Kagaku (Iwanami Shoten), June 2001, p.832

National-Private Disparity in University Scientific Research Grants
—Structural Challenges for Raising the Level of the Japanese Scientific Community—
(Original manuscript: Slightly different from the published version)
translated by Gemini

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The government is actively promoting science and technology policies. The economic downturn in the 1990s led to a relative decline in corporate research and development capabilities, resulting in many advanced technological fields where Japan fell behind other countries. Because Japan's R&D expenditure is highly dependent on the private sector compared to other nations, the decline in corporate research capabilities directly translates to a decline in the nation's overall research capabilities. The government's science and technology promotion policies are an effort to increase the proportion of national expenditure in R&D to levels comparable to Western countries, thereby boosting the overall national research activity while reducing reliance on the private sector.

For this reason, national research funding to universities is expected to increase in the future. However, Japanese universities' international competitiveness in research is weak, and there are several structural issues that need improvement. Among them, the public-private disparity in university research grants is a serious problem affecting the structure of Japanese university research. The contribution of private universities to the scientific community is remarkably low compared to other areas, and this is believed to be due to the public-private disparity in the allocation of national scientific research grants [1-3]. The author believes that for the advancement of the Japanese scientific community, the effective utilization of domestic human research resources through the participation of private university researchers is indispensable. However, the very existence of this public-private disparity is also subject to debate [4].

This short paper will first clarify the personnel composition of Japanese universities and the allocation of scientific research grants and research outcomes, revealing the fact that the allocation of scientific research grants is heavily skewed towards national universities compared to the actual personnel composition. Next, by demonstrating the correlation between scientific research grants and research outcomes, it will be shown that there is a strong correlation between the two. Furthermore, doubts will be raised regarding the fairness of scientific research grant allocation to private universities. Finally, based on this correlation, the paper will discuss efficient and desirable research grant allocation.

Current Status of Personnel Composition and Scientific Research Grant Allocation in Japanese Universities

Let's begin by understanding the current state of Japanese universities. Let's look at the personnel composition of Japanese universities. For four-year universities, the number of faculty members is 77,000 at private universities compared to 60,000 at national universities, and the number of students is 1.98 million at private universities compared to 620,000 at national universities. The number of graduates sent out into society each year from private universities is more than four times that of national universities. When comparing student numbers by field, private universities overwhelmingly outnumber national universities by about 10 times in humanities and social sciences. Even in STEM fields, where the difference is relatively small, private universities have 356,000 students compared to national universities' 180,000. In health sciences (medical, dental, and pharmaceutical fields), private universities have 85,000 students compared to national universities' 44,000, a difference of double. The only fields where national universities have more students are medical sciences within health sciences (18,000 for private, 25,000 for national) and education (56,000 for private, 81,000 for national).

Keeping the above human resource composition in mind, I would like to discuss the allocation of scientific research grants next. Scientific research grants come from several ministries, but among them, the largest in scale for university personnel and the one with high transparency is the Grant-in-Aid for Scientific Research (KAKENHI) from the Ministry of Education, Culture, Sports, Science and Technology. The following discussion will primarily focus on KAKENHI because it has the highest transparency, and publicly available data, though insufficient, can withstand objective discussion. Furthermore, reviews and improvements are being made regarding its screening process [5]. I would like to preface by saying that problems exist in the allocation of other research grants from other ministries and other MEXT grants. In the case of other research grants, the recipients, amounts, and even the reviewers are often not disclosed, and the reality is that they are not in a position to be discussed.

In FY2000, 141.9 billion yen in KAKENHI was disbursed, with 98.8 billion yen of that allocated through the Japan Society for the Promotion of Science (JSPS) (public disclosure of the remaining one-third of KAKENHI allocated through MEXT is also desired). While JSPS's allocation accounts for about two-thirds of the total KAKENHI, the overall picture of its recipients is available on the JSPS homepage (http://www.jsps.ab.psiweb.com).

