$$\ln\left(\frac{c}{y} - 1\right) = \ln(ae^{-bx}) = \ln a - bx \quad (3)$$

which gives a simple linear regression model, expressed as

$$Y = A + BX + \varepsilon \quad (4)$$

where X is an independent variable, Y is a dependent variable, A, B are parameters, and ε is a normally distributed error term. These variables and parameters are expressed as follows.

$$Y = \ln\left(\frac{c}{y} - 1\right), \; X = x \quad (5)$$

$$A = \ln a, \qquad B = -b \quad (6)$$

where *c* is predetermined taking into account actual values.

Using the data FY1989–FY2012 for STPF, FY1981–FY2012 for GASR, and FY1989–FY2012 for SCRP, we give the OLS (ordinary least square) estimation results for the parameters A and B in the above model in Table 1. Estimates for the original parameters *a*, *b*, *c*, and *d* are given in Table 2.

Table 1. Parameter estimates for A and B of STPF, GASR and SCRP

Parameter.	STPF	GASR	SCRP
A	3.697(11.57)	4.891(26.02)	6.432(18.90)
B	−0.3547(−15.86)	−0.3084(−27.70)	−0.4532(−17.49)
R^2	0.9196	0.9648	0.9388

‘t’ values are in parentheses

Table 2. Parameter estimates for *a*, *b*, *c*, and *d* of STPF, GASR and SCRP

Parameter.	STPF	GASR	SCRP
a	40.31	133.1	977.5
b	−0.3547	−0.3084	−0.4532
c	940	1650	507
d	440	356	18

Figure 3 is a chart showing the change in the budgeted amount of STPF over years from 1989 to 2012. Horizontal coordinate (x-axis) in Figure 4 indicates years during the period 1989-2012 whose notation corresponds to 1 to 24, respectively. Using the estimates shown in Table 2 for the mathematical model given in the form (1), the historical trend of Japan’s STPF can be expressed as follows.

$$y = \frac{940}{1 + 40.31e^{-0.3547x}} + 440 \qquad x = 1, 2, 3, \ldots \quad (5)$$

The graph given in Figure 3 shows both estimated and actual values for STPF during the period 1989–2012 where the years during that period correspond to 1, 2 …, and 24, respectively. We find that the graph in Figure 4 shows high goodness of fit as the estimated and actual values coincide very closely. In Figure 4 it can be seen that the greatest STPF growth rate for both estimated and actual values occur with a y-coordinate value around 910 (=940/2+440) in the first term, namely when the STPF value is around 135 BT in about 2006, which coincides with the time when the 3rd STBP started, i.e. when competitive research funds were announced for the first time.

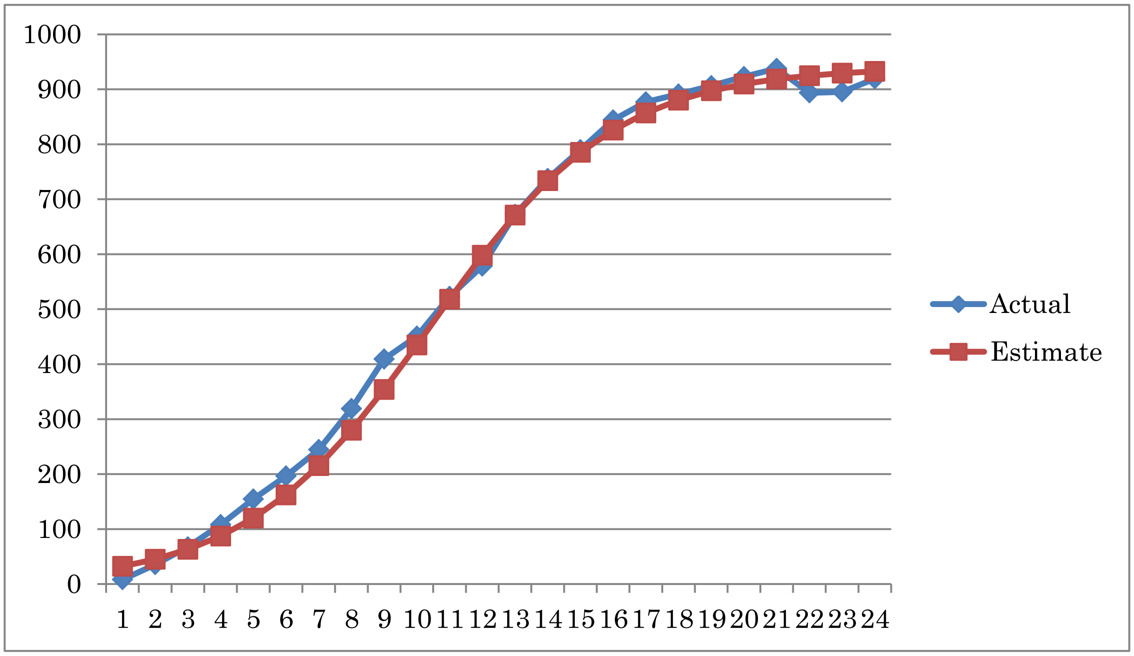


Figure 3. Actual data and estimated data for the STPF

Using the data FY1981–FY2012 for GASR and applying the mathematical model given in the form (1), parameter estimates are shown in Table 2. Years during the period 1981-2012 correspond to 1, 2 …, and 32, respectively. Thus, the historical trend of Japan's GASR fund can be expressed as

$$y = \frac{1650}{1+133.1e^{-0.3084x}} + 356 \qquad x=1,2,3,\ldots \tag{6}$$

Figure 4 also shows both estimated and actual values of the GASR fund. These two sets of estimated and actual values are very close, indicating high goodness of fit. In Figure 4 we find that STPF's highest growth rate is seen in both estimated and actual values at y-coordinate value of around 825 (=1650/2) for the first term in (1). This indicates that the corresponding year is around 2006, based on estimated and actual values in Figure 4, when the value of GASR was around 118 BY. This is also the year when the 3rd STBP started, i.e. when the competitive research fund was first implemented, as mentioned above.

