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For the Future of Japan's Research and Education Capabilities:

Challenges of Competitive Policies

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Discussions on university reform have become widespread. There are two primary sources of bias in the current university reform discourse. One is the decline in the 18-year-old population, and the other is pressure from the government, exemplified by competitive policies like "Global COE." Many people may have heard about the shrinking 18-year-old population but haven't given it much thought. However, as Professor Shinichi Yamamoto of Hiroshima University has long warned, this issue will significantly impact universities as a whole. The 18-year-old population, which exceeded 2 million during the peak of the second baby boom in the early 1990s, has plummeted to 1.2 million, or 60% of that number, as of 2008. According to statistics from the Ministry of Health, Labour and Welfare, this number is expected to remain relatively flat for the next ten years but will further decrease after 2020, reaching 900,000 in 2030 and 700,000 in 2050 (according to the National Institute of Population and Social Security Research). The current under-enrollment in some private universities is a direct result of this sharp decline in the 18-year-old population. Unless the university enrollment rate increases or the number of international students grows, the number of entrants will not rise. Therefore, when focusing on student enrollment, universities appear to be somewhat of a structurally depressed industry.

This problem not only affects universities but also continues to deliver a significant and sustained shock to Japanese society as a whole. Shifting the 18-year-old population by four years gives us the 22-year-old population, which forms the basic data for the number of new hires. If the number of young workers decreases so drastically, many, including myself, would be concerned about whether Japan can maintain its current prosperity. If the decline in the 18-year-old population is unavoidable, it becomes necessary to dramatically improve the quality of individual workers, making the enhancement of university education a significant challenge for human resource

development.

Meanwhile, the Ministry of Education, Culture, Sports, Science and Technology's (MEXT) competitive policies, another source of bias in university reform, began around 2000 and have been strongly promoted with the involvement of bodies like the Council for Science and Technology Policy and the Council on Economic and Fiscal Policy. The basic principle of these competitive policies is to "strategically allocate funds to research themes and universities selected through fair peer review by a third party." Currently, the proportion of funds allocated according to this policy is increasing, ranging from individual researcher grants to university-level funding. This suggests a clear intention from the government to improve research and education standards. However, one cannot help but harbor significant doubts as to whether the current competitive policies represent "true competition" and whether "transparent and fair third-party evaluations" are being conducted. This paper will address these issues sequentially while deepening our understanding of Japan's current situation.

1. Japan's Weakness: Fewer World-Class Research Universities Compared to Europe and the US

Under competitive policies, the term "international competitiveness" has become frequently heard in universities. News reports occasionally state that only about 5 to 10 Japanese universities rank among the top 100 globally. Those who encounter such reports likely get the impression that Japanese universities are significantly lagging behind the rest of the world. They might think that even the University of Tokyo and Kyoto University are barely considered world-class, and other former imperial universities are merely second-tier.

Many of these rankings have questionable methodologies. Here, to provide a reliable indicator of research capability, let's examine the publication count rankings from Thomson Reuters' Essential Science IndicatorsSM database. Table 1 presents data on the total number of papers across all scientific fields for the 11-year period from 1997 to 2007. The University of Tokyo holds a strong position at 6th worldwide, competing with super-elite institutions, and ranks 3rd among universities if research institutions like the Max Planck Society are excluded. Kyoto University is also performing exceptionally well at 14th. Osaka University is ranked 20th. Within the top 100 are major national universities, primarily former imperial universities, including Tohoku University (24th), Kyushu

University (54th), Nagoya University (59th), Hokkaido University (60th), and Tokyo Institute of Technology (81st). This indicates that, contrary to the general impression, Japan's top-tier universities are by no means weak.

"So, where is Japan weak?" To state the conclusion first, the disparity between the top approximately 10 universities and all other universities is extremely large. In other words, Japan's weakness lies in the lower research capabilities of universities other than the top 10, and the insufficient number of world-class universities. Between the 100th and 200th ranks in terms of publication count, there are only two Japanese universities: the University of Tsukuba (146th) and Hiroshima University (175th). In contrast, the United States boasts 45 universities within the top 100 and an additional 25 universities between the 100th and 200th ranks. This means the US has 5.6 times more universities in the top 100 and 7 times more in the top 200 than Japan. Even the United Kingdom and Germany, which have smaller populations and GDPs than Japan, have 16 and 15 universities, respectively, within the top 200. Japan's 10 universities are low not only compared to the US but also to Europe (other countries include Canada with 7, and Italy with 7).

