

CHAPTER 5

PCAST was interested in how R&D funding in the United States compares with that of other major R&D-performing nations, and raised the following issue to obtain information for its deliberations:

Compare U.S. R&D spending with comparable spending by the European Union, Japan, China, and other major R&D-performing nations.

International Comparisons

The United States has led the major R&D-performing nations for the last 20 years in terms of absolute levels of R&D spending (NSB, 2002).¹⁶ Since 1994, U.S. total R&D spending has steadily increased at a rate of approximately 6 percent a year (NSB, 2002). In 1999, the most recent year for which there are data for all of the G-7 countries,¹⁷ the United States spent \$245 billion on R&D activities—over 150 percent more than Japan (\$95 billion), the second-largest R&D-performing country, and over 55 percent more than the entire European Union (\$158 billion) (Table 5-1) (OECD, 2001). Furthermore, in inflation-adjusted purchasing power parity (PPP) dollars, U.S. R&D expenditures exceeded the combined total expenditures of the other G-7 countries and accounted for 44 percent of the OECD countries' R&D expenditures in 1999 (Figure 5-1 and Table 5-1; also see Appendix Table 24).¹⁸ In 2000, U.S. total R&D spending increased to \$265 billion (OECD, 2001).

In terms of relative shares, U.S. R&D spending in 1985 reached historical highs of 53 percent of the G-7 total and 48 percent of all OECD R&D (NSB, 2002). R&D spending worldwide slowed for several years in the early to mid-1990s, mainly due to economic recessions and general budgetary constraints that slowed both industrial and government sources of R&D support (NSB, 2002). By 1992, U.S. R&D spending had dropped to 49 percent of the G-7 total, and by 1995 it had dropped to 42 percent of the OECD R&D total (NSB, 2002). However in the past few years, R&D spending has rebounded in several countries. R&D spending in the United States has generally been stronger than elsewhere, thus increasing the U.S. share of both G-7 and OECD countries' R&D spending (NSB, 2002). By 1999, U.S. R&D had climbed to 52 percent of the G-7 total (\$471 billion) and 44 percent of the OECD total (\$558 billion).

¹⁶Unless otherwise noted, all R&D spending levels are converted to U.S. dollars using purchasing power parity (PPP) exchange rates.

¹⁷The G-7 countries are Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

¹⁸Current OECD members are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

Table 5-1. Gross Domestic Expenditure on R&D, G-7 and Other Selected Countries
(millions of current PPP dollars)