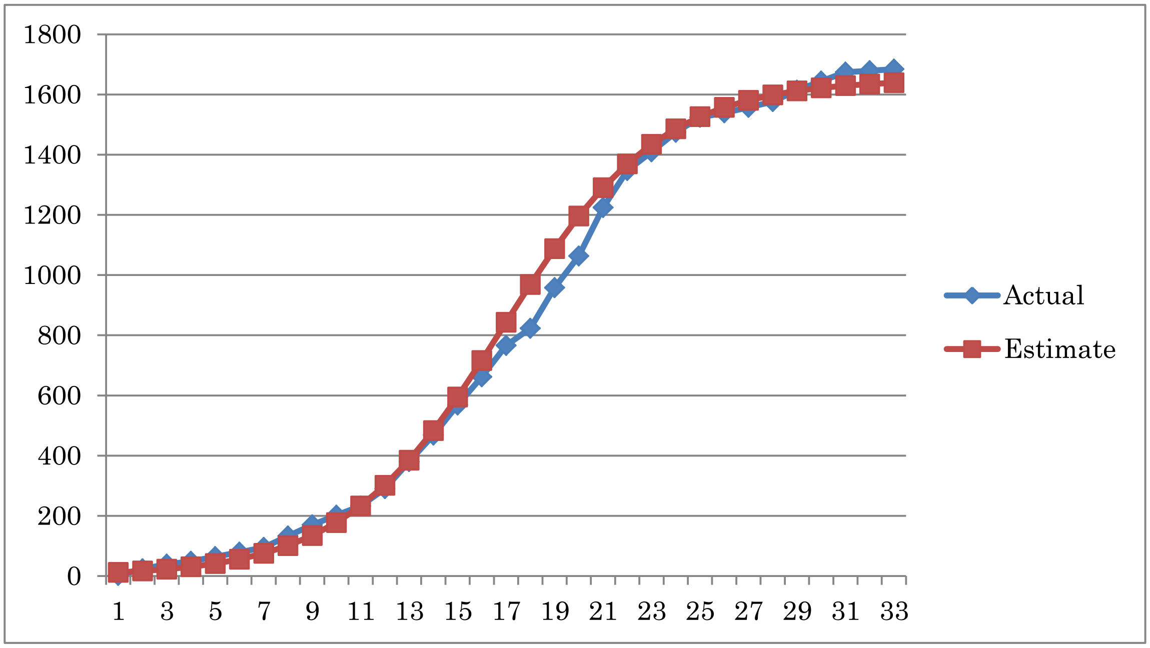


Figure 4. Actual data and estimated data for the GASR

We use the data FY1989–FY2010 for SCRP. Figure 5 shows both estimated and actual values for the historical trend of SCRP fund. Years during that period 1989-2012 correspond to 1, 2 …, and 22, respectively. Using the estimates shown in Table 2 and the mathematical model given by equation (1), the historical trend of Japan's SCRP fund can be expressed as follows.

$$y = \frac{507}{1+977.5e^{-0.4532x}} + 18 \qquad x=1,2,3,\ldots \tag{7}$$

Furthermore, regression results for the SCRP model show similar results with high goodness of fit such that the highest growth rate for the SCRF occurs at around 2003, when the 2nd STBP was implemented, i.e., when competitive research funding was increased with the introduction of the GASR fund. Moreover, the budget for SCRP was increased prior to the beginning of the GASR system, thus the typical characteristic for SCRF is a rapid increase of actual values in roughly 2001–2007,

On the other hand, we find that after 2011 the budget is slightly different from that before 2011. This is because the GASR fund introduced a new base fund system, when the then dominant Democratic Party took the initiative to increase the GASR fund dramatically. We believe that it is important to monitor the movement of the research fund system in Japan more carefully in the near future.

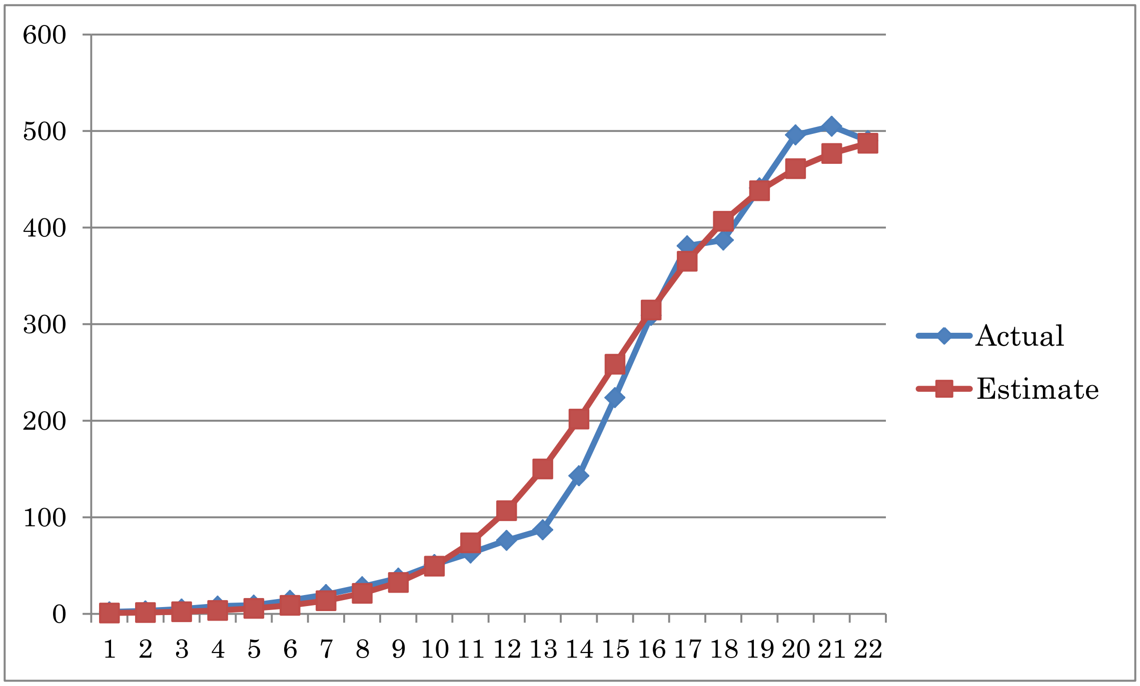


Figure 5. Actual data and estimated data for the SCRP

4. Measuring the Effects of the GASR Fund for the Japanese National University Corporation

In 2004 the Japanese government ministry MEXT declared a reform of Japanese national universities, changing their institutional status to national university corporations (NUC). Then some national universities were merged, reducing the total number of national universities from 100 to 90. In Japan, public universities, including both national and state universities, have played key roles in higher education with respect to both education and research since the 19^{th} century, when the largest and most prestigious universities in Japan such as University of Tokyo and Kyoto University, were established.