This scarcity of research universities significantly impacts Japan's overall research strength. This is because it means a substantially smaller number of researchers in excellent research environments and a smaller number of students trained in those environments. The total number of researchers at these 10 Japanese universities within the top 200 is approximately 24,000, and the number of students is 187,000. In contrast, the US has 70 such universities, with an estimated 170,000 researchers and 1.3 million students. The more researchers in top-tier environments, the more excellent research is produced. For example, if there is one excellent research outcome for every thousand top-tier researchers, a group (country) with a thousand top-tier researchers compared to one with seven thousand will produce seven times more results. This means they can produce seven times more excellent papers and patents. Furthermore, the difference in the number of students studying at these top-tier universities directly translates to a difference in human resource development capabilities. This not only affects university research supported by students but also signifies a substantial difference in future research capabilities when these graduates engage in research and development at companies or universities.

Considering the GDP and population ratios between Japan and the US, it would be desirable for Japan to have at least one-third of the US's 70 research universities. That

is, the current situation should be doubled to require 20 or more universities. This figure of 20 universities is an appropriate target when considering that the UK and Germany have around 16.

Table 1:

World Rankings of Research Institutions by Number of Publications, 1997-2007 (Compiled from Essential Science IndicatorsSM, Thomson Reuters)

Rank	Institution	Number of Papers
1st	RUSSIAN ACAD SCI*	121,055
2nd	CHINESE ACAD SCI*	102,488
3rd	University of Texas	93,242
4th	Harvard University	91,222
5th	Max Planck Society*	69,180
6th	University of Tokyo	68,121
14th	Kyoto University	49,585
20th	Osaka University	42,951
24th	Tohoku University	40,201
54th	Kyushu University	27,931
59th	Nagoya University	27,019
60th	Hokkaido University	26,908
81st	Tokyo Institute of Technology	23,870
146th	University of Tsukuba	17,292
175th	Hiroshima University	15,718

*Not a university but a group of research institutions.

2. Why Are There Only 10 Universities?

So, why are there only 10 Japanese universities within the top 200? Some might speculate that excellent researchers are concentrated in only the top 10 universities, or that other universities are simply not working hard enough. However, I would like to point out that there are economic reasons for this. Let's compare Japan with the United States, which has 70 universities within the top 200.

Figure 1 graphs the rankings of public research funding for Japanese universities (estimated values for 2006) and US universities. It shows that Japanese research funding declines sharply from the University of Tokyo down to about the 10th-ranked institution. This indicates that Japan's public research funding is concentrated in a tiny handful of institutions. Specifically, the slope of the curve changes dramatically around the 10th-ranked Kobe University, with much smaller research funds allocated to institutions below the top 10. The top 10 institutions account for half of Japan's total research funding, and the 10th-ranked university receives only about one-tenth of the funding of the 1st-ranked institution.

