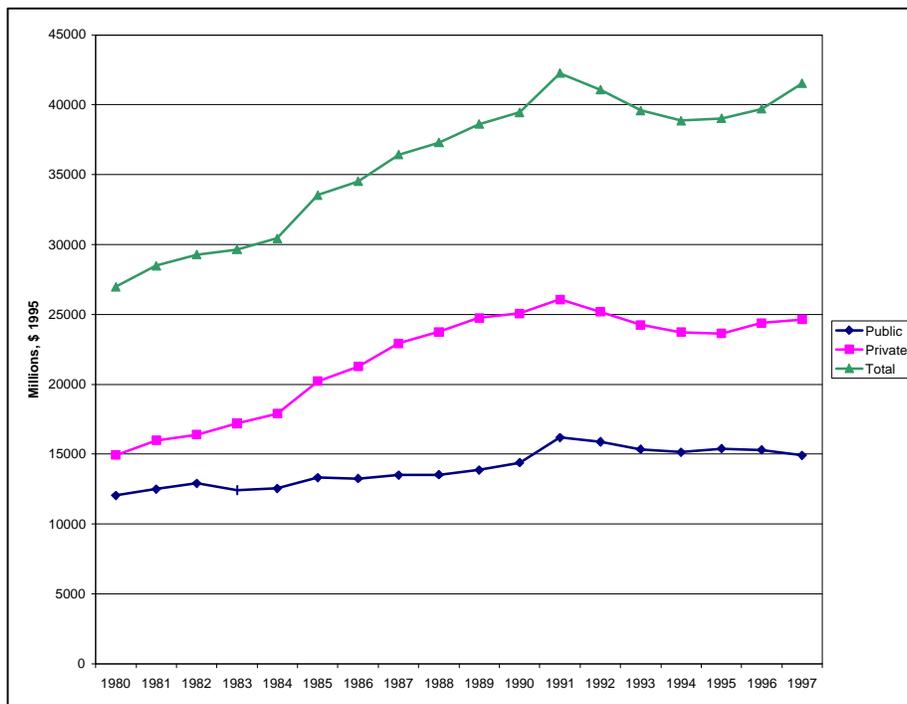


National Science and Technology Effort and Funding Goals

Germany's public and private sector R&D expenditures peaked in real terms in 1991. Since reunification, Germany's public R&D expenditures have declined both as a percentage of GDP and in real terms in subsequent years.ⁱ From its peak of 3.5% of the public budget in 1985, Germany's public R&D expenditures fell steadily over the ensuing decade, reaching a 30-year low of 2.6% in 1994.ⁱⁱ Similarly, private sector R&D declined by 6% in real terms between 1991 and 1997, after more than a decade of steady growth. In 1997, total national R&D spending in Germany was approximately \$42 billion. The public and private sectors contributed \$15 billion and \$25 billion to the total, respectively. The non-profit sector accounted for the remainder of about \$2 billion.