In this section, after reviewing the evaluation research for the funding system, we select 61 Japanese NUCs which have natural science schools, then evaluate their research activities, measuring the effects of GASR fund for the Japanese NUCs. Furthermore, using numerical data of 61 major universities in Japan, we show that the relationship between the GASR fund and various types of university budgetary data such as the total working fund (*TWE*), distributed operating fund (*DOF*), and other revenues (*OTR*) can be explained using various types of mathematical models. Through these mathematical modeling analyses we can evaluate quantitatively the effect of the Japanese research funding system on its performance and efficiency.

4.1 Reviewing the Evaluation Research for the Funding System

On measuring the effects of the funding system, Falk (1974) analyzed dynamics and forecasts of the R&D funding system by investigating the effects of the introduction of new areas of R&D interest. The relationships between U.S. R&D funding and other macro parameters were analyzed on an overall national basis and within the four major sectors of the economy. The author proposed an inherent stability of R&D operations, as illustrated by lack of good, short-term correlations between R&D funding and cyclical variants such as profits in industry or science and engineering graduate enrollments in institutions of higher education. D'este, et al (2013) investigate the relationship between sources of funding for research activity and the engagement of scientists in a specific type of knowledge transfer, that is, academic consulting. 2603 individual scientists who were funded by either public or private agents. They shed light on the conditions that favor academic consulting, saying that externally contracted research is positively related to the amount of monetary income from consulting contracts, but that international competitive funding has a negative effect. They also show that this negative effect is positively moderated by the size of contract funding: the effect of international competitive funding becomes positive for moderate and high levels of contract funding. Jacob and Lefgren (2011) estimated the impact of receiving an NIH grant on subsequent publications and citations. Authors find that an NIH research grant (worth roughly $1.7 million) leads to only one additional publication over the next five years, which corresponds to a 7 percent increase. The limited impact of NIH grants is consistent with a model in which the market for research funding is competitive, so that the loss of an NIH grant simply causes researchers to shift to another source of funding. Filippo, et al (2016) analyses Spain's Campus of International Excellence (CEI) Programme and its potential for raising the visibility of the country's universities, optimizing resources and intensifying interaction with the local surrounds. The results are analyzed in terms of the papers published. The analysis compares each university's individual output to the results obtained by these inter-institutional alliances, thus concludes that inter-institutional alliances can be an excellent strategy in order to obtain higher international visibility., the Spanish CEI initiative has promoted inter-institutional research collaboration, and Campus of International Excellence (CEI) is an effective programme to improve quality of scientific production. Huergo, et al (2016) estimate the effect of public low-interest loans for R&D projects on the probability of performing R&D by Spanish firms. The estimations provide evidence of the effectiveness of public low-interest loans, being the stimulus effect larger for SMEs than for large firms and also higher for manufacturing than for services. This result suggests that firms can be induced persistently to perform R&D activities by means of loans.

4.2 Measuring the Effects of the GASR Fund in Japan

In 2011 the National Institute of Science and Technology Policy (NISTEP) gave a Japanese university benchmarking for all Japanese universities (NISTEP(2011)). In the following analysis we select 61 NUCs in Japan, in which they have natural science schools. Those NUCs include all major universities in Japan. Using full sets of all financial data for those universities, including their operating expenses, revenues, and allocated GASR budgets, we examine quantitatively relationships among these sets of financial data, thus attempting to measure the effects of their operating expenses and revenues on the size of allocated GASR budgets and to compare certain features of all NUCs. The data used in this analysis include; allocated GASR budget values during the period 2010–2015, i.e. in the NUC 2nd midterm plan (refer to NUC); data from financial reports prepared by those corporations in 2010; data on the published academic papers during the period from 2007–2011 given in the NISTEP (2011) and GASR related data including number of newly accepted and continuing projects and allocated budget (refer to JSPS) in 2009.

Total working expenses (*TWE*) is obtained from the NUC 2nd midterm plan, in the period 2010– 2015 (approved by the minister of MEXT in March, 2010). The distributed operating fund (*DOF*) and other revenue (*OTR*) are also given in the NUC 2nd midterm plan. *OTR* data is defined as the sum of the *DOF* and hospital revenue (in the case of universities operating hospitals), subtracted from *TWE*. We use the 2009 data (refer to JSPS) for number of newly accepted and continuing projects, and their budgets allocated to each university. Data for the total number of published papers during the period 2007–2011 are from the NISTEP(2011).

Appendix A shows total working expenses (*TWE*, Unit:MY), distributed operating fund (*DOF*, Unit:MY), other revenue (*OTR*, Unit:MY), number of faculties (*NFC*), number of students (*NST*), number of selected GASR funding (*NSF*), number of distributed GASR fund (*DSF*), and number of published papers (*NPP*). First, we investigate the relation among various factors such as *TWE*, *DOF*, and *OTR* for 61 Japanese major universities with natural science schools. In the following analysis, we divide the set of 61 Japanese major universities into two groups; one consisting of 42 universities whose *TWE* is larger than 13 BY, and the other of 19 universities whose *TOE* is less than that figure. We denote the first group as set I, the other as set II, and the whole group of 61 universities as set III. This grouping is based upon the large gap in *TWE* value at the boundary 13 BY. Set II universities with *TWE* less than 13 BY consist of 6 local national universities, 8 technical colleges, 3 comprehensive universities consisting of only graduate schools and 2 women’s colleges.

Using the data given in Appendix A, we apply mathematical modeling analysis to determine the relationship among factors including the number of selected GASR funding (*NSF*) projects accepted, total working expenses (*TWE*), distributed operating fund (*DOF*), other revenue (*OTR*), and allocated GASR fund (*DSF*). We apply various mathematical models to determine the relationship between the independent variable *TWE* and other dependent variables such as *DOF*, *OTR*, *NFC* and *NSF*. We show function forms and parameter estimates for those mathematical models in Table 3, where the variable z has value $z = x$-130,000, and the model is expressed by the following equation.

$$y = az^b \qquad (8)$$

Thus, estimates of parameter a indicate the value of natural logarithm log a. I and II in Table 3 indicate the sets of NUCs, mentioned above, with *TWE* greater than the boundary 130 BY and those with *TWE* less than that, respectively. In Table 3 we find that all models can be expressed by linear functions for set I while those for set II are nonlinear with respect to concave functions. Table 3 shows that for set I mathematical models relating *TWE* and variables *DOF* and *OTR* are functions of form $y = ax$, where parameter estimates are 0.5584 for the dependent variable *DOF* and 0.4416 for *OTR*, respectively. This implies that increases in *DOF* and *OTR* corresponding to a unit increase 1 BY (200 MY per year as this unit increase of 1 BY corresponding to a 5 year period) are 558.4 MY and 441.6 MY, respectively.