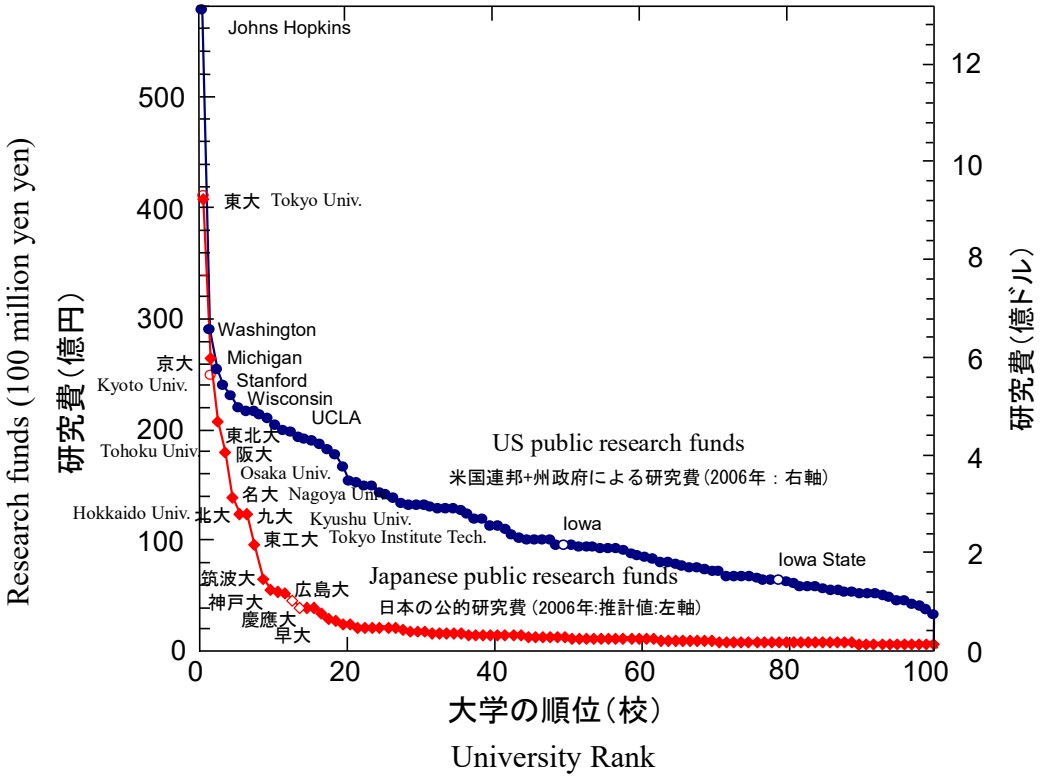

Figure 1　Japan-US Comparison of Public Research Funding by University Rank

Japanese public research funds (left axis) were estimated from the ratio of 'Scientific Research Grants + Revenue from Contracted Research, etc. (National and Local Governments) (indicated by circles in the figure)' in the financial statements of the University of Tokyo and Kyoto University, and '2006 Scientific Research Grant allocations.' US public research funds (right axis) are based on NSF Science and Engineering Indicators 2008.

In contrast, US research funding decreases gradually, presenting a stark contrast. In the US, the top 10 institutions account for only 20% of the total public research funding, and the 10th-ranked university receives 60% of the funding of the 1st-ranked institution. Even the 20th-ranked university receives 47% of the 1st-ranked institution's funding. The gradual decrease in research funding fosters a thick layer of research universities. While universities like Harvard and MIT come to mind when thinking of excellent research institutions, even a university ranked around 90th in the US has sufficient competitiveness. For example, the University of California, Santa Barbara, home to Professor Shuji Nakamura, renowned for his research on blue light-emitting diodes, produced two Nobel laureates (Physics and Chemistry) in 2000. UC Santa Barbara's public research funding was $110 million, ranking 94th nationwide in 2006. It is crucial to note that the high international competitiveness of the US is not supported by a handful of universities but by a cluster of nearly 100 universities.

In this figure, the left axis corresponds to Japanese research funding, and the right axis corresponds to US research funding. A simple comparison is difficult due to exchange rate differences and the significant disparity in the proportion of personnel costs within research funding between Japan and the US. Therefore, in this graph, a coefficient has been applied such that the Tokyo Institute of Technology (81st in world publication rankings) and the University of Iowa (47th in US public research funding) are at the same height (simultaneously, the University of Tsukuba (147th in publication rankings) and Iowa State University (78th in US public research funding) are also aligned at the same height). This effectively transforms the graph into a kind of "purchasing power parity" per paper. As this graph shows, the research funding equivalent to a US top 100 university is only found in about 10 Japanese universities. In other words, Japanese universities outside the top 10 are underfunded by global standards. This answers the previous question: "Why are there only 10 universities in the world's top 200?"