In terms of allocation through JSPS, 19 out of the top 20 universities in KAKENHI adoption are national universities, with only Keio University appearing at 12th among private universities. Looking at the number of adopted projects and the amount of funding, the top-ranked University of Tokyo received 11.5 billion yen for 2,488 projects, and Kyoto University, at 2nd, received 7.5 billion yen for 1,881 projects. In contrast, Keio University received 1.2 billion yen for 485 projects, which is about one-tenth of the University of Tokyo's funding. Since about half of KAKENHI funding is medical and biological related, Waseda University, which does not have a medical faculty, received even less, with 282 projects totaling 600 million yen. Even when looking at the average amount per KAKENHI project, the University of Tokyo receives about 4.6 million yen and Kyoto University 4 million yen, while Keio University receives 2.5 million yen and Waseda University 2.2 million yen. As you can see, there is a remarkably large disparity in the number of adopted projects and the amounts.

Aggregating the entire list of recipients, 73% of the 98.8 billion yen goes to national universities (79% including national research institutes), while private universities receive only 14%. Thus, national universities are allocated 5.2 times more KAKENHI than private universities. Compared to the human resource composition ratio of private and national universities mentioned earlier, it is clear that KAKENHI allocation is remarkably biased towards national universities. Reports indicate that the total research funding provided by the state to universities also shows a 4.6-fold difference, with private universities receiving 180 billion yen compared to national universities' 820 billion yen [1]. It can be inferred that this allocation ratio is not limited to MEXT's KAKENHI but is likely similar for budget allocations from other ministries as well.

Composition of Research Outcomes

Having understood the human resource composition of the scientific community and the KAKENHI allocation ratio, let's next look at the composition ratio of research outcomes. The most common indicator for evaluating research outcomes is the number of papers published in major academic journals worldwide. From the perspective of scientific application, the number of patent applications is also an important criterion for measuring university output. However, at present, Japanese university researchers generally do not prioritize patent applications, and universities often do not even track the number of patent applications. Therefore, this discussion will proceed based on the number of papers.

Regarding the number of papers by each university, excellent statistical values have recently been reported using citation statistics databases such as the U.S. ISI (The Institute for Scientific Information) [6-8]. Here, we used relatively recent university-specific paper data by Negishi et al. (total number of papers over 16.5 years from January 1981 to June 1997) [8]. Negishi et al. list the number of papers in all fields for the top 50 Japanese universities. Aggregating this data, the former seven imperial universities and Tokyo Institute of Technology account for 53% of the total papers, other national universities 30%, national research institutes 2%, private universities 10%, and public universities 5%. Since only 10 private universities are among the top 50, it is possible that a considerable number of papers from the total of 457 private universities in Japan are missing from this list. However, among the top 50 universities, national universities have 8.3 times the number of papers compared to private universities. Therefore, as far as the output of the Japanese scientific community is concerned, national universities, especially the former imperial universities, are the dominant entities.