Table 3. Regression results for explaining *DOF*, *OTI*, *NFC* and *NST*

Dep. V..		*DOF*		*OTI*		*NFC*		*NST*	
Indep. V.		*TWE*		*TWE*		*TWE*		*TWE*	
Model		$y=ax$	$y=az+b$	$y=ax$	$y=az+b$	$y=ax$		$y=ax$	$y=az^b$
Data		I	II	I	II	I	II	I	II
Para.	*a*	0.5584 (38.94) (0.0)	0.4626 (41.97) (0.0)	0.4416 (30.80) (0.0)	0.3632 (33.67) (0.0)	6.286 (22.51) (0.0)	3.938 (27.98) (0.0)	90.64 (14.91) (0.0)	2.921 (37.09) (0.0)
	b	-	38.19 (12.96) (0.0)	-	14.70 (5.097) (0.0)	-	-	-	0.5138 (13.47) (0.0)
R^2		0.9883	0.9772	0.9258	0.9651	0.9102	0.8522	0.8695	0.8149

Dep. V.:Dependent variable, Indep. V.:Independent variable, Para.:Parameters

Estimate in *NST*-*TWE* indicates log *a*

It can be seen that "the effect of increasing unit amount (200 MY) of *TWE* is larger for *DOF* than for *OTR* by more than 100 MY. On the other hand, for set II with, *TOE* greater than 130 BY, *DOF* and *OTR* increased to 463 MY and 363 MY, respectively, corresponding to a unit (1 BY) increase in *TWE*. This implies that the dependent variables *DOF* and *OTR* increase by roughly 100 MY more for set I than for set II. From the regression results in Table 3 on the relation between *DOF* and *TWE* for set II, given as

$$y = 0.4626x + 38.19 \tag{9}$$

it can be seen that the dependent variable *DOF* has a potential value of 3.82 BY, i.e. that much of *DOF* is almost guaranteed and it increases 463 MY corresponding to unit increase (1 BY) of *TWE*.

Defining the dependent variables for the independent variable *TWE* to be *NFC* and *NST*, we find that the regression model can be given by a function of form $y = ax$, which implies that both *NFC* and *NSF* increase proportionally to the increase in *TWE*. Parameter estimates of slope *a* are 6.286 for *NFC* and 90.64 for *NST*. These estimated values correspond to the increases in the number of faculties and the number of students corresponding to the unit (1 BY) increases in *TWE* for set II. For set II with *TWE* larger than 130 BY, the relationship between dependent variables *NFC* and *NST* and independent variable *TWE* can be expressed as a nonlinear function of form $y = az^b$, where parameter *b* is estimated to be $0<b<1$, implying a concave function. Estimate *b* is 0.432 and 0.514 for the variables *NFC* and *NST*, respectively. We can interprete parameter *b* as the elasticity of *NFC* and *NST* with respect to the variable *TWE*, therefore, increases in *NFC* and *NST* by 0.532% and 0.514% correspond to a 1% increase in *TWE*, which implies that the number of students increased around 0.1% more than the number of faculties, corresponding to a 1% increase in *TWE*.

We compare two cases; all 41 universities belonging to set I (case I) and set I without the smallest university (HMMT) of its 41 universities (case II), the parameter estimates are (a = 1.976, b = 0.4323) and (a = 0.8486. b = 0.5272) for cases I and II, respectively. Approximate curves are shown in Figure 7 where curves A and B correspond to cases I and II, respectively. We can conclude that *DOF* and *OTI* increase proportionally at a fixed rate while *NFC* and *NST* increase following a nonlinear concave curve, meaning the rates of increase gradually decrease.

Figures 6 and 7 show the relationship between *NFC*–*TWE* and *NST*–*TWE*, respectively, as seen in their respective approximate regression results and estimated curves.