3. Increased Research Funding Leads to Increased Research Capability

I mentioned that a lack of research funding leads to fewer top-tier research universities. Let's look closer at the relationship between research funding and publication count. The research capability of a given group (whether a single university or Japan as a whole) can be expressed as a product of the following:

Research Capability = Quality of Researchers × Number of Researchers × Research Funding

To examine the relationship between publication count (research capability) and research funding, Figure 2 plots the allocated research funds and the number of publications for the top 20 Japanese universities in terms of scientific research grants. The data used is from national universities only, based on "Financial Analysis of National University Corporations (January 2008, Mari Jibu et al.)" by the National Institute of Science and Technology Policy, MEXT.

A quick glance at the upper part of Figure 2 reveals a clear proportional relationship, as indicated by the straight line. In particular, the former imperial universities and Tokyo Institute of Technology lie almost perfectly on a straight line. This clear proportional relationship can be understood by considering that larger amounts of research funding allow for more investment in research equipment and greater use of materials, thereby increasing the number of research themes and, consequently, the number of publications. Furthermore, given that the quality of researchers among national universities is considered to be similar, the existence of this proportional relationship indicates that research funding is the most crucial factor in the equation above. In other words, increasing research funding enhances research capability.

Another characteristic is that the slope of this proportional relationship differs significantly between the top 1-10 ranked universities and the 10-20 ranked universities (regional national universities). Dividing the number of publications by scientific research grants reveals how many papers were published per 100 million yen. The lower part of Figure 2 plots the number of papers per scientific research grant, showing that as the grant amount decreases, the number of papers increases. For example, the University of Tokyo publishes 19 papers per 100 million yen, while Shinshu University publishes 80

papers per 100 million yen, making it four times more efficient.

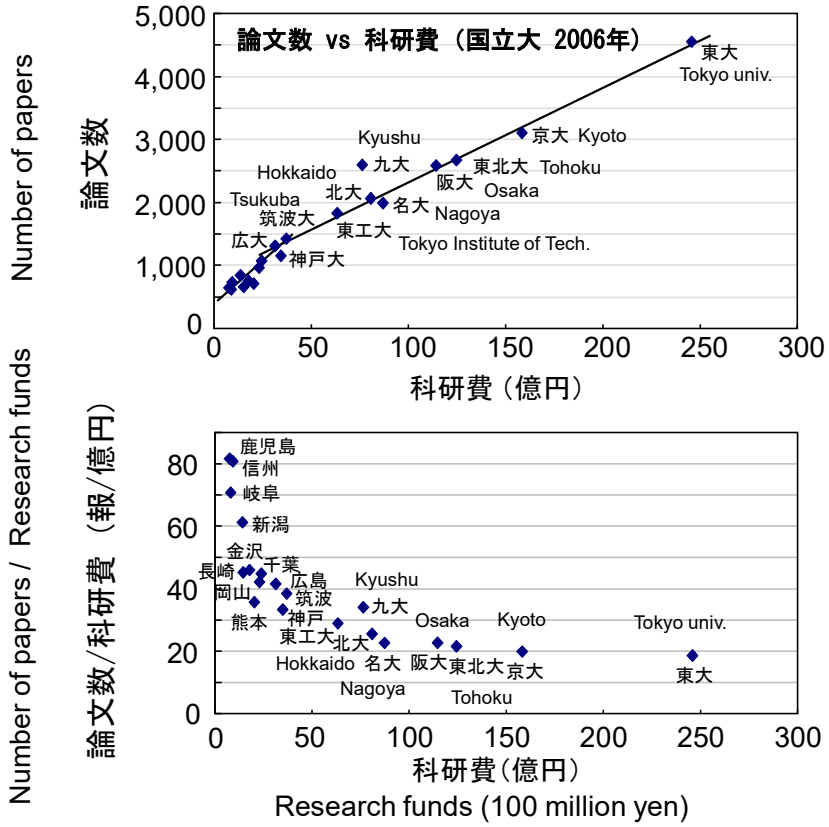

Figure 2 Number of Papers vs. KAKENHI (Grant-in-Aid for Scientific Research).