Figure 1. Germany R&D Expenditures by Funding Sector 1980-1997ⁱⁱⁱ



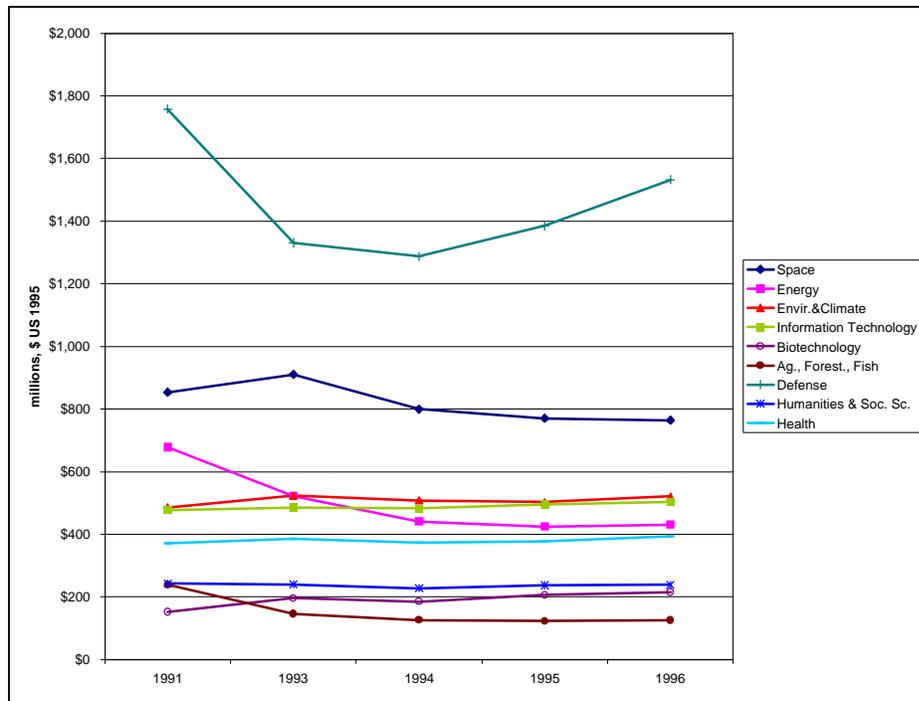
A few key factors help to account for the observed declines in private sector research sponsorship. According the Federal Research Ministry (BMBF), in many cases innovation has been dampened by the high risks associated with the development of new high technology products coupled with a relative scarcity of risk capital, which has had a particular impact on small and medium-sized enterprises.^{iv} Also, since Germany's technology-related industries generate a major portion of their revenues through exports, they are particularly vulnerable to exchange rate fluctuations; the high foreign value of the deutschmark that persisted throughout the first half of the 1990s, for example, put downward pressure on foreign sales of technology products and further intensified the competitive pressures on industry's R&D projects. Many companies, particularly small

and medium-sized enterprises, have found it prohibitively expensive to make financial commitments to innovative projects with longer amortization periods and higher risks.^v

Trends in government-sponsored R&D have been influenced by several major developments in Germany's regulatory framework and political economy. The progress made to date in integrating the eastern states into the larger German economy and society has come at an annual cost to the west of approximately \$100 billion; major federal expenditures for German reintegration are expected to remain necessary for several years to come.^{vi} The size of these investments in the east has forced the government to reduce substantially its spending on other priorities. Federally sponsored R&D programs have also felt the effects of the government's diversion of resources to the east as well as the impact of Germany's slow economic growth, high unemployment, and generally tighter government revenues during the 1990s.

Germany's public sector energy R&D support, discussed in greater detail below, has experienced the sharpest declines of any socioeconomic area--71% between 1985 and 1996 (see Figure 2). This trend is attributable in large part to funding cuts in Germany's nuclear fission programs, particularly those aimed at the development of new reactor technologies (see Figure 3).

Figure 2. Federal R&D Expenditures in Selected Areas, 1981-1996^{vii}



One of the growth areas in Germany's public R&D spending in the 1990s has been defense. Defense R&D spending rose by more than 15% between 1994-1996 to a level of \$1.5 billion—18% of the total government R&D budget. The German government has augmented its defense R&D budget in an effort to update weapons and information systems in the interest of readiness and defense integration with the European Union. According to the Federal Ministry of Defense, these increased expenditures are “unavoidable,” given the changing nature of military missions in the post-Cold War era, particularly Germany's need to be a full and equal partner in its alliance structures (e.g., NATO and WEU) and in major joint military R&D projects, such as the Eurofighter 2000. Over 70% of Germany's major defense R&D projects are now carried out in the context of international partnerships. Germany also views its defense R&D investments and participation in alliance activities as contributing to the further development of a common European defense identity and, thus, to European integration. The level of Germany's defense R&D expenditures is expected to decline over the next few fiscal years in response to at least two key factors.^{viii} First, the overall scarcity of government resources makes the current level of defense R&D expenditures unsustainable. Moreover, considering the continually growing complexity of technology and R&D, Germany will pool its defense research resources with other European countries (mainly France) for the development of multinational defense R&D initiatives and, ultimately, the creation of an international armaments agency.^{ix}