Consistency of Ratios Among Items

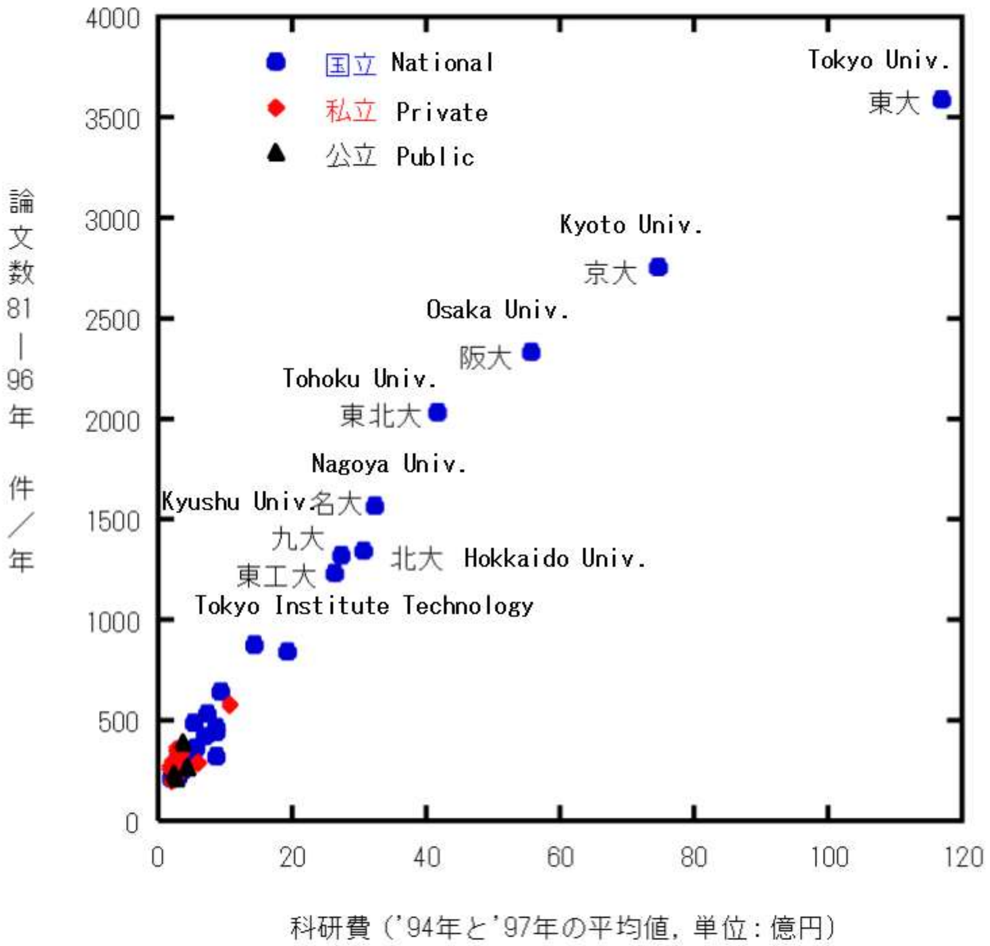
Table 1 summarizes the ratios of human resource composition, KAKENHI allocation, and paper count.

Table 1. Composition Ratio of Each Item. For the two groups, private and national universities, the smaller value was set to 1.

	Private Universities	National Universities
Faculty Members	1.3	1
Students	3.2	1
KAKENHI	1	5.2
Papers (Top 50 universities)	1	8.3

As Table 1 shows, KAKENHI allocation is remarkably biased towards national universities compared to the human resource composition ratio. Furthermore, national universities overwhelmingly dominate in terms of paper count. Therefore, the current understanding of the Japanese academic community is that national universities are central in both scientific research grant allocation and paper count, and this is remarkably unbalanced compared to the allocation ratio of domestic human resources.

Since both KAKENHI and paper count are high in national universities and low in private universities, there is a high possibility of a correlation between the two. To investigate this correlation, Figure 1 plots the amount of scientific research grants and the number of papers for each university. The number of papers used the data from Negishi et al. mentioned earlier. For the KAKENHI amount, the average of two years' KAKENHI in 1994 and 1997 was taken on the horizontal axis. Ideally, the publication year of papers and the year of KAKENHI allocation should match, but data for corresponding years of KAKENHI are not publicly available. Therefore, values based on a survey conducted by Asahi Shimbun to each university were used [9]. It is expected that the accuracy of the data will improve if past annual KAKENHI disbursement amounts are disclosed in the future.