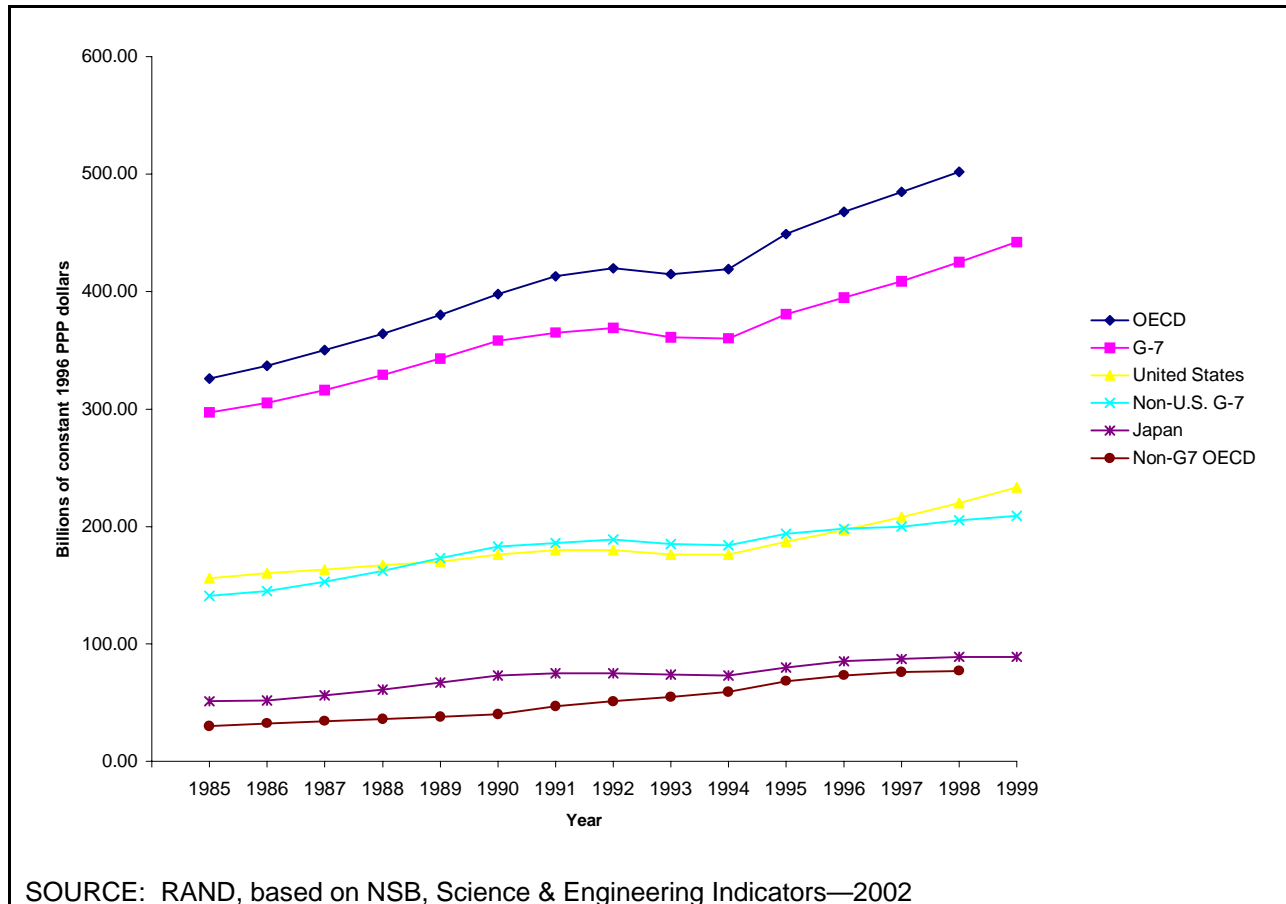
	1994	1995	1996	1997	1998	1999	2000
United States	169,270.0	184,306.0	197,830.0	213,038.0	227,350.0	244,699.0	265,318.0
Japan	75,287.2	84,783.3	85,469.6	89,632.5	93,119.6	95,084.6	NA
Germany	37,028.5	39,451.5	39,902.3	41,751.5	43,393.3	47,573.6	50,387.8
China	18,326.2	19,332.2	21,361.1	26,751.0	29,356.2	37,614.0	NA
France	26,517.1	27,722.6	27,783.8	27,084.8	27,758.2	29,239.9	30,192.5
United Kingdom	21,765.1	21,672.5	22,467.8	22,718.6	23,920.0	25,463.4	NA
South Korea	12,771.4	15,345.7	17,287.5	19,000.0	17,037.0	18,543.0	NA
Canada	10,693.0	11,697.5	11,749.2	12,499.6	13,856.9	14,727.3	16,094.7
Italy	11,343.7	11,522.8	12,100.8	11,913.4	12,621.8	13,830.3	NA
Russia	8,371.2	7,775.2	8,780.2	9,684.1	8,998.5	10,783.7	12,724.7
Taiwan	NA	6,508.0	7,047.7	7,884.6	8,608.1	9,570.4	NA
European Union	124,561.6	131,034.6	135,150.3	138,613.8	145,483.7	157,641.0	NA
Total OECD	402,577.0	442,543.3	470,013.8	496,756.0	522,427.0	557,683.0	NA

NA = Not Available

G-7 Countries are Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

SOURCE: RAND, based on OECD, Main Science and Technology Indicators: 2001-2 Edition.

Figure 5-1. U.S., G-7, and OECD Countries' R&D Expenditures



Another indicator of a country's commitment to growth in science and technology is the ratio of R&D spending to the GDP (NSB, 2002). According to the most-recent data from the OECD,¹⁹ the United States ranks fifth among OECD countries in terms of reported R&D-to-GDP ratios (see Table 5-2) (OECD, 2001). Sweden has the highest R&D-to-GDP ratio, followed by Finland, Japan, and Switzerland. Other large R&D performers in the OECD, including South Korea, Germany, France, the United Kingdom, Canada, and Italy, all invest smaller shares of their GDP in R&D than the United States. Of the non-OECD member countries, Israel's and Taiwan's nondefense R&D-to-GDP ratios compare favorably with those of the OECD member countries, with Israel ranking seventh in the world and Taiwan ranking twelfth. Although China and Russia spend a lot in absolute terms on R&D, their investments in R&D as shares of their GDPs are substantially lower than that of the United States.

