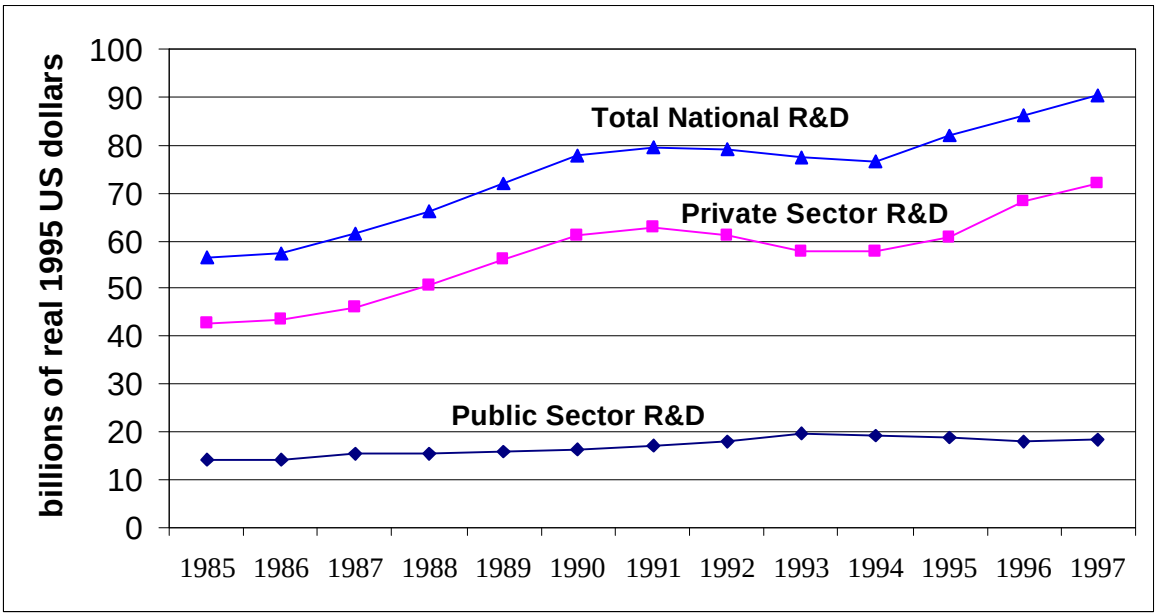
JAPANESE NATIONAL SCIENCE AND TECHNOLOGY EFFORT

As Figure 1 shows, the Japanese government funds a rather modest share of the national R&D effort, less than 25% of the national total in any given year over the last decade. In 1997, the Japanese government spent $18.3 billion on R&D while the private sector spent $71.9 billion on R&D for a national total R&D effort of $90.3 billion.[i]

Figure 1: Japanese National S&T Effort 1985-1997[ii]



The real decline in Japanese national (public and private sector) investments in R&D in the early part of the 1990s was the first-ever real decrease in the support for R&D in Japan, and in particular this represented the first real reductions in the private sector's support for R&D.[iii] Clearly, the economic stagnation in Japan for most of the 1990s has impacted the private sector's ability to support R&D. In the late 1980's, the private sector's investments in R&D were growing at an annual rate close to 10% a year. Between 1991 and 1995, the private sector R&D effort was in real decline. Japanese private sector R&D has been growing since 1995.

Virtually all (98%) R&D carried out by Japanese industry is financed by the companies themselves. That is, unlike the situation in the United States, very little public R&D funding flows from the national government directly to Japanese industry for activities like cost-shared R&D projects.[iv] In JFY1997, over 75% of Japanese private sector investments in R&D are accounted for by the R&D efforts of the chemicals, pharmaceuticals, electric machinery, and transport equipment (i.e., automobile) industries.[v]