The decline in publication efficiency at universities with large scientific research grants, such as the former imperial universities, sparked debate when the Asahi Shimbun reported it under the headline "University of Tokyo Papers Cost 18.45 Million Yen Each, Highest Cost Among National Universities" (January 31, 2008). In the current research funding review process, efficiency is not evaluated at all; only the number of publications can earn high marks. This means that researchers at high-cost universities, who utilize large amounts of research funding, are more likely to succeed in reviews, ultimately making Japan's overall paper production a high-cost endeavor. Therefore, given Japan's strained financial situation, it would be wise to begin considering including cost as an evaluation criterion. While discussions about university research tend to focus on the former imperial universities, even including Tokyo Institute of Technology, they only account for 40% of Japan's total publications. Regional national universities, in particular, produced roughly the same number of papers as the former imperial universities in 2006

with 60% of their scientific research grants. Their significant contribution to publications and high efficiency make them a crucial presence in Japanese research (though this discussion focuses on national universities, similar results are observed when including private universities [1]).

4. Are Japan's Research Enhancement Policies Correct?

Based on the current understanding that Japan has an insufficient number of research universities, let's consider whether Japan's competitive policies are appropriate. Even if doubling public financial expenditure on higher education cannot be realized immediately, MEXT has already launched competitive policies to strengthen research hubs, starting with the 21st Century COE Program in fiscal year 2001, followed by its successor, the Global COE Program, from fiscal year 2006. These programs utilize approximately 40 billion yen annually, so effective investment is expected. These programs allocate research funds to hubs consisting of 10 to 30 researchers, but ultimately, most of the selected hubs belonged to the top 10 universities. This means these policies are designed to make the universities within the top 10 even stronger.

As we have seen, the former imperial universities are already recording world-class publication numbers thanks to world-class research investments. Therefore, further investment through Global COE and similar programs is not wise. Instead, to increase the number of world-class research universities, it would be far more effective for Japan to allocate funds to universities ranked 10th and below. If 40 billion yen were allocated effectively, it could create approximately 10 new research universities, each with an annual research budget of 5 billion yen, capable of ranking within the top 200 worldwide. As a result, the number of researchers in top-tier research environments and the number of students trained there could be doubled. This approach would have a dual effect, benefiting both research and human resource development.

The Global COE program reduced the number of selected hubs by half compared to the 21st Century COE program, based on criticism that the latter had too many adopted hubs. However, considering the current understanding, halving the number of hubs has deepened the policy's error. With the increase in research funding that began in the 1990s, universities within the top 10 have already grown into world-class research universities [2]. Japan should recognize that it has now entered a second phase of strengthening universities ranked lower than these top institutions.

5. Problems with Competitive Policies

Next, let's look at the structural problems of competitive policies. Japan's research funding review system is considerably outdated compared to the United States. The curve of Japan's research funding in Figure 1 shows a sharp change in slope around the 10th position. In contrast, the US curve does not exhibit such a bifurcation point. Why is this?

In Japan, it is believed that "competitive policies lead to desirable resource allocation." However, when I was in high school, I learned that "in primitive capitalism, the strong become increasingly strong, dominating the market, and competition ends once oligopoly or monopoly is established." I further learned that to mitigate these harms, "fair trade commissions and similar bodies must intervene to prohibit market monopolies and ensure true free competition." Based on this knowledge, simply entrusting research funding allocation to pure competition would lead to oligopolization by a few. The bifurcation point observed in Figure 3 (should be Figure 1, there is no Figure 3 in the provided text) is precisely this point that separates the strong from the weak due to oligopolization.

Most of Japan's current research funding reviews are based on a "track record evaluation," which easily divides applicants into winners and losers. A track record evaluation assesses applicants highly if they have achieved many research results in the previous year or earlier. To avoid wasting research funds, allocating more funds to researchers with proven track records increases the safety of the investment. However, as can be seen by analogy with a baseball team, no team exists that uses only veterans simply because they have a track record. There are promising rookies even without a track record. Without allowing new entrants, true competition cannot emerge, and the team will not grow stronger. In the current system, once a researcher receives a large amount of research funding, they can publish many papers, and a large number of papers leads to more funding in the following year due to the emphasis on track record in reviews, creating a positive feedback loop annually. Conversely, if the opposite occurs, a negative feedback loop works, easily dividing applicants into winners and losers. As a result, winners and losers emerge at both the individual and university levels.