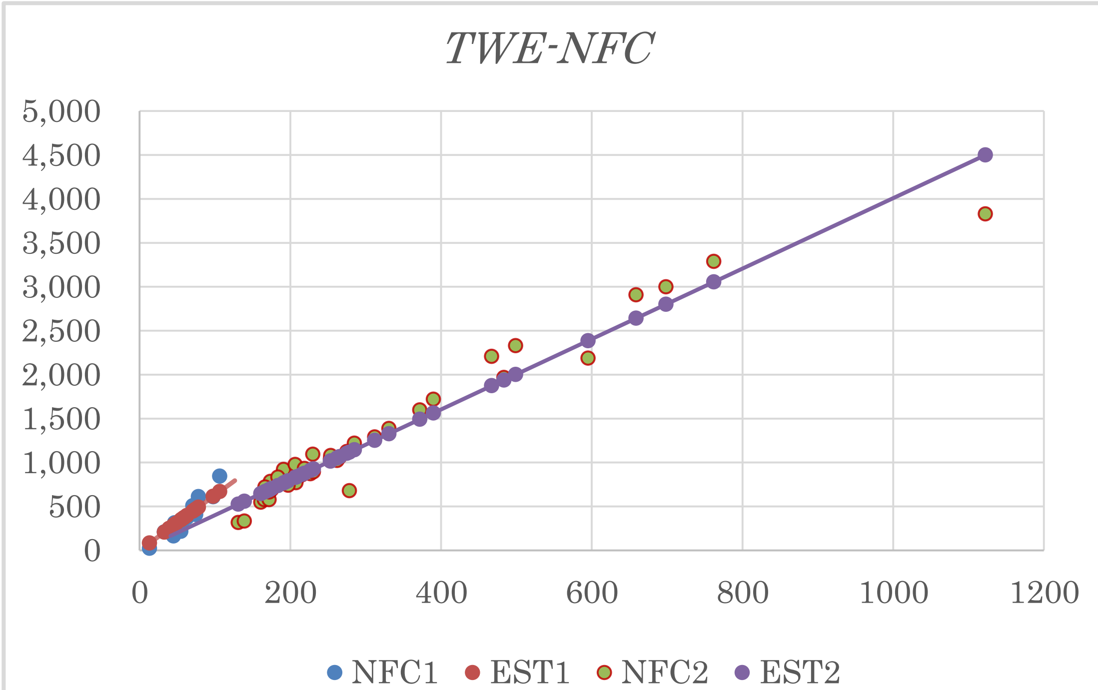


Figure 6. Actual data and estimates for the model *TWE-NFC*

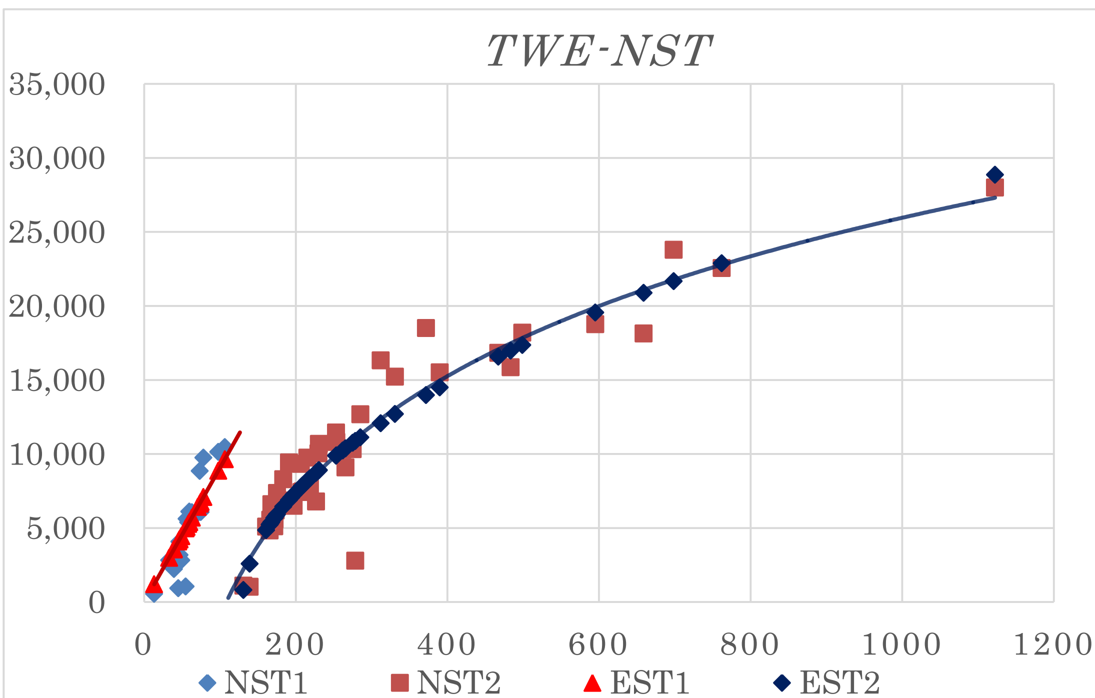


Figure 7. Actual data and estimates for the model *TWE–NST*

As can be seen in Table 4, the relations between *NSF* and other factors such as *TWE*, *DOF* and *OTR* can all be expressed as linear functions. Moreover, regarding the relationship between *NSF* and *TWE*, it is expressed by linear functions separately for two cases (*TWE* more than and less than 13 BY). As for the relationship between *NSF* and *DSF* (*OTR*), we use a quadratic function passing through the origin for all 61 universities data to determine the relationship between number of published papers (*NPP*) and number of proposals accepted for GASR funding (*NSF*), as shown in Figure 9.

Table 4. Regression results for explaining *NSF, DSF* and *NPP*

Dep. Var.		*NSF*		*NSF*	*NSF*	*DSF*	*NPP*
Indep. Var.		*TWE*		*DOF*	*OTR*	*NSF*	*NSF*
Model		$y=ax$	$y=az+b$	$y=ax$	$y=ax$	$y=ax^2+bx$	$y=ax$
Data used		I	II	III	III	III	III
Param.	*a*	2.494 (20.80) (0.0)	3.296 (40.36) (0.0)	5.864 (37.34) (0.0)	8.292 (47.46) (0.0)	1.799 (21.39) (0.0)	10.98 (66.81) (0.0)
	b	-	43.53 (1.993) (0.053)	-	-	1995.0 (10.87) (0.0)	-
R^2		0.9045	0.9754	0.9421	0.9574	0.9733	0.9701

Dep. Var.:Dependent variable, Indep. Var.:Independent variable, Param.:Parameters

The relationship between *NSF* and *TWE* can be expressed as a linear function, but as can be seen in Table 4, the set of universities can be divided into two groups, by means of a budget boundary 13 BY. Regression results show that the slope for the group I data is 2.49 while that for the group II data is 3.30. This can be interpreted as reflecting the fact that the increase rate of *NSF* with respect to the 1 BY budget increases in *TWE* would be almost 0.8 times larger for group II universities rather than for group I universities.

On the other hand, the relationship between *NSF* and *DOF* (*OTR*) can be expressed by the linear function $y = ax$ passing through the origin. The estimated slopes for these two linear functions, for *DOF* and *OTR* are 5.86 and 8.29, respectively. This implies that these estimates are almost twice those for *TWE*. This means that to achieve an increase in *DSF,* increasing *DOF* or *OTI* would be more effective than increasing *TWE*.

Figure 8 shows the relationship between *NSF* and *DSF* using the approximate quadratic function's graph. We find that increases in *DSF* corresponding to a unit increase in *NSF* are much higher than the proportional case, indicating that an increase in *NSF* would lead to a larger increase in *DSF*. Regarding the relationship between *NSF* and *NPP*, we see from Table 4 that the two are proportional, which implies that the coefficient is around 11.0. This means that a unit increase in *NSF* would lead to 11 publications of academic papers.

Figure 9 shows the relationship among all factors defined so far here. In Figure 9 directed edge indicates that the head and the tail correspond to the independent and dependent variables, respectively. In Figure 9, *L* and *Q* can be seen to be linear and quadratic, respectively; more over *LL* and *LN* imply that *L*:linear and *N*:nonlinear. The former character corresponds to the result for set I, the latter to that of set II.