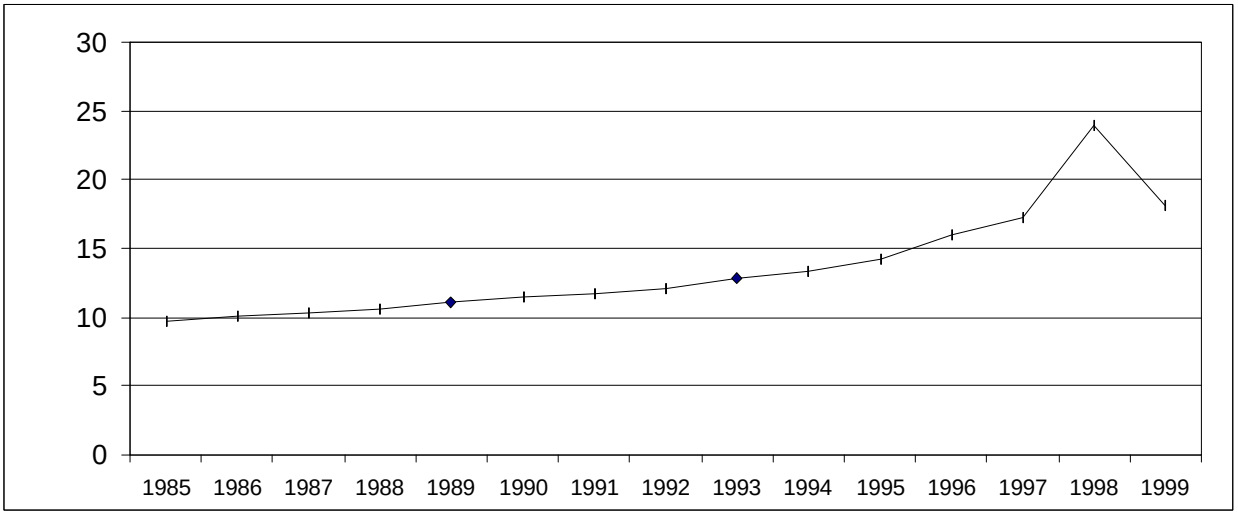
Japan's long slide into recession for most of the 1990s led to the first year-on-year (in JFY1993 and JFY1994) declines in total R&D spending since the end of World War II.[vi] Some analysts have attributed the government's highly publicized decision in 1996 to double public investments in R&D to the shock resulting from this realization. That is, there was a feeling that investments in R&D were too important to the nation's future prosperity to leave these investments so exposed to the vagaries of the business cycle. [vii]

The government's current emphasis on trying to develop a stronger basic science system is at least in part a recognition that industrial support for basic science is being reduced substantially and that the timeframes for private sector R&D are contracting.[viii] Recent surveys of businesses indicate that private sector investments in basic research are indeed in decline.[ix] Once again the government realized that perhaps the public sector should increase its investments in these long-term (presumably high-risk and hopefully high-payoff) R&D programs rather than letting national investments in basic research be so directly tied to fluctuations in the business cycle.[x]

Trends within Public Sector Support for Science and Technology

In 1996, the Japanese government publicly committed itself to doubling "R&D investments by the government as soon as possible" from its 1992 level. This plan stated that it would be desirable to accomplish this doubling by the year 2000, which would require the Japanese government to invest a cumulative total of $96 billion (17 trillion ¥) in R&D over the period 1995-2000.

Figure 2: Japanese Public Sector Support for S&T: 1985-1999[xi, 1]



The initial proposed JFY1998 budget called for only a 0.9% increase in funding for R&D, which made it appear quite unlikely that Japan would be able to accomplish its much publicized goal of doubling R&D development spending by the year 2000 over the level in 1992. However, because of the increasingly worrisome financial situation in Japan, the Japanese government released in mid May 1998 a comprehensive economic stimulus package that contained $3.53 billion (618.8 ¥ billion) increase in spending for S&T.[xii] On December 4, 1998, the government announced another stimulus package that contained a further $2.95 billion (511.1 Billion ¥) for S&T. Taken together these S&T stimulus packages along with the regular budget allocation represent an increase of 38.7% over the previous year.[xiii]

Perhaps unsurprisingly, much of the money in the science portion of these stimulus packages was earmarked for projects that will have direct and rather immediate economic benefit. For example, projects included $2.9 billion for new dormitories for foreign scientists and students, construction