This simple competition based on track record has such significant drawbacks and can hardly be called a desirable review system. In current Japan, competition has

already ended in oligopolization by winners, with the primary resource allocation going to a small number of winners. Although the Council for Science and Technology Policy has suggested that track record-based allocation is undesirable as it leads to the concentration of research funds in specific individuals, Japanese research funding agencies still prioritize track record, and the pace of improvement is slow.

6. The US Case: Moving Beyond Simple Competition and Human Resource Development

The US curve in Figure 1 does not show this bifurcation point, and astonishingly, the US implemented measures to address this problem 27 years ago. The 2005 annual report of the National Science Foundation (NSF), a major US research funding agency, states: "While 77% of research funds are allocated to the top 100 institutions, the goal is to maintain or increase the proportion of universities below the 100th rank." This means they are not simply leaving it to pure competition but are actively working to increase the proportion of lower-ranked institutions. This implies promoting new entrants to invigorate competition and place more universities and personnel in a competitive environment.

The NSF reformed its review system in 1981, adding two new evaluation criteria to the existing "expected research outcomes" and "researcher qualifications": "ancillary outcomes" and "impact on scientific and technological infrastructure." In simple competition, research groups with ample equipment and well-trained personnel have a significant advantage in reviews because they can achieve more research results. However, by adding these latter two criteria, it became possible to give high evaluations even to applications with lower research achievements if they contributed to nurturing new talent or forming new research hubs. While these new research hubs may not achieve spectacular research results immediately, they contribute to thickening the layer of US research and education in the medium to long term.

The NSF further revised its review criteria in 1997, reorganizing them into two main categories: "intellectual merit" and "broader impacts." Broader impacts include human resource development and hub formation. Japanese researchers who go to the US and apply for NSF grants often find this "broader impacts" criterion puzzling. This is driven by the overall strategic goal of strengthening US research, and it is strongly desired that Japan, too, expeditiously moves away from simple competition by emulating the US.

7. Japan's Outdated Review System: Is the Review Fair in the First Place?

Japan's review system is lagging behind the US not only in its fundamental policy, which remains at the level of "simple competition." More fundamentally, the very premise of competitive policies—"transparent and fair review"—is highly questionable. Examining the US system reveals that to conduct a fair review, two conditions must be met:

The first condition is the "ensuring of reviewer diversity," which forms a major cornerstone of the US review system. While the premise is that reviewers possess a certain level of academic knowledge, the US system explicitly requires a balance of reviewers, demanding diversity in their affiliated institutions, age, gender, and so on. Regarding affiliated institutions, it is recommended to include not only universities but also companies, as well as smaller research institutions (universities), and even a geographical balance within the US. Since scientific history offers numerous examples of new research being generated by young researchers, age consideration is also extremely important.

Reviewers are fundamentally expected not to act as representatives of their respective affiliated institutions but to review from diverse perspectives based on their diverse and differing intellectual backgrounds. However, even if this ideal situation deviates and the review committee devolves into a battleground between vested interests, a balanced and diverse reviewer composition can prevent privatization by certain groups and maintain a minimum level of fairness.

In contrast, the concept of diversity has been extremely weak in Japan. Reviewers overwhelmingly consist of individuals affiliated with former imperial universities, predominantly in their 50s and 60s, and almost exclusively male. This raises significant doubts about fairness and the ability to appropriately review new scientific challenges from diverse perspectives. The group that constitutes the vast majority of reviewers ("former imperial universities, male, 50s-60s") is also the primary beneficiary of research funding, making the formation of an inner circle easy. Many reviewers, even those ostensibly affiliated with private universities, are often honorary professors from former imperial universities. This type of bias also exists in deliberative councils related to universities within MEXT and other ministries. Since the majority of committee members are associated with former imperial universities, it becomes a major reason why discussions in forums that should address Japanese universities as a whole are skewed towards former imperial universities.