Table 5-2. Total R&D as a Percent of Gross Domestic Product (GDP)

Sweden (1999)	3.80	Brazil (1996)	0.91
Finland (1999)	3.22	Spain (1999)	0.89
Japan (1999)	2.93	Cuba (1999)	0.83
Switzerland (1996)	2.73	China (1999)	0.83
United States (1999)	2.65	Portugal (1999)	0.76
Israel (1997)	2.54	Poland (1999)	0.75
South Korea (1999)	2.47	South Africa (1998)	0.69
Germany (1999)	2.44	Hungary (1999)	0.69
Iceland (1999)	2.32	Slovak Republic (1999)	0.68
France (1999)	2.19	Greece (1999)	0.68
Denmark (1999)	2.06	Chile (1997)	0.63
Netherlands (1999)	2.05	Turkey (1999)	0.63
Taiwan (1999)	2.05	Argentina (1999)	0.47
Belgium (1999)	1.98	Romania (1999)	0.41
United Kingdom (1999)	1.87	Colombia (1997)	0.41
Singapore (1999)	1.87	Mexico (1999)	0.40
Canada (1999)	1.85	Panama (1998)	0.33
Austria (1999)	1.83	Bolivia (1999)	0.29
Norway (1999)	1.70	Uruguay (1999)	0.26
Slovenia (1999)	1.51	Malaysia (1996)	0.22
Australia (1998)	1.50	Trinidad and Tobago (1997)	0.14
Ireland (1997)	1.39	Nicaragua (1997)	0.13
Czech Republic (1999)	1.25	Ecuador (1998)	0.08
Costa Rica (1996)	1.13	El Salvador (1998)	0.08
New Zealand (1997)	1.13	Peru (1997)	0.06
Italy (1999)	1.03	European Union (1999)	1.86
Russian Federation (1999)	1.01	Total OECD (1999)	2.21

NOTE: Data presented are for latest available year (shown in parentheses).

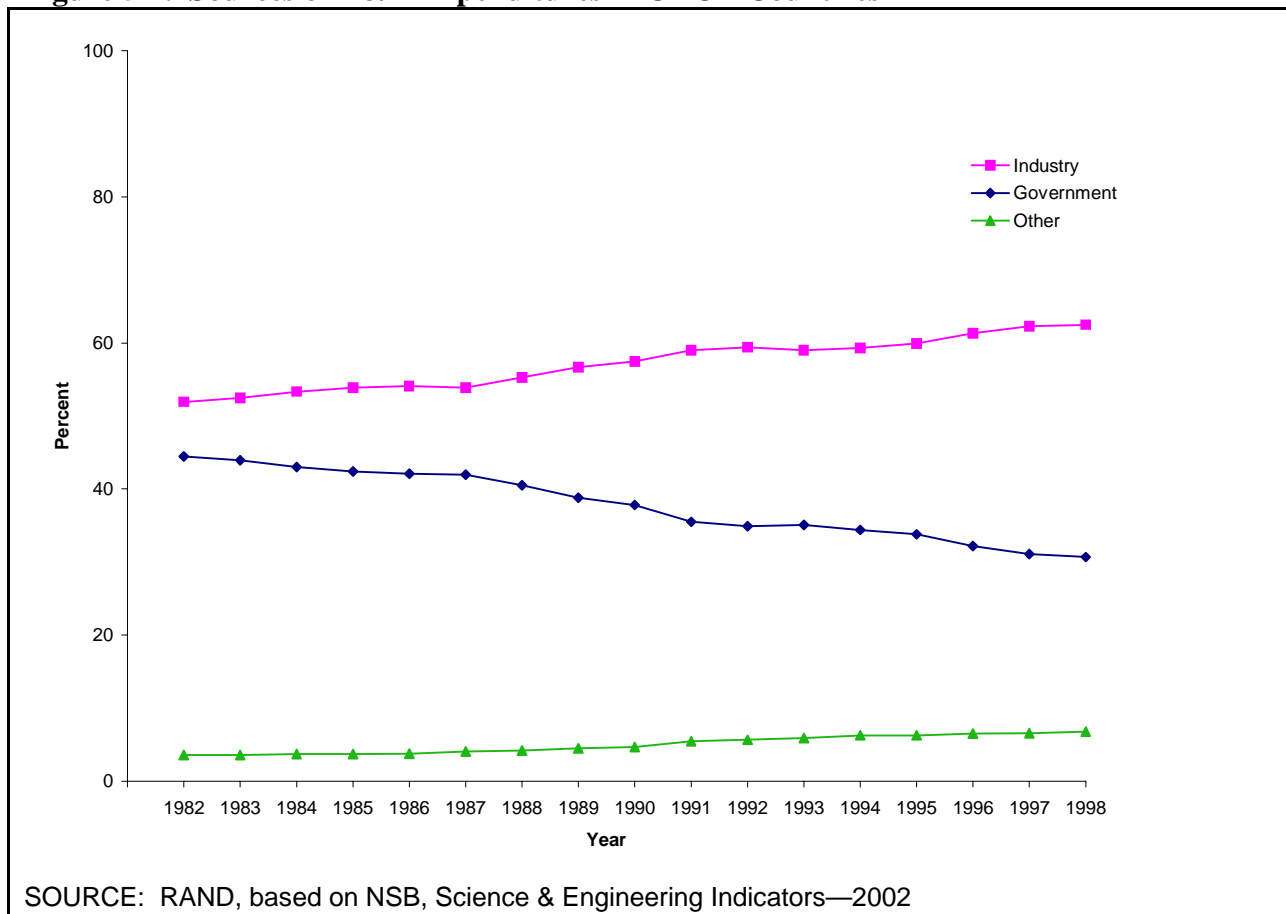
Data for Israel and Taiwan represent these countries' nondefense R&D/GDP ratio.