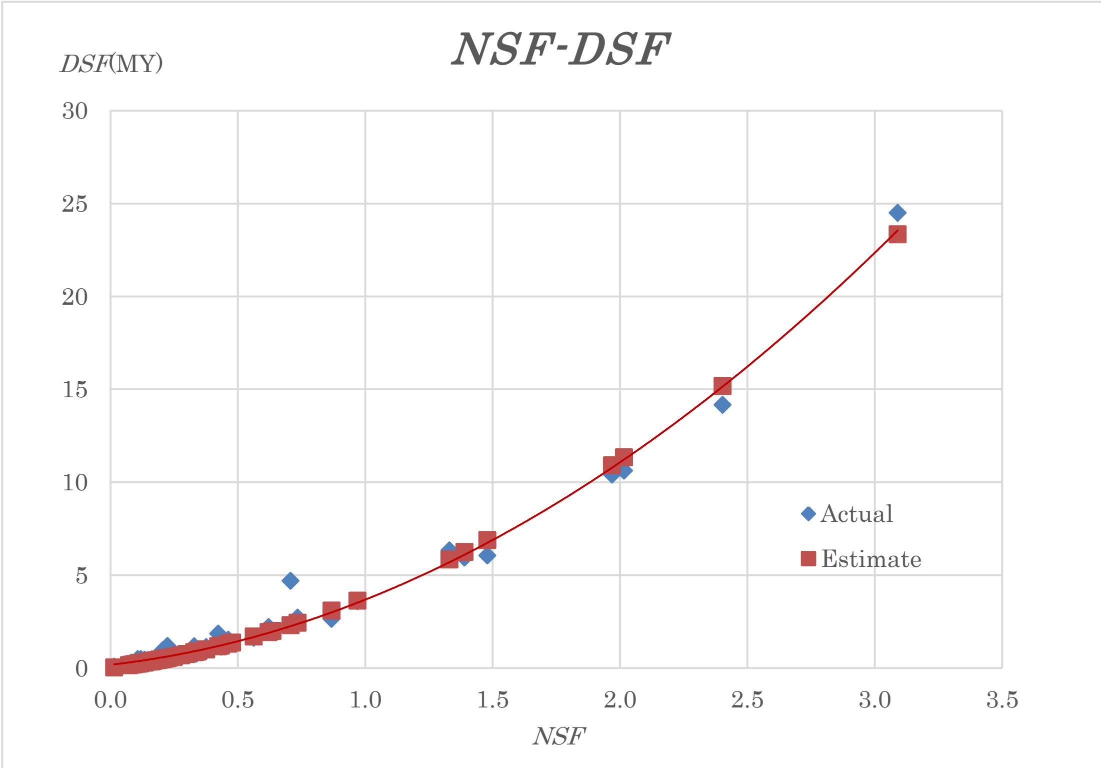
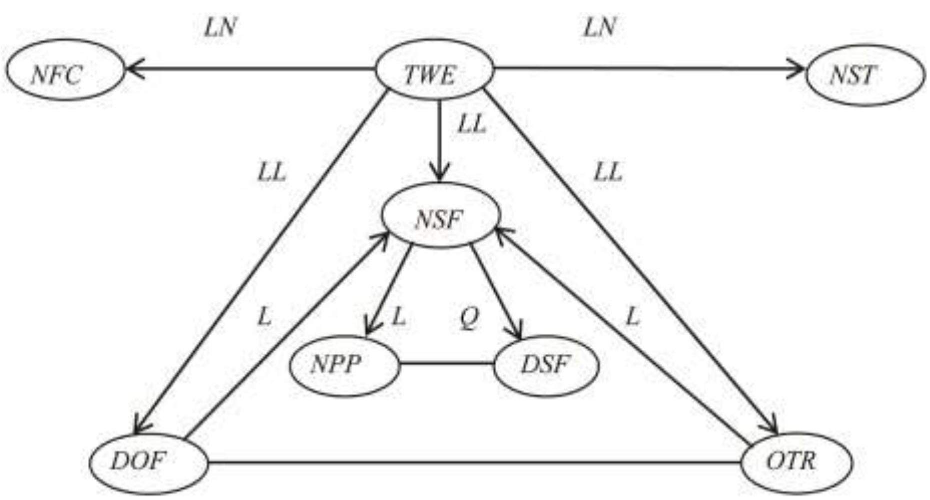


Figure 8. Actual data and estimated curve for the model *NSF -DSF*



TWE: total working expenses, *DOF*: distributed operating fund, *OTR*: other revenue, *NFC*: Number of faculties, *NST*: Number of students, *NSF*: Number of selected funds, *DSF*: Distributed GASR fund, *NPP*: Number of published papers

Figure 9. Relations among various factors

5. Summary and Conclusion with Policy Suggestions

GASR and two other major types of national competitive grants STPF and SCRP are major strategic funds for promoting science and technology research funds and health and labor sciences research grants. The FY2013 budgets of these three programs amounted to 238.1 BY, 62.5 BY, and 31.2 BY, accounting for nearly 80% of the competitive funding (408.5 BY) offered by all Japanese ministries. We find that the relationship between distributed GASR fund

(*DSF*)and number of selected funds (*NSF*) can be expressed as a quadratic function (see Figure 8). This implies that *DSF* increases more rapidly than *NSF*. Thus, we can say that *NSF* could increase both *DSF* and the allocated budget more substantially. Table 4 shows that the relationship between *NPP* and *NSF* can be expressed as a linear function whose graph passes through the origin, and whose slope of this straight line is 11.0, which implies that the average number of published papers corresponding to a GASR project would be around 11.

In section 4 we have shown the effects of the research funding system in Japan using data for major Japanese universities. We show that STPF increased drastically between 1985–2014, and observe that under those conditions, the competitive funds for promoting Japanese science and technology have increased substantially, and we characterize the historical development of STPF, GASR and SCRP comparatively and quantitatively.

The following is a summary of the above quantitative analysis of the growth of the GASR system. By applying our mathematical modeling approach to examination of the structure of the Japanese research funding system, we obtained the following results.

i) The behavior of STPF, GASR and SCRP can be expressed as a logistic growth curve. Estimates obtained with those logistic models indicate that the highest growth periods for these funds correspond to the second and the third STBP, and the reform period of the GASR, respectively. In particular, the period of fastest growth of the SCRP was around 2003, i.e., almost 3 years before the fastest growth periods of STPF and GASR.

ii) The relationship between *NSF* and *DSF* and *TWE*, *DSF* and *OTR* are all expressed in terms of linear functions. The relationship between *NSF* and *TWE* differs for smaller and larger groups with budgets of less than 130 BY. The former group has a growth rate 2.49; the latter 3.30. This implies that the rate of increase of *NSF* with respect to a 1 BY budget increase for *TWE* would be almost 0.8 larger for group II universities than for group I universities.