Another condition necessary for ensuring fairness is the "exclusion of conflicts of interest." The US system has strict regulations, such as prohibiting individuals from the same university as the applicant from serving as reviewers, and excluding those who have been collaborators within the past four years. In contrast, Japan either lacks such regulations or has very lenient ones. Cases where faculty members from the same department at the same university as the applicant serve as reviewers, or even where reviewers and applicants have a teacher-student relationship, are tolerated, indicating that pre-modern review practices still prevail.

Besides these two conditions, many other problems exist. In open calls for proposals that limit research themes, the content of the call is often leaked externally before it is officially published. Fairness cannot be maintained unless open calls are publicized simultaneously nationwide. If a program director involved in drafting the call for proposals leaks insider information, applicants who receive this information gain a significant advantage. Furthermore, in some research calls, despite limited themes, the period from the public announcement to the deadline is only one to two weeks. This makes it impossible to respond without prior knowledge of the call's content, suggesting that successful applicants are anticipated from the outset.

There are also instances where reviewers reveal their involvement in the review process after the fact, whispering to successful researchers, "I was on the review committee for that one." Leaking involvement in the review process is a way of flaunting influence over research funding allocation, which strengthens their political voice within the academic community. When the applicant and reviewer switch roles, this also serves as a "thank you in advance" greeting. To prevent such irregularities, it is necessary to prohibit information leaks before calls for proposals and after review deliberations, and to establish channels for collecting reports of fraudulent information.

If ensuring fairness is difficult in the current situation, the introduction of "masking review" where the applicant's identity is concealed during the review process is desirable. The Ministry of Internal Affairs and Communications introduced masking evaluation for young researcher reviews in 2004, and as a result, the difference in the number of successful applications between former imperial universities and other universities significantly narrowed [3]. This indicates that reviewers were not solely evaluating the research content in the application but were heavily influenced by the university affiliation of the applicant. Currently, some open calls even require the submission of résumés, including educational background, which deliberately provides an

opportunity for reviewers to favor their own academic cliques. The Council for Science and Technology Policy proposed "trial introduction of masking evaluation" in 2007, but it is currently only in the initial trial phase in some areas.

Information disclosure by many research funding agencies is insufficient. For example, the Japan Science and Technology Agency (JST) does not disclose the amount of research funding by university or the number of successful applications. It is said that a quarter of JST's research funding is allocated to the University of Tokyo, but the University of Tokyo's papers account for only 8% of Japan's total. This implies that simply being enrolled at the University of Tokyo makes one three times more likely to receive JST research funding based on publication ratio. Research funding agencies need to increase transparency by widely disclosing information to the public.

8. For the Future: Utilizing Human Resources = Women and Private Universities

Finally, I would like to discuss underutilized human resources for Japan's talent development. There are two groups in Japan that have not been fully utilized. One is women. The proportion of women among researchers in Japan is only 12.4% (2007), which is abnormally low compared to developed countries like the US (34%), where it is around 30%. In the US, positive action for minorities and women has been actively promoted since the 1960s, enabling preferential university admission and actively hiring them as university faculty. By providing accessible role models to students, further participation was encouraged. There is a Chinese proverb, "Start with what is near," and this was extensively implemented across the US. Positive action is a strategic investment in the future, continuing for two or three generations, and we must be careful not to be swayed by "reverse discrimination arguments" that only consider the present and arise from competition for a single post. While Japan has finally set numerical targets for the proportion of women among national university faculty, for example, its measures are considerably behind those of other countries. In Japan, which faces a rapidly declining birthrate, increasing the number of women researchers to the same level as developed countries is indispensable for maintaining overall research strength.

Another source of human resources in Japan is private universities. The reason why major research universities in Japan are still national universities is due to a slow transition from "traditional policies since the Meiji era." Since the Meiji era, the primary focus was on introducing Western science and technology, which necessitated

concentrating limited funds in a small number of imperial universities. More than a century later, many private universities have been established. Looking at the current personnel composition of universities (Figure 3), the number of faculty members at four-year universities (2007) is 95,000 in private universities versus 61,000 in national universities, and the number of students is 2.07 million in private universities versus 630,000 in national universities. This means that three out of four university graduates entering society each year are from private universities, making it clear that improving the level of private universities is paramount for enhancing Japan's human resource development capabilities. It is particularly noteworthy that the number of science and engineering students in private universities is twice that in national universities. While there is often an image of "private universities as humanities-focused," it is important to recognize that private universities contribute far more significantly to science and engineering as well.