Environmental and climate research has grown modestly in recent years, driven in part by growing efforts to improve scientific understanding of global change. Similarly, investments have grown in several applied environmental technology areas, including handling and recycling of municipal wastes, water and waste water treatment, and remediation of conventional defense wastes. R&D expenditures in this area are expected to increase by some \$40 million in 1998 to reach a total of \$500 million.^x

Biotechnology has become a major R&D priority in Germany. The German government believes that biotechnology will be one of the most important scientific and technological fields over the course of the next century and a key to future economic growth. Considering the globalization of markets for high technology products, the government believes that it will be essential for Germany to build its biotechnology science and technology base in order to take advantage of the growing world market opportunities in this area. Its “Biotechnology 2000” program aims to augment the domestic science base and at the same time to promote and accelerate the commercialization of biotechnological innovations. The government has ranked this area among its top R&D priorities, stating that it is imperative that Germany maintain its position among the leading biotech nations into the future. Between 1994 and 1997, federal biotechnology R&D investment grew from \$185 million to \$216 million—a real increase of 15%.^{xi}

Information technology is also a priority research area for the German government. Federal support for information technology has grown slowly but steadily throughout the 1990s, by 5% between 1991 and 1996 to a level of \$503 million. While the federal government supports a wide range of scientific and technological research in the information technology fields, including basic information science, artificial intelligence,

photonics, and advanced computation, multimedia research has grown most rapidly of all in terms of federal funding. The government believes that multimedia, denoting the fusion of text, graphics, pictures, sound, and film via digital information technology platforms, will play an important role in the future success of service-based economies such as Germany's. The federal government nearly doubled its support in this area from \$31 million to approximately \$60 million between 1994 and 1996 to spur development of new potential applications and to build the domestic research.^{xii}

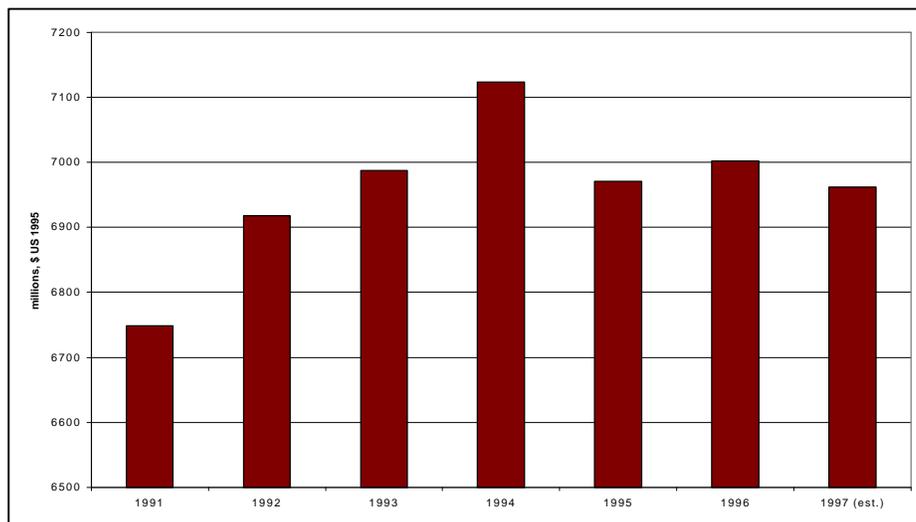
Science and technology play central roles in the achievement of several of the German government's priority policy objectives. One of the most important of these goals is the solidification of a reunified Germany and the reconstruction of the eastern German states. The rebuilding of the badly deteriorated research infrastructure in these states has been a cornerstone of the government's reunification efforts, since R&D-intensive industries are regarded as engines of Germany's future employment and economic growth, and social well-being. Between 1991 and 1994, the federal government invested some \$5.2 billion in the eastern states for the construction of several new research institutes, the refurbishment of universities, and for R&D projects.^{xiii} Eastern Germany now is home to many new research institutions, including 3 National Research Centers, 18 Max Planck institutes, 9 Fraunhofer Society institutes, and 25 Blue List institutes.¹