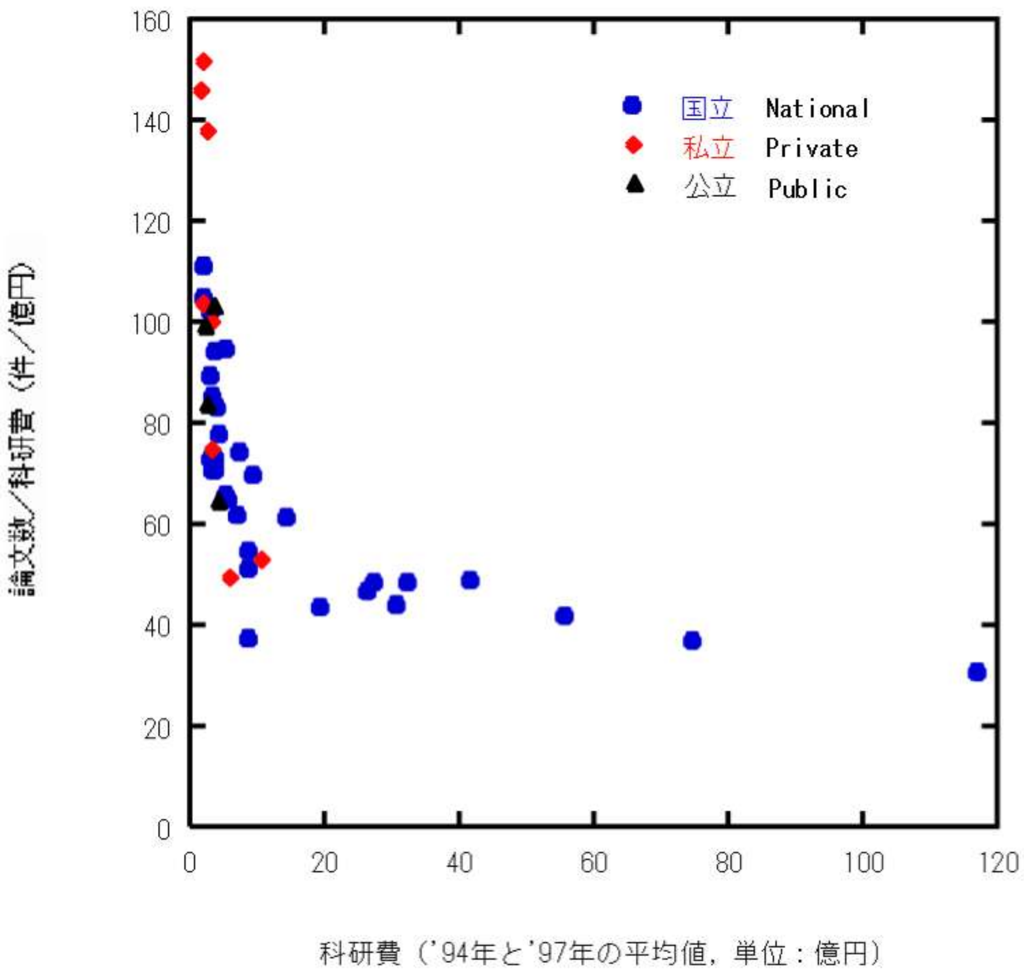
"KAKENHI (Average of '94 and '97, in 100 million yen)" on X-axis and "Number of Papers '81-'96 (items/year)" on Y-axis.

Figure 1. Number of Papers vs. KAKENHI (Grant-in-Aid for Scientific Research).
A proportional relationship is observed between KAKENHI and the number of papers, but a saturation tendency is noted where the increase in the number of papers levels off as KAKENHI increases.

As seen in Figure 1, a clear correlation is observed between the two. The most apparent correlation is a proportional relationship. Next, a saturation tendency is observed in universities with large total KAKENHI, where the number of papers relatively declines for the amount of KAKENHI. The universities with both remarkably large numbers of papers and KAKENHI, distributed from the lower left to the upper right in the figure, are the former imperial universities and Tokyo Institute of Technology. The regional national universities and private universities are densely distributed in the lower left of the figure. The relationship where national universities have overwhelmingly larger KAKENHI allocations and published papers than private universities, as shown in the previous chapter, can be clearly seen here as well.

This clear proportional relationship can be interpreted in two ways. One is that the larger the KAKENHI, the greater the research output and the more papers are published. The other is that the more papers are published, the larger the amount of KAKENHI is allocated. Regarding which of these two correlations is stronger, the former interpretation (that more KAKENHI leads to more papers) is considered stronger. This is because KAKENHI allocation decisions are not made based on the number of papers listed in each application, so the latter interpretation alone cannot explain the clear proportional relationship in Figure 1. In contrast, it is easier to understand that a larger KAKENHI amount allows for an increased number of research items, which consequently leads to more papers, and this correlation is considered stronger.