[1] The figures in this chart for JFY1998 fully reflect the two additional S&T stimulus appropriations that were announced by the Japanese government during 1998. As of the spring 1999, there had yet to be any stimulus packages announced by the government for JFY1999. It is important to note what an anomaly 1998 was.

of a new high-speed internet backbone to connect universities and national laboratories, construction of new laboratory space, development of a more powerful rocket booster for Japan's space program, and the start of the construction of a new $350 million ocean drilling ship.[xiv, xv, xvi] In addition to these infrastructure projects, the extra funds in these stimulus appropriations favor research programs that appear to have significant commercial application (e.g., nanotechnology, information science, and molecular biology).[xvii] The additional research funds appear to have relatively little money for existing "small science" research programs. Moreover, due to budget decisions made before the stimulus was announced, funding for certain government research institutes and large scientific facilities (e.g., high energy physics facilities) will actually experience cuts of 10% or more in their operating budgets this year.[xviii] The increasing use of these financial stimulus packages certainly helps to increase overall Japanese investments in S&T, but it has also raised concern that these stimulus packages' preference for funding projects with immediate economic payoff is starting to shift Japan's S&T program away from the government's stated goal of increased support for basic science. [xix]

Table 1: Selected Japanese Ministries' Funding of S&T (millions of 1995 dollars) [xx]

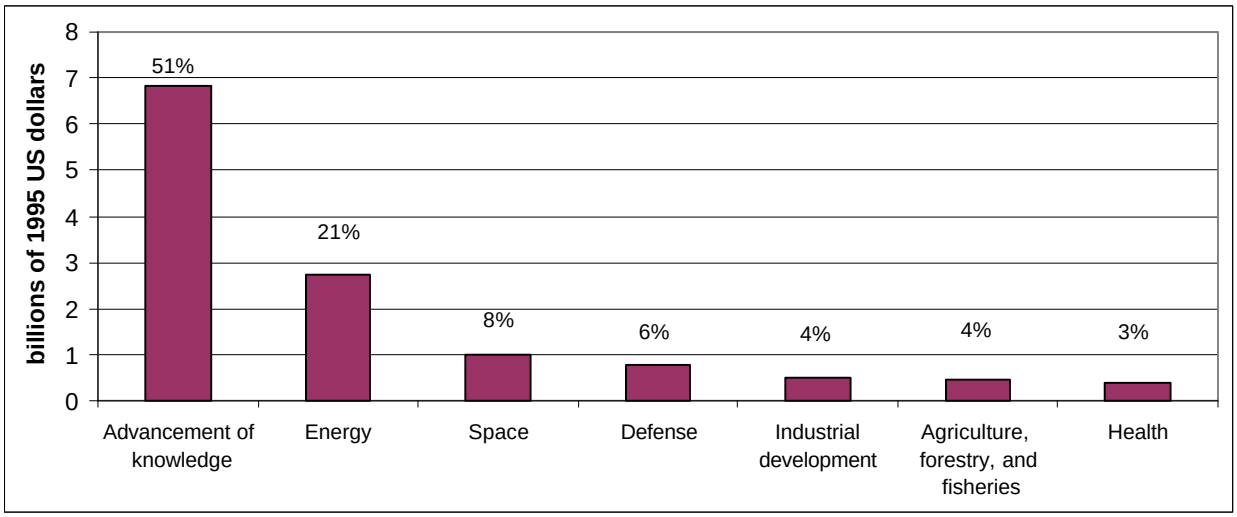
Ministry or Agency	**JFY1997**	**JFY1998** (including supplemental appropriations)
Ministry of Education, Science, and Culture (Monbusho)[2]	$7,390	$9,660
Science and Technology Agency	$4,210	$5,840
Ministry of International Trade and Industry	$2,710	$4,290
Defense Agency	$1,010	$830
Ministry of Agriculture, Forestry & Fisheries	$580	$740
Ministry of Health and Welfare	$520	$590
Ministry of Post and Telecommunications	$330	$1,360
Total All Ministries	$17,220	$24,000