The Schroeder government is addressing the need to strengthen Germany's university-based basic science capabilities and to design new mechanisms and incentives promoting collaboration between university researchers and the private sector. Germany's universities and other institutions of higher education, which performed an estimated \$7 billion worth of research in 1997, are a major element of the country's research infrastructure. Most funding for the higher education sector comes in the form of institutional block grants from state-level government. Since government support for university research has dwindled, as Figure 3 shows, the federal government believes that the creation of more collaborative ventures involving universities and firms within Germany and across international borders will be essential to the future health of Germany's university-based research capabilities. Thus, the promotion of private sector-university collaboration has become an important element of Germany's science policy.^{xiv}

In one of its earliest statements on science and technology policy, the Schroeder government has recognized the importance of investment stability for a healthy R&D enterprise and for the health of the economy. Addressing the volatility that has recently characterized the R&D investment climate, which the government believes has compromised Germany's position as a world leader in important research areas, will be a policy priority in the new Administration.^{xv} The Schroeder government has taken an important first step toward achieving this goal by securing a substantial increase in the 1999 budget of the Federal Research Ministry (BMBF).

¹ See Appendix A for a description of the missions of each of these institutions in the German research infrastructure.

Figure 3. Higher Education Expenditures on R&D, 1991-1997^{xvi}



The BMBF's 1999 budget will rise by some \$424 million over that of the previous year, bringing its total budget to just over \$7 billion. More than \$300 million of the new funding will be directed to the university sector for the construction of new research facilities and to provide support for scientific education. Approximately \$60 million in new funding will be used to sponsor research projects in high priority areas, including biotechnology, information technology, and transportation research.^{xvii}

ⁱⁱ BMBF, *Basic and Structural Data 1996/97* <http://www.bmbf.de/deutsch/zukunft/index.htm96/97>, pp. 143-144.

ⁱⁱⁱ International Energy Agency, 1996. *IEA Energy Technology R&D Statistics 1974-1995*, pp. 89-93.

^{iv} BMBF, 1996. *Basic and Structural Data 1996/97*, p. 143.

^v BMBF, 1996. *Bundesbericht Forschung 1996*, p. 17.

^{vi} BMBF, 1996. *Bundesbericht Forschung 1996*, p. 17.

^{vii} U.S. Department of Energy/Energy Information Administration, www.eia.doe.gov/emeu/cabs/germany.html

^{viii} BMBF, 1996. *Bundesbericht Forschung 1996*.

^{ix} Deutsche Bundeswehr, "Sicherheitspolitische Grundlagen,"

<http://www.bundeswehr.de/sicherheitspolitik/grundlagen/security-policy/I-5.htm>; BMBF, *Faktenbericht 1998*, p. 166.

^x BMBF, 1998. *Faktenbericht 1998*, p. 166.

^{xi} BMBF, 1998. *Faktenbericht 1998*, pp. 109-113.

^{xii} BMBF, 1998. *Faktenbericht 1998*, pp. 127.

^{xiii} BMBF, 1998. *Faktenbericht 1998*, pp. 125.

^{xiv} National Science Foundation, "How Is Science Faring in Germany's New Lands?," NSF/Europe Report No. 97 (February 1998), <http://www.amb-usa.fr/nsf/nsf97.htm>

^{xv} Edelgard Buhlmann, Federal Minister for Education and Technology, Speech before the German Bundestag November 12, 1998, <http://www.bmbf.de/deutsch/veroeff/presse/pm98/pm131198.htm>

^{xvi} Edelgard Buhlmann, Federal Minister for Education and Technology, Speech before the German Bundestag November 12, 1998, <http://www.bmbf.de/deutsch/veroeff/presse/pm98/pm131198.htm>

^{xvi} BMBF, 1998. *Faktenbericht 1998*, p. 44.

^{xvii} "Haushalt `99: Bundesregierung Setzt Deutliche Priorität bei Bildung und Forschung: Haushaltsmittel Werden um Rund 904 Millionen Mark Erhöht, <http://www.bmbf.de/deutsch/zukunft/index.htm>