The saturation tendency observed in universities with large KAKENHI is thought to be due to the finite number of researchers in each university. As long as there are limits to the human resources in each laboratory, the total working hours are finite, making it impossible to increase the number of papers proportionally to research funding. KAKENHI from MEXT has been increasing annually, with an 8% increase in FY2000 compared to the previous year. In the future, as KAKENHI amounts increase, this saturation tendency is likely to spread to universities with smaller allocations as well.



"KAKENHI (Average of '94 and '97, in 100 million yen)" on X-axis and "Number of Papers / KAKENHI ('81-'96 item/year / 100 million yen)" on Y-axis.

Figure 2. Number of Papers / KAKENHI vs. KAKENHI. The number of papers per KAKENHI is high in private and regional national universities. This can be interpreted as having a small amount of KAKENHI relative to the number of papers.

Figure 2 plots the number of papers per KAKENHI. The saturation relationship seen earlier is even more clearly visible in this figure. Universities with larger KAKENHI allocations, such as the former imperial universities, show a decreasing number of papers per KAKENHI. What's even more interesting is the trend for regional national universities and private universities with smaller total KAKENHI. The number of papers per KAKENHI allocation in these universities is remarkably high compared to the former imperial universities. This tendency is particularly strong in private universities, with some reaching three times that of the former imperial universities.

The fact that private universities have a high number of papers despite receiving particularly little KAKENHI reflects their reliance on research funding other than KAKENHI for their research activities. Given the low allocation of KAKENHI to private universities, the reality is that they are forced to utilize internal university funds for research. Furthermore, if this data is viewed from the perspective of evaluation based on outcomes (number of papers), it can be interpreted that private universities receive a small amount of scientific research grants relative to their number of papers. Therefore, this data indicates that there are doubts about the fairness of KAKENHI allocation screening.

This dominance of national universities in the academic community also extends to the composition of KAKENHI reviewers. Currently, the Japan Society for the Promotion of Science publicly discloses the KAKENHI reviewers from the previous fiscal year. Reviewers are structured in a two-tiered hierarchy, consisting of a large number of reviewers for the primary review and a small number for the secondary review. In the case of STEM fields, national university faculty account for 83% of primary reviewers, while private university faculty account for only 13%. For secondary reviewers, national university faculty account for 91% (76% from former imperial universities and Tokyo Tech + 15% from other national universities), while private university faculty account for only 6%. Furthermore, among national university reviewers, faculty from the former imperial universities constitute an overwhelming majority. Therefore, the group that accounts for the largest number of reviewers, the former imperial university group, is also the largest beneficiary of KAKENHI.

As shown in Figure 2, the group of private universities shows a relationship where the amount of KAKENHI received is small relative to the number of papers. To correct this imbalance and promote a balanced improvement in the scientific level within Japan, improvements in the review system are necessary. At the very least, reviewers should be allocated according to the original human resource composition ratio of private and national universities. The review system of the U.S. National Institutes of Health (NIH) also incorporates a system of randomly selecting reviewers from a pool of researchers who meet certain criteria. From the perspective of fairness, this system is superior to the current KAKENHI review system.

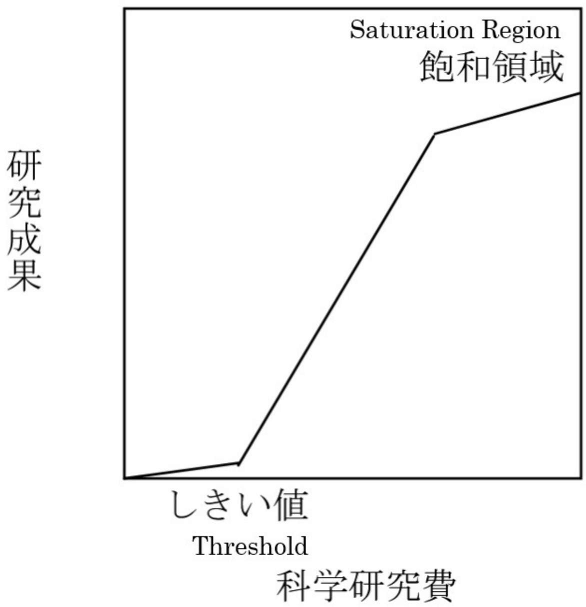
Efficient Allocation of Research Grants

Having understood that the current public-private disparity in university research grants in Japan significantly impacts the structure of the academic community, let's next consider efficient research grant allocation. National scientific research grants are funded by taxpayers' money, so they must ultimately be returned to the public and are accountable to the public [10].