On the other hand, the relationship between *NSF*, *TWE* and *OTR* can all be expressed as linear functions passing through the origin. Comparing the slopes of those estimates, 5.86 and 8.29, respectively, we find that these estimates are almost twice the size of total operating expenses. This implies that increasing *DOF* or *OTR* would be more effective than increasing *TWE* for increasing the *DSF*.

iii) The relationship between *DSF* and *NSF* for GASR can be expressed as a quadratic function passing through the origin. This implies that *DSF* increases more rapidly than the case of linear relation for *NSF*. Thus, we can say that an increase in the *NSF* would lead to a more substantial increase in *DSF*.

iv) For all 61 universities, the relationship between *NPP* and *NSF* can be expressed as a linear function with a slope of 11.0, which implies that the average *NPP* corresponding to a GASR project would be approximately 11.

We have examined the Japanese GASR system quantitatively and comparatively using recent data. The results reveal that the Japanese research funding system is in need of further reform and improvement if the Japanese research funding system is to improve. We believe that the results of our analysis will be of use for determining our future strategic research direction towards reforming the Japanese funding system in order to make it more effective and innovative.

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References

Anwar, S. & T. Oyama. (2007). Statistical data analysis for investigating government subsidy policy for private universities. *Journal of Higher Education, 55*(4), 407-423, On line ISSN 1573-174X, Springer.

Archibugi, D. Denni, M. & Filippetti, A. (2009). The technological capabilities of nations: The state of the art of synthetic indicators. *Technological Forecasting and Social Change, 76*, 9171–931. https://doi.org/10.1016/j.techfore.2009.01.002

D'este, P., Rentocchini, F., Grimaldi, R., Manjarrés-Henrίquezad, L. (2013). The relationship between research funding and academic consulting: An empirical investigation in the Spanish context. *Technological Forecasting and Social Change, 80*(8), 1535–1545. https://doi.org/10.1016/j.techfore.2013.04.018

Falk, C.E. (1974). Dynamics and Forecasts of R&D Funding. *Technological Forecasting and Social Change, 6*, 171–189. https://doi.org/10.1016/0040-1625(74)90016-X

Fandel, G. (2007). On the performance of universities in North Rhine-Westphalia, Germany: Government's redistribution of funds judged using DEA efficiency measures. *European Journal of Operational Research*, *176*(1), 521-533. https://doi.org/10.1016/j.ejor.2005.06.043

Filippo, D.De., F. Casani & E. Sanz-Casado. (2016). University excellence initiatives in Spain, a possible strategy for optimising resources and improving local performance. *Technological Forecasting and Social Change*, *113*, 185-194. https://doi.org/10.1016/j.techfore.2015.05.008

Geuna, A. & Ben R. Martin. (2003). University research evaluation and funding+ An International comparison. *Minerva, 41*, 277-304. https://doi.org/10.1023/B:MINE.0000005155.70870.bd

Huergo, E., Trenado, M. & Uviema, A. (2016). The impact of public support on firm propensity to engage in R&D: Spanish experience. *Technological Forecasting and Social Change, 113*, Part B, 206-219.

Jacob, A. & L. Lefgren. (2011). The Impact of Research Grant Funding on Scientific Productivity. *Journal of Public Economic*s, *95*, 1168-1177. https://doi.org/10.1016/j.jpubeco.2011.05.005

Japan Society for the Promotion of Science. (JSPS). http://www.jsps.go.jp/j-grantsinaid/27_kdata/index.html

Jeffrey, H., Sedgwick, J. & Gavin Gerrard, G. (2014). Public Funding for Ocean Energy: A Comparison of the UK and US. *Technological Forecasting and Social Change*, *84*, 155–170. https://doi.org/10.1016/j.techfore.2013.08.006

Kuwahara, T. (1999). Technology Forecasting Activities in Japan. *Technological Forecasting and Social Change*, *60*(1), Elsevier: 5–14.

Lootsma, F.A., T. C. A. Mensch, & F. A. Vos. (1990). Multi-Criteria Analysis and Budget Reallocation in Long-Term Research Planning. *European Journal of Operational Research*, *47*(3), 293–305. https://doi.org/10.1016/0377-2217(90)90216-X

McKinney, L. & L.S. Hagedorn. (2018). Performance-Based Funding for Community Colleges: Are Colleges Disadvantaged by Serving the Most Disadvantaged Students?. *Journal of Higher Education, 88*(2). Taylor Francis Online. https://doi.org/10.1080/00221546.2016.1243948

Muscio, A. Davide Quaglione, & Giovanna Vallanti. (2013). Does Government Funding Complement or Substitute Private Research Funding to Universities? *Research Policy, 42*(1), 63–75. https://doi.org/10.1016/j.respol.2012.04.010

National University Corporations. (NUC). http://www.mext.go.jp/a_menu/koutou/houjin/1352343.htm

National Institute for Science and Technology Policy. (NISTEP). (2011). "Japanese University Benchmarking 2011 focusing upon the research paper publications", National Institute for Science and Technology Policy, The Ministry of Education, Science and Culture, Japan.

Paredes-Frigolett, H. (2016). Modeling the Effect of Responsible Research and Innovation in Quadruple Helix Innovation Systems. *Technological Forecasting and Social Change, 110*, 126–133. https://doi.org/10.1016/j.techfore.2015.11.001

Psacharopoulos, G. (2008). Funding Universities for Efficiency and Equity: Research Findings versus Petty Politics. *Education Economics, 16*(3), 245–260. https://doi.org/10.1080/09645290802338078

Staphorst, L., L. Pretorius & M. W. Pretorius. (2016). Technology forecasting in the National Research and Education Network technology domain using context sensitive Data Fusion. *Technological Forecasting and Social Change, 111*, 110-123. https://doi.org/10.1016/j.techfore.2016.06.012

Vilkkumaa, E., A. Salo, J. Liesiö, & A. Siddiqui. (2015). Fostering Breakthrough Technologies — How Do Optimal Funding Decisions Depend on Evaluation Accuracy? *Technological Forecasting and Social Change, 96*, 173–190. https://doi.org/10.1016/j.techfore.2015.03.001

Yamashita, Y., H. N. Giang & T. Oyama. (2018). Investigating the performance of Japan's competitive grant Grants-in-Aid for Scientific Research System. *International Journal of Higher Education, 7*(5), 167-184. https://doi.org/10.5430/ijhe.v7n5p167

Zhao S.L., Cacccillatti L., Lee S.H., Song W. (2015). Regional collaborations and indigenous innovation capabilities in China: A multivariate method for the analysis of regional innovation systems. *Technological Forecasting and Social Change, 94*, 202-230. https://doi.org/10.1016/j.techfore.2014.09.014

Appendix A. *TWE*, *DOF*, *OTR*, *NFC*, *NST*, *NSF*, *DSF* and *NPP*.