In addition to calling for a doubling of the public sector's support for R&D, the 1996 "Science and Technology Basic Plan" (which lays out Japan's current national science policy and goals) called for a fundamental overhaul of the Japanese S&T system. The hoped-for result of these changes would be to create a national science system that fostered a more "creative research atmosphere." It is hoped that this new research atmosphere would be capable of producing a science system in Japan that produced world class basic science and world class scientists. Moreover, in its final report issued in December 1997, the Administrative Reform Council specifically advocated that government programs that have funded applied research programs that benefited a specific industry be scaled back or terminated. The report instead advocates funding for basic research and technology programs that are "one or two stages away" from commercial product development.[xxi] This new framework for Japan's national S&T goals stands in rather sharp contrast to the S&T goals pursued since the end of World War II, which centered on targeted industrial research (in the vernacular, "picking winners and losers") and adopting technologies from abroad to help Japanese industry "catch-up" with the West.[xxii, xxiii] Some of the major S&T reforms underway include:[xxiv, xxv]

[2] The Japanese parliament approved a plan to merge Monbusho and STA in 2001. The combined mega-science agency would control more than 50% of Japan's public sector research funds. (Normile, Dennis. "Japan: Imura Gets Job on Top-level Council. "*Science.* 280: 5371. June 19, 1998. pp 1828-1829.)

- Establishing new peer-reviewed research programs along with concerted efforts to decrease the portion of research funding given to national universities in block/formula grants by increasing the total amount of research support that is awarded competitively.[xxvi]
- Removing regulations and administrative procedures that hinder the private sector's ability to work with university-based researchers.[xxvii]
- Addressing long-standing human resource issues that are hindering Japan's ability to increase the number of scientists (as opposed to engineers) -- and in particular the number of scientists with advanced degrees -- working in Japan by initiating programs to increase the number of post-doctoral researchers working, increase the mobility of scientists and engineers, and increase the number of students entering S&E studies at universities.
- Attracting significant numbers of foreign scientists to come live and work in Japan until Japan can grow an indigenous cadre of basic scientists.
- Improving and modernizing research facilities and equipment at national universities and government research laboratories.

Figure 3: Major Socioeconomic Areas of Japanese Governmental S&T Support:



JFY1994[xxviii]

Figure 3 shows, the majority of Japan's support for research is for the "Advancement of Knowledge." These funds are essentially block grants for university-based research and for capital expenditures associated with university-based research. In other OECD nations, this "Advancement of Knowledge" category would be known as "General University Funds." The United States has no comparable system of spending significant amounts for the support of university-based research via block/formula grants. In the United States, nearly all university-based research is supported through competitive peer reviewed grants, which allow funding agencies to know what type of research is being supported (e.g., health research) and therefore make it unnecessary for the United States to use an "Advancement of Knowledge"-type blanket category.[3] It is also important to understand that this "Advancement of Knowledge" category

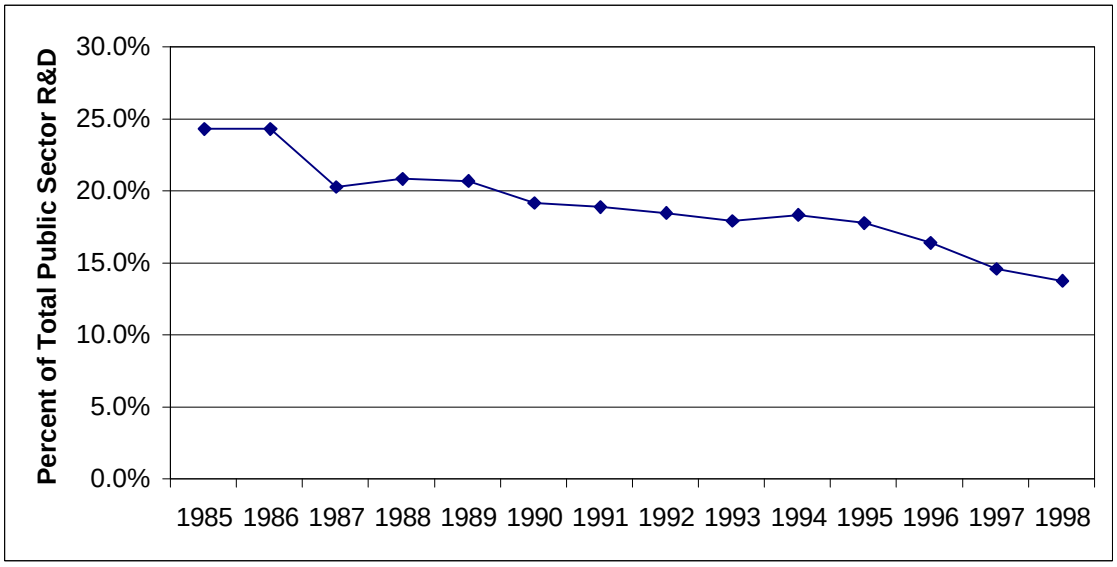
[3] It is very difficult to know with any degree of accuracy how this "Advancement of Knowledge" funding is used to support various fields of inquiry; however, it appears that health research, engineering, and social science fields of research *each* account for approximately a quarter of Japanese university-based research. See ("The Science and Technology Resources of Japan: A Comparison with the United States." Johnson, JM (Principal Author). National Science Foundation. NSF 97-324. 1997.)