From this perspective, it is clear that distributing research funds more equitably between national and private universities is far more desirable than the current situation where less than half of the domestic scientific community's human resources are effectively utilized. This would lead to a more efficient use of human resources. The most important aspect of research is individual creativity, so it is more desirable to broaden the pool of candidates to include private universities and fund research selected from a diverse range of ideas. The unique characteristics of each private university should also contribute to the diversity of ideas.

The clear proportional relationship seen in Figure 1 supports the simple notion that increasing scientific research grants leads to increased output. Rapidly increasing research funds to private universities, which receive only one-fifth of what national universities do, and fostering research universities where graduates from private universities can thrive, is an urgent task for raising the level of the Japanese academic community.

For the correlation between the number of research papers per laboratory unit and the amount of scientific research grants, the model in Figure 3 can be considered. The assumption that there is a threshold for scientific research grants is because scientific research depends on research equipment, meaning a certain amount is required to even begin research. On the other hand, saturation above a certain value occurs because there are limits to the human resources within a single laboratory, and increasing research funds beyond a certain point does not yield proportionally more research outcomes. Among these, the saturation tendency where the number of papers per KAKENHI decreases for universities with larger KAKENHI is clearly visible in these figures. According to this model, from the perspective of efficient KAKENHI allocation, providing too small an amount of KAKENHI is undesirable from a cost-effectiveness standpoint, as it cannot exceed the threshold. Conversely, providing too large an amount of KAKENHI also enters the saturation region, leading to insufficient cost-effectiveness. While the threshold and saturation values will vary depending on the research field, collecting this kind of data is important for efficient and scientific allocation of scientific research grants. Institutions that allocate research funds, such as the Japan Society for the Promotion of Science, should now be considering scientific allocation methods by collecting data on both aspects.



A conceptual graph. X-axis: Scientific Research Funds. Y-axis: Research Output.

Figure 3. Model of Laboratory Research Efficiency.
The graph should show an initial flat line (threshold), then a rising curve (proportional increase), and finally a plateau (saturation).

Currently in Japan, under the policy of concentrating research funds on excellent researchers, a situation where KAKENHI is concentrated on a limited number of researchers is frequently occurring. Some national universities are calling this a "research fund bubble" [11]. In terms of efficient allocation of public funds, allocating research funds to universities that are in the saturation region, where cost-effectiveness is relatively lower, is likely an undesirable allocation method [12].

On the other hand, in the case of private universities, increasing research funds has not yet reached the saturation region. Furthermore, by adding national research funds to the research facilities and human resources that private universities inherently possess, research outcomes can be generated. This is arguably even more efficient than the national university system, where the entire cost is borne by the state.

Currently, amidst a critical fiscal situation, the government is increasing scientific research grants year by year. Researchers should not merely rejoice at the increase in national scientific research grants but must also consider the efficient use of research funds and the return of research outcomes to the public. As discussed so far, the current situation shows that research funds are heavily invested in national universities, resulting in the ineffective utilization of domestic human resources. The author hopes that this short paper will serve as a catalyst for a discussion on the desirable structure of the Japanese academic community.

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[12] Some argue that to measure scientific output, not only the number of papers published but also how many times those papers are cited (this indicator is called the impact factor) should be included in the evaluation. According to the survey by Negishi et al., there is almost no difference in impact factor among the top three universities (University of Tokyo, Kyoto University, and Osaka University), and the tendency for cost-effectiveness to decrease for higher-ranked former imperial universities receiving KAKENHI still exists even when considering the impact factor.