No	UNV	*TWE*	*DOF*	*OTR*	*NFC*	*NST*	*NSF*	*DSF*	*NPP*
1	HKID	498,983	223,538	137,502	2,328	18,190	1,390	5,946,653	14,367
2	HRSK	194,022	65,543	34,977	803	6,846	212	488,571	1,861
3	IWAT	70,764	41,269	29,495	506	6,010	132	312,991	1,438
4	TOHK	658,941	280,373	199,222	2,906	18,133	1,969	10,410,869	21,838
5	AKIT	171,759	59,223	35,290	648	5,109	159	375,180	1,360
6	YAMG	191,031	71,117	49,089	920	9,421	247	569,819	2,505
7	IBRK	78,148	42,785	35,363	610	9,749	150	429,046	1,421
8	TUKB	467,255	251,349	101,315	2,207	16,828	970	3,602,009	9,009
9	UTSM	58,182	34,807	23,375	350	5,381	116	259,080	763
10	GUNM	226,706	72,901	40,836	871	6,787	374	901,992	3,096
11	SATM	73,219	36,948	36,271	464	8,849	222	497,137	1,506
12	CHIB	312,079	104,377	82,351	1,290	16,319	621	2,199,966	6,176
13	TKYO	1,122,466	496,078	400,259	3,828	27,992	3,090	24,492,612	36,925
14	TKIS	278,533	93,391	32,954	677	2,789	423	1,849,710	4,254
15	TKNK	74,538	38,236	36,302	407	6,070	224	1,184,168	3,357
16	TKKK	229,876	128,606	101,270	1,092	10,044	707	4,691,838	11,775
17	TKKY	48,935	32,984	15,951	246	2,817	73	215,461	957
18	OCHA	46,680	28,246	18,434	211	3,174	116	298,786	816
19	DNKT	55,889	31,221	24,668	310	5,619	164	462,142	1,522
20	YKHM	97,762	49,418	48,344	608	10,134	231	718,134	1,969
21	NIGT	285,177	100,819	68,288	1,219	12,676	478	1,348,629	3,934
22	NAGN	39,119	23,014	16,105	226	2,387	107	479,510	1,218
23	TOYM	206,624	78,621	48,486	976	9,328	299	730,956	3,118
24	KNZW	275,200	97,008	59,603	1,124	10,320	563	1,629,199	4,814
25	FUKI	160,918	58,282	28,434	546	5,089	221	478,667	1,606
26	YMNS	165,567	58,276	31,695	575	4,833	216	438,870	1,855
27	SNSH	253,148	85,954	64,411	1,037	11,446	344	951,956	3,677
28	GIFU	209,218	78,876	40,287	819	7,463	277	642,038	3,426
29	SZOK	106,346	58,411	47,935	843	10,456	279	661,667	2,290
30	HMMT	130,936	32,824	15,707	315	1,099	137	349,211	1,416
31	NAGY	483,508	198,904	128,578	1,966	15,854	1,331	6,333,098	14,027
32	NGKG	59,535	28,677	30,858	355	6,105	173	476,975	2,052
33	TYHS	39,394	22,834	16,560	213	2,227	119	483,606	1,265
34	MIED	207,511	69,567	53,476	768	7,420	250	667,400	2,488
35	SGIK	139,061	33,122	15,273	332	1,027	93	210,125	1,352
36	KYOT	761,977	335,749	252,379	3,288	22,559	2,403	14,163,991	27,295
37	KYKG	46,454	27,814	18,640	312	4,068	109	318,394	1,457
38	OSAK	698,512	289,261	233,532	2,997	23,787	2,016	10,619,188	21,807
39	KOBE	371,843	127,566	97,590	1,597	18,498	735	2,713,519	6,123

40	NRJO	32,879	21,484	11,395	209	2,822	94	193,360	860
41	TOTR	197,242	67,703	33,699	740	6,498	205	479,127	2,388
42	SHMN	173,624	62,709	42,902	784	6,182	191	400,024	1,816
43	OKYM	330,923	108,312	82,019	1,386	15,215	636	1,946,305	6,983
44	HRSM	389,902	158,220	103,899	1,718	15,509	868	2,645,566	7,795
45	YMGC	230,672	74,508	56,035	892	10,679	337	765,702	2,695
46	TKSM	218,802	81,045	39,597	931	7,810	376	1,124,100	3,355
47	KAGW	167,848	62,853	33,897	706	6,606	166	332,304	1,690
48	EHIM	215,458	81,295	53,424	857	9,742	329	1,171,585	3,247
49	KOCH	166,386	59,507	29,095	719	5,556	181	422,836	1,975
50	KYSH	595,106	250,146	164,657	2,186	18,765	1,480	6,056,465	14,783
51	KYSK	62,868	31,954	30,914	370	6,063	134	448,650	1,539
52	SAGA	175,299	63,348	33,417	690	7,363	163	336,488	2,197
53	NGSK	265,596	95,706	55,632	1,059	9,084	434	1,141,334	3,684
54	KMMT	262,072	90,469	56,786	1,021	10,302	463	1,524,931	4,056
55	OITA	171,868	56,739	34,001	576	5,797	163	284,373	1,431
56	MYZK	172,062	58,935	32,625	663	5,576	194	436,273	1,654
57	KGSM	253,612	94,790	68,357	1,078	10,803	340	818,162	3,077
58	RYKY	183,587	74,918	36,123	833	8,285	207	436,049	2,160
59	HKRK	45,011	33,124	11,887	163	924	83	290,433	1,099
60	NRST	54,777	37,289	17,488	215	1,043	205	951,724	1,753
61	SGKK	13,227	11,223	2,004	23	544	15	74,470	2,033

UNV.:University, *TWE*:total working expenses (MY), *DOF*: distributed operating fund (MY), *OTR*:Other revenue (MY), *NFC*:number of faculties, *NST*:number of students, *NSF*:number of selected GASR funding, *DSF*:number of distributed GASR fund (TY), *NPP*:Number of published papers (Units: MY:Million yen, TY:Thousand yen)