does not equate to "basic research." This category covers many things other than "basic research" and indeed, as noted above, Japan believes that it continues to underinvest in basic research. For example, a recent study found that relative to the size of its economy Japan invests in basic research at a level that is only 80% that of the US level.[xxix]

As is apparent from Figure 3, Japan devotes relatively little public S&T support to defense R&D. In fact, when compared to the US priorities, the different priority accorded to defense spending is rather stark; in 1994, defense R&D accounted for 20% of US national (public and private sector) R&D while in Japan defense spending accounted for 1% of the national R&D effort.[xxx]

Although the priority accorded to energy R&D in Japan is significant, Figure 4 shows that the priority accorded to this type of research has been in decline for more than a decade. Even with these reductions, Japan still spends considerably more as percent of its public sector R&D effort on energy R&D (13.7% in JFY 1998) than any other country.

Figure 4: Japanese Public Sector Energy R&D as a Percent of Total Publicly Supported R&D



[i] *Trends in Principal Indicators on Research and Development Activities in Japan: 1997.* Agency of Industrial Science and Technology. Tokyo.

[ii] *Trends in Principal Indicators on Research and Development Activities in Japan: 1997.* Agency of Industrial Science and Technology. Tokyo. "1998 Survey Of Research And Development In Japan." National Science Foundation, Tokyo Regional Office. Report Memorandum #98-18 (December 3, 1998). NSF translation of "summary report" released by the Japanese Statistics Bureau, Management and Coordination Agency of the Japanese Government. http://www.twics.com/~nsftokyo/rm98-18.html

[iii] Choy, Jon. "Research and Development Spending in Japan: Happy Days Are Here Again?" No. 39A. October 17, 1997. Japan Economic Institute. Washington, DC.

[iv] *The Science and Technology Resources of Japan: A Comparison with the United States.* Johnson, JM (Principal Author). National Science Foundation. NSF 97-324. 1997.

[v] Choy, Jon. "Research and Development in Japan: Squeezing More from Every Yen" No. 29A. July 31, 1998. Japan Economic Institute. Washington, DC.

[vi] Choy, Jon. "Research and Development in Japan: Squeezing More from Every Yen" No. 29A. July 31, 1998. Japan Economic Institute. Washington, DC.

[vii] Choy, Jon. "Research and Development Spending in Japan: Happy Days Are Here Again?" No. 39A. October 17, 1997. Japan Economic Institute. Washington, DC.

[viii] "STA Survey: Private Research, R&D Costs Increase." *Tokyo Kagaku Kogyo Nippo*. August 7, 1998. Page 1.

[ix] "Japan Manufacturers Spurning Basic Research: Government Survey." *Nihon Keizai Shimbun.* December 29, 1998.

[x] Alexandar, Arthur. "Basic Research and Science in the Japanese Economy" No. 11A. March 21, 1997. Japan Economic Institute. Washington, DC.