SOURCE: RAND, based on OECD, Main Science and Technology Indicators: 2001–2 Edition; and NSB, Science & Engineering Indicators—2002.

¹⁹The data in this report are based on the most-recent edition of OECD's "Main Science and Technology Indicators" (2001-2 Edition), which was published in November 2001.

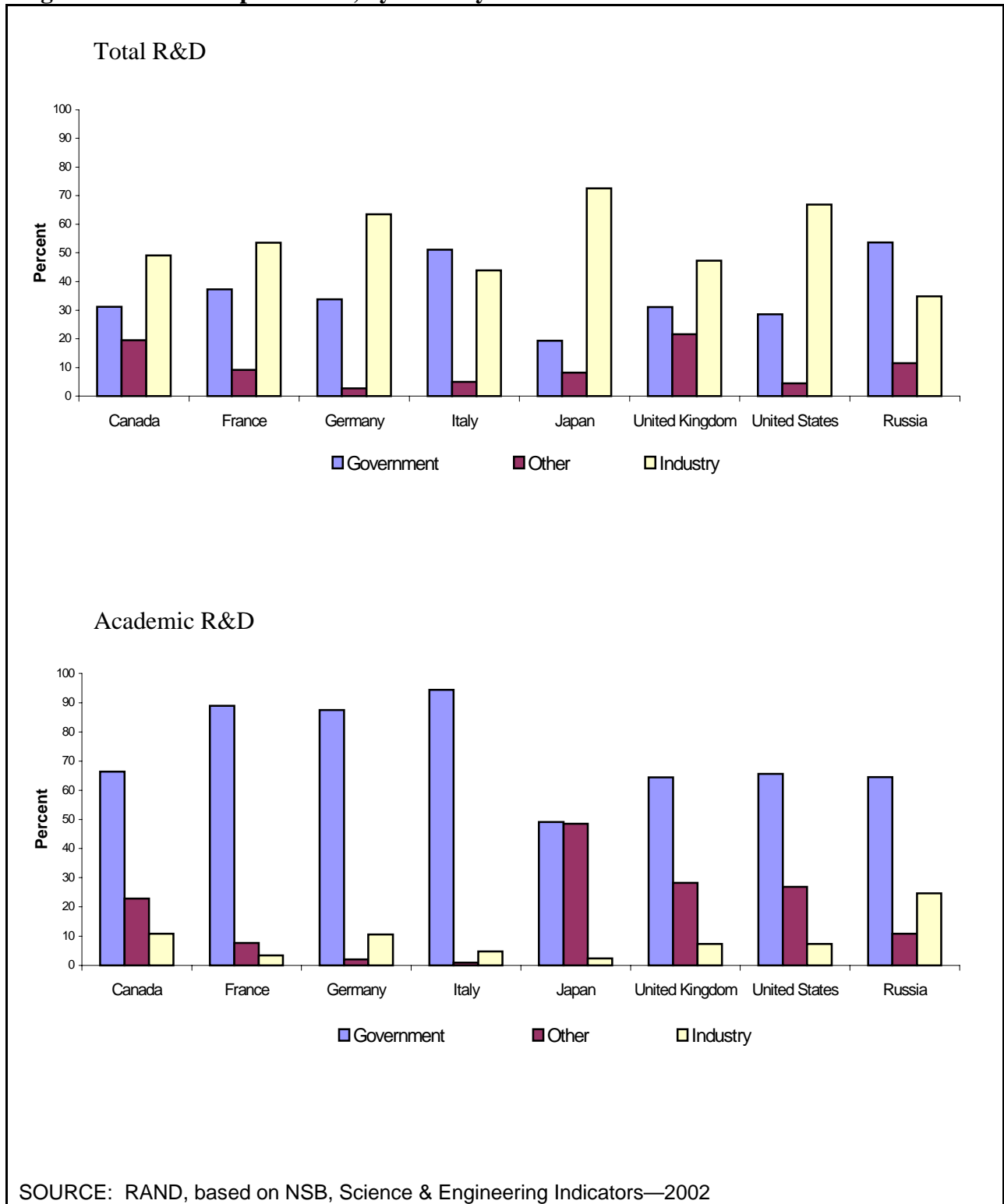
Industry investment in R&D has accounted for the dominant share of R&D spending in the OECD countries for the last 20 years, increasing from 52 percent in 1982 to 63 percent in 1998 (Figure 5-2; also see Appendix Table 25). Concurrent with this rise in industry spending on R&D was a relative decline in government funding of R&D, from 45 percent in 1982 to 31 percent in 1998. In all but one of the G-7 countries (Russia is not a G-7 country), industry was the leading funder of R&D (Figure 5-3; also see Appendix Table 26). In comparison, government funded the majority of R&D in Italy and Russia. In contrast, government was the primary funder of academic R&D in all the G-8²⁰ countries (Figure 5-3; also see Appendix Table 27). However, it is important to note that, in each of the G-7 countries, the government share of funding for academic R&D has declined over the past 20 years, as industry funding for academic R&D has increased (see Appendix Table 27).