Currently, public research funding for national universities is about five times that for private universities (Figure 3). This stands in stark contrast to the US, where research funds are appropriately allocated to private universities. Research in universities is also a high level of education. In Japan, the Third Science and Technology Basic Plan (2006-2010) has finally begun to emphasize "human resource development and utilization in research." Since scientific research is commissioned by the government to researchers, there is no reason why the commissioned researchers must be from national universities if the review and post-evaluation are strict. Looking at the success of private university graduates in various fields of society (private university graduates account for the majority of presidents of listed companies, successful bar exam candidates, and members of parliament), it can be assumed that a large number of talented individuals also exist in private universities in science and engineering. While a major factor supporting US competitiveness is often cited as "attracting global talent," Japan is not fully utilizing its valuable domestic talent. In the US, there are many research funds supporting research by women and minorities, and Japan also needs to enhance support for women and private university researchers. In our nation, which faces an unprecedentedly rapid decline in birthrate, the allocation of research funds is closely intertwined not only with research but also with human resource development. We hope that rational policies based on quantitative discussions will be implemented.

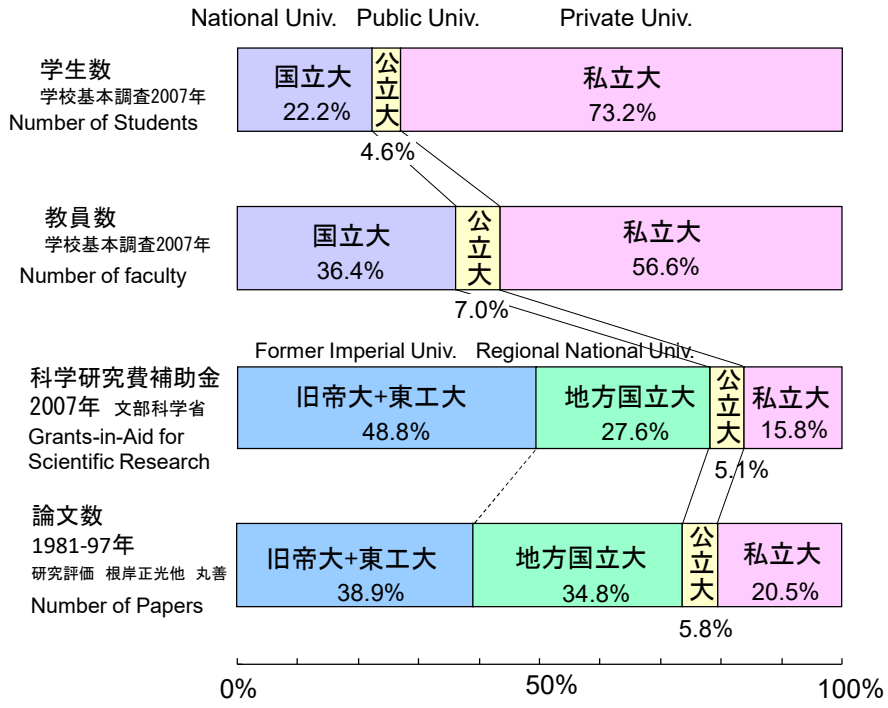

Figure 3

References:

[1] Takeuchi, Atsushi. "National-Private Disparity in University Scientific Research Funds – Structural Issues for Improving the Level of Japan's Scientific Community." Kagaku (Iwanami) Vol. 71, No. 6, p. 832 (2001).

[2] Koma, Atsushi. "The True Strength of Japanese Universities as Seen from the Number of Publications." Kagaku (Iwanami) Vol. 70, No. 9, p. 705 (2000).

[3] Hiromoto, Nobuhisa, and Higashikura, Yoichi. "Competitive Research Funding System and System Reform in the Information and Communications Field." IEICE Transactions on Communications Vol. 89, p. 524 (2006).