[xi] *Outline of JFY 1999 Government Budget Requested for Science and Technology.* Report Memorandum #98-14. http://www.twics.com/~nsftokyo/rm98-14.html September 14, 1998. National Science Foundation Tokyo Regional Office. Supplementary Budget for Emergency Economic Package Adds 511.1 Billion Yen for S&T. Report Memorandum #98-19. December 10, 1998. Tokyo Regional Office. National Science Foundation. http://www.twics.com/~nsftokyo/rm98-19.html. "JFY 1999 Government Budget Approved by the Lower House." Report Memorandum #99-02. February 22, 1999. Tokyo Regional Office. National Science Foundation. http://www.twics.com/~nsftokyo/rm99-02.html.

[xii] The "Proposed" Supplemental Budget Increases FY1998 S&T Funding Level by 20.3%. Report Memorandum #98-11." June 8, 1998. National Science Foundation, Tokyo Regional Office.

[xiii] Supplementary Budget for Emergency Economic Package Adds 511.1 Billion Yen for S&T. Report Memorandum #98-19. December 10, 1998. Tokyo Regional Office. National Science Foundation. http://www.twics.com/~nsftokyo/rm98-19.html

[xiv] Normile, Dennis. "Japan Budget: Bad Economy Is Good News for R&D." *Science.* Volume 281, Number 5383. September 11, 1998. p 1587.

[xv]. "New Projects Receive Boost as Cuts Pinch Current Work." Science. Vol 280. p. 669. May 1, 1998.

[xvi] Normile, Dennis. "Japan Budget: Science Gets Share of Stimulus Package." *Science.* Volume282. pp. 1393-1394. November 20, 1998.

[xvii] Normile, Dennis. "Japan Budget: Science Spending Keeps Rising But may Miss 5-Year Targets." *Science.* Volume 283. January 22, 1999. P. 478.

[xviii] Normile, Dennis. "New Projects Receive Boost as Cuts Pinch Current Work." *Science.* Vol 280. p. 669. May 1, 1998.

[xix] Normile, Dennis. "Japan Budget: Bad Economy Is Good News for R&D." *Science.* Volume 281, Number 5383. September 11, 1998. p 1587.

[xx] "Supplementary Budget for Emergency Economic Package Adds 511.1 Billion Yen for S&T. Report Memorandum #98-19." December 10, 1998. Tokyo Regional Office. National Science Foundation. http://www.twics.com/~nsftokyo/rm98-19.html

[xxi] Choy, Jon. "Research and Development in Japan: Squeezing More from Every Yen" No. 29A. July 31, 1998. Japan Economic Institute. Washington, DC.

[xxii] Agency for Industrial Science and Technology. "Agency for Industrial Science and Technology 1997-1998." Tokyo. 1998.

[xxiii] See Tassey, Gregory. "Comparisons of U.S. and Japanese R&D Policies." Japan Information Access Project, Special Reports. http://www.nmjc.org/jiap/specrpts/reports/sp3_1998.html March 1998.
[xxiv] Science and Technology Basic Plan (Cabinet Decision of July 2, 1996). English translation provided by the Science and Technology Agency. http://www.sta.go.jp/policy/kihonkeikaku/basicplan.html
[xxv] Normile, Dennis. "Japan: Mixed Grades for 5-Year Science Plan." *Science*. April 30, 1999. pp. 726-727
[xxvi] For a good overview of the challenges and difficulties facing the Japanese government in overcoming this problem, readers should consult: Choy, Jon. "Research and Development in Japan: Squeezing More from Every Yen" No. 29A. July 31, 1998. Japan Economic Institute. Washington, DC.
[xxvii] For more information readers should consider consulting. Normile, Dennis. "Intellectual Property: Japan Law Fosters Academic Patents." *Science.* 280: 5368. May 29, 1998. pp. 1340-1341.
[xxviii] "Science and Technology Indicators : 1997 -- A Systematic Analysis of Science and Technology Activities in Japan." National Institute of Science and Technology Policy. Tokyo. 1997.
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[xxx] Johnson, JM (Principal Author). "The Science and Technology Resources of Japan: A Comparison with the United States." National Science Foundation. NSF 97-324. 1997.