Figure 5-2. Sources of R&D Expenditures in OECD Countries



²⁰When Russia is included with the G-7 countries, this is usually referred to as the “G-8 countries.”

Figure 5-3. R&D Expenditures, by Country and Source of Funds



The primary objectives of R&D supported by governments vary considerably between countries (Figure 5-4; also see Appendix Table 28). In 1999, the U.S. government spent the majority of its R&D funds on defense, investing a larger share in defense than any other country. This dominance of U.S.-funded defense R&D was evident, even though there has been a steady decline in U.S. defense R&D spending since the mid-1980s—down from 69 percent in 1986 to 53 percent in 1999 (NSB, 2002). The U.S. government also spent a sizable share of its R&D dollars on health-related R&D. The other G-8 countries tended to emphasize R&D for the advancement of knowledge and economic development.

Japan, Germany, and Italy all spent 50 percent or more of their government R&D funds on the advancement of knowledge, which includes support for both advancement of research and general university funds (Figure 5-4).²¹ In fact, the general university funds portion of the advancement of knowledge category is the largest part of government R&D expenditures for most OECD countries (NSB, 2002). In comparison, the United States spent only 6 percent of its government R&D funds on the advancement of knowledge, mainly through funding of non-mission-oriented R&D by NSF and the DOE Office of Science.²² The majority of government-supported R&D at U.S. universities and colleges is mission oriented; R&D funds being allocated and awarded by federal agencies as research grants to address specific national goals and objectives, such as space exploration and defense, for which each agency is responsible.

Japan, Canada, and Russia all spent more than 30 percent of their government R&D funds on economic development activities (Figure 5-4).²³ Japan spent 19 percent of its total government R&D funds on energy related activities. Canada spent 13 percent of its total government funds on industrial development and 11 percent on agricultural activities. In Russia, industrial development is the leading socioeconomic objective, accounting for 23 percent of all government R&D (see Appendix Table 25). In contrast, industrial R&D accounted for less than 1 percent of government R&D in the United States, most of which was funded by the National Institute of Standards and Technology (NIST) of the Department of Commerce.

In the past two decades, the United States has led the world in total spending on R&D. At present, however, four other nations spend more of their GDP on R&D than does the United States. In all of these nations, including the United States, industry-funded R&D outpaced government-funded R&D, with the latter being the major source of funds for academic R&D in all G-8 nations. The main objective of government-funded R&D differs markedly among G-8 nations, however, with defense driving most of the government-funded R&D in the United States. In other G-8 nations, the advancement of knowledge and economic development dominated government-funded R&D.

²¹General university funds are block grants provided by government to the academic sector that can be spent at the discretion of the university on research of its choosing. Neither the United States nor Russia has a category equivalent to general university funds.

²²The United States defines the advancement of knowledge as research unrelated to a specific national objective.

²³Economic development programs include the promotion of agriculture, fisheries and forestry, industry, infrastructure, and energy.

Figure 5-4. Government R&D Support by Primary Objectives, G-8 Countries

